

## A time series analysis of students enrolled in Italian universities from 2000 to 2021

### Analisi delle serie storiche del flusso di studenti nelle università Italiane dal 2000 al 2021

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#### Abstract

In the last 20 years, the Italian university system has undergone various transformations. Two reforms (1999 and 2010) redesigned its educational offerings and governance system structure. These were superimposed by severe financial crises (2008, 2012, and 2020 with the pandemic from COVID-19) that eroded the purchasing power of families. Since 2005, 11 online universities (“università telematiche” in Italian) have been accredited. These phenomena have affected access to higher education and changed student enrollment flows to various universities. In this paper, we investigate university enrollment trends and mobility over the period 2000-2021, also concerning students’ residence, the type of university chosen, and the geographical location of institutions.

**Keywords:** Students Mobility; Italian Universities; Online Universities; University Enrollments.

#### Riassunto

Negli ultimi 20 anni, il sistema universitario italiano ha subito diverse trasformazioni. Due riforme (1999 e 2010) hanno ridisegnato l’offerta formativa e la struttura del sistema di governance. A queste si sono sovrapposte gravi crisi finanziarie (2008, 2012 e, ultima, quella del 2020 con la pandemia da COVID-19) che hanno eroso il potere d’acquisto delle famiglie. Dal 2003 sono state accreditate 11 università telematiche. Questi fenomeni hanno influenzato l’accesso all’istruzione superiore e modificato i flussi di iscrizione degli studenti alle varie università. In questo lavoro, analizziamo l’andamento delle iscrizioni alle università nel periodo 2000-2021, anche in relazione alla residenza degli studenti, al tipo di università scelta e alla posizione geografica degli istituti.

**Parole chiave:** Mobilità degli Studenti; Università Italiane; Università Telematiche; Iscrizioni Universitarie.

## 1. Introduction

Universities are playing a progressively important role in increasing human capital through education, especially through the participation of young adults.

Students with advanced qualifications have increased significantly in OECD countries over the past 20 years. 48% of people between the age of 24 and 34 had a college degree in 2021, up from 27 percent in 2000 (OECD, 2022).

High educational achievement is a protective factor against economic risks, as observed during the COVID-19 pandemic and after the 2008 financial crisis.

The European Union has set the target to increase the number of those who will have completed tertiary education to 45 percent by 2030. In such a challenge, Italy remains at the “tail end” (ANSA, 2021) with 29 percent of graduates in the 25-34 age group recorded in 2020. However, it ranks third in Europe in the tertiary student population (11.3 percent) behind Germany (18.2 percent) and France (15.3 percent).

European countries show great variety, both in participation and mobility of university students.

This variety depends on the distribution of their universities across regions in the same country, on urbanization, on employment opportunities, and on the quality standards of the regional education system. For example, Bulgaria, Cyprus, Hungary, and Lithuania are characterized by the presence of larger central universities recruiting the most domestic students (Rizzi et al., 2021).

In Italy, the case is of particular interest: the university system is depicted by an unbalanced flow of students to the Northern regions of the country for university studies (Columbu et al., 2021), a phenomenon widely studied in recent years.

The North-South divide increased with the students' migration from the South to the Central and Northern regions of the country (Enea, 2016; Santelli et al., 2022) have contributed to significant disparities between different geographical areas in the country in terms of socioeconomic and human capital. Intellectual migration is, in fact, a particular subset of the historical and consolidated internal migration path in Italy, especially after the economic crisis of 2008.

From this perspective, migration could be considered from two points of view: 1) as an investment to access better education and job opportunities and/or to increase future income; 2) as a consumption choice (Sanchez Barrioluego & Flisi, 2017). Agasisti and Dal Bianco (2007) adopt the human capital to explain the phenomenon of Italian students' mobility, different from previous literature based on two assumptions about students' behavior: migration for non-pecuniary reasons and migration in consideration of education as an investment. The study's main results show that the variables related to socioeconomic conditions have a strong predictive power on student mobility and university attractiveness. Moreover, some university characteristics can positively affect student flows (e.g., the number of faculties), while geographical distance plays an inertial role.

Other studies in recent years, based on various assumptions, contribute to investigating motivations and criteria of student mobility. Bratti and Verzillo (2019) seek to overcome some of the extant literature's weaknesses and contribute to the discussion on the role played by university quality in internal student mobility in Italy. Dotti and colleagues (2013) present a literature review that shows two main key determinations of a decision to move: 1) individual motivation and family background; 2) local and university-specific characteristics as a determinant. The study says that one of the key drivers of migration by university students is the presence of a good university in a given province and local labor market conditions, which is particularly interesting for graduates in scientific fields. For them, obtaining a job outside their region of origin is higher than it is for graduates in the humanities. Even Columbu and colleagues (2021) investigate migrations about disciplines, arguing that the highest rates of movers since completing a Bachelor's degree are registered in social sciences, journalism and information, business, administration, and law. The highest tendencies to be in mobility at the second level, in turn, are registered in social sciences, journalism and information.

The introduction of university financial autonomy in 1989 (Act 168 of May 9, 1989) triggered internal competition among universities to attract students from across the country.

In 1999 (Decree 509/1999 by the Ministry of Education, Universities and Research), two-level university degrees for tertiary education were introduced in Italy: a three-year Bachelor's degree (“Laurea Triennale” in Italian) followed by a two-year Master's degree (“Laurea Magistrale”), as required by the Bo-

logna Process. One of the main goals of this so-called “3+2” reform was to attract more students to higher education and to increase the graduate population. The effects have been largely disputed. Whereas the student population has effectively increased, the same has not been true for the graduate population rate (Corte dei Conti, 2010).

In 2003, online universities were established in the Italian higher education system (Decree of April 17, 2003, by the Ministry of Education, Universities and Research in agreement with the Ministry of Innovation and Technology). Within a few years, the number of online universities increased to 11 accredited institutions. The number of private, not online universities (which we simply call private), is also growing and currently stands at 18.

In 2010, the “Gelmini Reform” (or Act 240/2010) induced deep transformations in the governance and funding of universities. A large, and growing, fraction of funding for public universities has been tied to the number of regularly enrolled students (the so-called “standard cost”).

It is, therefore, easy to understand how students’ recruitment has become increasingly important to universities and how this activity has also seen increasing media attention, often based on statistically unreliable analyzes.

Recently, indeed, an apparent alarming drop in the number of university students was picked up and commented on in major national newspapers.

“Universities are emptying out” headlined *La Repubblica* on October 31 (Zunino, 2022), followed by more alarmed comments from *Il Sole 24 Ore* (Braga, 2022) and *HuffPost Italia* (Iori, 2022).

This paper takes its cue precisely from the ongoing public debate in Italy on student enrollment and mobility trends. It also aims to assess another aspect of the student mobility phenomenon in Italy: the role that online and private universities play in shifting student enrollments.

Our study aims to analyze the time series of Italian university enrollments from the academic year 2000/2001 to 2021/2022, focusing on mobility between geographic macro-areas and to online and private universities. We provide the results without going into the reasons behind them, with the aim of providing an aseptic description of the current state of play and some key points that are essential to engage in a data-driven discussion.

In the analysis, we used open data on the student population provided by the Italian Ministry of Education and, in the discussion, total population data from Eurostat.

After describing the origin and characteristics of the dataset used in the Materials and Methods section, the results are provided and discussed, accompanied by numerous graphs.

## 2. Materials and Methods

In this study, we have used micro-data from the National Student Registry provided by the Italian Ministry of Universities through the OPENDATA service of the USTAT portal (ustat.miur.it).

We have processed data related to the time series of enrollments in Bachelor’s (“Laurea Triennale”) and Master’s (“Laurea Magistrale”) degree courses from the academic year 2000/2001 to the academic year 2021/2022.

The dataset is updated to 17 December 2022.

In the text, we’ll use the beginning year to refer to the academic year (aka: 2000 refers to the 2000/2001 academic year; 2010 refers to 2010/2011, and so on).

Table 1 lists the datasets used with a short description.

As seen in Table 1, not all datasets contain the complete time series: some datasets start from the 2010-2011 academic year (from now we’ll refer as 2010).

The number of records in the whole dataset is just over 600,000.

Dataset	Description	Academic years	Variables
X02	Enrolled by University	2000-2001 to 2021-2022	Universities, Male students, Female students
X03	Enrolled by Disciplinary Group	2000-2001 to 2021-2022	Subject groups of degrees, Male students, Female students
X06	Enrolled by Age	2010-2011 to 2021-2022	Students' birth year, Male students, Female students
X07	Enrolled by Residence	2010-2001 to 2021-2022	Residence province, Male students, Female students
X14	Enrolled by Residence, University, Group	2010-2011 to 2021-2022	Residence province, University, Subject groups of degrees, Enrolled students

Table 1: List and description of datasets used in the study retrieved from USTAT portal (ustat.miur.it)

Data consistency was checked: we have observed a strong and presumed underestimation of enrollments to online universities (“università telematiche” in Italian) for the last academic year in the dataset, 2021-2022 (from now we’ll refer as 2021). This is most likely due to the different methods of enrollment in “traditional” and online universities. In the first ones, the enrollment period is limited to summer and autumn, and the enrollments usually close by the end of the calendar year (with a few exceptions). The logic is that students have to enroll before teaching activities start. In online universities, on the contrary, enrollment is usually open for the entire academic year, and students can enroll after the teaching activities have already started and, indeed, until the last day. This implies that as of December 2022, data from “traditional” universities are up-to-date and accurate, while data from online universities reported by the Ministry are underestimated (sometimes by a lot) because they are not yet up-to-date.

We contacted the statistics offices of the online universities and found that, at least 59,713 students were missing from the official data.

The analysis presented here is descriptive, exploratory, and comparative on time series covering 4 areas: student enrollments (total and by gender, age, and degree subjects); geographical areas of origin (residence); type and location of destination universities; the role of online universities.

Table 2 shows the classification of the three geographical macro-areas into which Italy is usually divided (North, Central, South) and the list of public universities in each area. The online universities and private universities are shown in Table 3.

Macro-area	Regions	Public universities	#
North	Valle d’Aosta, Piemonte, Lombardia, Trentino Alto Adige, Friuli Venezia Giulia, Liguria, Emilia-Romagna	Aosta*, Bergamo, Bologna, Bolzano*, Brescia, Ferrara, Genova, Milano Statale, Milano Bicocca, Milano Politecnico, Modena e Reggio Emilia, Padova, Parma, Pavia, Piemonte Orientale, Torino, Torino Politecnico, Trento, Trieste, Udine, Varese e Como Insubria, Venezia Ca’ Foscari, Verona	23
Center	Toscana, Umbria, Marche, Lazio, Abruzzo**, Molise**	Camerino, Cassino e Lazio Meridionale, Chieti e Pescara, Firenze, L’Aquila, Macerata, Politecnica delle Marche, Molise, Perugia Stranieri, Roma Foro Italico, Roma La Sapienza, Roma Tor Vergata, Roma Tre, Pisa, Siena, Perugia, Siena Stranieri, Teramo, Tuscia, Urbino	20
South and regional Islands	Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna	Bari, Bari Politecnico, Basilicata, Cagliari, Calabria, Catania, Catanzaro, Foggia, Messina, Napoli Federico II, Napoli L’Orientale, Napoli Parthenope, Napoli Vanvitelli, Palermo, Reggio Calabria Mediterranea, Salento, Salerno, Sannio, Sassari	19

Table 2: Public universities divided by macro-regional areas (names in Italian)

\* The Free University of Bozen-Bolzano and the University of Aosta, although not state universities, have been included among the public ones as they directly controlled by the local autonomous public institutions.

\*\* Abruzzo and Molise (and the universities in the regions) have been classified as regions of Central Italy (from a geographical point of view) even though ISTAT classifies them as being in South Italy (from a socio-economical point of view)

	Universities	#
Online universities	Benevento Giustino Fortunato, Chieti Leonardo da Vinci, Firenze IUL, Napoli Pegaso, Novedrate e-Campus, Roma Mercatorum, Roma Marconi, Roma San Raffaele, Roma Niccolò Cusano, Roma UniNettuno, Roma UniTelma	11
Private universities	Bra' Scienze Gastronomiche, Casamassima LUM Degennaro, Castellanza LIUC, Enna Kore, Milano Bocconi, Milano Cattolica, Milano IULM, Milano San Raffaele, Napoli Benincasa, Reggio Calabria Dante Alighieri, Roma Campus Biomedico, Roma Europea, Roma Link Campus, Roma LUISS, Roma LUMSA, Roma Saint Camillus, Roma UNINT, Rozzano (MI) Humanitas	18

Table 3: List of online and private universities

The research was conducted according to the following questions:

1. What is the trend in enrollments in the Italian university system over the last twenty years, and how have students changed in terms of gender and age?
2. What is the trend in the geographical origin of students enrolled?
3. What is the trend in the choice of training pathways in terms of geographical and disciplinary areas?
4. What is the trend in student mobility between geographical macro-areas and types of universities, particularly concerning recruitment by online universities?

We aggregated and compared data on the available time ranges for each research question.

In the analysis, we focused exclusively on the absolute number of enrolled students regardless of the reference population. We will see that the reference population is decreasing in the years covered by the analysis, and referring the data to the corresponding population class, this may amplify or reduce some of the trend effects. However, the study's main objective is to analyze the absolute number of students who have enrolled in the university system and their characteristics in the terms described by the research questions.

The analysis was conducted in the R v.4.2.1 environment using a computational Linux Ubuntu 20.0.4 server with an RStudio Server interface. We have performed the extraction, aggregation, analysis, and comparison of the data using a script package in the R environment explicitly created for this study.

The data visualization was performed dynamically using Flourish and can be viewed at this URL: <https://public.flourish.studio/story/1741258/>

### 3. Results

In this section, we will describe the evidence of the main results obtained by the research questions.

Following are the results of the research questions we set out.

1. *How have enrollments in the Italian university system evolved over the last twenty years, and how have students changed in terms of gender and age?*

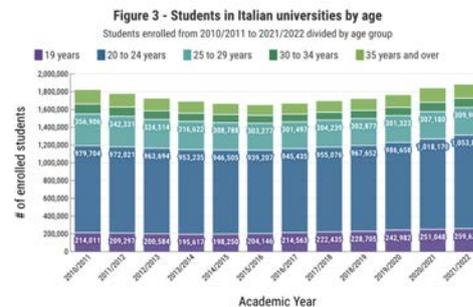
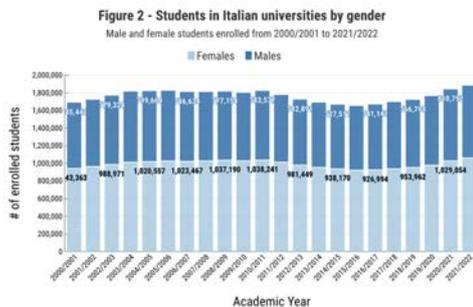
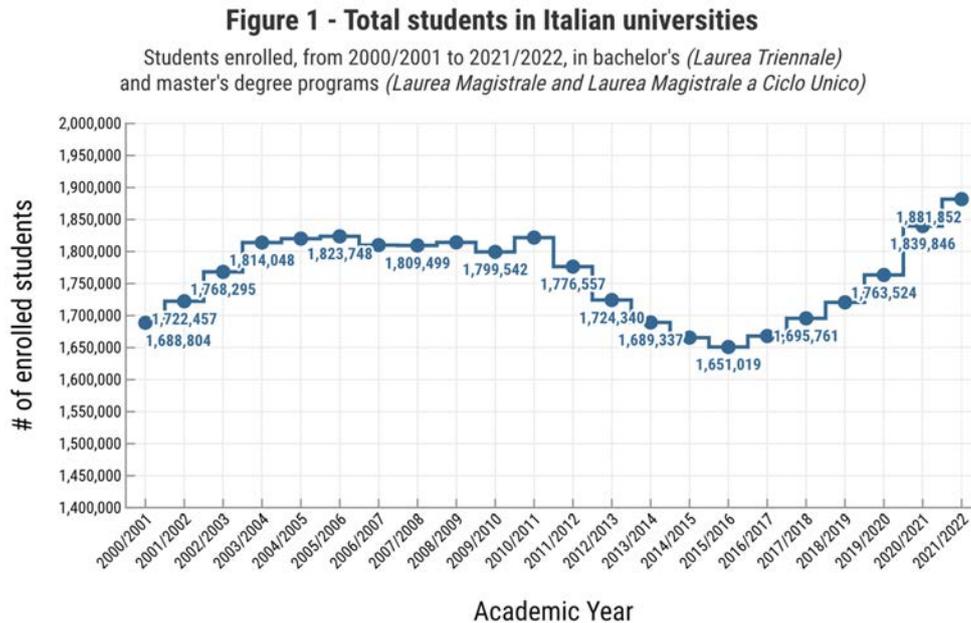
Figures 1, 2, and 3 show the evolution of the number of students enrolled in the Italian university system, in total (Figure 1), by gender (Figure 2), and by age group (Figure 3, from 2010 to 2021).

Figure 1 shows four trends corresponding to as many periods:

- from 2000 to 2003: a growth period (with an over 100,000 student increase), presumably due to the launch of the “3+2” reform with which Bachelor's and Master's degree courses were introduced, replacing the previous one-tier system;
- from 2003 to 2010: a period of stationarity, which we could use as a reference for subsequent years;
- from 2010 to 2015: a significant and continuous reduction of about 150,000 students in five years, leading to the lowest number of university students since 2000. This period has coincided with the

- effects of the financial crises of 2008 and 2011;
- from 2015 to 2021: a constant growth in the number of enrolled students, with an increased number of more than 230,000 units.

If we consider the year 2010 as a reference point (the end of the stationary period) and the average value for the period 2003-2010 of roughly 1,815,000 students as a reference value, then we observe a positive balance of over 65,000 students in 2021 compared to 2010.



Figures 1, 2, and 3: Students enrolled in Italian universities by gender and age from 2000 to 2021

From 2000 to 2021, there have been virtually no significant changes with regard to gender (Figure 2), the prevalence of women being constant (around 56 percent).

On the other hand, enrollments by age group reveal interesting trends (see Figure 3 for 2010-2021):

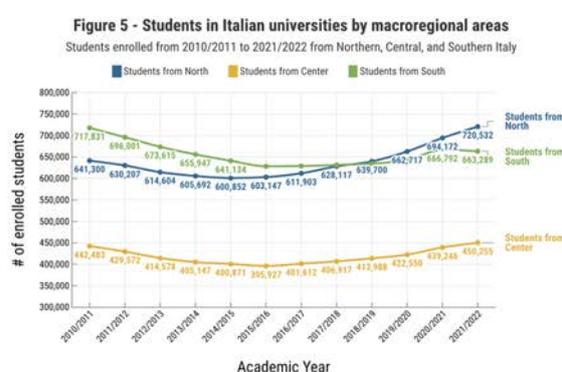
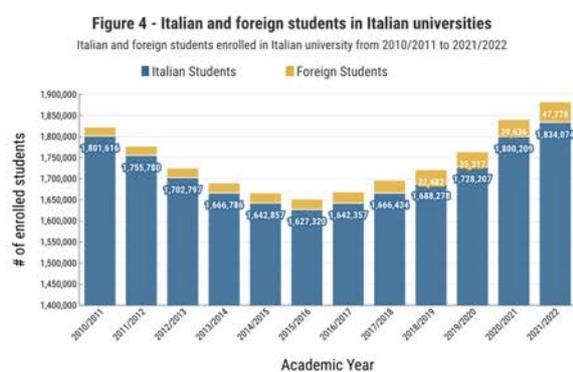
- age group 19 (assumed new entrants after high school): the minimum occurred two years earlier (in 2013) compared to the overall total and to the other age groups, where it has shown between 2015 and 2016;
- age groups 19 and 20-24: between 2010 and 2021 they show a positive balance (about 45,000 and 75,000 students respectively, or 120,000 students together);
- upper age groups (25-29, 30-34, 35+): all experienced a negative balance, from 2010 to 2021, in terms of enrolled students.

The overall positive balance was thus determined by the larger number of “regular” students aged 19-24.

## 2. What is the trend in the geographical origin of students enrolled?

Figure 4 and Figure 5 show the geographical origins of the enrolled students. In particular:

- Figure 4 depicts Italian and foreign students' enrollment trend since 2010. The balance in 2021 was positive for both Italian students (+ 34,000 approx.) and foreign students who have doubled, although their number was still extremely marginal (around 48,000 students in the last year, corresponding to an incidence of around 2.5 percent of the total);
- Figure 5 shows the geographical origins of Italian students divided into the three main macro-areas (North, Central, and South). It highlights the significant drop in students from Southern Italy (almost -55,000) and the concurrent increase in students from Northern Italy, which implied the “historical overtaking” in 2017. Over the past 50 years, students from Southern Italy have always been the largest cohort.



Figures 4 and 5: Geographical origins of students enrolled in Italian universities from 2010 to 2021

## 3a. What is the trend in the choice of training pathways in terms of disciplinary areas?

Figures 6 through 9 show the choices of educational pathways in relation to macro-fields (STEM, HEALTH, and SOCIAL SCIENCES AND HUMANITIES, see Figure 6) and disciplines as defined by the Ministry of Universities (Figures 7-8-9).

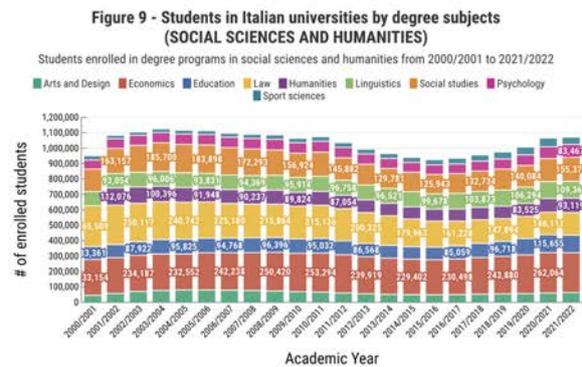
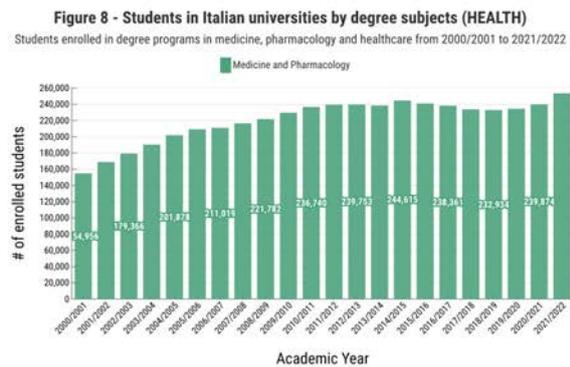
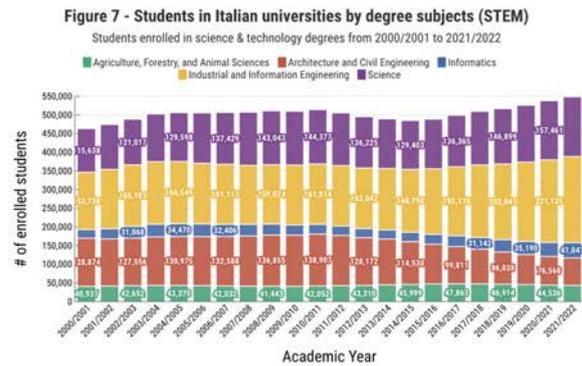
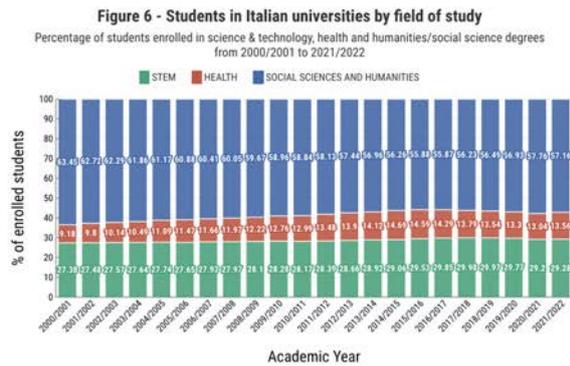
There is an evident increase from 2000 to 2021 in the number of students enrolled in degree programs in the HEALTH field (Figure 8), where access is by limited numbers and a heavy selection is made at admission.

No remarkable differences in the number of enrollments in STEM and SOCIAL SCIENCES AND HUMANITIES degree programs since 2000 can be observed.

In the 20-year period, the increase in STEM students was less than 2 percent, with an overall quote of less than 30 percent, despite programs to support technical-scientific degrees (examples in the Italian context are actions such as “Piano Nazionale Lauree scientifiche” – National Plan for Scientific Degrees – supported by the Ministry of Education since 2004 or those of “Piano Nazionale Scuola Digitale” – National Plan for Digital Schools – of 2015 aimed in particular at women, *Action #20 - Girls in Tech & Science*).

Although in accordance with the European average, Italy's percentage of students enrolled in STEM-related Bachelor's and Master's degree programs still lags far behind countries such as Greece (39 percent), Serbia (38 percent), Germany (38 percent), Romania (36 percent) and Finland (36 percent) (data referenced to 2020 from Eurostat's Education and Training > Tertiary Education database).

The drop in SOCIAL SCIENCE AND HUMANITY students was mainly generated by the increased number of students in HEALTH degree programs. Intra-group variations were also observed (Figures 7 and 9).



Figures 6, 7, 8, and 9: Students enrolled in Italian universities by field of study from 2000 to 2021

In the STEM sector, the Architecture and Civil Engineering field of study has lost more than 50,000 students over the past two decades, while the Industrial and Information Engineering and Computer Science fields have gained more than 90,000 students.

In the SOCIAL SCIENCES AND HUMANITIES sector, there has been a significant decline of over 100,000 students in the Law degree programs and slight increases in Education, Sports Science, Psychology, and Linguistics.

### 3b. Which are the destination universities?

The enrollment split between public universities and online and private universities is shown in Figure 10. Although slightly growing, the public university system has yet to reach the enrollment levels of 2010 (about 140,000 students missing) and is even lower than in 2000.

Referring in more detail to enrollment trends at universities in the geographic macro-areas (Figure 11), we found that the number of students at universities in Northern Italy has steadily increased since 2010 and even during the 2011-2015 crisis period has remained almost constant.

The latest data for 2021 show that enrollments in Northern universities are about 60,000-70,000 more compared to 2007-2010 and over 100,000 more compared to 2000.

On the contrary, as early as 2004-2005, a drop in the number of students enrolled in universities in the Center and, more notably, in the South is observed. A net loss of 100,000 and 160,000 students, respectively, was observed in 2021 compared to the year 2005.

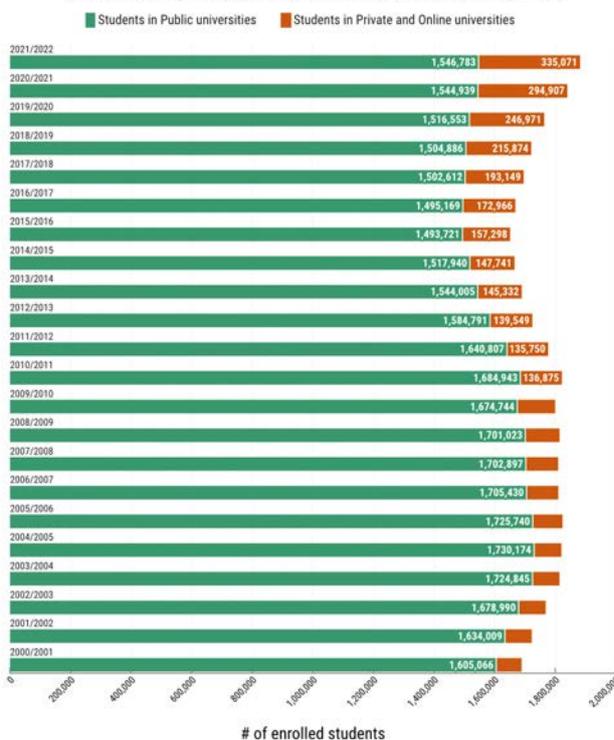
In 2015-2021, the increased number of students in the Italian university system was mainly caused by the growth of enrollments in non-public universities. This rise, confirmed by the OECD (2022), which reports a doubling of enrollment in private universities from 2013 to 2020 in Italy, also occurred (with differences in the characteristics of private institutions) in other European countries such as Finland, Germany, Spain, Austria, and France.

Figure 12 shows slow but steady growth in private university enrollments over time. In addition, online

universities are growing very fast, with an exponential trend reaching over 220,000 students in just a few years, or nearly 12 percent of the total, and is projected to reach 20 percent within two to three years.

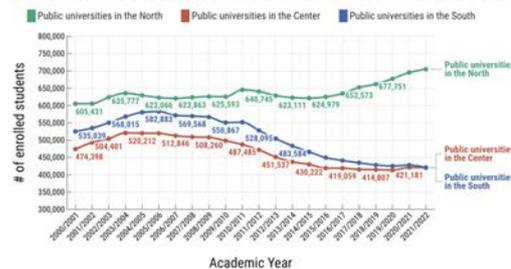
**Figure 10 - Students in Public and [Private + Online] Italian universities**

Students enrolled in Italian Public and Private+Online universities from 2000/2001 to 2021/2022



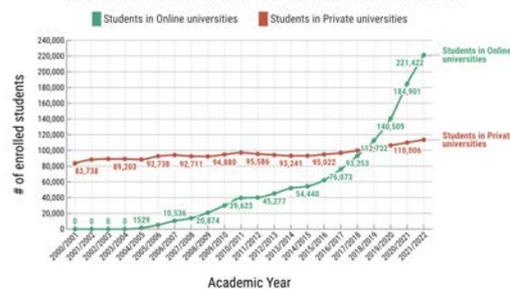
**Figure 11 - Students in Italian Public universities by university location (North, Center, South)**

Students enrolled in Public universities in the Northern, Central and Southern Italy from 2000/2001 to 2021/2022



**Figure 12 - Students in Italian Private and Online universities**

Students enrolled in Italian Private and Online universities from 2000/2001 to 2021/2022



Figures 10, 11, and 12: Students enrolled in public, private, and online Italian universities by university location from 2000 to 2021

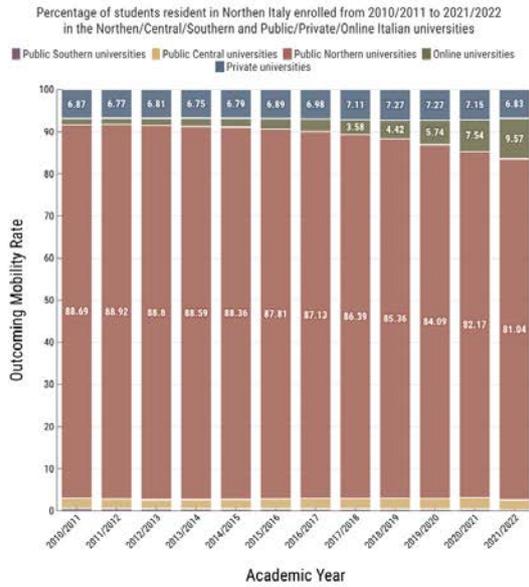
#### 4. What is the trend in student mobility between geographical macro-areas and types of universities, particularly concerning recruitment by online universities?

Figures 13, 14, and 15 show the destination universities in terms of public universities in the regional macro-areas or online universities or private universities for students residing in the Northern, Central and Southern regions. Since 2010, mobility has been mostly toward the North. In 2021, students from the North studied at universities within the same macro-area, about 8 percent of students from the Center moved to the Northern universities, and about 18 percent of students from the South moved either to the Center (8.0 percent) or to the North (9.1 percent). Mobility from the Center to the North has doubled in the past decade. Mobility from the South to the Center or to the North has increased by less than 2 percent, with a reversal of preferences: in the early 2010s, students mostly preferred universities in the Center; since 2019, the preference has shifted to those in the North.

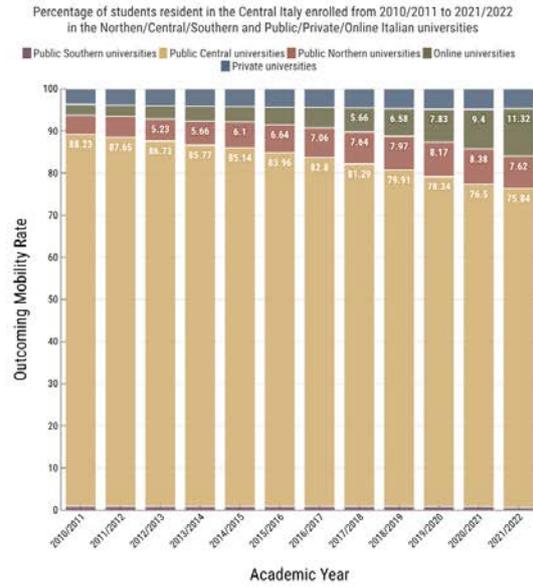
However, the most striking finding is the decrease over time (consistent for the South) of students studying at a university in their own geographic macro-area. Southern universities have lost nearly 15 percent of students residing in the same regions, not to the benefit of public universities in the North-Center, but rather to online universities. The same phenomenon, with lower values, occurred for students residing in North and Central Italy.

Finally, Figure 16 shows the share of students residing in the three macro-areas who have attended online universities since 2010. Until 2021, we can observe a strong growth in the number of students at online universities, which have increased from about 40,000 enrollments in 2010 to 212,000 in 2021. Half of the students enrolled in online universities come from Southern regions. These territories have experienced the largest decline in enrollment in the university system and the largest decline in enrollment in universities in their macro-area and have seen their (almost exclusively local) student population shrink by more than 25 percent in ten years.

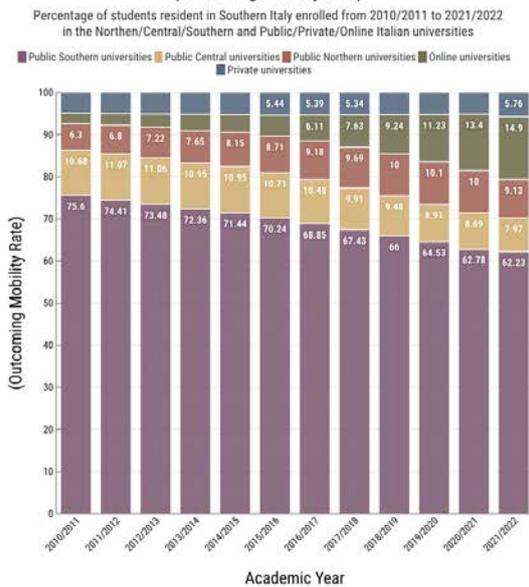
**Figure 13 - Where students resident in Northern Italy are enrolled (Outcoming Mobility Rate)**



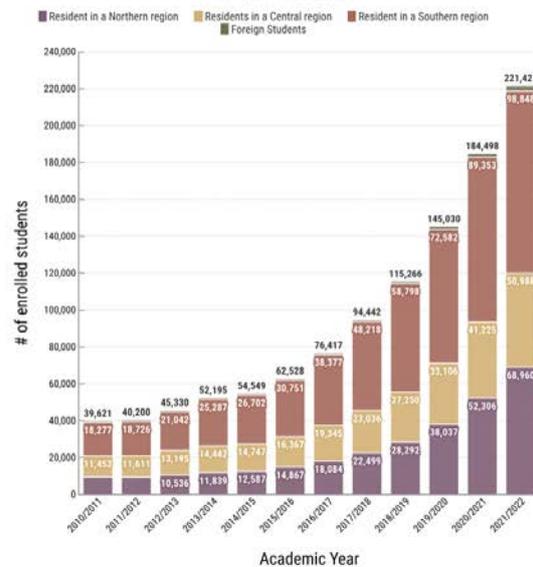
**Figure 14 - Where students resident in Central Italy are enrolled (Outcoming Mobility Rate)**



**Figure 15 - Where students resident in Southern Italy are enrolled (Outcoming Mobility Rate)**



**Figure 16 - Online Italian universities: where students come from (Students resident in Northern, Central, and Southern Italy enrolled in Online universities from 2010/2011 to 2021/2022)**



Figures 13, 14, 15, and 16: Enrollments in public, private, and online Italian universities based on students' residence from 2010 to 2021

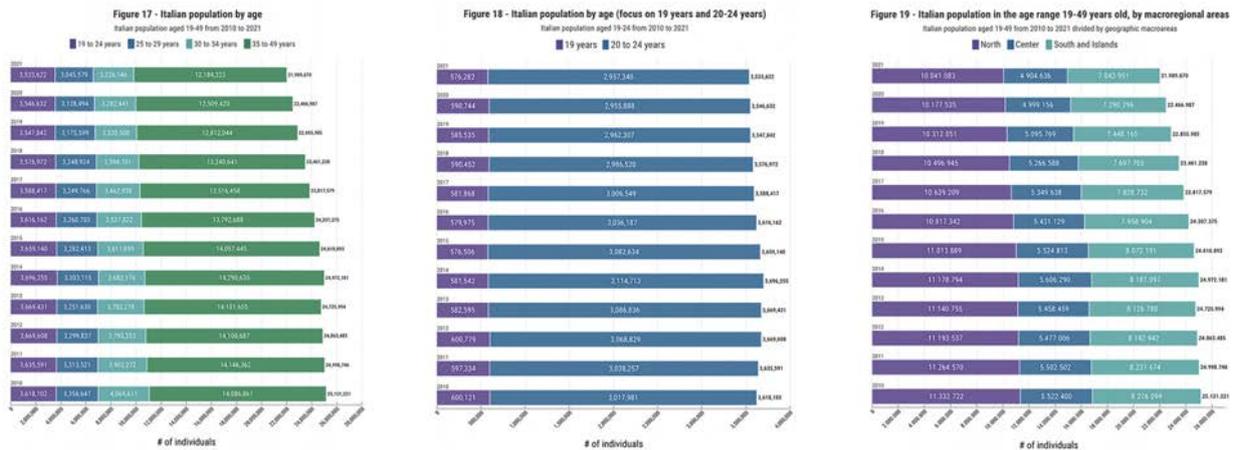
#### 4. Discussion and Conclusions

In this brief discussion, we will summarize and highlight the primary outcomes of the data review. Deliberately, here, we will not discuss causation, effects, or interpretations that, while reasonable and possible, would not be supported by congruent experimental evidence.

Another aspect deliberately omitted in the previous paragraphs is the demographic effect. Italy's resident population has been decreasing for many years now, and as the recruitment pool shrinks, this is also reflected in enrollment trends.

A dynamic interactive, high-definition presentation of all figures, completed with numerical data, is available at the following URL: <https://public.flourish.studio/story/1741258/>.

Figures 17 and 18 show Italy's resident population trends from 2010 to 2021 (as of Jan. 1) by age group.



Figures 17, 18, and 19: Population in Italy from 2010 to 2021 by age group and macro-regional area

The population in the 19-24 age group has shrunk by about 85,000 out of over 3.6 million (about 2.3 percent!), of which 25,000 out of 600,000 are 19-year-olds (over 4 percent!).

Figure 19 displays the trends in the populations of the North, Center, and South regional macro-areas in the 19-49 age group in the same years.

All three macro-regions show significant population drops of nearly 15 percent for the South and around 11-12 percent for the Center and North.

In interpreting the time series, we should “discount” these decreases and thus consider even more amplified the effects related to each growth phase and dampened (if not nullified) the results associated with the decreasing phases.

The data give us clear indications: despite the population decrease, the number of university students in Italy has been steadily increasing for at least seven years (Figure 1), reaching an all-time high in 2021.

The number of 19-year-old students has grown by more than 18 percent since 2010 (Figure 3), which, net of the population drop, means a relative growth of well over 20 percent (corresponding to +45,000 students in absolute terms). The fraction of 19-year-olds entering college was just under 36 percent in 2010 and has become nearly 45 percent in 2021.

The same phenomenon appeared for the 20-24 age group. The fraction of university students relative to the population was about 32.5 percent in 2010 and has become 35.6 percent in 2021, an absolute increase of more than 70,000 students.

The older age groups experienced a decline, more consistent in the 25-29 age group.

**Recent high school graduates and students in the specific age groups of the university population, namely 19-24 years old, were leading the increase in enrollment.**

Also on the rise, there were students residing abroad, doubling in 10 years, but their incidence was just over 2.5 percent (Figure 4).

Students resident in the South were found to be decreasing (about -55,000; -7.6 percent), and residents in the North were increasing (+80,000, +12.5 percent).

This caused, in 2017, a shift in population. Usually, students from the South have been in the clear majority. As of 2017, the university population of students resident in the North is prevailing (Figure 5).

Suppose we normalize enrollment to the resident population. In that case, however, we get strong growth (at a constant population) in students resident in the North (+21 percent) and the Center (+12.7 percent) and also a consistent increase in those residents in the South (+7.9 percent). The implication is that the reduction in the absolute number of students resident in Southern Italy is entirely generated by the population drop and mitigated by the increased share of people facing university studies.

Despite all awareness and support actions, STEM disciplines still suffer, standing at 29 percent of students' enrollment, growing by only one percent compared to 2010 and two percent to 2000 (Figure 6).

In the analysis of student flows, we note that the increase in students is mainly supported by the increased enrollments in online (and private) universities. In contrast, the public university system, although showing a slow and steady increase since 2015 (lowest in the last twenty years), still remains below the

level of 2000 (about 60,000 fewer students; -3.7 percent), and its maximum reached in 2004, almost 185,000 fewer students corresponding to a fall of more than 10 percent! (Figure 10).

The universities in the Center and, above all, those in the South are the ones that pay the consequences (Figure 11).

The former (Center) lost about 70,000 students in 10 years (about -14 percent), while the latter (South) loose, in the same period, as many as 130,000 (a loss of more than 23 percent that cannot be justified, if only in part, by the demographic decline).

The Northern universities have been growing steadily even during the crisis period (2010-2015), gaining more than 60,000 students since 2010 (about 11 percent more) despite the demographic shrinkage of the student population.

These are long-term trends and do not seem tied to any particular contingencies. They begin as early as 2004-2005. Still, from 2010 we see an acceleration with a sharpening gap between students attending universities in the North and students attending universities in the Center or South.

Online universities show a dramatic surge in the number of enrollments that brings them in a few years, from about 40,000 students in 2010 to over 220,000 in 2021! Private non-online universities are also growing, although slowly (Figure 12).

If one cross-references this figure with the increase in enrollment in the 19-24 age groups and the reduction of “adult” students, then there is room to suggest that a greater share of “regular” students (i.e., at the typical age of the university student) is turning to online universities.

**The increase in students over the past decade has been generated mainly by the growing role of online and private universities. Enrollments in the Center and, especially, in the South are plummeting while enrollments in universities in the North are steadily growing.**

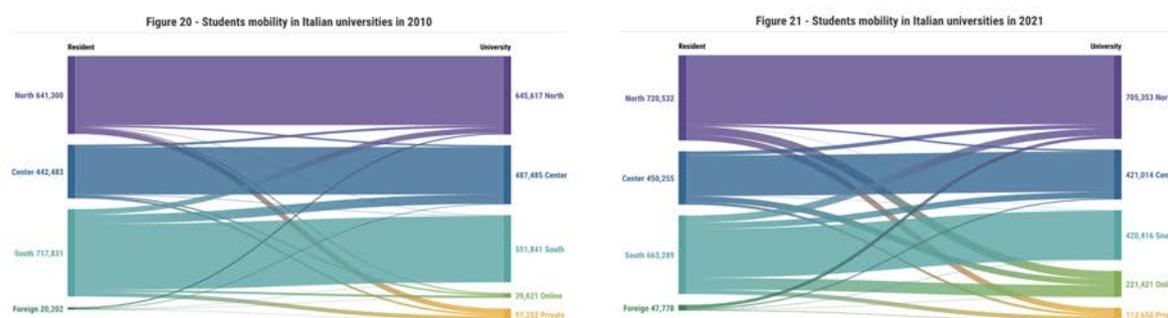
In the intersection of origin (where students come from) and destination (where students go), it is evident that students from the North are not moving (except only residually) to universities in the Center or the South (Figures 13-15). The share of students resident in the Center and studying at universities in the North is on the rise (almost doubled since 2010, from 4.5 percent to 7.6 percent).

The share of students from the South moving to universities in the Center or Northern Italy is roughly stable but with a reversal occurring in 2018 between destination universities located in the Center and universities located in the North to the latter’s gain.

Southern universities show a decrease of about 13 percent in the share of residents in Southern regions, which is virtually the only recruitment pool for them.

However, they all lose shares of students to online universities (in 2021, 9.6 percent, 11.3 percent, and 14.9 percent for residents in the North, Center, and South, respectively).

A comparison between 2010 and 2021 in students’ mobility is summarized in Figures 20 and 21.



Figures 20 and 21: Alluvial diagrams showing the changes in student mobility in 2021 (right) compared to 2010 (left)

Online universities recruit more than 50 percent of their students from the Southern Italian pool (Figure 16). Northern universities largely compensate with more students moving from the Center and the South.

**Online universities attract students from all three regional macro-areas and mainly from the South. Northern universities increase their enrollments while those in the Center and, to an even greater extent, those in the South decline significantly.**

Although many aspects deserve further study, it is worth highlighting the presence of some established and medium- to long-term dynamics:

- increase in enrollments in online and private universities;
- increase in enrollments at universities in the North;
- decrease in enrollments at universities in the Center and South;
- increased migration of Southern students to online universities.

The causes for these phenomena are beyond this analysis's scope. The effects of economic crises, students' perceptions of the quality of universities, local labor market dynamics, and the demand for new teaching approaches and innovative services should be analyzed rigorously and in detail. It remains true and highlighted by the data that the growth of online universities has not been stimulated by the pandemic phase (if anything, it may have been the opposite) but is a phenomenon that comes from afar.

This study is the first in a series of analyzes. In-depth studies are underway on the effects of the population decrease, on the dynamics of STEM discipline choices for gender and destination universities, more on enrollment trends, teaching and non-teaching staff at universities, and resources allocated to universities.

### Credit author statement

According to CRediT system: Tommaso Minerva: Conceptualization, Methodology, Software, Project Administration; Annamaria De Santis: Writing - Original Draft, Writing - Review and Editing, Formal analysis, Data Curation, Visualization; Claudia Bellini: Resources, Writing - Original Draft, Writing - Review and Editing; Katia Sannicandro: Resources, Writing - Review and Editing.

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### Conflict of interests

The authors declare no conflict of interest.

### Websites

USTAT – Italian University Open Data

*ustat, miur.it*

EUROSTAT – Educational and Training Database and Demographic database

*https://ec.europa.eu/eurostat/web/main/data/database*

FLOURISH – Data visualization online tool

*flourish.studio*

R-STUDIO – Server IDE for R statistical programming language (now POSIT)

*posit.co/products/open-source/rstudio-server/*

R – Statistical Programming Language

*r-project.org*

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