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DOES GRADUATE HUMAN CAPITAL PRODUCTION INCREASE LOCAL ECONOMIC DEVELOPMENT? AN INSTRUMENTAL VARIABLE APPROACH

Adalgiso Amendola

Department of Economics and Statistics, University of Salerno, Via Giovanni Paolo II, 132 - 84084 - Fisciano (SA) – Italy. Centre for Labour Economics and Economic Policy (CELPE), Via Giovanni Paolo II, 132 - 84084 - Fisciano (SA) – Italy. E-mail: adamendola@unisa.it

Cristian Barra

Department of Economics and Statistics, University of Salerno, Via Giovanni Paolo II, 132 - 84084 - Fisciano (SA) – Italy. Centre for Labour Economics and Economic Policy (CELPE), Via Giovanni Paolo II, 132 - 84084 - Fisciano (SA) – Italy. E-mail: cbarra@unisa.it

Roberto Zotti

Department of Economics and Statistics "Cognetti De Martiis" - University of Torino, Campus Luigi Einaudi, Lungo Dora Siena 100A, 10153 Torino – Italy. E-mail: roberto.zotti@unito.it

Abstract

Using a survey on Italian graduates, we investigate whether universities' degree production affects the economic development of the regions where academic institutions are located. To deal with suspected endogeneity between human capital development and economic growth, we employ an instrumental variable approach, using a global lump sum transferred to each university as an instrument for human capital production. Once we control for the regional flow of mobile students and graduates, the findings reveal the beneficial effect of the university system on local economic development through the gain in human capital.

Keywords:
Universities; Growth; Human Capital; Knowledge

JEL Codes:
I23; I25; J24; O10

1. INTRODUCTION

The role of higher education institutions in fostering local economic development has been the object of intense debate, and the last few years have seen a growing interest in measuring the effect of university presence in the areas where they are located. Indeed, universities can contribute to local development through their role of regional multipliers in determining the local and regional income expenditure-employment effects (Faggian and McCann, 2009a).

The short-term multiplier benefits related to the entire flow of regional economic activities (e.g. the industry that provides goods and services to the universities, salaries and benefits to employees, local income and employment) have been emphasized. More long-term multiplier effects are instead associated with the provision of university education and training that raises the local stock of human capital, thus leading to higher economic development (Peterson and Hanusheck, 2013). Moreover, a highly educated workforce is more likely to be involved in product and process innovation activities (Romer, 1990) and to exploit the adoption of technologies not yet widely implemented. A comprehensive view of universities' economic impact should also take into account knowledge creation and innovation through research (e.g. publications) and technology transfer (e.g. third mission) activities, which may also contribute to spillover effects and regional competitiveness (Drucker and Goldstein, 2007).

However, students and graduates are highly mobile (Faggian et al. 2007a; Whisler et al. 2008), and a complex set of labor supply and demand factors is at work. It is not obvious that regions hosting universities producing more highly skilled graduates will have higher benefit from it. Indeed, the literature on the effect that universities have on their regional environment generally ignores the role played by the mobility of students and graduates, though skilled migration is a well-known channel of knowledge transfer between regions (Gagliardi, 2015). It could in fact be argued that the knowledge generated by universities may not all necessarily remain in the local region. Regions should be able both to retain their own graduates, offering appropriate labor market conditions, and to attract students and graduates from other regions, providing high quality higher education facilities and institutions. In other words, universities act as crucial additional drivers of development in the regions where they are located. Therefore, it is important to take into account that the local gain associated with the presence of universities will depend on the mobility of both students and graduates.

Since little research has been done to determine the extent to which student and graduate migration may play a role in shaping how universities can affect local economic development, the paper seeks to provide a bridge between the previously largely unconnected fields of literature such as the effects of universities' degree production on the development of the areas where they are located (Abel and Deitz, 2012) and the importance of taking into account the interregional migration of human capital (Faggian et al. 2017). More specifically, the article aims to extend the existing literature in the following ways.

Firstly, using a survey on Italian graduates, this paper focuses on the traditional teaching role of university institutions through which knowledge, skills and aptitude are transmitted to graduates, boosting local economic development as they move from universities to the labor market. By analysing whether economic growth depends on human capital development mainly operating through an upgrading of human capital stock in the regions where the universities are located, we provide an answer to this question by specifically taking into account the possibility that students could migrate to attend the university and that graduates could move far from the studying region to enter the job market. Controlling for a number of individual, university and environmental characteristics, we estimate a simple Ordinary Least Squares (OLS) model explaining the relationship between the knowledge produced in the higher education sector and local economic development. Once we control for the regional flow of mobile students and graduates, our results show that human capital accumulation is positively correlated with a higher local gross domestic product.

Secondly, while the pathways through which higher education activities can act to raise local economic development are clear, empirical evidence documenting the existence of a causal relationship is still scarce. To date, to the best of our knowledge, few papers have explicitly considered the direct link between university presence and economic performance (Cermeño, 2019;

Valero and Van Reenen, 2019; Kantor and Whalley, 2019; Agasisti et al. 2019; Kantor and Whalley, 2014; Cantoni and Yuchtman, 2014; Abel and Deitz, 2012; Aghion et al. 2009; Andersson et al., 2004). Indeed, OLS estimates might not show a causal relationship if, in turn, local economic development at least in part determines universities' production of graduates (for instance, changes in economic conditions could lead to an increase in the demand or supply of graduates). In this paper, endogeneity problems that may derive from reverse causality or omitted variables are handled through an instrumental variable approach which uses as an instrument for the number of graduates the ordinary financing fund, a global lump sum that the Italian Ministry of Education, University and Research transfers to each university and that can be managed by universities autonomously. We take advantage of the facts that part of the funding is assigned according to historical reasons which are independent both to the current performances of the universities and to economic development (more details are provided in Section 5.2). As there is little reason to expect a direct effect of these funding on changes in regional economic development other than through university activity, we regard using the historical quota of the funding as a compelling instrumental variable for contemporaneous universities' degree production. Using this strategy, we can estimate the causal effect of university graduate human capital production on region economic development (alternative instrumental variables strategies are also suggested in Section 7). Two-stage least squares (2SLS) estimates confirm the OLS results, supporting the idea that a key contribution of universities to local development relates to their teaching mission. Indeed, higher education institutions play a role in providing knowledge spillovers through the human capital embodied in graduating students.

The paper is organized as follows. The next two sections discuss the literature related to the relationship between universities' activities and economic development, and to the determinants of student and graduate migration. Section 4 describes the dataset and the empirical strategy. Section 5 summarizes the results from both OLS estimations and the 2SLS estimates. Section 6 explores heterogeneity in the results, while Section 7 provides robustness using alternative instruments. Finally, Section 8 concludes and offers some policy implications.

2. UNIVERSITIES AND LOCAL ECONOMIC DEVELOPMENT

One of the most important and oldest functions of universities is the provision of educational services to the cities and the regions where they are located (Brizzi et al. 2007). To underline the potential effects that higher education institutions may have on the local community, the notion of universities as urban developers has been used (Perry and Wiewel, 2005). Universities contribute to the economy of the area in which they are located to the extent that both local consumption and the quality of the neighborhood increase as a direct consequence of their institutional activities (e.g. additional demand due to students and employees, demand for services). Therefore, regional investments supporting engagement between universities and the community could have an important multiplier effect, leading to short-term expenditure-based demand-side effects. Moreover, universities can promote and support economic development in the areas in which they are located in an indirect way (see Bleaney et al. 1992). They provide highly educated graduates (excellence in teaching), produce research published in scholarly journals (excellence in research), and yield services for the industry sector and specifically for boosting firms' innovation activities (technology transfer channel). As a consequence, long-term knowledge-based supply-side effects are produced. In other words, universities generate both codified knowledge (e.g. academic patents and scientific publications) and tacit knowledge, which is embodied in the skills of university graduates (for a review and a discussion on the role that universities can play in regional development, see Arbo and Benneworth, 2007; Drucker and Goldstein, 2007; Bonaccorsi, 2016). The following literature streams aim to emphasize a wider set of aspects concerning higher education than research or third mission activities, to the extent that academic institutions are recognized as engines of local development since they provide highly skilled human capital.

The importance of the conventional teaching role of education institutions has been increasingly discussed in the literature (Abel and Deitz, 2011, 2012; Hermannsson et al. 2017). Highly educated individuals are found to contribute positively to regional development by increasing the economy's knowledge base and innovative activities (Faggian and McCann, 2009b; Fritsch and

Aamouche, 2013). Regions with a university have a continuous flow of new tertiary-educated human capital and thus have an advantage over other regions (Haapanen and Tervo, 2012), and cities that have institutions for higher education within their borders may serve as escalators for the surrounding regions (Fielding, 1992). More specifically, the presence of universities is considered a reason why some regions are more innovative than others (Simmie, 2002). Overall, university graduates are among the main factors that allow some states to have significantly higher per capita income than others (Bauer et al. 2012). Indeed, spillovers to local business via university links are present due to the local generation of a skilled workforce (Faggian and McCann, 2006). Graduates are a critical mechanism through which the knowledge produced in the higher education system gets transferred into the labor market (Marinelli, 2013), and employers seem increasingly to be demanding workers with a graduate qualification (Wößmann, 2008). Graduates may also decide to start up new firms that boost the dynamics of the local economic environment (Florax, 1992; Goldstein et al. 1995). Indeed, more skilled and educated workers have a higher chance of being involved in the implementation of new technologies (Woznaik, 1987), and so the skill composition of the labor force affects the technology used by firms. High quality human capital, as measured by the number of university graduates, explains local entrepreneurship in high-tech industries (Acosta et al. 2011) and has a positive effect on the creation of knowledge-intensive firms (Bonaccorsi et al. 2014).

3. DETERMINANTS OF MIGRATION

Also noteworthy is the primary role of the university system as a conduit for bringing and attracting potential high quality undergraduate human capital into a region (Faggian and McCann, 2006). Not only does the presence of a university enhance the level of human capital through education, but it is also an attractive channel for potentially high skilled people (Dotti et al. 2013). Indeed, universities attract highly talented individuals that may be employed at a local level, hence increasing the level of human capital in the area where they are located (Dotti et al. 2013).

The greater the net flow of newly acquired human capital, the greater are specifically regional returns to national higher educational policies (Faggian and McCann, 2009b). Therefore, the enrolment process could be seen as a form of early brain drain, and attracting university graduates as a form of late brain drain. In other words, it has to be taken into account that universities may attract bright students (graduates) who may decide to stay (move) after they have graduated.

Different regional employment opportunities, favourable economic conditions, individual characteristics and university prestige are among the main determinants of graduate migration between regions. Overall, socio-economic conditions that increase the likelihood of increasing income, better employment opportunities and better institutions (e.g. more effective regional policies) drive the migration choices of both students and graduates (Nifo and Vecchione, 2014). An overall finding in the literature is that previous migration (as a student) is highly correlated with subsequent migration (as a graduate). In other words, the first move from the place of origin to another region to attend university and the subsequent move from the university to first employment are highly correlated (Faggian et al. 2007a, 2007b; Krabel and Flother, 2012; Haussen and Uebelmesser, 2018). The quality of the university (both in teaching and research) and the institutional structure of the higher education system have an influence on migration choices, increasing the regional attractiveness for skilled and learned students and graduates (Faggian et al. 2007b; Dotti et al. 2013; Ciriaci, 2014). Indeed, the propensity to migrate is an increasing function of the ranking of universities (McCann and Sheppard, 2001). In addition to the quality of the university (the presence of a good university in a given province or region), student and graduate mobility may also depend on the local labor market conditions in the destination location (Dotti et al. 2013; Di Cintio and Grassi, 2013). Regional characteristics may also play an important role, such as the quality and availability of amenities (Glaeser and Gottlieb, 2006; Gottlieb and Joseph, 2006) and the quality of life offered (Di Pietro, 2005; Dalmazzo and De Blasio, 2007). Graduates are more attracted by dense urban regions (Glaeser and Ressenger, 2010; Venables, 2011) and by regions with characteristics similar to their own region (Buenstorfet et al. 2016). In general, the higher the economic attractiveness of the destination region in comparison with the original location, the higher the likelihood of student and graduate mobility (Faggian and McCann, 2009a). Individual characteristics such as ethnicity (Faggian et al. 2006), gender (Faggian et al. 2007b), marital status and the presence of children (Haussen and Uebelmesser, 2018) also play an important role. Family ties discourage migration (Helderman et al. 2006) and increase the likelihood of the graduates staying in the region in which they have graduated (Bush and Weigert, 2010).[1]

4. EMPIRICAL STRATEGY AND DATA SOURCES

4.1. Empirical strategy

In order to analyze the relationship between universities' graduate human capital production and local economic development, we specify the following empirical model:

$$ln\, GDPC_k = \beta_1\, lnGRADUATES_{jk} + \beta_2 UNIV_{CHARACT\, jk} + \beta_3 IND_{CHARACT\, ijk} + \beta_4 FAM_{CHARACT\, ijk} + \beta_5 REGIONAL_{CHARACT\, k} + \varepsilon_{i,j,k} \quad (1)$$

where ln is the natural logarithm, GDPC is gross domestic product per capita[2] measured as the sum of the gross values of all units divided by workers in each area (province) in which the university is located.[3] It could take a considerable amount of time before the output of universities results in economic development; therefore, to account for the transition to the labor market, GDPC is measured four years after graduation. The decision to use the time lag of four years comes from the fact that we use a survey conducted in 2015 on a cohort of students who graduated in 2011. Therefore, we measure the effect of human capital produced in 2011 on economic development in 2015 (the year of the survey).[4] GRADUATES measures the flow of new tertiary-educated human capital, being the number of graduates in year 2011. Subscripts i, j and k refer to the unit of analysis (graduate), the institution where the student obtained the degree (university) and the area where the university is located (region or province), respectively.

UNIV$_{CHARACT}$ is a vector of university characteristics measured in 2011 (the year in which students obtained the graduation). It contains the student-academic staff ratio (*Student-academic staff ratio*) as the total number of undergraduate students over the total number of academic staff. It captures the human resources used by a university for teaching activities and the quality of teaching. The assumption is that an increasing student-academic staff ratio will have a negative impact on students' academic performance.[5] We include a dummy controlling for the presence of a medical school (*Med school*), which has been shown to have a statistically significant impact on the efficiency of universities (Siegel et al. 2008). More specifically, the presence of a medical school may reduce university performance, probably due to the heavy service commitments of medical schools or to differences in the health product market (Thursby and Kemp, 2002; Anderson et al. 2007; Chapple et al. 2005). On the other hand, universities with medical schools may have better performances than those without. For example, it might be easier for them to conduct clinical trials and to produce a large number of university licenses related to biomedical inventions (Kempkes and Pohl, 2010). Two variables controlling for university outcomes other than the production of graduates are also included. The first is the amount of scientific research produced per academic staff (*Publications/Academic Staff*), in order to control for the fact that scientific research results in knowledge that can spur innovation by firms (Autant-Bernard, 2001; Bercovitz and Feldman, 2007) and lead to local economic growth (Goldstein and Renault, 2004). We use the number of publications on Web of Science as a proxy for the overall quality of research, which in turn can have an effect on regional propensity to innovation (see Lee, 2011; Wolszczak-Derlacz and Parteka, 2011; Duh et al. 2014). We also use the number of patents per academic staff (*Patents/Academic Staff*), a standard measure for innovation activities, which aims to measure the third mission of universities (Bonaccorsi et al. 2014).

IND$_{CHARACT}$ is a vector of individual characteristics, relative to year 2011, containing a dummy variable that identifies female graduates (*Gender*), as gender differences have been found in degree performances (Smith and Naylor, 2001; McNabb et al. 2002). We include the age at the graduation through a set of four dummy variables, when students obtain the degree at less than 22 years old (*Age at Graduation 1*: control group), between 23 and 24 years old (*Age at Graduation 2*), between 25 and 29 years old (*Age at Graduation 3*) and at more than 30 years old (*Age at Graduation 4*).[6] These variables also control for the fact that older students are more likely to leave university before completion of their degree (Montmarquette et al. 2000). We include three variables controlling for the Italian university educational system, being a dummy for post-reform graduates (*3 Year course*: control group), a dummy for the level of degree obtained (*Master level degree*) and a dummy for pre-reform graduates (*Old cycle degree*),[7] and three dummies measuring the area of study, being science (*Science*), technology (*Technology*) and human sciences (*Humanities*: control group). Finally, the graduate's university performance (*Degree marks*),[8] as a proxy for the quality of the student, has also been used.

FAM$_{\text{CHARACT}}$ is a vector of family characteristics, relative to year 2011, including a set of dummies measuring the level of education of the respondent's father and mother (*Illiterate*: control group; *Primary*, *Lower secondary*, *Higher secondary*, *University degree*). Indeed, family background is a key determinant of student progression (Checchi et al. 2013).

Finally, REGIONAL$_{\text{CHARACT}}$ is a vector of regional variables relative to year 2015, the same year in with the GDPC has been measured. We include the rate of employment (*Employment rate*), measured as the number of people with a job as a percentage of the labor force, and a measure of the industry turnover (*Turnover*), measured as the difference in entry (positions filled) and exit (positions left) rate, to control for mobility of the stock of employees. Both are intended to capture labor market effects. We also use a measure of urban density (*Population density*), measured as the number of inhabitants in the region per square kilometre, aiming to control both the effects of urbanization economies and unobserved region-specific effects. High population density should boost innovation activities as it provides the opportunity for intensive contacts and cooperation (for a similar view, see Feldman, 2000; Fritsch, 2000). In order to control for the age structure of the population, we include the share of the population having between 0-24, 25-64 and over 65 years old, respectively (*Age population 0-24:* control group; *Age population 25-64*, *Age population over 65)*. We further take into account the educational attainment of the individuals using the share of the population aged 30-34 years old with either first or second stage of tertiary education according to the International Standard Classification of Education (*Share population tertiary*). Finally, we also control for the status of urbanization by including the share of municipalities with a medium-high level of urbanization according to the Italian National Institute of Statistics (*Urbanization*). Four macro area dummies have been also included taking the value of 1 if the individual is in a university located in North-western, North-eastern, Central, and Southern regions, respectively, and 0 otherwise.

However, using the specification detailed above, we do not take into account that the presence of a university also enhances the level of human capital in the area where it is located by operating as an attractive channel for potentially highly skilled individuals that, following graduation, may be employed at a local level. As a further step, we therefore estimate the following model:

$$ln\,GDPC_k = \gamma_1 \ln\left(GRADUATES_{jk} - GRADUATES_{jh}\right) + \gamma_2 UNIV_{CHARACT\,jk} + \gamma_3 IND_{CHARACT\,ijk} + \gamma_4 FAM_{CHARACT\,ijk} + \gamma_5 REGIONAL_{CHARACT\,k} + \varepsilon_{i,j,k} \quad (2)$$

Equation (2) has the same specification as equation (1), except that we are excluding from the analysis those graduates who have previously moved in order to enrol in the university. In other words, we exclude graduates who left their original region of residence h and migrated to a region k to attend the university, with $k \neq h$. In a counterfactual world, this scenario would correspond to measuring the effects that universities have on local development through the production of graduates if they have not enrolled and graduated students coming from other regions. The idea is that the greater the net inflow of students from other regions, the greater the net inflow of newly acquired human capital and the greater the specifically regional returns (Faggian and McCann, 2009a; 2009b). Figure 1 shows the map of Italy with the share of graduates (number of graduates divided by population/10,000) by region who obtained a degree in a region different from their region of residence[9].

(Figure 1 around here)

Finally, we also take into account that Italy is characterized by sharp and widening economic disparities between northern and southern macro areas, with a long history of south-to-north labor migration. It could indeed be argued that the migration rate of students from southern to northern universities could be considered an important cause of the qualitative and quantitative human capital weakness in southern Italy, and so for the persistence of this form of territorial dualism in the country. In the past few years, on average, between 20 percent and 25 percent of the southern population enrolled in the higher education system studied in a university located in the central-north part of the country (Figure 2 show the mobility rate towards northern universities of individuals under 20 years old from southern Italy).

(Figure 2 around here)

Therefore, as a further step, we estimate the following model.

$$ln\,GDPC_k = \delta_1 \ln\left(GRADUATES_{jk} - GRADUATES_{jw}\right) + \delta_2 UNIV_{CHARACT\,jk} + \delta_3 IND_{CHARACT\,ijk} + \delta_4 FAM_{CHARACT\,ijk} + \delta_5 REGIONAL_{CHARACT\,k} + \varepsilon_{i,j,k} \quad (3)$$

Equation (3) has the same specification as equation (1), but now we are excluding from the analysis those graduates who migrate from the original region of residence w in southern-central regions and move to a region k in northern regions in order to enrol at university, with $k \neq w$[10]. Figure 3 shows a map of Italy with the share of graduates (number of graduates divided by population/10,000) who obtained a degree in universities in the north-west, north-east and central regions after moving from southern Italy[11].

(Figure 3 around here)

A potential limitation of the above described approach is the peculiar nested structure of the data. Indeed, the empirical analysis performed is a so-called micro-macro situation (as defined by

Snijders and Bosker, 1999) where independent variables defined at lower level (individual and university) are assumed to affect a dependent variable defined at the higher level (province or region). In other words, each individual in our dataset has received a group mean variable of the group to which he or she belongs. Although less work has been devoted in the statistical literature to deal with this estimation issue, it has been showed that in specific conditions this approach may lead to inaccurate estimates of the standard errors of the model parameter. Indeed, Croon and van Veldhoven (2007) and Bennink et al. (2013) proposed regression models for analysing micro-macro relations by making use of a specific type of latent class model with continuous and discrete variables, respectively. Their approach incorporates fundamental components of the persons-in-variables approach, in which the correlation within and between levels are explicitly acknowledged and accounted for. However, as showed by Croon and van Veldhoven (2007) in a simulation study, the estimate regression coefficients of the individual- and group-level variables varies with the latter bias being less extreme and more dependent on the number of observations per group[12]. This makes us more confident of the empirical analysis as the main variable of interest is a group-level variable such as the number of graduates (e.g. each individual in the analysis takes the sum of the number of graduates of the university where he/she is enrolled) being also the size of the groups very large. More importantly, Foster-Johnson and Kromrey (2018) show, especially in case the researcher is interested in group-level predictors (as we do), that the group level aggregation approach in conjunction with using White's correction will maximize statistical power for these (e.g. group level) predictors[13]. Therefore, we rely on a group means analysis combined with White's heteroscedasticity adjustment in order to reduce the possible inaccuracy that an analysis of micro-macro multilevel situation presents.

4.2. Dataset and descriptive statistics

The data used to study the contribution of universities to local economic development are collected from different databases.

Migration choices of Italian students and graduates derive from the latest survey administered by the Italian National Institute of Statistics (ISTAT) on Italian graduate labor market entry conditions. This survey was conducted in 2015 on a cohort of students who graduated in 2011. It included approximately 50,000 graduates. The ISTAT survey collected information on previous educational attainment, degree results, employment status and parents' socio-economic status, as well as a range of personal characteristics[14]. Furthermore, ISTAT provides data on students' region of residence before enrolling at the university, the region of the university attended, and the region of residence three years after graduation. This information is then used to determine whether the individual moved away from his/her original region to study, or from the studying region after graduation. Figure 4 shows the map of Italy with the locations of the universities included in the dataset.

(Figure 4 around here)

We collect the number of publications for each university from the Thomson Reuters ISI Web of Science database (part of the ISI Web of Knowledge), which lists publications in quality journals in all scientific fields. We count all publications (scientific articles, proceedings papers, meeting abstracts, reviews, letters, notes, etc.) with at least one author declaring an affiliation to the university under consideration, and use them as a measure of the research performance of universities. The number of patents by higher education institutions is taken from the Permanent Observatory on Patenting by Italian Universities and Public Research Institutes. Finally, the environmental variables used to estimate the local economic impact of HEIs are taken from ISTAT.

A glance at the descriptive statistics, summarized in Table 1, reveals some interesting features of the Italian context that are worthy of comment. Universities in the southern regions have, on average, a lower number of graduates with respect to those in the northern regions. On average, around 55 percent of the sample is composed of female graduates and almost 50 percent is aged between 25 and 29 years. Almost 50 percent of the students obtained a three-year degree. On average, around 55 percent of graduates obtained a degree in social sciences and humanities and 45 percent in science and technology. Considering performance by geographical area, the north-central areas outperform the southern area when considering the variables for the estimation of economic development. GDPC is much higher in the north than in the south of Italy, with a 25 percent gap between north-western and southern regions. This well-known phenomenon influences various relevant aspects of the country's economy and society. For instance, with regard to the structure of the Italian labor market, southern regions have a considerably lower employment rate than northern ones—less than 49 percent, as opposed to 66 percent in north-eastern regions and over 64 percent in the north-west.

These geographical differences are also evident when it comes to the characteristics of the universities. Universities in the south tend to have more students and fewer professors, and this leaves them with worse student-academic staff ratios than their counterparts in the north. There are also substantial differences in the number of academic publications, with a higher ratio of publications per professor for universities in the north than for those in the south. Almost 80 percent of the universities have a medical school. These differences in the descriptive statistics strongly suggest that some important differentials in universities' performances do exist, and it is necessary to consider these when analysing the impact of universities on local economic development.

(Table 1 around here)

5. RESULTS

5.1. Baseline results

Table 2 presents the OLS results to analyze whether human capital production positively correlates with local economic development. In all regressions, standard errors are robust to heteroscedasticity. The dependent variable is the gross domestic product per capita at province level. The main parameter of interest is β_1 in equations (1), (2) and (3), which measures how economic development at the local level is correlated with the human capital production of universities operating in the same area of influence.

Let us first consider the main specification (1), where the whole sample of graduates is used without taking into account individual migration history. The empirical evidence shows that the number of university graduates is positively correlated to local development. More specifically, a 1 percent increase in the number of graduates is correlated to an increase of GDPC by about 0.060 percent.

Regarding the influence of university characteristics, the estimates show interesting results. As already specified by Curi et al. (2012), the empirical evidence on whether the presence of medical schools makes universities more or less productive is controversial, and the differences in results might be due to the different production process characterizations in the different models. Medical school is negative and statistically significant supporting the idea that the presence of a medical school is correlated to a reduction of the university's performance, probably due to the heavy service commitments of medical schools or to differences in the health product market (Thursby and Kemp, 2002; Anderson et al. 2007; Chapple et al. 2005). The student-academic staff ratio is also negative and statistically significant. Considering this measure as a proxy for the quality of teaching, the estimates show that, other things being equal, a higher number of students per professor (or a lower number of professors per student), is negatively correlated with the economic development of the area where the university is located. In line with the main literature, results also show a positive and statistically significant coefficient of the ratio between patents and academic staff. Indeed, universities also aim to build links between research and business as part of their third mission, through patents (Henderson et al. 1998), business incubators, collaboration agreements and spin-offs (Shane, 2002), and the contribution of universities to local development is increasingly focused on the transfer of technology. A challenging evidence is instead the negative coefficient of the number of publications per academic staff. Indeed, we would have expected a positive relationship between the academic research produced by the university and the local economic development of the area where the university is located, on the assumption that the higher the quality of the academic research, the larger the contribution to industrial innovation (Mansfield, 1995). However, the existence of a trade-off between university missions has to be taken into consideration, particularly between academic excellence and local knowledge spillovers useful for economic growth (Moscati et al. 2010; Perotti, 2010). Among the possible explanations proposed in the literature, there is a change in the incentive structure, as acts conducive to knowledge spillovers may be not particularly rewarded in academia, where career advancement is predominantly dictated by the quality of scholarly research. Consequently, researchers will be more focused on high-ranked journal publications to increase their own reputation. In such circumstances, consultancies or informal collaboration may be too time-demanding, and scholars may tend to concentrate on less industry-oriented academic publications. For evidence of a substitution effect among academic excellence and knowledge spillovers from the local economy perspective, see Maietta (2015) and Maietta et al. (2017).

In terms of regional characteristics and economic opportunities, results show that the coefficient of the employment rate in the region where the university is located is positive and statistically significant. This suggests that having a higher percentage of individuals with a job (also linked to a higher chance of having more workers being involved in innovation activities) is positively correlated with local economic development. Population density has a significant and positive coefficient, indicating that a higher level of inhabitants in the region per square kilometre is associated with higher levels of region efficiency and growth, confirming that a ‘‘densely populated regions provide a variety of opportunities for interaction and rich supplies of inputs” and a “comprehensive physical and institutional infrastructure is advantageous for innovation activities’’ (Fritsch and Slavtchev, 2011, page 912). The measure of industry turnover is also positive and statistically significant, confirming the positive relationship between good labor market conditions and local economic development. Results also show that regions more urbanized and characterized by a high share of tertiary educated individuals are positively associated to local economic development.

Finally, we also include individual and family characteristics. The control for the graduate's university performance is positive and statistically significant. Higher degree marks, a proxy for higher skills, are positively correlated to local development as well as graduating in a technological field of study. Results also confirm the importance of the social background (more specifically, having a mother with secondary or higher education is positive and highly statistically significant).

The main results hold when we take the migration history into account. Table 2, column 2, shows the estimates when we restrict the sample of graduates by excluding all those who migrated from their residence region to another region in order to enrol in the university. Table 2, column 3, instead, excludes only those graduates who have moved from a region in the south to a region in the north of the country in order to attend university. In both cases, the empirical evidence shows that the number of graduates is positively associated to local development.

(Table 2 around here)

5.2. Dealing with endogeneity: an instrumental variable approach

The main threat to the correct estimation of the effect of universities' performance on local economic development stems from the likely endogeneity of the relationship due to omitted variables or reverse causality. In particular, regions may show higher levels of economic development for reasons other than the presence of university graduates that are still somehow correlated to our measure of performance. Results may also be confounded by reverse causality problems. Indeed, university graduate production affects local economic development, but at the same time, economic development may affect the ability of universities to produce highly skilled graduates. In other words, virtuous cycles may be present. As graduates increase local development, wealthier regions will attract more students in search of good labor opportunities. The consequent higher level of human capital in wealthier regions leads regions to invest even further in higher education institutions. Moreover, regional economic development may influence the performance of the university (e.g. producing graduates) if we imagine that increased efficiency in the commercial sector has a spillover effect on the public sector. To address these issues, we estimate the model using an instrumental variable (IV) estimation strategy[15].

For the IV approach to be valid, we need to find a variable that is related to university graduates (the variable to be instrumented) but not to local economic development (the outcome of interest). We rely on some specific characteristics of the Italian higher education funding system. More specifically, we use as an instrument for the number of graduates the ordinary financing fund (FFO), a global lump sum that the Italian central government transfers to each university and that can be managed by universities autonomously. To do this, we collect data from universities' balance sheets provided by the Ministry of Education, Universities and Research (https://ba.miur.it/index.php). The FFO was first introduced in 1993 and since then supported the autonomy of universities in their use of state financial support, introducing a lump sum contribution to higher education institutions. The FFO was allocated according to a mixed model based on historical data (at the beginning counting for more than 80 percent of the total FFO allocation) and a formula-based adjustment component (initially taking the form of 34 percent for teaching and 66 percent for research performance) which was introduced to offset the historically-based funding allocation. The formula-based component, initially based mainly on input indicators such as student numbers, now takes into account output indicators for teaching and research and it was introduced to encourage universities to improve the quality of their services. Indeed, an increased part of the FFO has been distributed according to performance indicators related to teaching activities, research activities and efficiency of institutional organization. Although the quota allocated via the formula was very low until 2008, only occasionally reaching values of around 6–8%, since then, a growing share of funds has been based on teaching and research performance indicators (Geuna et al. 2015) reaching in same cases values of around 30%.

It could be argued that being the formula-based adjustment component of the FFO related to the performances of the universities, it is not completely independent from the economic development and could be influenced by the conditions of the contexts in which universities are located making the FFO a questionable exogenous source of variation. However, as above underlined, part of the FFO is assigned according to historical reasons being this basic quota divided among the universities in proportion to the sum of the State transfers and the expenses incurred directly by the State for each university in the 1993 financial year. Despite the fact that the historical allocation of the funding is basically based on the funding that the universities have been given in 1993, therefore favouring the institutions that received higher funding in that year, this would make it independent from present economic performances[16] leaving us with a convincing argument that this part of the instrument is actually exogenous. Therefore, in order to address this issue, we split the historical and formula-based component of the ordinary financing fund and use only the former quota, which is not assigned according to the teaching and research performance indicators (therefore unrelated to the academic performance of the university), as an instrument for the number of graduates. See Table 3 for the FFO funding flows in the years around the period under analysis and Figure 5 for the FFO distribution with respect to the total revenue of Italian universities in the period 2000–2015.

(Table 3 and Figure 5 around here)

These types of fund do not impact local economic development directly, but only by positively affecting the production of graduates. The mechanism that we have in mind relates to the way in which universities use these funds. When the government provides money to universities, it is usually intended to stimulate additional research, teaching or institutional activities. Universities are therefore incentivized to use these resources in a productive manner in order to perform well and attract funding in subsequent years. So, while the level of funds coming from these sources is too small to have a direct effect on the economy of a particular local territory, the funds influence the local economy through incentives for the university to produce a highly educated graduate workforce.

We estimate the following equations:

$$ln\, GDPC_k = \beta_1\, lnGRADUATES_{jk} + \beta_2 UNIV_{CHARACT\, jk} + \beta_3 IND_{CHARACT\, ijk} + \beta_4 FAM_{CHARACT\, ijk} + \beta_5 REGIONAL_{CHARACT\, k} + \varepsilon_{1i,j,k} \quad (4)$$

$$ln\,GRADUATES_{jk} = \theta_1 lnFFO_{jk} + \theta_2 lnGDPC_k + \theta_3\, lnUNIV_{CHARACT\,jk} + \theta_4 IND_{CHARACT\,ijk} + \theta_5 FAM_{CHARACT\,ijk} + \theta_6 REGIONAL_{CHARACT\,k} + \varepsilon_{2\,i,j,t} \quad (5)$$

The coefficient β_1 in equation (4) is the effect of interest to us. In equation (5), we formalize the effect that economic development has on university graduates, assuming that θ_1 is positive (e.g. higher economic development tends to increase the number of graduates). From equations (4) and (5), it is easy to verify that the performance of universities might be correlated with the error term $\varepsilon_{1\,i,j,t}$[17].

(Table 4 around here)

Results are summarized in Table 4 (Table A1 in the Appendix shows the coefficients for all the variables). Column 2 shows the results when the sample of all graduates is taken into account. Column 4 shows the results when we restrict the sample by excluding graduates who obtained their degree in a university located in a different region from their region of residence. Finally, Column 6 presents the estimates when we exclude graduates who move from a region in the south to a region in the north of the country in order to attend university. Columns 1, 3 and 5 show the first-stage regressions. The instrumental variable positively and significantly influences the measure of human capital development (e.g. graduates). The diagnostic tests indicated that our instrument is valid. Firstly, the first stage F statistic is considered to check whether the instrument is not weak. Since the F-statistic for testing whether the instrument coefficient is equal to zero is always statistically significant (p-value 0.0000) and well above the threshold value of 10 suggested by Staiger and Stock (1997), we are also reassured that the instrument is not weak. Secondly, we also test that the variable being challenged (number of graduates) could be treated as exogenous in order to derive consistent estimates. The Durbin-Wu-Hausman test provides sufficient evidence to reject the null hypothesis of exogeneity of our endogenous regressor. The small p-value (0.0000) indicates that OLS is not consistent, giving credit to our IV approach.

The empirical evidence suggests that the number of graduates, in all specifications, produces a positive and highly statistically significant effect on local economic development of the areas where they are located. More specifically, a 1 percent increase in the number of graduates increases local development by about 0.076 percent, 0.084 percent and 0.074 percent, respectively, when we use the whole sample of graduates (Table 4, column 2), when we exclude those who have migrated from their region of residence to another region in order to enrol in the university (Table 4, column 4), and when we exclude the graduates who have moved from a region in the south to a region in the north of the country in order to attend university (Table 4, column 6). Estimates related to the individual, family, university and regional characteristics do not change significantly.

5.3. Graduates and labor market

So far, we have assumed that local economic development depends on human capital increase, mainly operating through an upgrading of human capital stock in the area where the universities are located. The kind of mechanism that we have in mind is related to the fact that improvements in the population's human capital lead to improvements in labour, which in turn lead to higher activity rates in the region and lower unemployment rates, thus fostering greater economic development in the region. In other words, we assume that graduates directly raise the human capital level in a region if they remain in the area and enter the local labor market. However, because college graduates are highly mobile (Kodrzycki, 2001; Faggian et al. 2007a; Whisler et al. 2008), it is not obvious that regions producing more graduates will also have higher human capital levels. To take this point into account, we repeat the analysis using only those graduates who already entered the labor market in the same region where the university is located. Therefore, we exclude all those graduates who do not work or, if working, do so in a region other than the one where they graduated from university.

(Table 5 around here)

The empirical evidence, using the IV approach, again strongly suggests that the number of graduates, in all specifications, produces a positive and highly statistically significant effect on local economic development in the areas where they are located. More specifically, a 1 percent increase in the number of graduates increases local development by about 0.102 percent considering the main specification when the whole sample of graduates is used (Table 5, column 2). When we restrict the sample of graduates by excluding those students who have migrated from their region of residence to another region in order to enrol in the university (Table 5, column 4), results show that a 1 percent increase in the number of graduates increases local development by about 0.118 percent. Finally, when we exclude graduates who have moved from a region in the south to a region in the north of the country in order to attend university (Table 5, column 6), estimates show that a 1 percent increase in the number of graduates increases local development by about 0.113 percent. Table A2 in the Appendix shows the coefficients for all the variables.

6. HETEROGENEITY

6.1. Importance of the degree sector: science, technology and social sciences

The existing literature demonstrates the importance of universities to specific industries, particularly those utilizing science and technology. Universities specializing in applied sciences and engineering have a broad positive effect on new firm creation in a given province, while universities specializing in social sciences and humanities have no effect on new firm creation at the local level whatever industry category is considered (Bonaccorsi et al. 2013). In other words, the positive impact of university knowledge embedded in graduates may also depend on the scientific specialization of universities (e.g. instruments and techniques developed within engineering departments can be directly used to improve production processes and to help solve complex technical problems). The characteristics of Italian universities[18] do not allow us to compare individuals graduating from universities offering only science, technology, engineering and mathematics with those graduating from universities offering only social sciences degrees. In order to better underline the importance of the degree sector, we repeat the analysis separately for science and technology and for social sciences and humanities graduates.

The estimates, summarized in Table 6[19], again strongly suggest that the number of graduates produces a positive and highly statistically significant effect on local economic development of the areas where they are located. A 1 percent increase in the number of graduates increases local development by 0.105, 0.126 and 0.117 percent for the science and technology (Table 6, columns 2, 6 and 10) and by 0.096, 0.108 and 0.105 percent for the social sciences and humanities (Table 6, columns 4, 8 and 12) degrees. In all cases, the effect of the number of graduates is higher in magnitude for the science and technology sector. Table A3 in the Appendix show the coefficients for all the variables.

(Table 6 around here)

6.2. University reputation

We expect that strong and influential universities may make a higher contribution to local economic development. We use the annual ranking compiled by *Il Sole 24 Ore*[20] to measure the reputation of the universities. Institutions are evaluated according to both teaching (work of faculty members, the ability to ensure that students complete their studies on time, international relations and work placements for students) and research outputs (the quality of scientific outputs, the quality of doctoral studies, the ability of departments to obtain external funding for their projects.). Moreover, the assessment is also based on university attractiveness (number of students from other regions), sustainability (average number of professors teaching core subjects), internships and mobility, scholarships, drop-out rate and efficacy (actual number of credits obtained on average by each student), characteristics that are not directly linked with economic development. We divide the universities into tertiles according to the scores obtained in such evaluation and then repeat the analysis for those in the first tertile (i.e. the most highly ranked universities) and for those in the latter two tertiles[21].

Results, summarized in Table 7[22], still show that the degree production of universities has a direct positive and significant effect on local economic development, but this is higher in magnitude when highly ranked universities are considered. A 1 percent increase in the number of graduates increases local development by 0.101, 0.115 and 0.106 percent when highly ranked universities are considered (Table 7, columns 2, 6 and 10) and by 0.090, 0.086 and 0.088 percent when the moderately ranked are taken into account (Table 7, columns 4, 8 and 12). Table A4 in the Appendix show the coefficients for all the variables.

(Table 7 around here)

6.3. Local economic development

Finally, we examine whether the results depend on the distribution of the measure of economic development—in other words, whether the main results are driven by universities being located in areas characterized by high or low levels of economic development. To do this, we repeat the analysis by separating the universities located in areas with high economic development levels (i.e. with a GDP per capita above the median) and the universities located in areas with low economic development levels (i.e. with a GDP per capita below the median).

Results are showed in Table 8[23]. On average, a 1 percent increase in the number of graduates increases local development by 0.115, 0.172 and 0.127 percent when universities are located in the highest GDP values areas (Table 8, columns 2, 6 and 10) and by 0.033, 0.035 and 0.035 percent when universities are located in the lowest GDP values areas (Table 8, columns 4, 8 and 12). Table A5 in the Appendix show the coefficients for all the variables. Results suggest not only that the number of graduates increase local gross domestic product, but also that the effect is stronger in areas that already have a good level of development. In other words, the findings point to the existence of virtuous circles, with economic development, coupled with the production of graduates by universities operating in the region, boosting economic performance yet further.

(Table 8 around here)

7. ALTERNATIVE INSTRUMENTS AND ROBUSTNESS

For robustness, we propose two additional instruments that can be used to correct the endogeneity of the relationship between universities' performance and local economic development due to omitted variables or reverse causality (see Agasisti et al. 2019 for a similar approach).

We again rely on some specific characteristics of the higher education funding system. More specifically, we use, alternatively, the amount of grants that universities receive from foundations (Grants from foundations) and the revenue that universities receive in terms of student fees (Student's fees). To do this, we use once more information on universities' balance sheets from the Ministry of Education, Universities and Research (https://ba.miur.it/index.php). Since its creation, the share of government funding of universities (the FFO used as instrument in Section 5.2) in Italy fell from 57.8 percent in 2005 to 53.7 percent in 2012, with a corresponding increase in the relative importance of funding from private foundations and student fees. Both contribute significantly to the support of higher education expenditures and research (Geuna and Piolatto, 2016).

With regard to the grants that universities receive from foundations, contractual funding and specifically contracts from other organizations have increased of 9 percentage points to reach 18 percent of the total income of the universities (Geuna et al. 2015), and competitive research funding as well as those for development and investments coming from foundations play a significant role. It could be argued, however, that the amount of grants funding available to a university will be dependent on the local economic conditions and that better local economies will have more private institutions offering grant money. We argue that the grants that universities receive from foundations are a suitable instrumental variable for contemporaneous universities' degree production as follows. Firstly, several are the reasons (in same cases dating back to centuries ago) according to which an area of the country may host a private foundation. For instance, one of the greatest private foundations with banking origin based in the North of Italy, as well as one of the oldest and largest private foundations in Europe (namely *Fondazione Compagnia di San Paolo* and related to one of the main Italian banking group), has been founded in 1563 in order to help the needy and to block the expansion of the Protestant Reformation. Therefore, it could be the case that some areas may have more private foundations for reasons more or less related to past economic development which are however not automatically correlated to the present economic performances and university characteristics. Secondly, the competitive processes through which the foundations aim to pursue socially useful objectives in the field of scientific research and technology transfer are not always necessarily linked to the territory where the university and the private foundations are based[24]. Some of these foundations are also internationally or family based and therefore even more disconnected with the local territory. Finally, in some cases the foundations have bank origin and part of the funding offered to actively promote the activities of the universities rest on the total share of profit that the bank obtained (which in some way could be linked on the richness of the territory). However, to our knowledge, these foundations are linked to (big) banks that are localized in different areas of Italy, making the share of profit originate from different territories and less correlated to the economic conditions of a specific area. Therefore, there is reason to expect that grant funding available to universities from private foundations is not necessarily positively correlated with local economic development.

With regard to the revenue that universities receive in terms of student fees, universities have also been encouraged to finance a greater share of their budgets from students' tuition fees in order to boost enrolment rates at little cost to public finances (Dima, 2004). Again, it could be argued that universities in places doing better economically can charge higher student fees because local students are wealthier making our instrument invalid. We claim this should not be the case for reasons related to the characteristics of the higher education system in Italy. Indeed, a law in Italy establishes that the overall share of student fees cannot exceed the 20 percent of the state funds allocated to universities.

Moreover, university fees in Italy are considered to be very low, especially when compared to the rest of Europe and the USA. Therefore, even though universities are located in places doing better economically, they are not allowed to increase fees to obtain more revenue. This makes the revenue that universities receive in terms of student fees an appropriate instrumental variable for universities' degree production.

The main assumption is again that these types of funds (grants and student fees) do not impact local economic development directly, but only by positively affecting the activities of universities such as the production of graduates. The mechanism that we have in mind again relates to the way in which universities use the additional funds available from foundations and fees. When foundations provide money to universities, it is usually intended to stimulate additional competitive research, teaching or institutional activities. Universities are therefore incentivized to demonstrate that they can use these resources in a productive manner in order to attract funding in subsequent years. A similar reasoning applies to the use of fees. When students are charged higher fees, they exert more control over the efficient use of resources. For example, students' councils monitor that funds are used to improve teaching and services. So while the level of funds coming from these sources is too small to have a direct effect on the economy of a particular local territory, the funds (both contributions from foundations and student fees) influence the local economy through incentives for university performances.

Results are summarized in Tables 9 and 10, where grants from private foundations and revenue from students' fees are used, respectively, as instruments[25]. In both tables, Column 2 shows the results when the sample of all graduates is taken into account. Column 4 shows the results when we restrict the sample by excluding graduates who obtained their degree in a university located in a different region from their region of residence. Finally, Column 6 presents the estimates when we exclude graduates who move from a region in the south to a region in the north of the country in order to attend university. Columns 1, 3 and 5 show the first-stage regressions. We report the analysis using only those graduates who already entered the labor market in the same region where the university is located. Therefore, we exclude all those graduates who do not work or, if working, do so in a region other than the one where they graduated from university. The instrumental variable positively and significantly influences the measure of human capital development (e.g. graduates). Again, the first stage F-statistic for testing whether the instrument coefficient is equal to zero is always statistically significant (p-value 0.0000) and well above the threshold value of 10 suggested by Staiger and Stock (1997). The Durbin-Wu-Hausman test provides sufficient evidence to reject the null hypothesis of exogeneity of our endogenous regressor. The small p-value (0.0000) indicates that OLS is not consistent, giving credit to our IV approach. The empirical evidence, using the IV approach, again strongly suggests that the number of graduates, in all specifications, produces a positive and highly statistically significant effect on local economic development in the areas where they are located.

(Tables 9 and 10 around here)

Finally, we are aware that we propose a so-called micro-macro multilevel model that uses lower-level (individual and university) characteristics to predict an aggregate level outcome and that this could be considered as a departure from convention in the field (probably rarely estimated in social science). As already specified in Section 4.1., we rely on a group means analysis combined with White's heteroscedasticity adjustment in order to reduce the possible inaccuracy that an analysis of micro-macro multilevel situation presents (Foster-Johnson and Kromrey, 2018). For robustness, we also repeat the empirical analysis using standard errors clustered at regional level (see Table A6 to A9 in the Appendix[26]) showing that the main results do not change.

8. CONCLUSIONS AND POLICY IMPLICATIONS

8.1. Conclusions

This article examines the relationship between human capital, skills development and local economic growth, considering that academic institutions contribute to local development through the production of highly skilled graduates and consequently of a highly educated workforce. We take into account that the local gain associated with the presence of universities will depend on the mobility of both students and graduates. Moreover, we use data and econometric procedures that directly confront the potential biases induced by simultaneity and omitted variables, therefore estimating a causal effect of graduate human capital production on local economic development.

We focus on the Italian experience because during the 1990s, in reply to nationwide policy changes pushing the expansion of enrolment and encouraging local solutions, Italian universities started to expand their supply in a regime of higher autonomy (Bratti et al. 2008). However, in spite of this higher degree of autonomy, higher education institutions have a similar organizational structure and governance, remaining broadly similar in their mission and status, and being traditionally strongly regulated by central government in the sphere of managerial issues and finance. All institutions have university status, and the vast majority of them are comprehensive in terms of their subject coverage (e.g. they are simultaneously academically- and vocationally-oriented institutions). The academic recruitment system, although reformed in recent years, is the same for all universities. Universities also share the same eligibility rule for student enrolment. In other words, any institutional difference that can be considered as a confounding factor in the analysis is de facto excluded.

From OLS estimates, results show a positive association between human capital development (i.e. number of graduates) and GDPC at the local level. However, the effect could be a bias deriving from the fact that the level of economic development also has an effect on the production of a high-quality graduate workforce. In order to deal with this endogeneity problem, a 2SLS approach has been used, instrumenting the number of graduates with the historical part of the ordinary financing fund that the central Italian government transfers to each university and that can be managed by universities autonomously. These types of fund, we argue being independent both to the current performances of the universities and to economic development, do not impact local economic development directly, but only by positively affecting the production of graduates. Once we control for the flow of mobile students and graduates as well as for endogeneity issues, the estimates confirm the beneficial effect of the university system on local economic development through the gain in human capital in the areas in which universities are located. The effect is stronger for graduates in the science and technology sector, for highly ranked universities, and for those institutions located in areas that already have a good level of development.

8.2. Policy implications

Several policy implications can be derived from our analysis.

Firstly, the findings confirm the conclusions of existing empirical studies on the causal localized knowledge spillovers due to the presence of higher education institutions (Kantor and Whalley, 2014; Kantor and Whalley, 2019; Cermeño, 2019 for USA; Cantoni and Yuchtman, 2014 for Germany; Andersson et al. 2004 for Sweden; Agasisti et al. 2019 for Italy; Valero and Van Reenen, 2019 for a worldwide analysis). It is also important underlining the importance of universities and their incubators on local productivity in USA vs Europe and among European countries. The governance of the universities varies substantially between USA and European (and also within European) universities. Many of the highest performing US universities are private (private universities also differ considerably in their autonomy and degree of competition from states' public institutions) and receive essentially no guaranteed government funding. Instead, they depend greatly on tuition payments from students (which families – not government grants – largely funds) and federal research grants, which are awarded through rigorous competition. European universities depend on private funding to a lesser extent than American universities, are characterized by a higher public-spirited culture and charge lower student fees (with the exception of UK universities). Private universities are less widespread and when present they are very much funded and regulated by public authorities (see Aghion et al. 2010). Understanding the mechanism through which the university effect works is an important area to investigate further. However, comparing the case of Europe to the case of USA, in terms of what is the effect from the universities, is still an empirical question. The funding system and the management practices of the higher education system play an important role and the historic importance of universities throughout Europe is undeniable. Despite the geographical differences, overall the empirical evidence leads to a call for more investment in the tertiary education system, given that this would affect not only the performance of the universities, but also the economic conditions of the areas where the institutions are located. Even though some of the findings are related to very contested effect. In Italy, for instance, there is an important human capital inequality between south and north, which may also eliminate the positive impact from local universities on businesses and the overall productivity of the economy in the country.

Secondly, the literature underlines that proximity to a university leads to an expansion of the available knowledge base for firms and strengthens the university-industry partnership (Carboni, 2013; Muscio, 2013). These findings give credit to policy interventions and investments in tertiary education to the extent that the activities performed in such institutions foster economic competitiveness. However, our results show the presence of virtuous circles, meaning that the effect of human capital production on local economic development is stronger for universities located in territories with high economic growth which in turn stimulates the universities to reach higher performance levels (for a similar result, see Agasisti et al. 2019). This is an important issue to take into account, as Italy is a country characterized by different starting points of local economic development, as is the case with its north-south gap. A policy devoted to improving the performance of universities in the south of Italy can be justified in the long run by the building of economic capacity at the local level. Otherwise, the attraction of highly skilled students and graduates may even increase the already large regional disparities instead of working as an adjustment mechanism. Nevertheless, this approach is also risky and could be wasteful if local industries are not culturally ready to benefit from the highly skilled human capital. Students and graduates make decisions assuming that they also observe the outcomes of the local labor market to increase the probability of finding a good job. In other words, investment in higher education would be pointless if not associated with an improvement in employment conditions to avoid highly skilled graduates produced by universities located in the south moving to other regions because of the inappropriateness of the local labor market.

Thirdly, in line with previous empirical evidence (Ciriaci, 2014), our results support the idea that investing in universities could be considered an additional policy instrument that regions may use to foster local economic development by attracting skilled individuals (both students and graduates). The idea that there is an incentive for (already rich) regions to invest in higher education in order to attract good students could be also interpreted as a concern when Italian north-south dualism is taken into account. According to a recent report made by the Association for the Development of Industry in the Southern Italy[27] (SVIMEZ, 2018), in the period from 2002 to 2015, the outflow of skilled individuals net of return migration still produced a loss of around 700,000 units. Among them, two in three were between 15 and 34 years old and one in three had a university degree. In other words, the migration of skilled individuals may also increase the already large territorial disparities in the country (Fratesi and Percoco, 2014), given that the loss of human capital due to the migration of skilled individuals is detrimental for southern regions. A virtuous cycle may be generated given that lower job market opportunities in the south determine the migration of individuals, leading to a reduction in government funding to the university system and then to a decrease in the number of graduates. The overall consequence is that of reducing the effect that the higher education system could have on boosting firms' innovation activities (see SVIMEZ, 2018). It is necessary that poor regions (e.g. those in the south) also invest in the higher education system to avoid students and graduates leaving the region, thus transforming the brain drain into brain gain.

Finally, some consideration could be made in terms of university funding cuts. Nowadays, we face a system in which the total amount of university funding has decreased in the last few years with, instead, a relative increase in the importance of external contractual funding. Indeed, it is a matter of fact that universities are directing their efforts in order to attract funding and contract from other (public and private) organizations to sustain their missions. The amounts of money directly allocated as a result of evaluation is small since input indicators and historical allocation remain dominant and it is possible that a performance-based funding system entrains other parts of the funding system. However, it is also clear that the importance of other contractual funding varies across regions in Italy (Anvur, 2014) as well as that highly industrialized regions in the North of the country may be favoured. Still with regards to the decreasing trend of university funding, it is also a case for a reflection in terms of governance for tertiary education institutions in Italy. What seems the most promising perspective is the construction of an even more pronounced system of incentives that the actual one that works on the allocation of the (few) resources available such that the distribution of a large part of the funding is determined through the achievement of some performance criteria. This would be an important step to lead a prominent transition from a centralized university system to a model that incorporates more autonomy of universities that without the introduction of assessment tools would probably be a failure (see for a more detailed discussion on this point Geuna and Rossi, 2017). In conclusion, performance-based funding systems would also identify those universities not attaining a minimum adequate standard of performance. However, as academic jobs typically involve multiple tasks, incentives based on the performance in a specific task, such as for instance research output, could reduce workers' effort in another, such as teaching. As a consequence, the role of education as a channel of university-based knowledge spillovers may have been weakened. One possible explanation is the decrease in national funding to universities; funds are increasingly linked to the assessment of academic research quality. Consequently, researchers will be more focused on high-ranked journal publications to increase their own and their faculty's reputation. More broad indicators need to be studied, so that the distribution of resources does not exceedingly penalize both very small and small universities, given that the empirical finding reveal the beneficial effect of the regional human capital accumulation on local economic development.

While our empirical evidence indicates a causal link between graduate human capital production and local economic development, future work would benefit from a careful analysis of the mechanism behind these gains. More specifically, our research opens the way to future interesting extensions. One immediate extension would be understanding the effect that universities located in southern regions might have on local economic development if their students enrol in a university located in their region of origin after completing high school or their graduates stay in the region of origin after graduation.

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TABLES

Table 1: Descriptive statistics (mean values by geographical areas)

		Mean values				
Variable	Definition	North-Western	North-Eastern	Central	Southern	Italy
GDPC	Gross domestic product normalized by workers	68446.28	64680.06	61743	55253.53	61417.55
Graduates	# of graduates by universities	1154.42	1244.41	1138.48	932.86	1083.53
Gender	Dummy variable =1 if female	0.552	0.554	0.536	0.546	0.552
Age at graduation 1	Dummy variable =1 if age <22	0.133	0.132	0.085	0.066	0.098
Age at graduation 2	Dummy variable =1 if age between 23 and 24	0.310	0.281	0.248	0.215	0.256
Age at graduation 3	Dummy variable =1 if age between 25 and 29	0.449	0.468	0.485	0.499	0.479
Age at graduation 4	Dummy variable =1 if age >30	0.107	0.117	0.181	0.218	0.165
Old cycle degree	Dummy variable =1 if pre-reform graduate	0.140	0.122	0.152	0.213	0.166
3 Years course	Dummy variable =1 if post-reform graduate (3 years)	0.489	0.506	0.460	0.418	0.459
Master level degree	Dummy variable =1 if post-reform graduate (2 years)	0.371	0.372	0.388	0.369	0.375
Science	Dummy variable =1 if degree in Science	0.262	0.264	0.276	0.283	0.273
Technology	Dummy variable =1 if degree in Technology	0.163	0.195	0.197	0.177	0.181
Humanities	Dummy variable =1 if degree in Humanities	0.575	0.541	0.527	0.540	0.546
Degree marks	Degree marks obtained	102.14	102.07	104.32	103.40	103.02
Student-academic staff ratio	# of students over total # of academic staff	61.031	33.141	34.72	88.256	61.123
Med school	Dummy variable =1 if the university has a Medical school	0.822	0.814	0.789	0.805	0.808
Publications/Academic staff	# of publication over total # of academic staff	1.472	1.640	1.416	1.181	1.382
Patents/Academic staff	# of patents over total # of academic staff	0.031	0.019	0.094	0.061	0.052
Employment rate	# of individuals with a job/eligible population (15-64)	64.231	66.065	61.105	48.963	58.214
Turnover	Difference in entry and exit rate	-1.247	-1.156	-1.330	-1.407	-1.305
Population density	# of inhabitants in the region by squared km	760.960	341.291	396.114	601.23	547.97
Age population 0-24	Share of the population having between 0-24 years old	0.218	0.223	0.212	0.229	0.222
Age population 25-64	Share of the population having between 25-64 years old	0.545	0.544	0.541	0.538	0.541
Age population over 64	Share of the population having between over 65 years old	0.236	0.232	0.246	0.232	0.236
Share population tertiary	Share of the population age 30-34 with tertiary education	27.866	27.633	30.237	22.722	26.320
Urbanization	Share of municipalities with a medium-high level of urbanization	43.621	34.191	24.701	32.785	34.066
Father university degree	Dummy variable =1 if respondent's father has a university degree	0.195	0.183	0.208	0.187	0.193
Mother university degree	Dummy variable =1 if respondent's mother has a university degree	0.154	0.141	0.175	0.164	0.160
FFO	Ordinary financing fund (Instrument)	1.28e+08	1.34e+08	1.72e+08	1.35e+08	1.41e+08
Grants from foundations	Amount of grants received from foundations	2841725	1441388	2690899	894991	1808646
Student's fees	Revenues received in terms of student fees	4.86e+07	5.05e+07	4.88e+07	3.55e+07	4.42e+07

Note: Author's calculation

Table 2: The relationship between university graduates and local economic development – OLS estimates

Dependent variable: GDPC at local level	(1) OLS	(2) OLS	(3) OLS
Graduates	0.060*** (0.0007)	0.056*** (0.0008)	0.057*** (0.0007)
Individual characteristics			
Old cycle degree	-0.003*** (0.0007)	-0.004*** (0.000)	-0.002*** (0.0008)
Master level degree	-0.007*** (0.0006)	-0.006*** (0.0007)	-0.0056*** (0.0007)
Science	-0.001*** (0.0005)	-0.002*** (0.0005)	-0.002*** (0.0005)
Technology	0.008*** (0.0006)	0.0153*** (0.001)	0.015*** (0.001)
Gender	-0.0003 (0.0004)	-0.002*** (0.0005)	-0.001** (0.0004)
Degree marks	0.0003*** (0.00003)	0.0004*** (0.00003)	0.0003*** (0.00003)
Age at graduation 2	0.004*** (0.0008)	0.004*** (0.0009)	0.004*** (0.0008)
Age at graduation 3	0.009*** (0.0008)	0.010*** (0.0009)	0.008*** (0.0009)
Age at graduation 4	0.012*** (0.001)	0.014*** (0.001)	0.011*** (0.001)
University characteristics			
Student academic staff ratio	-0.001*** (0.00006)	-0.001*** (0.00007)	-0.001*** (0.00006)
Med school	-0.004*** (0.001)	0.007*** (0.001)	-0.001 (0.001)
Publication/Academic staff	-0.025*** (0.001)	-0.037*** (0.001)	-0.026*** (0.001)
Patents/Academic staff	0.990*** (0.031)	1.402*** (0.036)	1.068*** (0.033)
Regional characteristics			
Employment rate	0.010*** (0.00007)	0.012*** (0.0001)	0.010*** (0.00008)
Turn over	0.014*** (0.0004)	0.011*** (0.0006)	0.013*** (0.0004)
Population density	0.00006*** (0.0000004)	0.00006*** (0.0000004)	0.00006*** (0.0000004)
Share population tertiary	0.001*** (0.0001)	0.004*** (0.0001)	0.001*** (0.0001)
Age population 25-65	0.743*** (0.064)	-0.723*** (0.080)	0.396*** (0.066)
Age population over 65	0.023 (0.032)	-0.488*** (0.040)	-0.105*** (0.033)

Urbanization	0.0001***	0.00005**	0.0001***
	(0.00002)	(0.00002)	(0.00002)
Family characteristics			
Primary father	-0.001	-0.00005	-0.0007
	(0.0009)	(0.001)	(0.0009)
Lower secondary father	-0.0006	-0.00001	-0.0003
	(0.0009)	(0.001)	(0.0009)
Higher secondary father	0.0003	0.001	0.001
	(0.001)	(0.002)	(0.001)
University degree father	0.0007	0.002**	0.001
	(0.001)	(0.001)	(0.001)
Primary mother	0.001	0.002***	0.00177*
	(0.0009)	(0.001)	(0.0009)
Lower secondary mother	0.003***	0.005***	0.003***
	(0.0009)	(0.001)	(0.0009)
Higher secondary mother	0.004***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)
University degree mother	0.004***	0.006***	0.004***
	(0.001)	(0.001)	(0.001)
Constant	9.541***	10.340***	9.767***
	(0.039)	(0.046)	(0.040)
Macro area fixed effects	Yes	Yes	Yes
Number of observations	50788	40104	46838

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over, the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in column (1) includes all graduates. Estimation in column (2) excludes the graduates from a university located in a different region from the residence region. Column (3) excludes the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

Table 3: FFO funding flows (%), 2009-2013

	2009	2010	2011	2012	2013
Historical component	86.7	80.8	84.2	78.5	81
Performance	7.1	10	12	13	13.5
Special funding	6.1	9.1	3.7	8.4	5.6

Source: Geuna and Rossi (2015), p. 117

Table 4: The effect of university graduates on local economic development – IV strategy using FFO as instrument

Dep. Var.: GDPC	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)
	(1)	(2)	(3)	(4)	(5)	(6)
Number of graduates		0.076***		0.084***		0.074***
		(0.0006)		(0.0008)		(0.0006)
Ordinary financing fund	0.496***		0.495***		0.500***	
	(0.0008)		(0.0008)		(0.0008)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	50,778	50,778	40,104	40,104	46,838	46,838

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over, the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1) and (2) includes all graduates. Estimation in columns (3) and (4) excludes the graduates from a university located in a different region from the residence region. Columns (5) and (6) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

Table 5: The effect of university graduates on local economic development – IV strategy using FFO as instrument

Dep. Var.: GDPC	First-stage (1) (1)	IV (1) (2)	First-stage (2) (3)	IV (2) (4)	First-stage (3) (5)	IV (3) (6)
Number of graduates		0.102***		0.118***		0.113***
		(0.001)		(0.001)		(0.001)
Ordinary financing fund	0.514***		0.451***		0.468***	
	(0.002)		(0.002)		(0.002)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	27,709	27,709	25,297	25,297	26,421	26,421

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over, the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1) and (2) includes all graduates. Estimation in columns (3) and (4) excludes the graduates from a university located in a different region from the residence region. Columns (5) and (6) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

Table 6: The effect of university graduates on local economic development – IV strategy using FFO as instrument

Dep. Var.: GDPC	Science and Technology		Social Science and Humanities		Science and Technology		Social Science and Humanities		Science and Technology		Social Science and Humanities	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)	First-stage (5)	IV (5)	First-stage (6)	IV (6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Number of graduates		0.105***		0.096***		0.126***		0.108***		0.117***		0.105***
		(0.001)		(0.001)		(0.002)		(0.002)		(0.001)		(0.002)
Ordinary financing fund	0.508***		0.521***		0.448***		0.454***		0.468***		0.469***	
	(0.002)		(0.002)		(0.003)		(0.003)		(0.002)		(0.003)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	14,050	14,050	13,659	13,659	12,662	12,662	12,635	12,635	13,310	13,310	13,111	13,111

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1), (2), (3) and (4) includes all graduates. Estimation in columns (5), (6), (7) and (8) excludes the graduates from a university located in a different region from the residence region. Columns (9), (10), (11) and (12) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

Table 7: The effect of university graduates on local economic development – IV strategy using FFO as instrument

Dep. Var.: GDPC	Highly ranked		Moderately ranked		Highly ranked		Moderately ranked		Highly ranked		Moderately ranked	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)	First-stage (5)	IV (5)	First-stage (6)	IV (6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Number of graduates		0.101***		0.090***		0.115***		0.086***		0.106***		0.088***
		(0.001)		(0.002)		(0.001)		(0.002)		(0.001)		(0.002)
Ordinary financing fund	0.506***		0.550***		0.461***		0.554***		0.488***		0.543***	
	(0.002)		(0.004)		(0.002)		(0.003)		(0.002)		(0.004)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	18,657	18,657	9,052	9,052	16,690	16,690	8,607	8,607	17,626	17,626	8,795	8,795

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1), (2), (3) and (4) includes all graduates. Estimation in columns (5), (6), (7) and (8) excludes the graduates from a university located in a different region from the residence region. Columns (9), (10), (11) and (12) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

Table 8: The effect of university graduates on local economic development – IV strategy using FFO as instrument

Dep. Var.: GDPC	Highest GDP values		Lowest GDP values		Highest GDP values		Lowest GDP values		Highest GDP values		Lowest GDP values	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)	First-stage (5)	IV (5)	First-stage (6)	IV (6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Number of graduates		0.115***		0.033***		0.172***		0.035***		0.127***		0.035***
		(0.001)		(0.001)		(0.002)		(0.001)		(0.002)		(0.001)
Ordinary financing fund	0.358***		0.577***		0.287***		0.570***		0.337***		0.569***	
	(0.002)		(0.003)		(0.002)		(0.004)		(0.002)		(0.003)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	14,088	14,088	13,621	13,621	13,104	13,104	12,193	12,193	13,155	13,155	13,266	13,266

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1), (2), (3) and (4) includes all graduates. Estimation in columns (5), (6), (7) and (8) excludes the graduates from a university located in a different region from the residence region. Columns (9), (10), (11) and (12) exclude the graduates who migrate from the original region of residence in the Southern-Central regions and move to a region in the Northern regions.

Table 9: The effect of university graduates on local economic development – alternative IV strategy using grants from foundations as instrument

Dep. Var.: GDPC	First-stage (1) (1)	IV (1) (2)	First-stage (2) (3)	IV (2) (4)	First-stage (3) (5)	IV (3) (6)
Number of graduates		0.136*** (0.002)		0.177*** (0.003)		0.167*** (0.003)
Grants from foundations	6.30e-08*** (1.00e-09)		4.44e-08*** (8.76e-10)		5.04e-08*** (9.70e-10)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	27,707	27,707	25,297	25,297	26,421	26,421

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over, the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1) and (2) includes all graduates. Estimation in columns (3) and (4) excludes the graduates from a university located in a different region from the residence region. Columns (5) and (6) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

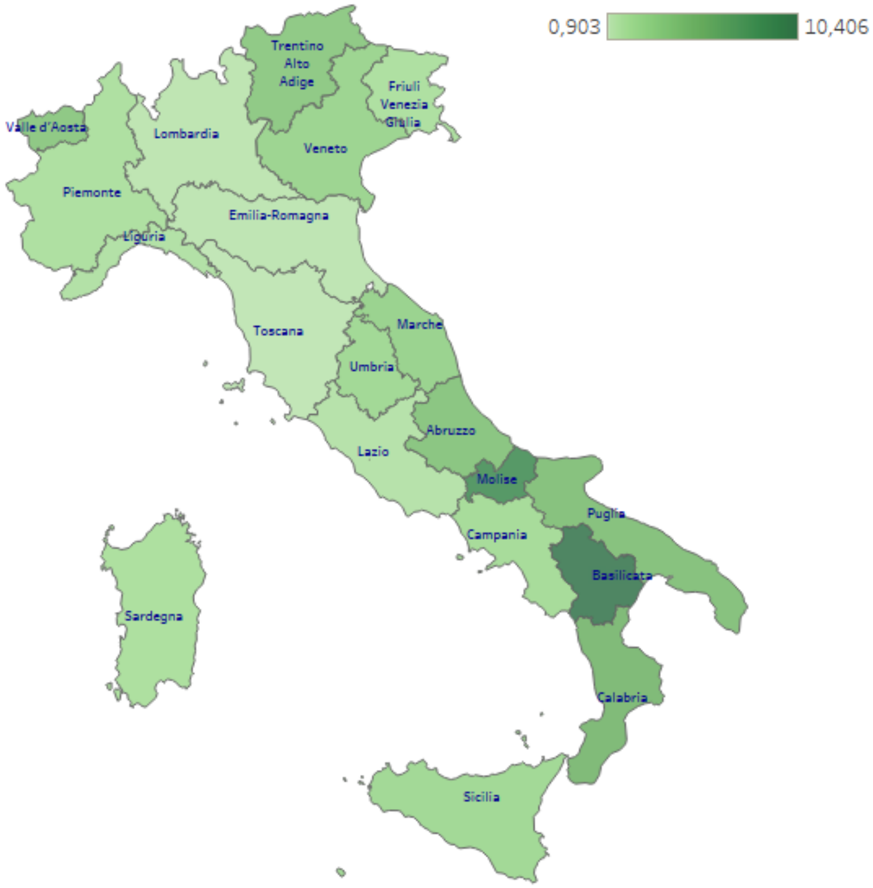
Table 10: The effect of university graduates on local economic development – alternative IV strategy using students'fees as instrument

Dep. Var.: GDPC	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)
	(1)	(2)	(3)	(4)	(5)	(6)
Number of graduates		0.100*** (0.001)		0.115*** (0.001)		0.111*** (0.001)
Student's fees	0.452*** (0.002)		0.401*** (0.002)		0.412*** (0.002)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Family characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	27,709	27,709	25,297	25,297	26,241	26,241

Note: Standard errors in brackets. ***p<0.01, **p<0.05, and *p<0.10. The dependent variable is the gross domestic product per capita. University characteristics include the student-academic staff ratio, the presence of a medical school, the ratio between academic publications and the number of professors, the ratio between the number of patents and the number of professors. Individual characteristics include gender, age at graduation, degree marks, type of degree. Family characteristics include the level of education obtained by the father and mother. Regional characteristics include the rate of employment, turn-over, the density, the age structure and the educational attainment of the population as well as the degree of urbanization. Estimation in columns (1) and (2) includes all graduates. Estimation in columns (3) and (4) excludes the graduates from a university located in a different region from the residence region. Columns (5) and (6) exclude the graduates who migrate from the original region of residence in the Southern regions and move to a region in the Northern regions.

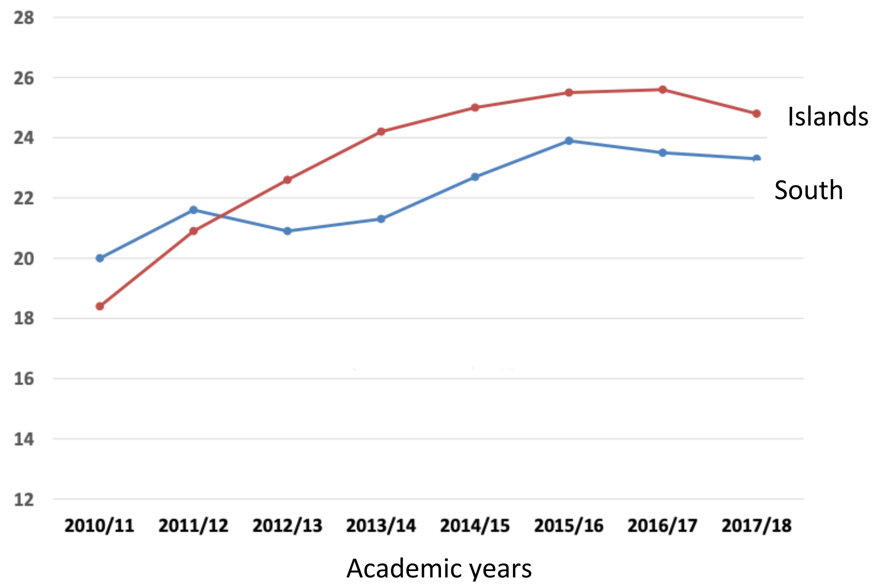
FIGURES

Figure 1: Map of Italy showing the outflow of students from their region of residence to other regions to get the degree



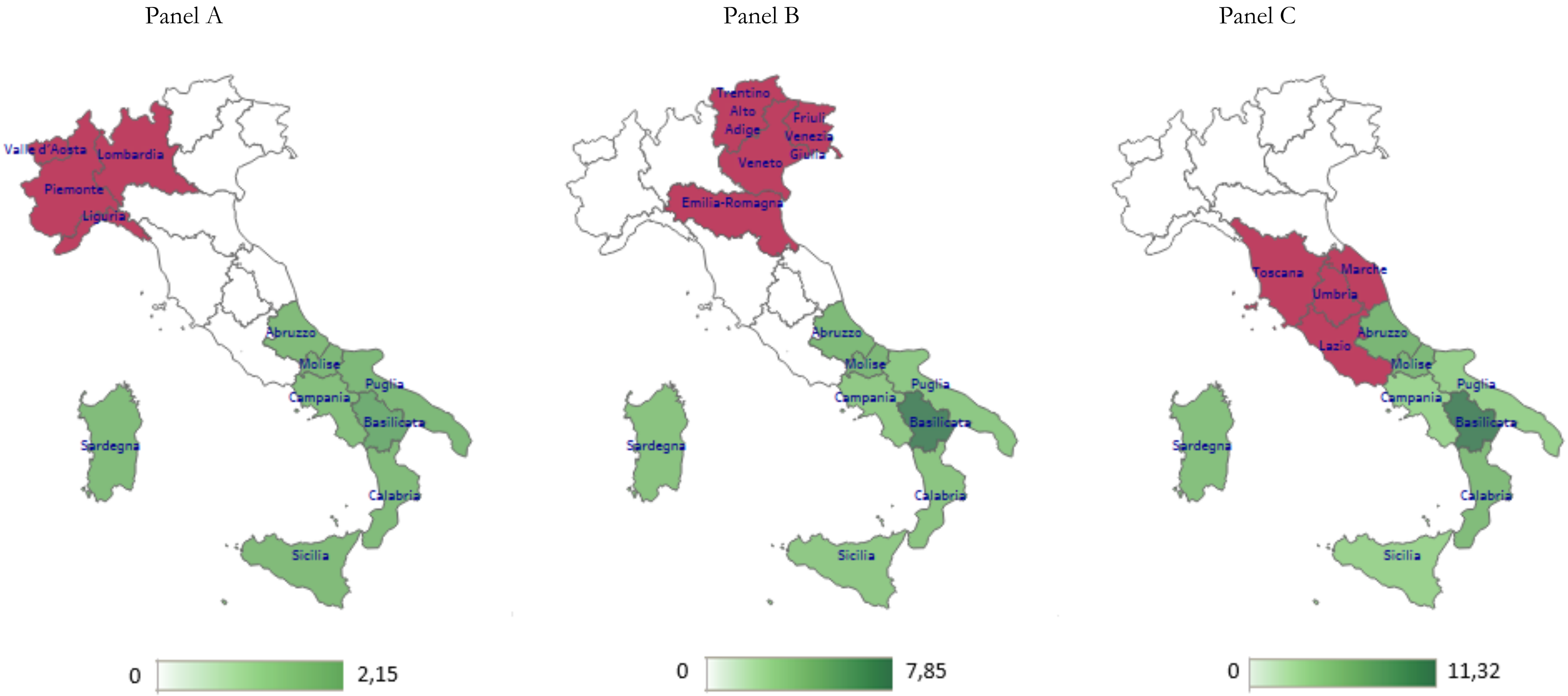
Note: It shows how many students in a certain region have graduated in other regions (i.e. it shows the outflow of students from this region to other places). Therefore regions with a dark shade in the figure are those regions with a high number of students that migrate to another region in order to enrol in the university and get the degree.

Figure 2: Mobility rate towards Northern universities of under 20 years old individuals from the Southern Italy



Source: National Agency for the Evaluation of Universities and Research Institutes

Figure 3: Map of Italy with the number of graduates who obtained the degree in the universities in the North-West, North-East and Central regions moving from the Southern Italy

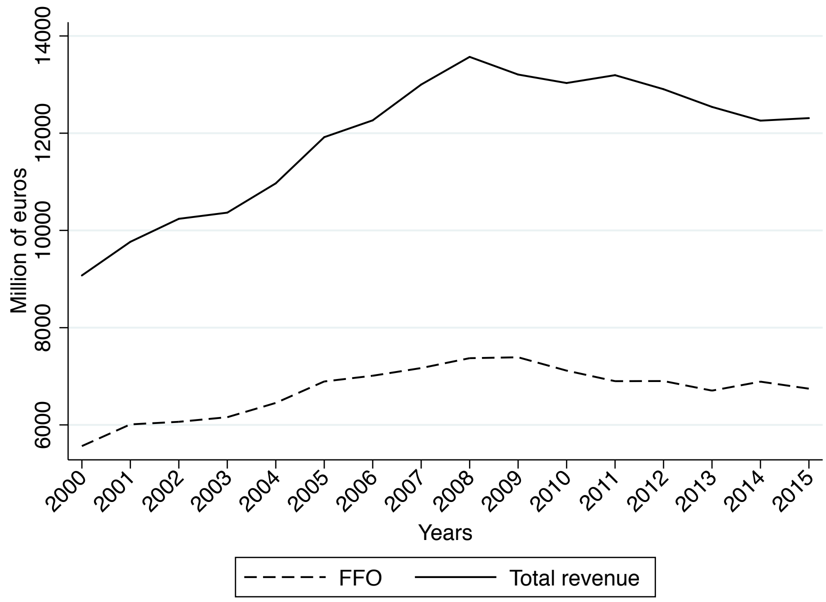


Note: It shows how many students in a certain region of the South of Italy have graduated in other regions of the Centre-North of Italy (i.e. it shows the outflow of students from regions in the South to other places located in Centre-Northern regions). Regions with a dark shade of Figure 3 are the regions in the South of Italy (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna) with a high number of students that migrate to another region of the North-West (Panel A – Valle d'Aosta, Lombardia, Piemonte and Liguria), North-East (Panel B – Trentino Alto Adige, Friuli Venezia Giulia, Veneto and Emilia-Romagna) and in the Centre (Panel C – Toscana, Marche, Umbria and Lazio) of Italy in order to enrol in the university and get the degree.

Figure 4: Map of Italy with the localization of the universities included in the data set.

Note: Author's elaboration

Figure 5: Distribution of FFO and Total Revenue of Italian universities



Source: own elaboration on data from the Ministry of Education, Universities and Research

[1] For a review of the effect of human capital migration (e.g. graduates) and its regional consequences (on both the receiving and the sending regions), see Faggian et al. (2017).

[2] Following Valero and Van Reenen (2019) and Cermeño (2019), we use gross domestic product per capita as a measure of local economic development as it well assesses the expansion of an area's economy. Since the question asked in this study regards the impact of students on local productivity, perhaps a more informative quantification could be the GDP per graduated students rather than GDP per capita, which may lop-side the information towards other influences on local productivity not related to the students. The main results are robust to the new specification of the dependent variable even though very different in magnitude. Therefore, we believe that GDP per capita still better represents the most appropriate dependent variable in our empirical framework.

[3] Each graduate i belonging to university j is assigned the gross domestic product per capita of the area k where the university is located. Due to the importance of capturing the contribution of higher education institutions to economic development at the local level, we use GDPC of the province (equivalent of NUTS3 level) instead of the region where the university is located. Results do not change when using GDPC at regional level.

[4] To further examine whether the results are sensitive to the choice of using GDPC in 2015, we measure GDPC in years 2013 (two years after the graduation), in year 2014 (three years after the graduation) and in 2016 (five years after the graduation). Results, available on request, are robust. With regard to the related literature, Carree et al. (2014) examine the contribution of universities to growth, evaluating teaching, research and intellectual property rights activities, and lag the graduates by one year to account for the transition to the labor market.

[5] Students may still be capable of thriving in a more streamlined academic environment, as universities with some resource slack reorganise their teaching activities in such a way as to preserve students' academic performance.

[6] Age at graduation proxies the age of students, as we do not have this information.

[7] With the implementation of the so-called 'Bologna Process', the Italian higher education system has been reformed by organising the curricula in two main cycles: a first cycle (upon completion of which a Bachelor's-level degree is obtained) geared to the employment market and lasting (at least) three years; and a second cycle (leading to a Master's-level degree, lasting two years) conditional upon the completion of the first cycle. There were still cycles of the old university system lasting at least four years for those students enrolled before the reform.

[8] Students can graduate obtaining marks from 66 to 110 with distinction.

[9] More specifically, it shows how many students in a certain region have graduated in other regions (i.e. it shows the outflow of students from this region to other places). Regions with a dark shade in the figure are those regions with a high number of students that migrate to another region in order to enrol in the university and get the degree.

[10] In both equation (2) and equation (3), we are assuming that the production function of universities does not change when we do not consider graduates who have migrated in order to enrol in the university. This is a critical point of the theoretical set-up that we have in mind. Indeed, it could be the case that academic staff workload and time dedicated to scientific research vary when fewer students are enrolled.

[11] More specifically, it shows how many students in a certain region of the South of Italy have graduated in other regions of the Centre-North of Italy (i.e. it shows the outflow of students from regions in the South to other places located in Centre-Northern regions). Regions with a dark shade of Figure 3 are the regions in the South of Italy (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna) with a high number of students that migrate to another region of the North-West (Panel A - Valle d'Aosta, Lombardia, Piemonte and Liguria), North-East (Panel B - Trentino Alto Adige, Friuli Venezia Giulia, Veneto and Emilia-Romagna) and in the Centre (Panel C - Toscana, Marche, Umbria and Lazio) of Italy in order to enrol in the university and get the degree.

[12] Indeed, they show that unadjusted and adjusted analyses may yield similar results on the basis of the large group sizes and the large full sample size.

[13] We are aware, however, that as also specified by Foster-Johnson and Kromrey (2018), if the focus is on individual-level variables then the Croon and van Veldhoven (2007) approach followed by White's correction yields somewhat better power rates.

[14] More specifically, ISTAT carries out the sample survey on university graduates' vocational integration by interviewing a sample of graduates who attained the university degree four years before. The survey aims at detecting graduates' employment conditions about four years after graduation. A large number of information is gathered through the survey: educational experience; access to the labor market; job search; family situation, referring both to the family of origin and to the current one at the time of the interview. It included approximately 50,000 graduates, interviewed by a mixed technique of a computer and assisted telephone (CAWI/CATI) interview with a response rate of 49.4% and 43.5% respectively. The sample is stratified and derived by dividing the population by gender, attended university and field of study and it represents about 17% of the cohort of 2011 Italian graduates (299,449 individuals). Both response rate and representativeness of the survey are similar to the previous ISTAT survey on Italian graduates used in the literature (see for instance, Ciriaci, 2013). ISTAT attributed a weight to each individual in the sample – the carry-over coefficient – namely, the number of units of the population of the original sample represented by the individual him/herself. More details on the survey available at https://www.istat.it/it/archivio/94564.

[15] To the best of our knowledge, few papers have explicitly considered the direct link between university presence and economic performance. Cermeño (2019) uses the distance to the closest research nuclear facility that took place in the USA between 1943 and 1970 to measure spatial spillovers generated by universities. Valero and Van Reenen (2019) estimate fixed effects models at the sub-national level as well as lagged university openings to measure the economic impact of universities. Kantor and Whalley (2019) use the late nineteenth-century establishment of agricultural experiment stations at pre-existing land-grant colleges across the United States to estimate the importance of proximity to research for productivity growth. Kantor and Whalley (2014) estimate local agglomeration spillovers from US research university activity, using university endowment values and stock market shocks as an instrument for university research spending. Cantoni and Yuchtman (2014) use distance from universities following the Papal Schism, an exogenous event which led to the founding of new universities in Germany, to measure the causal role played by medieval universities in 14th century in the commercial revolution. Abel and Deitz (2012) exploit exogenous variation in the characteristics of colleges and

universities to predict differences in higher education activities across metropolitan areas. Aghion et al. (2009) propose a series of political instruments (details of appointments to committees in legislatures) for different types of education spending to measure the effects of investments in college education. Andersson et al., 2004 use exogenous changes in the size of the universities to estimate the effect of the spatial decentralization of post-secondary education on regional development.

[16] More precisely the only endogeneity left would be due to the fact that the historical component of the funding is related to the economic development or to some characteristics of the universities in 1993 which are not automatically correlated to the current trend of the economy and university characteristics.

[17] The variable selected as the instrument meets the two essential conditions for validity (relevance and exogeneity). Indeed, the ordinary financing fund does influence the university production of graduates in equation (5), but they are not correlated with the error term $\varepsilon_{1\ i,j,t}$.

[18] The type of degree offered by Italian universities is very similar and almost all universities offer science and technology as well as social sciences and humanities degrees.

[19] Columns (2) and (4) summarize the results when the whole sample of graduates is used, Columns (6) and (8) when we exclude those students who have migrated from their region of residence to another region in order to enrol in the university and finally Columns (10) and (12) when we exclude graduates who have moved from a region in the south to a region in the north of the country in order to attend university. Columns 1, 3, 5, 7, 9 and 11 show the first stage regressions.

[20] An Italian national daily business newspaper.

[21] The idea to use such measure comes from the fact that in recent years, more and more numerous are the rankings published in the newspapers or technical reports available, covering several aspects of higher education and being particularly relevant considering that rankings have a strong impact on academic decision-making and behavior, and on the structure of the institutions, that higher education institutions are focusing on the criteria with the highest impact on the ranking, and that also students and graduates recruiters follow the hierarchy of institutions. We use this measure in order to separate the institutions according to an external source of evaluation and further analyze whether strongly considered and influential universities may make a higher contribution to local development.

[22] Columns (2) and (4) summarize the results when the whole sample of graduates is used, Columns (6) and (8) when we exclude those students who have migrated from their region of residence to another region in order to enrol in the university and finally Columns (10) and (12) when we exclude graduates who have moved from a region in the south to a region in the north of the country in order to attend university. Columns 1, 3, 5, 7, 9 and 11 show the first stage regressions.

[23] Columns (2) and (4) summarize the results when the whole sample of graduates is used, Columns (6) and (8) when we exclude those students who have migrated from their region of residence to another region in order to enrol in the university and finally Columns (10) and (12) when we exclude graduates who have moved from a region in the south to a region in the north of the country in order to attend university. Columns 1, 3, 5, 7, 9 and 11 show the first stage regressions.

[24] Of course we understand that having more private foundation around could increase the likelihood that a research team will participate to these processes. But it could be possible that a research team in area j could participate and win grants offered by a private foundation in area k (depending on the fact that some foundations are private entities operating on a non-profit basis, with full decision-making autonomy for the definition of their institutional mission).

[25] Results are reported only for the main estimates. Results for all specifications are available on request.

[26] Table A6 uses FFO as instrument and reports the estimates when using the all sample of graduates; Table A7 uses FFO as instrument and reports the estimates when using only those graduates who already entered the labor market in the same region where the university is located; Tables A8 and A9 use grants from foundations and student's fees as instruments and report estimates when using only those graduates who already entered the labor market in the same region where the university is located.

[27] A private non-profit institution for the development of business and industries in the south of Italy, whose aim is the study of the economy of the South of Italy to propose development programmes.