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HUMAN CAPITAL, GOOD GOVERNMENT AND ECONOMIC DEVELOPMENT: EVIDENCE FROM ITALIAN PROVINCES

ADALGISO AMENDOLA, CRISTIAN BARRA and
ROBERTO ZOTTI

Human capital, good government and economic development: Evidence from Italian provinces

Adalgiso Amendola[1], Cristian Barra[2], and Roberto Zotti[3]

[1]Department of Economics and Statistics, University of Salerno and CELPE -
adamendola@unisa.it
[2]Department of Economics and Statistics, University of Salerno and CELPE -
cbarra@unisa.it
[3]Department of Economics and Statistics "Cognetti de Martiis", University of Torino -
roberto.zotti@unito.it

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Abstract

Whether the increase in a region's economic activity could be at-
tributable to the presence of a university is an important issue in eco-
nomic geography. This paper uses the age of universities (some dating
back to the 11th and 12th century) along with grants from private foun-
dations and student's fees as instruments for human capital production,
to estimate the impact of universities' degree production on the economic
development in context of Italy. We furthermore test whether institutions,
in terms of voice and accountability, government effectiveness, regulatory
quality, rule of law, and corruption, may play an important moderating
role in the human capital production-local economic development rela-
tionship. The findings firstly reveal the beneficial effect of the university
system on local economic development through the gain in human cap-
ital. Secondly, we argue that the development of high quality legal and
administrative institutions is an important channel linking universities to
greater economic activity.

1   Introduction

In the last few years, the economic literature has seen a growing interest in the role of the universities in the areas where they are located, generating a discussion on whether the increase in a region's economic activity could be attributable to the presence of a university. Differently from an extensive literature on human capital - for instance years of schooling - and growth, more recent research has brought the attention to the impact of universities themselves. A general finding is that regions with more universities per capita in the past exhibit higher growth rates of gross domestic product (GDP) per capita in the long run (Valero and Van Reenen, 2019). Several are the channels through which this evidence could be potentially explained. To start with, universities provide education and training that raise the local stock of human capital, thus leading to higher economic development (Peterson and Hanusheck, 2013). Indeed, employers seem to be increasingly demanding workers with a graduate qualification and universities are producers of human capital and skilled workers (Wößmann, 2008). Moreover, universities also contribute to knowledge creation and innovation through research (Goldstein and Renault, 2004) and technology transfer activities, which may also contribute to spillover effects and regional competitiveness (Andrews, 2017).

Our work is firstly related to the few recent papers that, to the best of our knowledge, 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. Anderson 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. For Italy, Agasisti et al. (2019) use a system generalized method of moments along with some specific characteristics of the higher education funding system to handle endogeneity problems between the efficiency of universities and economic development to show that knowledge spillovers occur to areas that are in close geographical proximity to efficient universities. Amendola et al. (2020) use the historical quota of the government funding to the universities as an instrument for contemporaneous universities' degree production to predict beneficial effects of the university system on local economic development.

Our work is also related to the strength of the literature that has increasingly

looked for institutional and policy-related determinants of growth performance (Glaeser et al., 2004). Although being extensive, gaps remain, in particular with respect to the understanding of the transmission mechanisms between institutions and growth (see Rodríguez-Pose (2020) for a review of the recent progress in the comprehension of the role of institutions for development). Indeed, greater focus should be made on how institutions and government quality shape economic activity, especially, at sub-national level. The idea is that universities may contribute to make institutions work better. Our hypothesis is that, by defining incentives and constraints on human behaviour as well as by reducing uncertainty and information costs, institutions may influence the conditions for increasing local economic development. For instance, a less corrupted environment might encourage firms to invest more in economic activities and might foster investment in highly skilled workers. Thus, we claim that there is a direct effect of human capital production on economic development. But, in addition, there is also an indirect effect through the shaping of institutions where the universities are located. In other words, institutions may play an important moderating role in the human capital production-local economic development relationship.

This paper aims at contributing to the literature by proposing an empirical analysis of the impact of the performance of Italian universities on local GDP. Specifically, we address the following research questions: (i) Is there a statistical link between the universities' degree production and the economic development of the geographical area in which they operate? (ii) If so, what is the role of institutions in shaping the human capital production-local economic development relationship? We answer these questions by employing an econometric analysis which uses a dynamic panel model for the period 2006-2012. The data cover 53 public universities, clustered into 47 provinces (see Section 4 for more details on the geographical stratification of the sample).

More specifically, this paper firstly 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 provinces where the universities are located, 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. Our results show that human capital accumulation is positively correlated with a higher local GDP.

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. 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 age of the universities. We take advantage of the fact that some universities were established during the 11th and 12th century as local knowledge shocks. The expectation is that the establishment of a new university leads to later economic growth. As there is little reason to expect a direct effect of the age of the university (often founded before the twentieth century) on changes in local non-education sector wages as well as local economic development other than through university activity, we regard using age of the university as a compelling instrumental variable for contemporaneous university human capital production. Using this strat-

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egy, we can estimate the causal effect of university graduate human capital production on regions' economic development. Alternative instrumental variables strategies are also suggested such as the amount of grants that universities receive from private foundations and the revenue that universities receive in terms of student fees (more details are provided in Section 6). 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.

Thirdly, this paper uses the Institutional Quality Index (IQI) (Nifo and Vecchione, 2014) as a measure of institutional quality in order to test whether government quality matters in the university-local development nexus. The index, available at Italian province level, combines five domains (voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption), so the economic dimension of institutional quality can be taken into consideration. Results suggest that the development of high quality legal and administrative institutions is an important channel linking universities' activities to provincial economic development. More specifically, the paper underlines the importance of having a high level of endowment of social facilities and economic structures, a low degree of tax evasion and shadow economy, and a high control of corruption.

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 role played by the institutions. Section 4 describes the dataset. Section 5 details the empirical strategy. Section 6 summarizes the empirical evidence from both OLS and 2SLS estimates, also exploring the heterogeneity in the results. Finally, Section 7 concludes and offers some policy implications.

2   University's contribution to the economy

Universities can contribute to local economic development through their role of regional multipliers in determining the local and regional income expenditure-employment effects (Faggian and McCann, 2009a). Short and long-term effects have emerged as the core of the debate. More specifically, the short-term multiplier benefits are related to the entire flow of regional economic activities such as, for instance, the provision of goods and services to the universities, or the salaries and benefits of the workers in the related industries (short-term expenditure-based demand-side effects). More long-term multiplier effects are instead associated with the provision of university education and training. It raises the local stock of human capital (Peterson and Hanusheck, 2013), including knowledge creation and innovation through research and technology transfer activities (Drucker and Goldstein, 2007), which may also contribute to spillover effects and regional competitiveness (long-term knowledge-based supply-side effects).

In what follows, the paper focuses on the latter indirect effects through which universities can promote and support economic development in the areas in which they are located. There are several channels through which universities may affect growth including knowledge transfer through education and human resources development (i.e., the human capital of students and graduates), knowledge creation and regional innovation through research (i.e., publications) and finally, via technology transfer activities (i.e., the third mission).

The first channel is related to the supply of human capital. The presence of universities is considered a reason why some regions are more innovative than others (Simmie, 2002). Indeed, 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 Aamoucke, 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). 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 et al., 2006) and graduates are a critical mechanism through which the knowledge produced in the higher education system gets transferred into the labor market (Marinelli, 2013).

Knowledge spillovers from universities to firms also involve research published in scholarly journals. Indeed, 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). Despite the fact that this knowledge can be easily transferred at low cost (i.e., downloaded from the Internet) and therefore is not tied to a firm's location, proximity to high-output universities may be important for accessing research networks (Audretsch and Lehmann, 2005). Higher education institutions should, therefore, focus more on research activities to respond to regional needs (Chatterton and Goddard, 2000)

In addition to their traditional teaching and research activities, universities also aim to build links between research and business as part of their third mission, including through patents (Henderson et al., 1998), business incubators, collaboration agreements and spin-offs (Shane, 2002). Moreover, university researchers themselves produce innovations, sometimes in collaboration with local firms. Many empirical papers have found that universities increase local innovative capacity (Toivanen and Väänänen, 2016, Andrews, 2017, Watzinger et al., 2018).

The present paper aims to emphasize the first set of aspects concerning higher education - controlling for research and third mission activities - to the extent that academic institutions are recognized as engines of local development since they provide highly skilled human capital.

3   Human capital, institutions and growth

An additional aspect to take into account is that universities may sustain pro-growth institutions. Indeed, universities could promote strong institutions directly by providing a platform for democratic dialogue and sharing of ideas, through events, publications, or reports to policy makers. And indirectly, via their role as human capital producers. We argue that incremental investment in human development would impact economic growth positively in the presence of strong and functional institutions because additional stock tends to be employed in constructive and socially productive activities.

Since the nineties (North, 1990), the role of political and administrative contexts in affecting economic development and its capacity for growth has gained increasingly attention and many scholars have focused on the links between institutional quality (in terms, for instance, of well-defined property rights, respect for regulations, degree of corruption, and barriers to entry on markets) and economic results.

The relationship between human capital, institutions and economic development is still an open question in the literature as no clear-cut empirical evidence has been found on the channels through which institutions influence economic growth. Even though the consensus is that institutional quality matters (Ketterer and Rodríguez-Pose, 2018), and it is a plausible explanation of the divergent economic paths of sub-national territories. Human capital has been considered the basic source of growth, and the driver of democracy and improved institutions (Glaeser et al., 2004). Better institutions create a better environment and legal structure that favours investments and directs them towards activities able to ensure higher and faster economic growth and performance (Aron, 2000, Loayza et al., 2005, Bowen and De Clercq, 2008). The links between institutions and entrepreneurship (Bjørnskov and Foss, 2008) and entrepreneurship and economic growth (Bjørnskov and Foss, 2012) has been explored, with institutions playing a moderating role. Institutional differences are considered as a key factor in explaining the causes of growth and stagnation as well as disparities in productivity and accumulation of physical and human capital (Rodrik et al., 2004). Part of the literature underlines the role of sub-national institutions. Institutional quality determines the capacity of regions to compete (Annoni and Dijkstra, 2013, Huggins et al., 2014) and shapes differences in employment growth (Di Cataldo and Rodríguez-Pose, 2017), in entrepreneurship (Audretsch and Belitski, 2017, Fritsch and Wyrwich, 2018) and innovation capacity (Rodríguez-Pose and Di Cataldo, 2015). Indeed, local outcomes of national systems may differ across space, according to the particular configurations of institutional factors at local, especially at regional, levels (Rafiqui, 2010). The quality of government at regional level, especially government effectiveness and the fight against corruption, has been found as a key driver of economic performance, more that geographical factors (Ketterer and Rodríguez-Pose, 2018). There is evidence of a link between the quality of government and the capacity of regions to innovate (Rodríguez-Pose and Di Cataldo, 2015) as well as of a link between institutional quality at local level and productivity differentials (Lasagni et al., 2015).[1]

4 Data sources and stylized facts

First, we provide a brief description of the key variables, namely, university and territorial characteristics as well as institutional proxies. We then present stylized facts that motivate the subsequent econometric analysis.

4.1 University and territorial characteristics

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

Data related to the universities are collected from the National Committee for the Evaluation of the University System (CNVSU). The data set refers to 53 Italian public universities over the years 2006 to 2012. We exclude all private sector universities due

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[1]On the other hand, at country level, the relationship between education and institutions has been questioned considering that the effects found in the cross section of countries are not robust to including country fixed effects and exploiting within-country variation (Acemoglu et al., 2005). Moreover, at local level, it has been also showed that institutional differences within a country do not matter for economic performance and that institutions do not play a role in explaining regional differences in income per capita (Gennaioli et al., 2013).

to the absence of comparable data on various dimensions. We collect data on university students, graduates and academic staff. We also 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. All the above mentioned data are collected at university level and then aggregated at province level. Finally, the environmental variables used to estimate the local economic impact of universities are taken from the Italian National Institute of Statistics (ISTAT). Data are collected at province level. More details on the main variables used in the analysis as well as some descriptive statistics are provided in Section 5.

4.2 Quality of institutions

To select proxies for institutions affecting the human capital production-local economic development, this paper uses the IQI index (Nifo and Vecchione, 2014). The index, available at Italian province level, combines five domains (voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption), so the economic dimension of institutional quality can be taken into consideration. More specifically, (a) *Voice and accountability* takes in to account the participation in public elections, the phenomenon of associations, the number of social cooperatives and cultural liveliness (measured in terms of books published and purchased in bookshop); (b) *Government effectiveness*, measures the endowment of social facilities (e.g. education, healthcare and leisure) and economic structures (roads, railroads, ports, airports, energy, information and communication technology, banking) in Italian provinces as well as the administrative capacity of provincial and regional governments in relation to policies concerning health, waste management and the environment; (c) *Regulatory quality* captures the effectiveness of local administrators in promoting and protecting business activity, taking into account the degree of openness of the economy, business environment (including information on entrepreneurship, the job market, tax system, market competition, bureaucracy, cooperation between firms) and the economic structure (business density, business starts-up/mortality, local government employees); (d) *Rule of law*, summarizes data on crime against persons or property, on magistrate productivity, trial times, the degree of tax evasion and the shadow economy; finally, (e) *Control of Corruption* which is an inverse corruption index and it is based on three variables regarding crimes committed against the public administration, the number of local administrations overruled, and a composite index of corruption (proposed by Golden and Picci (2005)). All of the sub-indices are positively correlated with institutional quality. Descriptive statistics of the main institutional variables used in the analysis are provided in Section 5.

4.3 Stylized facts

Before conducting the econometric analysis, we present simple evidence indicative of the relationship between university human capital production and growth as well as of

the possible key role of government quality in the nexus between graduate production and economic development.

Figure 1 plots the number of university graduates (at province level) against the GDP per worker for all provinces in the sample used in the analysis. The scatter plot provides a prima facie evidence of the positive relationship between university human capital production and economic deveoplment of the provinces where the universities are located.

Figure 2, instead, plots the number of university graduates (at province level) against the GDP per worker, for provinces with high and low government quality classified by using the median level of the quality indicators. More specifically, attention is focused firstly of the Institutional Quality Index (Figure 2a) and then on five dimension of government quality such as Voice and Accountability, Government effectiveness, Regulatory quality, Rule of law and Control of corruption (Figures 2b, 2c, 2d, 2e and 2f, respectively). Considering the overall Institutional Quality Index (Figure 2a), it is clear that a higher production of graduates is associated with higher growth especially under high quality local governments. With regards to the dimension of the institutional quality, interestingly, the positive correlation between graduates and economic development is particularly evident for provinces characterized by a high level of Voice and Accountability (Figure 2b), Government effectiveness (Figure 2c) and Regulatory Quality (Figure 2d). Although the scatter plots provide evidence of raw correlations, preliminary evidence suggests that provinces in which are located universities with a higher production of human capital have a higher economic development as well as that institutions seem to play a role in the human capital production-economic development nexus.

5 Econometric analysis

This section sets up the main hypotheses to be tested in the empirical analysis, presents summary statistics for the sample used in the regressions, and explains the empirical model and estimation method.

5.1 Main testable hypothesis

The paper underlines the importance of the conventional teaching role of education institutions with the idea that highly educated individuals contribute positively to regional development by increasing the economy's knowledge base, consistently with the previous studies surveyed in the literature review suggesting that the flow of new tertiary-educated human capital is positively associated with local economic development. Moreover, as also stylized facts suggested, graduate human capital production may be particularly growth-enhancing under local governments with high quality. These consideration lead to the following hypothesis:

1. Universities positively affect the economic development of the area where they are located via knowledge transfer and graduate human capital production.

2. High quality legal and administrative institutions matter in the university-local development nexus, being an important channel linking universities to greater economic activity.

5.2 Empirical specification

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

$$lnGDPW_{it} = \beta_1 lnGRADUATES_{it} + \beta_2 UNIV_{CHARACT_{it}} + \beta_3 PROV_{CHARACT_{it}} + \tau_t + \epsilon_{it} \tag{1}$$

In equation (1) ln is the natural logarithm, $GDPW$ is gross domestic product per worker measured as the sum of the gross values of all units divided by workers in each province in which the university is located. $GRADUATES$ measures the flow of new tertiary-educated human capital, being the the number of graduates in year t. Subscript i refers to the province where the university is located.

$UNIV_{CHARACT}$ is a vector of university characteristics measured at log level. More specifically, we use two variables controlling for university outcomes other than the production of graduates. The first variable 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 (Lee, 2011, Wolszczak-Derlacz and Parteka, 2011, Duh et al., 2014). The second variable is 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). We also control for the amount of human resources used by the university for teaching activities and the quality of teaching using the total number of undergraduate students over the total number of academic staff members (*Students/Academic Staff*). The assumption is that an increasing student-academic staff ratio will have a negative impact on students' academic performance[2].

$PROV_{CHARACT}$ is a vector of regional variables measured at log level. We include the number of employed individuals at time t minus the number of employed individuals at time t-1 (*Labour growth*), intended to capture labor market effects (a similar control is used in Agasisti et al. (2019), Amendola et al. (2020)). We also use the amount of R&D expenditures, both in the private and public sector (*R&D expenditures*). Indeed, research and development activities, likewise patents, could be considered as new ideas and pieces of knowledge that may turn into innovation when commercially exploited. Moreover, innovation is fundamental to the economic growth of an area as well as knowledge and technological progress are among the main engines of economic dynamics (see Capello and Lenzi (2014) for more details on the role played by knowledge and innovation as drivers of regional economic growth)[3]. We finally 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)).

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

[3]R&D expenditures are not available at provincial level and it is, therefore, used at regional level

Finally, in order to control for the fact that the geographical areas of the country are characterized by different starting points of local economic development, as it is the case in Italy with its north/south gap, four macro area dummies have been also included taking the value of 1 if the province is located in North-western, North-eastern, Central, and Southern (control group) regions, respectively, and 0 otherwise. τ_t are year dummies controlling for time-specific effects and ϵ_{it} is an i.i.d. error term.

5.3 Summary statistics

Table 1 shows the descriptive statistics on the main variables used in the empirical analysis. See Figures A1, A2, and A3, in Appendix, for a graphical representation of the human capital production, economic development and the quality of the institutions at province level, respectively.

Universities in the southern regions have, on average, a lower number of graduates with respect to those in the northern regions. The north-central areas outperform the southern area also when considering the variables for the estimation of economic development. GDPW is much higher in the north than in the south of Italy. 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 labour growth than northern ones. Regional R&D expenditures are also much lower in the southern regions.

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 a worse student-academic staff ratio 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. 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.

With regard to the variables used to measure the quality of institutions, a clear pattern emerges having the southern regions lower values of all the government quality dimensions.

Finally, the average age of the universities in the North-East and Central regions is around four hundred years. On average, universities located in the central and north-west regions receive more grants from foundations followed by those located in the north-east and southern areas. Universities located in the north-east regions collect more revenue from student's fees.

6 Results

6.1 Baseline results: without the role of institutions

The baseline OLS results are presented in Table 2. In all regressions, standard errors are clustered at regional level[4]. The dependent variable is the gross domestic product

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[4]The standard errors of the coefficients have been clustered around the region in which the universities are located because the institutional setting and the economic dynamism, which are similar within the same kind of area, may affect the behaviour of higher education

per worker at province level. The main parameter of interest is β_1 in equation (1) which measures how human capital production of universities is correlated with economic development of the province where they are located.

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 GDPW by about 0.040 percent.

Regarding the influence of university characteristics, the student-academic staff ratio is negative and weakly 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, even though not 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, 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).

6.2 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

institutions located there.

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. 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). More specifically, we use as an instrument the age of the university[5]. As there is little reason to expect a direct effect of the age of the university (often founded before the twentieth century) on changes in local non-education sector wages as well as local economic development other than through university activity, we regard using age of the university as a compelling instrumental variable for contemporaneous university human capital production. The concept of university goes back to twelfth and early thirteenth centuries. Different were the reasons according to which that period was remarkable for the development of education. There was the need to make use of institutions where a large number of students could be trained to defend the dogma and the organisation of the church (universities trained lawyers and administrators employed in the massive organisation of the church institutions). Many universities, indeed, grow up from secular schools. Some of the universities were originally organised as educational guilds obtaining same kind of autonomy as any other. More importantly, their organization affected the progress and intellectual development of the whole Europe. In Italy, many universities were born during the twelfth and early thirteenth centuries (such as Bologna, Padova, Napoli, Parma, Pavia) as Figure 3 shows. The idea is that the age of the university, being a proxy of its reputation and prestige - a function of when the institutions were founded and how long their endowments have been able to grow - is exogenous to the future economic activity that may occur in the territories where they are located. We consider universities, especially those established during the twelfth, thirteenth and fourteenth centuries as local knowledge shocks. The expectation is that the establishment of a new university leads to later economic growth.

We also propose and verify the robustness of 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), Amendola et al. (2020) for a similar approach). We rely on some specific characteristics of the higher education funding system. More specifically, we use, alternatively, the amount of grants that universities receive from private foundations (Grants from foundations) and the revenue that universities receive in terms

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[5]We take the average age of the universities located in each province to take into account the possibility the more universities are located in a province. It could be argued that this is not a valid approach as there are provinces with very old and very new born universities. We claim this is not an issue as in almost all the cases there is only one university in each province being the only exception areas like Rome, Naples, or Milan where more than one university is located.

of student fees (Student's fees)[6].

With regard to the grants that universities receive from foundations[7], it could be argued 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. 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[8].

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[6]We use once more information on universities' balance sheets from the Ministry of Education, Universities and Research (https://ba.miur.it/index.php).

[7]Competitive research funding as well as those for development and investments coming from foundations play a significant role. Indeed, 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)

[8]The main assumption is that these types of funds (grants and student fees) do not impact

We estimate the following equations:

$$lnGDPW_{it} = \beta_1 lnGRADUATES_{it} + \beta_2 UNIV_{CHARACT_{it}} + \\ + \beta_3 PROV_{CHARACT_{it}} + \tau_t + \epsilon_{1it}$$ (2)

$$lnGRADUATES_{it} = \theta_1 INSTR_{it} + \theta_2 lnGDPW_{it} + \theta_3 UNIV_{CHARACT_{it}} + \\ + \theta_4 PROV_{CHARACT_{it}} + \tau_t + \epsilon_{2it}$$ (3)

The coefficient β_1 in equation (2) is the effect of interest to us. In equation (3), we formalize the effect that economic development has on university graduates, assuming that θ_1 is positive. From equations (2) and (3), it is easy to verify that the performance of universities might be correlated with the error term ϵ_{1it}.

Results are summarized in Table 3. Columns 2, 4 and 6 show the results when the age of the university, the grants from foundations and student's fees have been used as instruments, respectively. 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 and 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 (not reported in tables but available on request) provides sufficient evidence to reject the null hypothesis of exogeneity of our endogenous regressor. The small p-value indicates that OLS is not consistent, giving credit to our IV approach.

The empirical evidence suggests that the number of graduates, in two out of three 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 0.030 percent (although not statistically significant), 0.053 percent and 0.059 percent, respectively, when we use the age of the university (Table 3, column 2), the grants from foundations (Table 3, column 4), and the students' fees (Table 3, column 6). Estimates related to the university and regional characteristics do not change significantly.

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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 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.

6.3 Heterogeneity depending on geographical position and on the level of economic development

We further examine whether the effects of human capital production vary according to the geographical position of the universities as well as to the distribution of the measure of economic development.

Firstly, as Italy is a country characterized by an important north-south gap, we examine whether the results depend on the geographical location of the universities. To do this, we repeat the analysis by separating the provinces located in the northern and central-southern regions. Results, summarized in Appendix (Table A1) again suggest that the number of graduates, in all specifications, produces a positive and highly statistically significant effect on local economic development in the provinces where they are located[9]. In all the specifications, the instrumental variable positively and significantly influences the measure of human capital development (e.g. graduates). More specifically, a 1 percent increase in the number of graduates increases local development by a range between 0.035 and 0.060 percent when universities are located in the northern provinces (Table A1, columns 2, 6 and 10) and by a range between 0.111 and 0.122 percent when universities are located in the central-southern provinces (Table A1, columns 4, 8 and 12).

Secondly, 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 worker above the median) and the universities located in areas with low economic development levels (i.e. with a GDP per worker below the median). Results, summarized in Appendix (Table A2) again suggest that the number of graduates, in all specifications, produces a positive and highly statistically significant effect on local economic development in the provinces where they are located[10]. In all the specifications, the instrumental variable positively and significantly influences the measure of human capital development (e.g. graduates). No significant differences are detected between areas. More specifically, a 1 percent increase in the number of graduates increases local development by a range between 0.026 and 0.049 percent when universities are located in provinces with GDP per worker values below the median (Table A2, columns 2, 6 and 10) and by a range between 0.040 and 0.058 percent when universities are located in provinces with GDP per worker values above the median (Table A2, columns 4, 8 and 12)[11].

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[9]Columns 2, 4, 6, 8, 10 and 12 present the estimates when the age of the universities, the amount of grants that universities receive from foundations and the revenue that universities receive in terms of student fees are used as instruments, for Northern and central-Southern regions. Columns 1, 3, 5, 7, 9 and 11 show the first-stage regressions.

[10]Columns 2, 4, 6, 8, 10 and 12 present the estimates when the age of the universities, the amount of grants that universities receive from foundations and the revenue that universities receive in terms of student fees are used as instruments, for universities located in high and low GDPW provinces. Columns 1, 3, 5, 7, 9 and 11 show the first-stage regressions.

[11]The only exception when the grants from foundations is used as instrument, the effect of graduates is positive but not statistically significant for those provinces with a low level of economic development (Table A2, column 6).

6.4 The role of institutions

6.4.1 Institutions affecting economic development

We now test the hypothesis that institutions may play a role in the human capital production - economic development nexus. To measure the quality of institutions at province level, we use the IQI index (Nifo and Vecchione, 2014), that combines five different domains - voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption - along with each domain used separately. To do this, we repeat the analysis by separating the universities located in provinces with a high index of government quality (i.e. with a IQI index above the median) and the universities located in provinces with a low index of government quality (i.e. with a a IQI index below the median). The same applies for each single domain of the institution quality index.

Tables 4 summarizes the results, for the aggregate IQI index, when the age of the university is used as instrument (Columns 1-4). Using the five dimensions of the index, we also calculate two additional aggregate indices based on the mean of the separate dimension of institutional quality (Columns 5-8) and on a computation using the principal component analysis (Columns 9-12), respectively[12]. Table A3, in Appendix, report the results when Grants from foundations and Students' fees are used as instrument. When the aggregate IQI index is used, which combines the five domain above discussed, the empirical evidence shows that human capital production seems to be more important for provinces with a level of aggregate institutional quality below the median. Indeed, a 1 percent increase in the number of graduates increases local development by 0.108 percent, when universities are located in the provinces with values of IQI index below median (Table 4, column 2). Human capital production has still a positive coefficient, but with lower magnitude and statistical significance - a 1 percent increase in the number of graduates increases local development by 0.029 percent - for universities located in the provinces with values of IQI index above median (Table 4, column 4). Results are confirmed when using alternative indices such as the mean of the five domains (Table 4, Columns 6 and 8) and the measure based on the principal component analysis (Table 4, Columns 10 and 12). We also repeat the analysis using Grants from foundations and Students' fees as instrument. Results suggest that the number of graduates, in all specifications, produce a positive and highly statistically significant effect on local economic development both in the provinces with values of IQI index below and above the median (see Table A3 in the Appendix).

6.4.2 Institutions, or income levels?

Although government quality appears to matter in the human capital production-local economic development nexus, because high-income provinces tend to have higher quality institutions, the result may simply reflect the different growth effects of this human capital production across different income levels. To explore this possibility, we first classify provinces into those with high-and low quality of the institutions. And then, within provinces with high-and low quality of the institutions, we further separate the universities located in areas with high economic development levels (i.e.

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[12]Columns 2, 4, 6, 8, 10 and 12 present the IV estimates. Columns 1, 3, 5, 7, 9 and 11 show the first-stage regressions.

with a GDP per worker above the median) and the universities located in areas with low economic development levels (i.e. with a GDP per worker below the median).

The results are summarized in Table 5 when the Age of the university is used as instrument. Tables A4 and A5, in Appendix, report the results when Grants from foundations and Students' fees are, instead, used as instruments. Columns 2 and 4 of Table 5 show that, for provinces with quality of institutions below the median level, human capital production tends to foster growth regardless of income level, suggesting that income levels themselves appear to have limited impact on the growth effects of human capital production, as long as the level of government quality is controlled for. Columns 6 and 8 of Table 5, instead, show the results for provinces with quality of institutions above the median level. The number of graduates has a positive and statistically significant effect on economic development only for those universities located in provinces with high economic development levels. This result suggests that income level still plays an important role on the growth effects of human capital production, also when the level of government quality is controlled for, in case of provinces characterized by a high level of government quality. Results are confirmed when the Grants from foundations are used as instrument (Table A4 in Appendix). When the Student's fees are used as instrument (Table A5 in Appendix), the empirical evidence suggests that human capital production tends to foster growth regardless of income level, as long as the level of government quality is controlled for, for both provinces with government quality below and above the median level[13].

6.4.3   Does the type of institution matter?

So far, we have considered the role of the institutions using an aggregate index (being a combination of five different domains). In order to shade more light on the different channels through which institutions may be playing a role, we estimate again equations (2) and (3) using, separately, voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption as proxies of the quality of the institutions.

Tables 6 and 7 present the results when the age of the university is used as instrument. More specifically, Table 6 summarizes the results for Voice and accountability (Columns 1-4) and Government effectiveness (Columns 5-8) while Table 7 presents the results for Regulatory quality (Columns 1-4), Rule of Law (Columns 5-8) and Control of corruption (Columns 9-12)[14]. Tables A6, A7, A8 and A9 in Appendix, report the results when Grants from foundations and Students' fees are used as instruments.

Table 6 (Column 8) and Table 7 (Columns 8 and 12) indicate that the quality of government, measured through Government effectiveness, Rule of Law and Control of Corruption, plays an important role in the human capital production-local economic development under high quality institutions (above the median level). Indeed, a 1 percent increase in the number of graduates increases local development by 0.039, 0.069 and 0.042 percent, respectively. Whereas under low quality governments (below the median level), it does not have a significant effect for either proxies (Table 6, Column 6, and Table 7, Columns 6 and 10).

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[13]Due to the sample split, results are obtained on few observations for each of the sub-sample also causing low value of the F-test in the IV estimation. The role of income level should be further strengthened with additional analyses.

[14]Columns 2, 4, 6 and 8 in Table 6 and Columns 2, 4, 6, 8, 10 and 12 in Table 7 present the IV estimates. Columns 1, 3, 5 and 7 in Table 6 and Columns 1, 3, 5, 7, 9 and 11 in Table 7 show the first-stage regressions.

Results do not show significant differences when Voice and accountability is used as a measure of institutions quality. Indeed, a 1 percent increase in the number of graduates increases local development by 0.057 percent when universities are located in the provinces with values of Voice and accountability below median (Table 6, column 2) and by 0.044 percent when universities are located in the provinces with values of Voice and accountability above median (Table 6, column 4).

The opposite result is, instead, reached, when the quality of institutions is measured through Regulatory quality. Indeed, a 1 percent increase in the number of graduates increases local development by 0.078 percent, when universities are located in the provinces with values of Regulatory quality below median (Table 7, column 2) while it does not have a significant effect for universities located in the provinces with values of Regulatory quality above median (Table 7, column 4).

7 Conclusions and policy implications

7.1 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 test the hypothesis that institutions may play an important moderating role in the human capital production-local economic development relationship. 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.

From OLS estimates, results show a positive association between human capital development (i.e., number of graduates) and GDPW 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. To deal with this endogeneity problem, a 2SLS approach has been used, instrumenting the number of graduates with the age of the universities. Being a century-old university, a good proxy of its reputation and prestige as some universities were established during the 11th and 12th century - we argue also independent both to the current performances of the universities and to economic development, does not impact local economic development directly, but only by positively affecting the production of graduates (by attracting the best students and academic staff). Alternative instrumental variables strategies are also suggested such as the amount of grants that universities receive from private foundations and the revenue that universities receive in terms of student fees. Once we control for the 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.

When the quality of institutions is taken into account, the empirical evidence indicates that the quality of government, measured through Government effectiveness, Rule of Law and Control of Corruption, plays an important moderating role in the human capital production-local economic development relationship. Indeed, human capital production positively affect growth only for universities located in provinces characterized by a high level of endowment of social facilities and economic structures,

by a low degree of tax evasion and shadow economy and finally by a higher control of corruption.

7.2   Policy implications

Several limitations as well as implications and future lines of research can be derived from our analyses.

A first limitation of the analysis is related to data constraints. Indeed, we claim that not only university human capital production directly affects local economic development, but also indirectly through the shaping of institutions where the universities are located. Of course, it could be argued, and we agree with that, that this process may take a long time and we should therefore better claim this process using data on a longer time-span.

Secondly, we claim to offer a solution to the concern that if knowledge spillovers are present in different directions such that local territories benefit from the presence of highly productive universities much as the higher education institutions do from the presence of highly innovative and developed territories. However, endogeneity may also arise from the fact that local areas benefit from the better quality of local government as well as the quality of government is also higher due to fast growing and more developed territories (e.g. more productive firms are located by). This complicated relationship - universities, institutions and local economic development, deserves to be further examined, both theoretically and econometrically, in future studies.

Thirdly, since the research question of the study regards the impact from graduates on local productivity, perhaps a more informative quantification could be the GDP per graduated students rather than GDP per worker, which may lop-side the information towards other influences on local productivity not related to the students. Moreover, it could be questioned whether GDP per worker is good measure of local economic development. We believe that using gross domestic product per worker is a good measure of local economic development as it assesses the expansion of an area's economy. The same output has already been used in the related literature that considered the direct link between university presence and economic performance (see, among others Valero and Van Reenen (2019) and Cermeño (2019)). It is true that other possible measure such as employment growth or wage growth could be also used. For instance Crespo et al. (2020) analyze the impact of the university system performance on labor productivity growth for Spanish provinces. Further work is needed to incorporate such measures in the analysis.

Several implications can also be derived from our analysis.

First, the findings confirm the conclusions of existing empirical studies on the causal localized knowledge spillovers due to the presence of universities (Cermeño (2019), Kantor and Whalley (2014, 2019) for the United States; Cantoni and Yuchtman (2014) for Germany; Anderson et al. (2004) for Sweden; Agasisti et al. (2019), Amendola et al. (2020) for Italy; Valero and Van Reenen (2019) for a worldwide analysis).

Secondly, the empirical evidence suggests the importance of measuring the development of human capital and skills to better understand the mechanism behind the local economic development activities of the universities. Controlling for the possible effect of making innovations and publications (for which little or no effect is found), the paper argues that human capital production is the main channel affecting local economic development. Unfortunately, the data used in the analysis does not allow to say anything on the demand effects. Of course, it has to be kept in mind that

incentives and funding models acknowledge the multiple missions of universities and that universities not only supply knowledge outputs, such as graduates and research papers, but are also involved in collaborations with private firms through licensing and spin-offs.

Thirdly, government institutions make a difference and are identified as potential elements shaping the growth-enhancing potential of the universities on the territories where they are located. Indeed, institutions play an important moderating role in the human capital production-local economic development relationship. Results underline the importance of the level of endowment of social facilities and economic structures suggesting that those environment conditions may guarantee a high level of assimilation of the human capital and skills introduced by the universities in the market being crucial for university-firm level relationship. In the same direction, having a strong protection of intellectual property rights intensifies the incentives to invest in human capital. Local territories with governments that are capable of designing and implementing effective policies and keeping corruption below certain levels, represent an important channel linking universities and greater economic activity. In conclusion, in presence of a strong institutional environment, the effect of university human capital production on local economic development is raised suggesting that high government quality will facilitate the connection between organizations, higher education institutions and firms, providing the right incentives and generating the adequate environment for universities to supply knowledge outputs.

Fourthly, results also suggest to use the five domains (voice and accountability, government effectiveness, regulatory quality, rule of law, and control of corruption) along with the aggregate quality of government index, when testing the hypothesis that institutions may play a role in the human capital production - economic development nexus.

Finally, the empirical evidence shows that the effects of human capital production on local economic development is stronger in central-southern than in the northern regions. This result support the idea that investing in tertiary education could be considered an additional policy instrument that southern regions may use to foster local economic development to the extent that the activities performed in such institutions may possibly decrease the large territorial disparities in the country.

Our research opens the way to future interesting extensions. One immediate extension would be to further test the role played by the context in which the firm operates-in terms of the quality of institutions—and assess the connection between regional quality of government and the university-firm relationship.

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Tables

Table 1: Descriptive statistics by macro-areas of country and for the whole Italy

	North-East	North-West	Centre	South	Italy
GDPW	60.4730	61.7398	56.1393	48.1123	54.9144
	(2.5846)	(5.7976)	(5.0013)	(3.8832)	(7.1970)
Graduates	3,873.38	2,951.48	3,591.22	2,912.77	3,275.82
	(3,082.81)	(1,829.77)	(2,516.81)	(1,905.02)	(2,358.17)
Publications/Academic staff	1.1801	1.2768	1.0584	0.8951	1.0589
	(0.5330)	(0.5038)	(0.4319)	(0.2523)	(0.4375)
Paents/Academic staff	0.0071	0.0111	0.0068	0.0047	0.0068
	(0.0047)	(0.0109)	(0.0055)	(0.0045)	(0.0067)
Student/Academic staff	26.4653	27.5076	29.5574	34.2704	30.3729
	(3.7249)	(6.7174)	(6.0075)	(7.7876)	(7.2772)
R&D expenditures	1,333,270.47	3,227,055.21	1,340,906.55	500,823.22	1,338,544.13
	(647,446.83)	(1,304,052.47)	(1,107,979.53)	(382,701.01)	(1,264,931.05)
Labour growth	0.0026	0.0039	0.0037	-0.0048	0.0002
	(0.0214)	(0.0224)	(0.0208)	(0.0325)	(0.0265)
Population density	312.81	512.85	209.96	297.16	319.11
	(283.65)	(554.32)	(190.36)	(564.62)	(459.58)
Control of corruption	0.9046	0.8784	0.9195	0.7147	0.8290
	(0.1019)	(0.0713)	(0.0750)	(0.2164)	(0.1765)
Government effectiveness	0.5859	0.5086	0.3913	0.2636	0.4040
	(0.1522)	(0.0913)	(0.2146)	(0.0839)	(0.1896)
Regulatory quality	0.5789	0.5203	0.5786	0.3167	0.4660
	(0.1344)	(0.1146)	(0.0994)	(0.1746)	(0.1869)
Rule of Law	0.4872	0.5185	0.7317	0.5101	0.5548
	(0.1207)	(0.1639)	(0.1317)	(0.2212)	(0.1984)
Voice and accountability	0.5245	0.5278	0.5014	0.3072	0.4350
	(0.1174)	(0.2011)	(0.1338)	(0.0951)	(0.1670)
IQI index	0.7220	0.6794	0.7246	0.4050	0.5911
	(0.0821)	(0.0946)	(0.1532)	(0.1763)	(0.2067)
IQI index (pca)	1.1287	0.7641	0.9364	-1.4869	0.0000
	(0.5580)	(0.8203)	(0.9769)	(1.3295)	(1.5857)
IQI index (mean)	0.6162	0.5907	0.6245	0.4225	0.5378
	(0.0407)	(0.0563)	(0.0753)	(0.1126)	(0.1255)
Age of university	453.80	215.56	435.00	184.55	305.55
	(404.52)	(246.83)	(298.66)	(196.34)	(310.39)
Grants from foundations	1,492,714.51	1,783,723.43	2,295,345.63	335,370.29	1,264,935.96
	(1,880,676.85)	(1,377,954.68)	(3,694,941.81)	(576,592.66)	(2,186,028.15)
Student's fees	38,889,156.61	30,433,605.78	29,105,566.52	22,784,566.07	28,989,962.32
	(33,292,613.93)	(19,083,271.96)	(20,880,910.01)	(40,902,875.93)	(32,904,729.29)
Obs.	70	56	70	126	322

Note: Standard deviations in brackets

Table 2: The relationship between university graduates
and local economic development – OLS estimates - Years 2006-2012

Dep. Var: GDPW	(1)
Graduates	0.040***
	(0.010)
Publications/Academic Staff	-0.019*
	(0.010)
Patents/Academic Staff	0.002
	(0.002)
Students/Academic Staff	-0.086*
	(0.048)
R&D expenditures	-0.017
	(0.013)
Labour growth	0.236
	(0.162)
Population density	0.028*
	(0.016)
Constant	3.941***
	(0.241)
Macro area fixed effects	Yes
Year fixed effects	Yes
Obs.	276

Note: Standard errors, clustered at regional level, in brackets
* p <0.10, ** p <0.05, *** p <0.01

Table 3: The effect of university graduates on local economic development – IV strategy - Years 2006-2012

Dep. Var.: GDPW	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)
	(1)	(2)	(3)	(4)	(5)	(6)
Graduates		0.030		0.053***		0.059***
		(0.026)		(0.018)		(0.011)
Age of the university	0.001***					
	(0.000)					
Grants from foundations			1.21e-07***			
			(3.75e-08)			
Student's fees					1.85e-08***	
					(4.46e-09)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F	26.96		10.51		17.19	
(p)	0.0001		0.0045		0.0006	
Obs.	276	276	276	276	276	276

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: The effect of university graduates on local economic development – The role of institutions – IQI index – Years 2006-2012

	IQI index				IQI index (Mean)				IQI index (PCA)			
	Below-median		Above-median		Below-median		Above-median		Below-median		Above-median	
Dep. Var.: GDPW	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)
Graduates		0.108***		0.029*		0.110***		0.024		0.107***		0.021
		(0.025)		(0.016)		(0.022)		(0.016)		(0.020)		(0.013)
Age of the university	0.001***		0.0008***		0.001***		0.0008***		0.001***		0.0009***	
	(0.0002)		(0.0001)		(0.0002)		(0.0002)		(0.0002)		(0.0001)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	40.29		21.32		56.48		17.72		68.46		25.52	
(p)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Obs.	123	123	147	147	126	126	144	144	125	125	145	145

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Table 5: The effect of university graduates on local economic development – The role of income - Years 2006-2012

	IQI index – below median				IQI index – above median			
	Below-median GDP		Above-median GDP		Below-median GDP		Above-median GDP	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
Dep. Var:: GDPW	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.076**		0.050**		-0.147		0.035**
		(0.031)		(0.022)		(0.242)		(0.014)
Age of the university	0.001***		0.0009**		0.0002		0.001***	
	(0.0002)		(0.0003)		(0.0004)		(0.0001)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	29.09		5.87		0.42		48.42	
(p)	0.0000		0.0196		0.5183		0.0000	
Obs.	63	63	60	60	62	62	85	85

Note: Standard errors, clustered at regional level, in brackets; * p $<$0.10, ** p $<$0.05, *** p $<$0.01

Table 6: The effect of university graduates on local economic development – The role of institutions – IQI index components – Years 2006-2012

	Voice and accountability				Government effectiveness			
	Below-median		Above-median		Below-median		Above-median	
Dep. Var:: GDPW	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.057***		0.044***		0.034		0.039***
		(0.022)		(0.011)		(0.025)		(0.012)
Age of the university	0.001***		0.001***		0.001***		0.001***	
	(0.0001)		(0.0001)		(0.0002)		(0.0001)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	67.03		65.64		34.78		56.75	
(p)	0.0000		0.0000		0.0000		0.0000	
~								
Obs.	126	126	144	144	126	126	144	144

Note: Standard errors, clustered at regional level, in brackets; * p $<$0.10, ** p $<$0.05, *** p $<$0.01

Table 7: The effect of university graduates on local economic development – The role of institutions - IQI index components - Years 2006-2012

	Regulatory quality				Rule of Law				Control of Corruption			
	Below-median		Above-median		Below-median		Above-median		Below-median		Above-median	
	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)
Dep. Var.: GDPW	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Graduates		0.078*** (0.016)		0.019 (0.013)		0.015 (0.016)		0.069*** (0.023)		0.024 (0.019)		0.042*** (0.015)
Age of the university	0.001*** (0.0001)		0.0008*** (0.0001)		0.001*** (0.0001)		0.001*** (0.0002)		0.001*** (0.0001)		0.001*** (0.0001)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	101.89		26.34		60.32		33.86		78.18		35.42	
(p)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Obs.	133	133	137	137	139	139	131	131	122	122	148	148

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figures

Figure 1: GDP per worker and university human capital production at province level
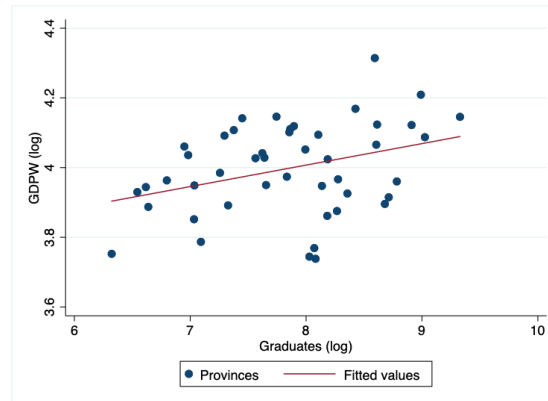
Figure 2: GDP per worker and university human capital production at province level

(a)   (b)

(c)   (d)

(e)   (f)

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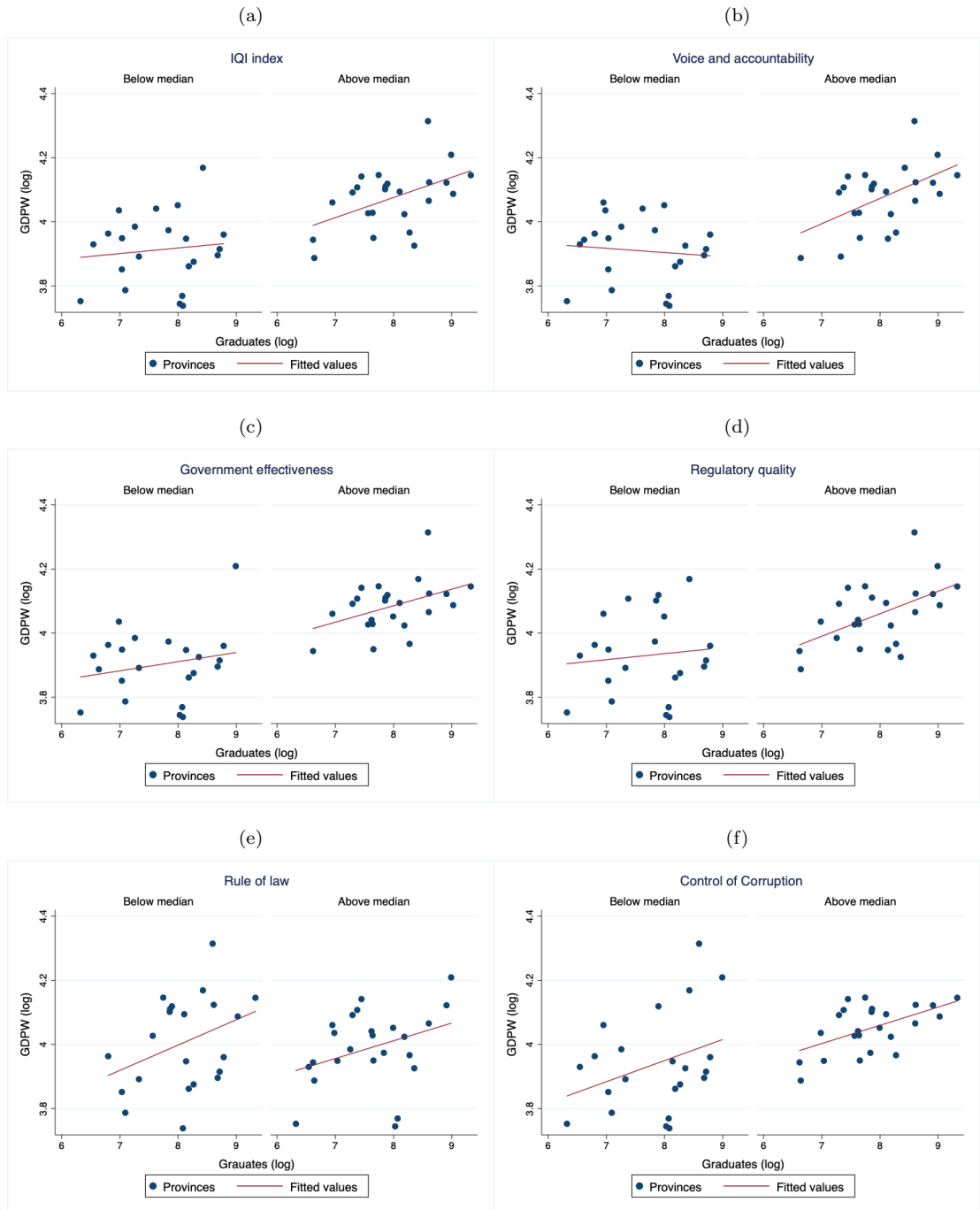
Figure 3: Universities by year of foundation

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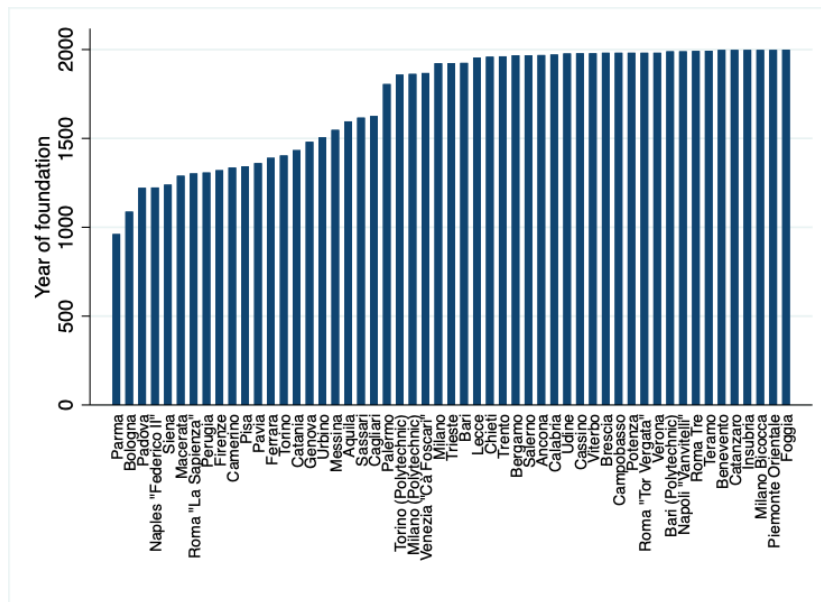
Appendix: Tables and Figures

Table A1: The effect of university graduates on local economic development – Territorial differences - Years 2006-2012

	North		Centre-South		North		Centre-South		North		Centre-South	
Dep. Var.: GDPW	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)
Graduates		0.035***		0.122***		0.060***		0.114**		0.039***		0.111***
		(0.010)		(0.045)		(0.015)		(0.045)		(0.008)		(0.024)
Age of the university	0.001***		0.0008***									
	(0.0001)		(0.0001)									
Grants from foundations					1.83e-07***		8.42e-08***					
					(3.35e-08)		(2.23e-08)					
Student's fees									1.86e-08***		1.70e-08***	
									(8.60e-10)		(2.15e-09)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	106.14		19.82		29.70		14.33		465.46		62.45	
(p)	0.0000		0.0000		0.0000		0.0002		0.0000		0.0000	
Obs.	108	108	162	162	108	108	168	168	108	108	168	168

Note: Standard errors, clustered at regional level, in brackets; * p $<$0.10, ** p $<$0.05, *** p $<$0.01

Table A2: The effect of university graduates on local economic development – Different levels of GDPW - Years 2006-2012

	Below-median		Above-median		Below-median		Above-median		Below-median		Above-median	
Dep. Var.: GDPW	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)
Graduates		0.044**		0.040***		0.026		0.058***		0.049***		0.041***
		(0.018)		(0.010)		(0.023)		(0.016)		(0.016)		(0.0089)
Age of the university	0.001***		0.001***									
	(0.0002)		(0.0001)									
Grants from foundations					$1.79e\text{-}07$***		$9.97e\text{-}08$***					
					$(4.49e\text{-}08)$		$(1.81e\text{-}08)$					
Student's fees									$1.63e\text{-}08$***		$1.93e\text{-}08$***	
									$(2.57e\text{-}09)$		$(9.60e\text{-}10)$	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	43.10		117.03		15.91		30.44		40.26		402.69	
(p)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Obs.	128	128	142	142	134	134	142	142	134	134	142	142

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: The effect of university graduates on local economic development – The role of institutions – IQI index – Years 2006-2012

	IQI index				IQI index			
	Below-median		Above-median		Below-median		Above-median	
Dep. Var.: GDPW	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.093**		0.047***		0.059***		0.039***
		(0.041)		(0.012)		(0.013)		(0.008)
Grants from foundations	1.53e-07***		1.12e-07***					
	(5.55e-08)		(1.87e-08)					
Student's fees					3.65e-08***		1.49e-08***	
					(3.52e-09)		(1.29e-09)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	7.65		36.04		107.36		133.69	
(p)	0.0067		0.0000		0.0000		0.0000	
Obs.	129	129	147	147	129	129	147	147

Note: Standard errors, clustered at regional level, in brackets; * p <0.10, ** p <0.05, *** p <0.01

Table A4: The effect of university graduates on local economic development – The role of income – Years 2006-2012

Dep. Var.: GDPW	IQI index – below median				IQI index – above median			
	Below-median GDP		Above-median GDP		Below-median GDP		Above-median GDP	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.228		0.044***		-0.002		0.064***
		(1.485)		(0.015)		(0.014)		(0.024)
Grants from foundations	-2.27e-08		1.84e-07***		1.38e-07***		8.96e-08***	
	(1.59e-07)		(4.78e-08)		(4.00e-08)		(2.59e-08)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	0.02		14.88		11.85		11.98	
(p)	0.8870		0.0004		0.0012		0.0009	
Obs.	69	69	60	60	62	62	85	85

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: The effect of university graduates on local economic development – The role of income - Years 2006-2012

	IQI index – below median				IQI index – above median			
	Below-median GDP		Above-median GDP		Above-median GDP		Below-median GDP	
	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
Dep. Var.: GDPW	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.036**		0.031***		0.026**		0.044***
		(0.015)		(0.011)		(0.010)		(0.010)
Student's fees	4.45e-08***		2.37e-08***		1.06e-08***		1.68e-08***	
	(5.19e-09)		(4.17e-09)		(2.91e-09)		(8.82e-10)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	73.50		32.23		13.21		364.68	
(p)	0.0000		0.0000		0.0007		0.0000	
Obs.	69	69	60	60	62	62	85	85

Note: Standard errors, clustered at regional level, in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: The effect of university graduates on local economic development – IQI index componenents - Years 2006-2012

	Voice and accountability				Government effectiveness			
	Below-median		Above-median		Below-median		Above-median	
Dep. Var.: GDPW	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.122**		0.060***		0.061		0.059***
		(0.059)		(0.015)		(0.045)		(0.013)
Grants from foundations	1.52e-07**		9.30e-08***		2.08e-07**		1.21e-07***	
	(6.74e-08)		(1.75e-08)		(8.09e-08)		(1.87e-08)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	5.07		28.32		6.60		41.75	
(p)	0.0262		0.0000		0.0115		0.0000	
Obs.	132	132	144	144	131	131	145	145

Note: Standard errors, clustered at regional level, in brackets; * p <0.10, ** p <0.05, *** p <0.01

Table A7: The effect of university graduates on local economic development – IQI index componenents – Years 2006-2012

Dep. Var.: GDPW	Regulatory quality				Rule of Law				Control of Corruption			
	Below-median		Above-median		Below-median		Above-median		Below-median		Above-median	
	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)
Graduates		0.020		0.049***		0.086**		0.064***		0.100*		0.052***
		(0.033)		(0.010)		(0.035)		(0.021)		(0.051)		(0.014)
Grants from foundations	1.83e-07***		1.30e-07***		1.39e-07***		1.17e-07***		1.98e-07**		1.23e-07***	
	(5.84e-08)		(1.88e-08))		(3.68e-08)		(2.09e-08)		(8.56e-08)		(1.80e-08)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	9.85		47.86		14.21		31.29		5.33		46.61	
(p)	0.0021		0.0000		0.0003		0.0000		0.0228		0.0000	
Obs.	138	138	138	138	139	139	131	131	128	128	148	148

Note: Standard errors, clustered at regional level, in brackets; * p $<$0.10, ** p $<$0.05, *** p $<$0.01

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Table A8: The effect of university graduates on local economic development – IQI index componenents - Years 2006-2012

	Voice and accountability				Government effectiveness			
	Below-median		Above-median		Below-median		Above-median	
Dep. Var.: GDPW	First-stage (1)	IV (1)	First-stage (2)	IV (2)	First-stage (3)	IV (3)	First-stage (4)	IV (4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduates		0.061***		0.049***		0.081***		0.047***
		(0.021)		(0.007)		(0.022)		(0.007)
Student's fees	1.37e-08***		1.93e-08***		1.46e-08***		2.07e-08***	
	(2.41e-09)		(1.03e-09)		(2.44e-09)		(1.12e-09)	
University characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro area fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	32.15		353.40		35.58		341.92	
(p)	0.0000		0.0000		0.0000		0.0000	
Obs.	132	132	144	144	131	131	145	145

Note: Standard errors, clustered at regional level, in brackets; * p <0.10, ** p <0.05, *** p <0.01

Table A9: The effect of university graduates on local economic development – IQI index componenents – Years 2006-2012

Dep. Var.: GDPW	Regulatory quality				Rule of Law				Control of Corruption			
	Below-median		Above-median		Below-median		Above-median		Below-median		Above-median	
	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)
Graduates		0.051***		0.027***		0.043***		0.080***		0.109***		0.038***
		(0.012)		(0.008)		(0.012)		(0.016)		(0.022)		(0.009)
Student's fees	3.49e-08***		1.59e-08		1.80e-08***		1.62e-08***		1.42e-08***		2.11e-08***	
	(2.78e-09)		(1.41e-09)		(1.32e-09)		(2.09e-09)		(2.23e-09)		(1.40e-09)	
University 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
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	156.95		127.20		185.78		59.78		40.92		227.54	
(p)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	
Obs.	138	138	138	138	139	139	137	137	128	128	148	148

Note: Standard errors, clustered at regional level, in brackets; * $p<0.10$, ** $p<0.05$, *** $p<0.01$

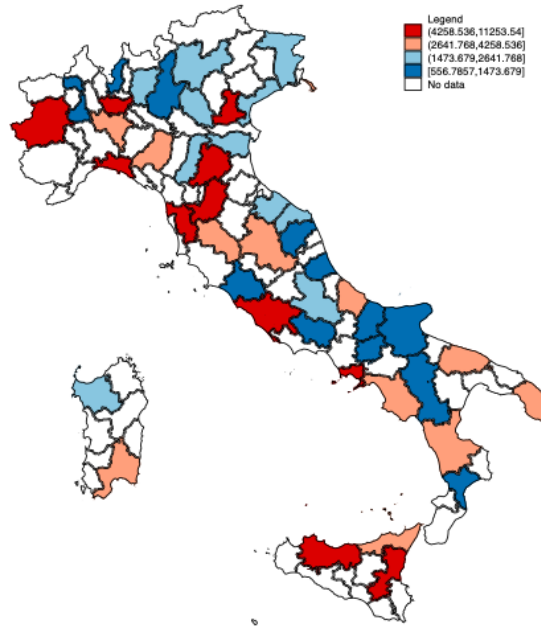Figure A1: Human capital production at province level
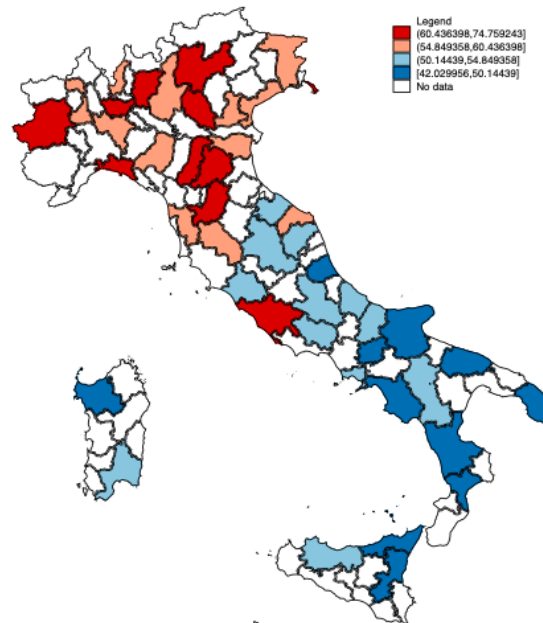
Figure A2: GDP per worker at province level

Figure A3: Quality of Government indicators at province level

(a)
IQI index

(b)
Voice and accountability

(c)
Government Effectiveness

(d)
Regulatory quality

(e)
Rule of law

(f)
Control of Corruption