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BRAIN GAIN VS. BRAIN DRAIN. THE EFFECTS OF UNIVERSITIES' MOBILE STUDENTS **ON TERRITORIAL INEQUALITIES**

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Brain gain vs. brain drain. The effects of universities' mobile students on territorial inequalities

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Abstract

Our study examines the relationship between university student mobility and local economic dynamics. Universities are pivotal in shaping societies and economies as hubs of knowledge creation, innovation, and cultural exchange. While recent research underscores the significant impact of university students on local development, there is a notable gap in understanding the distinct effects of mobile versus resident students on the local economy. Using data from 90 NUTS3 provinces in Italy between 2013 and 2019, we investigate the spatial inequalities generated by student mobility. Our focus is on second-level university students, who are closer to entering the labor market and thus have a more immediate impact on the local economy. Employing a standard fixed effects growth model, our findings reveal that incoming students significantly boost the economic growth of the destination province, particularly in the Center-North regions (brain gain). Conversely, the southern provinces suffer reduced growth due to the loss of talented students (brain drain). Thus, student mobility exacerbates the enduring spatial disparities in Italy contributing to uneven economic development across regions.

Keywords and phrases: mobile university students, brain drain, spatial disparities, growth model Jel Classification: I25, J61, O47, R11, C23

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1 Introduction

Universities play a crucial role in shaping local societies and economies, serving as dynamic hubs of knowledge creation, dissemination, and innovation. Beyond their traditional function as centers of higher learning, universities function as engines of economic growth, driving innovation, fostering entrepreneurship and supplying a skilled workforce to meet the demands of evolving industries (Drucker and Goldstein, 2007; Uyarra, 2010). Moreover, universities often serve as cultural and intellectual centers within their communities, fostering a vital ecosystem of ideas, creativity, and collaboration. The presence of universities in the territory contributes to the socioeconomic development of the regions they are located in (Valero and Van Reenen, 2019; Marrocu et al., 2022).

More recently, a separate body of research has delved into the distinct impact that university students have on local development (Breznitz et al., 2022). As focal points for higher education and innovation, universities draw in a substantial influx of students from various regions and countries. This influx, in turn, fuels the advancement of their host communities by influencing spending patterns and employment opportunities (Carrascal Incera et al., 2022). Moreover, mobile students are more talented and foster entrepreneurial activities and the dissemination of knowledge (Breznitz et al., 2022; Wu and Eesley, 2022). Despite these recent developments in the literature, there is still much research to be done to assess the impact of the inflow of university students on the local economic system.

We aim to contribute to this stream of literature by analyzing how university mobile students contribute to the economic dynamics in the territory where they decide to move to attend university courses. Moreover, we aim to assess whether the effects of mobile and resident students on the local economy differ.

Our empirical analysis focuses on Italy, examining 90 NUTS3 areas from 2013 to 2019, before the COVID pandemic. Italy presents an interesting case study due to its well-defined and persistent spatial pattern of student mobility. There is a substantial and increasing flow of talented students moving from southern provinces to the universities in the Center-North regions. (Enea, 2018; Columbu et al., 2020; Attanasio, 2022). Between 2010 and 2022, the southern regions lost, on average, 22% of high school leavers to central and northern institutions, while attracting only 1.6% of students from the Center-North. This trend has worsened over time, with the percentage of students migrating from the South increasing from 20% in 2010 to 25% in 2022.¹ This spatial pattern also interests the graduated student flows analyzed in our study. Between 2013 and 2019, an average

¹See the USTAT open data portal on Italian higher education system https://dati-ustat.mur. gov.it/dataset/immatricolati/resource/fa028588-c0a3-4dc3-a73f-915162ed99b4.

of 24.7% of first-level graduates from southern universities enrolled in a master's degree in the Center-North, while only 0.6% of graduates moved in the opposite direction. This graduate outflow phenomenon is especially relevant for southern regions' local development considering that a large share of these mobile students, once graduated, integrate into the local workforce (AlmaLaurea, 2021), strengthening the economy of the northern provinces (brain gain) while simultaneously depleting opportunities in the southern regions (brain drain). Consequently, student mobility exacerbates the enduring spatial disparities within Italy.

Thus, a more specific research question is to investigate the spatial inequalities generated by student mobility. Accordingly, we analyze the impact of both incoming and outgoing students on the GDP per capita growth rate of Italian NUTS3 regions. Furthermore, we assess whether the northern provinces benefit from a brain gain instead of a brain drain suffered by the southern areas due to student outflows. Lastly, we compute the contribution of student mobility to the existing income gap between the South and the Center-North of Italy over the considered period.

Another novelty of our analysis is that we focus on the mobility flows of students who have completed a first-level degree and chosen to pursue a second-level degree in a different Italian province. Section 3.1 provides a detailed definition of these mobile students. Unlike Ballarino et al. (2022), which examines first-level students, we concentrate on second-level students because they are closer to entering the labour market and, therefore, have a more immediate impact on the economic performance of the destination region.

The empirical model is based on a standard fixed effects growth model where the province's per capita GDP growth rate depends on the inflows and outflows of mobile students while controlling for other characteristics of the local economy, like resident students, initial GDP conditions, and population density.

Our results show that in Italy, incoming students have a notably positive and significant impact on the economic growth of the province where they study. This effect is especially pronounced in the Center-North regions, where the influx of students contributes to a 'brain gain' phenomenon. On the other hand, in the southern provinces, the departure of talented university students leads to a "brain drain", resulting in reduced local growth rates.

The remainder of the paper is organized as follows. Section 2 reviews the recent literature on the impact of university and mobile students. Section 3 focus on mobility students data, our variable of interest. Section 4 discusses the empirical growth model and the estimation results, with specific attention paid to spatial inequalities. Additionally, it presents the results of some robustness analyses. Section 5 presents an extension based on the income levels. Section 6 concludes.

2 Background literature

In the knowledge-based economy, universities play a vital role in shaping the educational and technological landscape and contributing to the socioeconomic development of the regions where they are located (Valero and Van Reenen, 2019; Marrocu and Paci, 2013). A vast literature (Drucker and Goldstein, 2007; Uyarra, 2010) recognizes the complexity and differentiation of universities' functions, categorized into three objectives: teaching, research, and the "third mission".² The literature has extensively examined the impact of universities' activity on local economic performance, focusing on their effects on Gross Domestic Product (GDP) per capita growth (see the recent literature review by Brekke, 2021). Noteworthy examples include Goldstein and Renault (2004), Lendel (2010) and Drucker (2016) on United States counties and states; Schubert and Kroll (2016) on German NUTS3 regions; Agasisti et al. (2019) on labor market areas in Italy. Other studies present cross-country analysis on GDP impact: Valero and Van Reenen's seminal contribution (2019), which examines 1500 regions worldwide and Agasisti and Bertoletti (2022), and Lilles and Rõigas (2017) which focus on NUTS2 European regions. Differently, Marrocu et al. (2022) analyze the direct and indirect effects of universities presence on total factor productivity for 270 regions in the European Union.

Another stream of the literature examines the specific contribution of university students on local performance (see the recent special issue of Regional Studies, Breznitz et al. (2022)). As higher learning and innovation centers, universities attract a significant influx of students from other regions and nations, which contribute to the growth of their host communities through their impact on spending, employment, entrepreneurship, and knowledge spillovers.

University students, particularly those living away from their hometowns, create a substantial demand for goods and services in the local economy. Students contribute to increased consumer spending, from accommodation and transportation to groceries, entertainment, and leisure activities. This heightened demand fosters growth in local businesses, such as restaurants, retail stores, and service providers, leading to a positive multiplier effect on the economy and generating more job opportunities for the local workforce (Carrascal Incera et al., 2022). Inflow students often require part-time jobs (particularly in sectors like hospitality, retail, and services) to support their studies and living expenses, increasing local employment and production. On the other hand, local students may have more established living arrangements, such as living with their family, and consequently, they do not produce additional effects on local spending.

²The "third mission" includes several activities like know-how and technological transfer, regional leadership, knowledge network hubs, entrepreneurship development, and public engagement.

Moreover, university campuses often serve as hotspots for entrepreneurial activities (Bergmann et al., 2016; Pugh et al., 2018). The academic environment and access to research facilities and potential collaborators encourage students to explore entrepreneurial ventures. Many successful startups have emerged from university campuses, bringing innovations and job opportunities to the local community. This entrepreneurial culture generates new ideas and discoveries, diversifies the local economy, and fosters knowledge spillovers within the local community (Varga, 2009; Ponds et al., 2010). The collaboration and knowledge transfer between students, faculty, and local businesses can drive productivity gains and competitiveness in the local economy (Benneworth and Hospers, 2007; Pugh, 2017). Another important impact of mobile university students on local communities is that they bring diverse perspectives and cultural experiences. This cultural exchange enriches the local social structure by fostering diversity, promoting intercultural exchanges, and attracting businesses interested in engaging with a cosmopolitan community. The fusion of cultures can also stimulate the local arts and entertainment scene, creating a creative environment, further boosting the area's attractiveness and contributing to its overall economic development (Florida, 2002; Ottaviano and Peri, 2006; Marrocu and Paci, 2013).

Another channel linking the presence of an inflow of students to local GDP growth is the retention of talent. The literature has emphasized how students with better school performances show a higher propensity to migrate during their university career (Ballarino et al., 2022; Usala et al., 2023). These talented mobile students, seeking quality education and research opportunities, are attracted by renowned universities and educational institutions that compete to attract them in their territories (Cattaneo et al., 2017). Indeed, the literature underscores how the quality of research can positively affect the enrollments (Bratti and Verzillo, 2019; Ciriaci, 2014), especially for high-quality institutions (Biancardi and Bratti, 2019), and how the quality of mentoring services, infrastructures and, in general, overall students satisfaction can contribute to institutions attractiveness (Gibbons et al., 2015). Besides institutions' quality, students' location preferences depend on many elements that affect their costs of enrollment, such as tuition fees (Murphy et al., 2019; Hübner, 2012), the availability of transport infrastructures (Cattaneo et al., 2016), and the provision of supportive policies for less advantaged students (Castleman and Long, 2016; Dynarski et al., 2021). Moreover, students decision to invest in higher education is also conditioned by the socioeconomic condition of hosting territories (Giambona et al., 2017; D'Agostino et al., 2019; Rizzi et al., 2021) since, upon completing their studies, mobile students may choose to stay and work in their study region, especially if they find suitable job opportunities or decide to start their own businesses (Fini et al., 2022). In fact, mobile students tend to stay outside their home region after graduation, favoring the same geographical area where they studied (Haapanen and Tervo, 2012). This tendency is more pronounced among high-performing students compared with their low-performing peers (Oggenfuss and Wolter, 2019).

Thus, the presence of thriving industries and research centers can provide attractive career prospects for graduates, encouraging them to stay and contribute their expertise to the local workforce. Accordingly, by leveraging educational institutions, creating attractive job opportunities, fostering innovation, promoting community engagement, and implementing supportive policies, regions can position themselves as hubs for talent and innovation. This can lead to a "brain gain" for the destination region and, consequently, a "brain drain" for the origin region of the student flows. In the "brain gain" virtuous circle, the territory can nurture an ecosystem that attracts, develops, and retains skilled individuals through labour and entrepreneurship retention (Kitagawa et al., 2022). Moreover, the long-term presence of skilled individuals not only contributes to the local economy but also enriches the social and cultural fabric of the community, fostering sustainable growth and prosperity (Faggian et al., 2017). An opposite "brain drain" vicious circle sets in the origin territory of student outflows: less talented individuals, less attractive job opportunities, less innovation, and lower economic performance. This negative effect is especially severe in more peripheral areas, where institutions need to overcome the deterrent effect of distance to attract more students in their local regions (Suhonen, 2014; Spiess and Wrohlich, 2010).

This phenomenon is relevant in the Italian case, where, over a long period of time, the student mobility flow has a well-defined spatial pattern with a high and persistent outflow of skilled students moving from the southern provinces toward the universities located in the North of Italy (Columbu et al., 2020).³ Moreover, once they achieve graduation, most of these students enter the local labour market (AlmaLaurea, 2021) of the region in which they attend the university. Thus, the influx of highly skilled and educated individuals bolsters the local economy of the northern provinces (brain gain) while depressing the southern ones (brain drain), exacerbating the long-standing spatial inequalities in Italy. This is especially relevant for less-advantaged students, since they tend to enroll in their home region (Impicciatore and Tosi, 2019) and are more affected by the access barriers to tertiary education (Türk, 2019).

 $^{^{3}}$ To have a better understanding of the elements that characterize student mobility in Italy see the thematic series in Attanasio (2022).

3 Data and variables

This section presents the main variables used in the analysis of the effects of student mobility on territorial inequalities combining data on income growth at the NUTS3 level with the information on student mobility choices between first and second-level degrees. The variables definition and their sources are reported in Table A.1 in the Appendix.

3.1 Student mobility

The data on student mobility choices has been extracted from the administrative database MOBYSU.IT, which includes individual data on the population of students enrolled in Italian universities. MOBYSU.IT allows us to follow students throughout their careers from enrollment to graduation and to trace all the changes regarding the chosen universities and degree programs. This information allows us to measure student mobility flows by exploiting the data on universities' and degree programs' locations. We focus our analysis on second-level mobility, given by the choices of students who have graduated from a first-level degree and decided to enroll in a second-level degree.⁴ Moreover, focusing on second-level mobility, we can use the information on students' choices in the last step of their careers before entering the job market. Indeed, students who decide to migrate to pursue their academic career do not usually return to their origin area after graduation and are more likely to stay in the area where they obtain their graduation (AlmaLaurea, 2022; Oggenfuss and Wolter, 2019). This strategy allows us to identify how universities can impact territorial growth by attracting graduate students from other parts of the country.

Accordingly, starting from the population of students enrolled for the first time in an Italian university between the academic years 2010 and 2019, we apply a set of eligibility criteria to identify the population of interest. Specifically, we observe 3,035,179 students enrolled for the first time in a first-level degree in the Italian higher education system. From this population, we identify the graduated students by keeping the information on 1,147,636 students that have obtained the first-level degree in the time frame considered. Since we are interested in the impact of student mobility flows between first- and second-level degrees, we drop the information regarding graduates who have not enrolled in any second-level program (596,771). Moreover, we drop students enrolled in an online degree program. Therefore, the final data include 523,280 students who have obtained

 $^{^{4}}$ In Italy there are two kinds of first-level or bachelor's degree programs: the *Laurea* which is a 3 years program and the *Laurea a ciclo unico* that is a 5 or 6 years program. Second-level or master's degree program are 2-years programs called *Laurea Magistrale*.

a first-level degree and have decided to enroll in a second-level degree within the Italian higher education system between 2013 and $2019.^5$

In the next step, we identify the 'mobile' students. To this aim, we define a matrix where each cell contains, for each academic year, the number of students who graduated in the origin province who have decided to enroll in a second-level program in the destination province. To eliminate commuter students, we keep only those students who have chosen a university located in a province different from the origin one and have traveled more than 90 minutes to reach the destination university. This choice avoids considering 'mobile' students those who enroll in a second-level program in a different province but can easily continue to reside in their origin area and daily commute to the university location.⁶ From this matrix, we obtain, for each province i, two main variables of interest. The first measures the number of students that migrate into the province i from other provinces of the country in year t $(stud_in_{i,t})$. The second measures the number of students who decided to migrate outside the province i in year t (stud out_{i,t}). Moreover, to control for the number of students in the provinces, we keep the information on the number of graduates that stay in the origin province after graduation. Figure 1 shows the dynamic of our variables of interest, aggregated at NUTS1 level. The figure on the left shows the total number of student inflows. Tertiary students prefer universities located in the Center-North to complete their post-graduate studies. The figure shows a marked and increasing gap between the Center-North (i.e., the Center, the North-east, and the North-west) and the South (including the two big islands, namely Sicily and Sardinia). The figure on the right shows a quite different picture in terms of the outflows of students. The South is the main sending region, followed by the Center and the North-east. An important trend that emerges from the student outflow graph is that student mobility is also increasing in the northern regions. However, while southern students move to the Center-North, northern students move to a different province but stay in the Center-North. This spatial asymmetry has a clear impact on net flows, as it is shown in Figure 2. The north area of Italy has a positive and growing gain of tertiary students. On the contrary, the South is losing tertiary students, and the net loss worsens over time. Outflows and inflows of students compensate with each other in the Center. Overall, Figure 2 provides evidence of a noticeable brain drain from the southern regions to the Center-North. What is more, the brain drain is increasing over time. For these

 $^{^{5}}$ We start from 2013 to consider that students of the 2010 cohort need at least 3 years to complete their first-level degree and enroll in a second-level degree.

⁶For example, the distance between the city of Pavia, in Lombardy, and the city of Alessandria, in Piedmont, is 45 minutes by car. We observe 4,950 pairs of municipalities that host a degree program and are located in different provinces. Among these pairs of municipalities, 869 are located at less than 90 minutes of distance.

reasons, in the econometric analysis we will also investigate if and to what extent inflow and outflow students impact differently on the two macro-areas of the Country.

[FIGURE 1 HERE]

[FIGURE 2 HERE]

3.2 Student mobility and income growth

We define our dependent variable as the growth rate of the GDP per capita in the province. As explained in the subsequent section, the growth rate is computed over a three-year period to capture the comprehensive effects of students' presence in the hosting regions, as previously discussed in Section 2.

To provide some suggestive evidence on the relationship between student mobility choices and income growth, Figure 3 includes two maps that show the average student migration balance (on the left) and the average annual income growth rate (on the right) at the NUTS3 level. Student migration balance is given by the ratio between the average number of incoming and outgoing students. Therefore, a value greater than one indicates provinces that, on average, have experienced a net influx of students over time. To ease the interpretation of the map, the provinces with a migration balance lower than one are shown in yellows and reds, while values greater than one are reported in greens.

[FIGURE 3 HERE]

The data on student migration balance shows an asymmetric situation where most of the provinces that experienced a net influx of students are located in the north, while southern provinces are characterized by a net loss of graduates over time. Instead, the center of the country is characterized by a more heterogeneous picture with the provinces of Rome, Florence, and Pisa, which experienced a positive influx of students and are characterized by the presence of very important universities. The inflows-outflow balance is especially severe in the province of Isernia (which is not far from the big universities located in Rome) and in the regions of Campania and Calabria. If we compare the distribution of student migration balance with the one regarding the GDP per capita growth, we can notice a positive correlation: most northern regions are both attractive for mobile students and experienced higher values of GDP growth, while the opposite is true for provinces in the South and in the Center, especially considering the Islands. However, we can observe many exceptions to this general pattern, especially considering the provinces in the south-east of the country and the provinces of Oristano and Cagliari in Sardinia where, despite the net loss of students, we register an average growth in the GPD per capita that is greater than the median value.

4 Empirical analysis

4.1 Econometric model

Our empirical model relies on the standard cross-regions (conditional) convergence equation of Barro and Sala-i-Martin (2003), as follows:

$$log\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha log\left(y_{i,t-1}\right) + \beta_1 log\left(stud_in_{i,t-1}\right) + \beta_2 log\left(stud_out_{i,t-1}\right) + \gamma X'_{i,t-1} + \delta_t + \theta_i + \mu_{j,t} + \epsilon_{i,t}$$

$$(1)$$

where, the dependent variable is the growth rate of GDP per capita of province i in year t. As we are interested in capturing all the possible channels through which mobile students might affect the income growth of the hosting region (see Section 2), we consider a period of 3 years to compute our dependent variable.⁷ As in Barro (2015), we average across annual growth rates of GDP per capita of each period, computing a 3-year moving average.⁸ All the regressors are measured at the initial period. We observed 90 provinces over the years 2013-2019. Thus, we have a panel of n=90 and T=4. Accordingly, $y_{i,t-1}$ is the initial level of GDP per capita. We expect α to have a negative sign due to diminishing returns, as predicted by neoclassical models. The effect of our variables of interest, namely the number of incoming students (stud_in) and the number of outgoing students (stud_out) are measured by β_1 and β_2 , respectively. We then add a vector of time-varying controls at NUTS3 level (X'), such as the population density and the number of resident students. The latter controls for possible shocks caused by the opening and closing of universities across provinces during the sample period. Since many factors that affect the provincial growth rates are time-invariant we include a rich set of fixed effects to reduce the omitted variable bias. Specifically, year

⁷Three years is roughly the average time for achieving the master's degree during the considered period (AlmaLaurea, 2021). Moreover, the impacts on investments, firm creation and labor markets manifest themselves with some delay.

⁸We keep only those provinces with at least one university in one year during the analyzed period.

fixed effects (δ_t) control for national spillover effects, while the NUTS3 fixed effects θ_i account for time-invariant differences in productivity, technology, and institutions across Italian provinces. We also include region-by-year fixed effects to control for spillover effects at the NUTS2 level. Including fixed effects in the regression might cause an overestimate of the convergence rate. However, the trade-off between the overestimation of the rate of convergence and the reduction of the omitted variable bias is not severe when the observed units are not heterogeneous (such as within country regions) and the length of the period is not too long (see, Gennaioli et al., 2014; Barro, 2015, for a discussion). Finally, $\epsilon_{i,t}$ is the disturbance term. Table 1 illustrates some descriptive statistics of the variables. It emerges a substantial within variation for the dependent variable as well as for the two variables of interest. Differently, both the population density and the number of local students are characterized by a low within standard deviation.

[TABLE 1 HERE]

4.2 Results for the baseline model

The equation 1 is estimated using the (within) fixed-effects estimator. The results of the full model are reported in Table 2, column 1. The estimated coefficient of the initial level of per capita GDP is negative and statistically significant, suggesting the presence of conditional convergence. Though the convergence rate appears high, it is worth remembering that this relatively high convergence speed is conditional to all the factors controlled by the inclusion of the (rich set of) fixed effects. As with regard to our variables of interest, the estimated effect of incoming students on the growth rate is positive and statistically significant. A 20% increase in the number of incoming students (i.e., the median value of our sample) raises the annual growth rate by 0.04%, on average at NUTS3 level. Differently, losing tertiary students does not affect the per capita GDP growth rate. The estimated coefficients for the two controls, namely population density and the number of resident students, are not statistically significant. These results are not surprising, given the inclusion of the fixed effects and that the two variables have a low within variation (see Table 1). In the subsequent columns, we check the stability of the results by dropping alternatively one of the two variables of interest (column 2 and column 4) and the number of resident students (column 3). In column 2, the estimated impact of incoming students equals the one found in the full model. In column 3, we

drop the stock of local students obtaining the same results with respect to the other regressors. The specification in the last column includes only the outgoing students and the population density, but the results remain unaffected. Overall, after controlling for different spatial and time fixed-effects, we find that incoming tertiary students have a positive effect on the growth rate of the Italian provinces.⁹

[TABLE 2 HERE]

4.3 Brain-gain versus brain-drain: an analysis by macro area

As shown in Section 3, interregional student mobility in Italy exhibits a distinct spatial pattern. Provinces in the Center-North attract significantly more students than they lose, while the southern provinces experience the opposite. This disparity is not static; it is growing over time, further widening the gap between northern and southern regions. In this section, we investigate whether the asymmetry in the flow direction between the Center-North and the South also affects the impact of student mobility on the growth rate. Accordingly, we estimate a modified version of equation 1 where each variable of interest is alternatively interacted with a dummy variable, taking a value equal to 1 if the province is located in the South and 0 if the province is located in the Center-North. The results are reported in Table 3. As it emerges from Column 1, the incoming students have a positive and statistically significant effect on the growth rate of provinces located in the Center-North. The estimated impact is the same as the one estimated in Table 2. On the contrary, the impact of incoming students on the growth rate of southern provinces is positive, but the estimated coefficient is very small and not statistically significant. Thus, the results in column 1 suggest that, on average, only provinces located in the Center-north benefit from the positive effect of incoming students on the per capita GDP growth rate. Interestingly, when we analyze the difference in the impact of the number of outgoing students between the Center-North and the South, we find an opposite outcome (column 2). The linear combination test on the sum of the two coefficients, namely the outgoing students and the dummy variable, indicates a negative and statistically significant impact equal to 0.003. Therefore, a 24% rise in the number of outflow students (i.e., the median value of the growth rate of outgoing students in the southern provinces) decreases the annual growth rate of southern provinces by 0.07%.

 $^{^{9}}$ The results are robust to different specification of the variables of interest. Namely, we normalized by the total population and by the total number of local students (see Section 4.4).

In summary, our results suggest that the Center-North Italian provinces benefit from the influx of students, experiencing a positive brain gain. In contrast, the Southern regions suffer from a brain drain due to the loss of outgoing students, which exacerbates regional economic disparities.

[TABLE 3 HERE]

4.4 Robustness

In this section, we carry out some robustness analyses on our variables of interest. First, we use the ratio of both incoming and outgoing students on total number of local students to control for the size of the university student population. The results reported in Table 4, columns (1) to (3), are not statistically different from the main results reported in Table 2. Second, we measure our main regressors as a ratio of incoming (outgoing) students in the local population. Again, the results reported in the last three columns of Table 4 are similar to the ones obtained by measuring the variables in levels.

The final robustness check aims to determine whether the baseline results discussed in Table 2 are affected by the different types of second-level degrees in which mobile students are enrolled. The literature has investigated the differentiated impact on economic performance stemming from graduates in disciplines like Science, Technology, Engineering, and Mathematics (STEM) compared to non-STEM fields (see Murphy et al. 1991, for an early contribution and Kitagawa et al. 2022, for a more recent study). The idea is that what really matters for economic growth is not only the level of human capital stock (usually measured by the number of graduates) but also the type of knowledge embodied in this human capital. Graduates from STEM fields are equipped with innovation-enhancing skills that are increasingly valuable in a knowledgebased economy. Therefore, we aim to test where students in STEM programs have a stronger impact on local economic performance. To this end, we re-estimated the model, focusing solely on STEM mobile students. As shown in Table 5, the impact of STEM students is not statistically different from that of the overall mobile student population. Further research is needed on this issue, as the effect of STEM mobile students on local development may require a longer time lag to become effective, potentially through an increase in entrepreneurial activities (Colombo and Piva, 2020). Moreover, as suggested by Kitagawa et al. (2022), the effect of STEM students on the local economy may vary between urban and non-urban contexts.

[TABLE 4 HERE]

[TABLE 5 HERE]

5 An extension: the impact of student mobility on income inequalities between the South and the Center-North.

The previous section shows the impact of student mobility flows on the regional income growth in Italy. Building on this result, this section extends our investigation by examining the relationship between student mobility and regional income inequalities. This empirical exercise helps to measure how students contribute to the levels of income in regions and how this effect differs when considering southern or northern areas of the country. To this end, we estimate the following econometric model:

$$log(y_{i,t}) = \beta_0 + \beta_1 log(stud_in_{i,t-1}) + \beta_2 log(stud_out_{i,t-1}) + \gamma X'_{i,t-1} + \delta_t + \theta_i + \mu_{j,t} + \epsilon_{i,t}$$
(2)

where, the response variable now is the log of GDP per capita. The right-hand side of equation 2 is the same as the one in equation 1 with the exclusion of the initial level of GDP per capita. Column 1 of Table 6 shows the results without the interaction term. A 20% increase in the number of incoming students raises the per capita GDP by 0.08%. On the contrary, the estimated coefficient of the outgoing students is very small and not statistically significant. In column 2, we interact the incoming students variable with the dummy South to investigate whether the impact of incoming students on GDP per capita differs between provinces in the South and those in the Center-North. The linear combination test reveals a negligible and not statistically significant impact of incoming students on the GDP per capita of southern provinces. Conversely, for central-northern provinces, a 22% increase in the number of incoming students (i.e., the median growth rate of incoming students in these provinces) raises the GDP per capita by 0.18%.. The results in column 3 indicate that a 24% rise in the number of outflow students (i.e., the median value of the growth rate of outgoing students in the southern provinces) decreases the GDP per capita by 0.22%. Interestingly, the latter value is very close to the effect estimated by Binassi et al. (2021) for the South using a different methodology,

over the period 2007-2018. Regarding the effect of outgoing students on the GDP per capita of provinces located in the Center-North, the estimated coefficient is very small, and it is not statistically significant.

Overall, this empirical exercise confirms our previous findings and further indicates that the internal mobility of tertiary students exacerbates the income inequality between the South and the Center-North. To give a better interpretation of this result, we use the estimated effects and the observed annual growth rates of incoming students (for the Center-North) and outgoing students (for the South) to compute the contribution of student mobility to the dynamics of GDP per capita inequality between these two macro areas during our time frame. ¹⁰ The results are shown in Figure 4. At the end of our sample period, the mobility of tertiary students contributed to enlarging the GDP per capita gap between the South and the Center-North by 1.3 thousand euros.

[TABLE 6 HERE]

[FIGURE 4 HERE]

6 Discussion and conclusion

Universities draw an extensive influx of talented students from various regions and countries who are attracted by the quality of teaching, research, and services and the opportunities offered by the local labour market. This influx, in turn, fuels the advancement of their host communities by influencing spending patterns and employment opportunities and fostering entrepreneurial activities and the dissemination of knowledge.

The study delves into student mobility in Italy and its impact on local economic performance, analyzing 90 NUTS3 provinces from 2013 to 2019. We focus on the mobility flow of students who have obtained a first-level degree and have decided to enroll in a second-level course in a different Italian province. Focusing on students transitioning from first to second-level degrees adds a hint to understanding the dynamics of talent

¹⁰The annual growth rate of incoming (outgoing) students for each macro-area is computed as a weighted average of the annual growth rates at NUTS2 level, using as weight the number of local students.

migration and local economic regional development. Italy's student mobility exhibits a distinct spatial pattern, with a significant influx of students from the South to central and northern regions, intensifying over time. Between 2013 and 2019, on average, 24.7 percent of first-level graduates in southern universities decided to enroll in a master's degree program provided in a central or northern region, while only 0.6 percent of graduates followed the opposite migration pattern.

The study employs a fixed-effects panel growth model to analyze the relationship between students' mobility and economic growth in Italian provinces. The first result is that, looking at the whole Italy, incoming tertiary students positively impact the local growth rate, with a 20 percent increase in mobile students raising the GDP growth by 0.04 percent, while the loss of tertiary students does not affect the economic growth of the origin province. The results also indicate a negative and statistically significant coefficient for the initial level of per capita GDP, suggesting conditional convergence. Population density and resident student numbers show no significant impact. Stability checks confirm these findings.

Further analysis divides provinces into Center-north and South regions, revealing a clear spatial disparity in student flows. Provinces in the Center-north benefit more from incoming students, while the impact is weaker in the South. Conversely, outgoing students negatively affect growth in the South but not significantly in the Center-North, exacerbating regional disparities. Thus, the graduate flow phenomenon strengthens the economy of the Northern provinces (brain gain) while simultaneously depleting the opportunities in the southern ones (brain drain), exacerbating the enduring spatial disparities within Italy.

This brain gain vs brain drain spatial pattern generates a self-reinforcing virtuous circle in the northern regions and a vicious circle in the southern provinces. In the North, the influx of talented students positively impacts the local economy and its innovative and entrepreneurial activities, giving rise to higher economic growth and employment opportunities and, therefore, attracting more mobile students. In contrast, the southern regions lost a significant part of their most capable graduates, thus further impoverishing the local social and economic structure.

Based on these empirical insights, a range of policy interventions may be proposed to address the spatial disparities observed among Italian regions stemming from student mobility. First, direct targeted investments towards enhancing southern areas' education infrastructure, research facilities, and faculty development. Such initiatives aim to augment the educational landscape, improving the quality of academic offerings and support services. This enhancement seeks to oppose the brain drain phenomenon by fostering an environment conducive to retaining and attracting talented students. Moreover, tailored programs and incentives could be devised to incentivize graduates from southern universities to return to their native regions after completing their studies. These initiatives might encompass a spectrum of support mechanisms, including financial incentives, vocational guidance, and avenues for professional development and career progression. Policy measures are also required to nurture entrepreneurship and foster innovation within southern regions by providing incentives and resources to promote nascent enterprises and facilitate their growth.

At a broader level, it becomes imperative for public authorities – operating at European, national, and regional levels – to devise and execute holistic regional economic development strategies accustomed to the distinctive necessities and impediments of the southern regions. By implementing these policy measures, Italy can work towards reducing the spatial disparities caused by student mobility, thereby promoting inclusive growth and fostering sustainable development across regions.

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Figure 1: Tertiary student mobility, macro-regions (NUTS1)



Figure 2: Net flows of tertiary student mobility, macro-regions (NUTS1)



Figure 3: Students migration balance and GDP growth

Note: The map on the left show the NUTS3 distribution of the ratio between the average number of incoming students and the average number of outgoing students observed for each province between 2013 and 2019. In this case yellows and reds indicate values below 1 (negative balances) while greens indicate values above 1 (positive balances). The map on the right show the average annual growth rate of the GDP per capita between 2013 and 2019. In this map, the yellows and reds indicate values below the observed median value while greens indicate values above the median.

		Mean	Std. Dev.	Min	Max	${ m N/n}/{ar{T}}$
GDP pc growth	overall	0.06	0.03	-0.03	0.16	360.00
	between		0.02	0.02	0.09	90.00
	within		0.02	-0.01	0.14	4.00
GDP pc	overall	26506	7287	14500	55800	630
	between		7224	14957	52957	90
	within		1188	23249	31835	7
Incoming students	overall	143	376	0	2963	609
	between		342	0	1951	90
	within		148	-1193	1155	7
Outgoing students	overall	139	202	0	1174	624
	between		178	0	853	90
	within		95	-474	522	7
Resident students	overall	714	1576	0.00	12858	609
	between		1492	3	10321	90
	within		469	-4147	3298	7
Population density	overall	285	405	27	2652	630
	between		406	34	2625	90
	within	•	17	145	473	7

Table 1: Descriptive statistics

	()	(-)	(-)	()
Dependent variable: GDP per capita growth	(1)	(2)	(3)	(4)
GDP per capita	-0.359***	-0.360***	-0.361***	-0.349***
	(0.029)	(0.027)	(0.027)	(0.027)
Incoming students	0.002**	0.002**	0.002**	
5	(0.001)	(0.001)	(0.001)	
Outgoing students	-0.000			-0.000
	(0.001)			(0.001)
Population density	0.032	0.022	0.022	0.030
	(0.066)	(0.064)	(0.064)	(0.068)
Resident students	0.001	0.000		
	(0.001)	(0.002)		
N	283	292	292	283
\mathbb{R}^2	0.713	0.714	0.715	0.708

Table 2: The impact of student mobility on regional growth.

Notes: Robust standard errors clustered by region (NUTS3) in parentheses. Unbalanced panel with n = 90 and T = 4 (2013 – 2019). The results are obtained using the within fixed effects estimator. All regressors are measured at the initial period (t - 3). All models include year fixed effects, NUTS3 fixed effects, and year by NUTS2 fixed effects. *** significant at 1%, ** significant at 5%, * significant at 10%.

GDP per capita -0.337^{***} -0.344^{***} (0.023) (0.024)	
(0.023) (0.024)	
$1 \rightarrow 2 \rightarrow $	
Incoming students 0.002	
(0.001)	
South \times Incoming students -0.001^*	
(0.001)	
Outgoing students -0.001	
(0.001)	
South \times Outgoing students -0.002^*	
(0.001)	
Population density -0.026 -0.022	
(0.061) (0.066)	
Desident students 0.001 0.002*	
Resident students 0.001 0.002	
Linear Combination South 0.000 -0.003**	
S.E. (0.001) (0.001)	
Linear Combination Center-North 0.002^{**} -0.001	
S.E. (0.001) (0.001)	
N 294 285	
R^2 0.677 0.678	

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Table 3: The impact of student mobility on regional growth: differences between South and Center-North

Notes: Robust standard errors clustered by region (NUTS3) in parentheses. Unbalanced panel with n = 90 and T = 4 (2013 – 2019). The results are obtained using the within fixed effects estimator. All regressors are measured at the initial period (t-3). All models include year fixed effects, NUTS3 fixed effects, and year by NUTS2 fixed effect. *** significant at 1%, ** significant at 5%, * significant at 10%.

Dep. var.: GDP per capita growth	(1)	(2)	(3)	(4)	(5)	(6)
GDP per capita	-0.361***	-0.361***	-0.349***	-0.359***	-0.360***	-0.347***
	(0.028)	(0.027)	(0.027)	(0.029)	(0.027)	(0.028)
T /T	0.001*	0 001**				
Incoming students/Local students	0.001*	0.001**				
	(0.001)	(0.001)				
Outgoing students/Local students	-0.001		-0.001			
o assoring stadents/ Docar stadents	(0.001)		(0.001)			
	(0.001)		(0.001)			
Incoming students/Population				0.002**	0.002^{**}	
				(0.001)	(0.001)	
				~ /	· · · ·	
Outgoing students/Population				-0.000		-0.000
				(0.001)		(0.001)
	0.00 -	0.004	0.000	0.000	0.000	0.000
Population density	0.037	0.024	0.030	0.033	0.023	0.026
	(0.068)	(0.066)	(0.067)	(0.066)	(0.064)	(0.068)
Resident students				0.001	0.000	0.001
Resident Students				(0.001)	(0.000)	(0.001)
D.T.	202	202	202	(0.002)	(0.002)	(0.002)
N - 2	283	292	283	283	292	283
\mathbb{R}^2	0.713	0.713	0.709	0.713	0.714	0.708

Table 4: Robustness

Notes: Robust standard errors clustered by region (NUTS3) in parentheses. Unbalanced panel with n = 90 and T = 4 (2013 – 2019). The results are obtained using the within fixed effects estimator. All regressors are measured at the initial period (t-3). All models include year fixed effects, NUTS3 fixed effects, and year by NUTS2 fixed effects.*** significant at 1%, ** significant at 5%, * significant at 10%.

Dependent variable: GDP per capita growth	(1)	(2)	(3)
GDP per capita	-0.401***	-0.377***	-0.338***
1 1	(0.043)	(0.029)	(0.025)
	0.004444	0.004444	
Incoming students STEM	0.001**	0.001**	
	(0.001)	(0.001)	
South \times Incoming students STEM		-0.001	
South / mooning bouldened S 1211		(0.001)	
	0.001		
Outgoing students STEM	-0.001		-0.000
	(0.001)		(0.001)
South \times Outgoing students STEM			-0.002*
0 0			(0.001)
Desident students	0.001	0.000	0.001
Resident students	(0.001)	(0.000)	(0.001)
	(0.003)	(0.002)	(0.001)
Population density	0.256^{*}	-0.023	-0.025
	(0.152)	(0.085)	(0.062)
Linear Combination South (STEM-IN)		0.001	
S.E.		(0.001)	
Linear Combination Center-North (STEM-IN)		0.001	
S.E.		(0.001)	
Linear Combination South (STEM-OUT)			-0.000
S.E.			(0.001)
Linear Combination Center-North (STEM-OUT)			-0.000
S.E.			0.001
Ν	193	205	283
R^2	0.664	0.594	0.645

Table 5: Robustness: only STEM mobile students

Notes: Robust standard errors clustered by region (NUTS3) in parentheses. Unbalanced panel with n = 90 and T = 4 (2013 – 2019). The results are obtained using the within fixed effects estimator. All regressors are measured at the initial period (t - 3). All models include year fixed effects, NUTS3 fixed effects, and year by NUTS2 fixed effect. *** significant at 1%, ** significant at 5%, * significant at 10%.

Dependent variable: GDP per capita level	(1)	(2)	(3)
Incoming students	0.004^{*}	0.008***	
	(0.002)	(0.002)	
Outgoing students	0.000		-0.000
	(0.003)		(0.003)
Population density	0.012***	0.009**	0.007
i op alaeten densteg	(0.001)	(0,004)	(0.005)
	(0.001)	(0.001)	(0.000)
Resident students	-0.003	-0.002	0.002
	(0.005)	(0.005)	(0.004)
	· · · ·	· · · ·	· · · ·
South \times Incoming students		-0.007**	
		(0.003)	
South \times Outgoing students			-0.009***
			(0.003)
Linear Combination South		0.000	-0.009***
S.E.		(0.003)	(0.003)
Linear Combination Center-North		0.008^{***}	-0.000
S.E.		(0.002)	(0.003)
Ν	451	463	505
\mathbb{R}^2	0.898	0.997	0.997

Table 6: The impact of student mobility on regional GDP pc level.

Notes: Robust standard errors clustered by region (NUTS3) in parentheses.

All models include year fixed effects and NUTS3 fixed effects

*** significant at 1%, ** significant at 5%, * significant at 10%.



Figure 4: The impact of tertiary student mobility on GDP per capita inequality between the South and the Center-North (euros). The figure shows the GDP per capita changes considering the estimated impact of university student mobility.

A Appendix

Variable	Definition	Source
Incoming students	Number of students that migrate <i>into</i> the province i from other provinces of Italy and who have travelled more than 90 minutes from their city of residence.	MOBYSU.IT
Outgoing students	Number of students that migrate <i>outside</i> the province i to other provinces of Italy and who have travelled more than 90 minutes from their city of residence.	MOBYSU.IT
Resident students	Number of students that enroll in a second-level program in province i after their graduation in province i .	MOBYSU.IT
GDP per capita growth	growth rate of the GDP per capita of province i in time t .	ISTAT
GDP per capita	Gross Domestic Product per capita.	ISTAT
Population density	People per sq. km of land area.	ISTAT
South	Dummy equal to 1 if the province (NUTS3) is located in the South.	Own elaboration

Table A.1: Variables definitions and sources

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