HIGHER EDUCATION AND SPANISH REGIONAL ECONOMIC GROWTH

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PRELIMINAR VERSION

Abstract

This paper is aimed at studying the link between the regional economic growth and higher education development in a macroeconomic regression for a panel of Spanish regions between 1985 and 2016. The regional economic growth is measured as GDP growth per capita, whereas higher education development is calculated by means of an alternative indicator to the ones used in the traditional literature: the growth rate of the total number of students enrolled in each academic year. We find that higher education growth has a positive impact on the regional macroeconomic growth. As this effect is more intense in less wealthy regions, we may conclude that higher education plays a positive role in the regional economic and social cohesion, when narrowing the economic well-being gap among regions. On the other hand, the reduced internal mobility of labour force in Spain is reflected in the existence of some little intense spillover neighbouring effects. Finally, composition effect analysis becomes relevant as we can observe many different effects in the field of knowledge.

Keywords: Economic growth; regional; higher education; economic cohesion

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Introduction

There is a general consensus that education improves individuals' productivity by increasing their human capital stock and therefore contributes to growth (Hanushek and Wößmann 2010). As Aghion et al. (2006) pointed out, high productivity and innovation make a relatively more intensive use of skilled labour, so that the analysis of the impact of education on economic growth becomes particularly relevant when dealing with higher education. In this sense, Valero and Van Reenen (2019) identify a varied number of channels through which universities may have an impact on growth, both economic[1] and social[2]. In line with this, Di Liberto (2008) considers that higher levels of education could be associated with many productivity improving factors not captured by private returns: for example, a reduction in crime, increased social cohesion, more informed political decisions, intergenerational benefits (assuming parents' education is transmitted to their children) and technological and organisational improvements. Finally, Sianesi and Van Reenen (2003) think that the effects of education vary according to the level of a country's development: while primary and secondary skills appear to be related to growth in the poorest and in intermediate developing countries respectively, it is tertiary skills that are important for growth in OECD countries.

There is extensive literature that analyses the link between human capital and economic growth from a macroeconomic perspective (see for example, De Meulemeester and Rochat 1995; Sianesi and Van Reenen 2003; Hanushek and Wößmann 2010; Dias and Tebaldi 2012; Breton and Breton 2016; Marconi 2018; Valero and Van Reenen 2019). These papers mainly used national data while, however, the regional scope provides a more appropriate analysis scenario than the international one. On the one hand, using large international datasets incorrectly imposes a single coefficient and thus equal returns on schooling among different countries (Di Liberto 2008; Hanushek 2013). On the other hand, the regional analysis allows controlling for the heterogeneity problem by focusing on a more homogeneous dataset rather than on an international sample. Di Liberto (2008),

[1] An increase in highly-qualified labour force demand; an increase in technological innovation processes and an improvement of production processes derived from the growth of the university system and the contribution of researchers; the effect on goods and services demand derived from greater consumption made by teachers and students.

[2] An increase in the democratic values among population and their involvement in the political system.

and Gennaoili et al (2014) think that the problem of omitted variables is surely less severe at regional than at national level.

Nevertheless, the majority of papers analysing the link between higher education and economic development at regional level show a microeconomic approach assessing; for example, the effect of higher education on business activities, entrepreneurship, technological innovation, existing know-how transfer or human capital stock. Drucker and Goldstein research (2007) includes an extensive summary of empiric papers for the USA, Canada and the EU, and offers a review of the studies from a methodological perspective. Considerable attention is paid to the methodological advantages and shortcomings of four major research designs evidenced in the literature: single-university impact studies (not generally considered valid), surveys (not used for the estimation of impact), knowledge production functions (the most popular approach), and cross-sectional and quasi-experimental designs (with a small number of studies and with data from single countries or regions). More recently, Bonaccorsi et al. (2019) present a wide updated survey of existent literature classified according to the pathways through which higher education institutions impact on the economy: generation of human capital, research activities, start-up design, attractiveness for foreign investment, and highly added-value procurement.

However, based micro-analyses do not allow assessing the effect of higher education on economic growth accurately. According to Lucas (1988), public returns to education exceed private returns, often assuming that high average levels of human capital along the economy increase any given worker's productivity. On the other hand, Di Liberto (2008) considers that differences in human capital endowments and their rates of investment have long been recognised as an important element in explaining observed GDP gaps. However, there are a few studies that analyse the effect of education on regional development from a macroeconomic point of view. Lodde (1997) examines the relationship between the allocation of human capital (primary, secondary and higher education years and shares) among different activities, and productivity growth in European regions (1981-1991). Neither secondary education nor higher education have significant effects on the growth rate once country dummies have been included among the regressors. Di Liberto (2008) studies the connection between growth of GDP per capita and human capital (include measures of average primary, secondary and tertiary education) in a convergence regression for a panel of Italian regions (1961, 1971, 1981 and 1991). She finds that tertiary education seems to have a negative impact on regional growth. Only Valero and Van Reenen (2019) specifically analyse the effect of higher education. They use information of 15,000 universities in about 1,500 regions across 78 countries between 1950 and 2010 to reach the conclusion that a 10% increase in the number of universities is associated with over 0.4% higher GDP per capita in a region. Their paper presents three main weaknesses: first, as they use the number of universities as an indicator of higher education development level, they do not take into account the quantitative effect (the number of students per university is not stated); second, also missing some observations as many regions which either have 0 universities or do not show any variation in its number during a great part of the analysed period (the median growth rate of the number of universities is zero); third, using information of countries around the world makes it more complicated to define what a region is like, so that for example, they take California (USA), whose GDP doubles that of Spain, the same as the province of Lugo (NUTS3, and located in Spain), which has not got any universities, and represents 0.7% of Spanish GDP. Finally, using large international data sets incorrectly imposes a single coefficient among regions of different countries.

Therefore, this research is aimed at providing empirical evidence to know more about the impact of higher education on regional economic growth using a macroeconomic regression for a panel of Spanish regions. For such purpose, GDP per capita shall be used as a macroeconomic indicator, whereas higher education relevance will be measured in terms of the total number of enrolments each year (university students stock). Besides, we will try to control for the effect of wealth inequality among regions, the spillover effect among regions, and the composition effect coming from the different fields of knowledge individuals may choose. For such purpose, we will use economic data of Spanish Autonomous Regions (NUTS2 according to Eurostat terminology) covering the period 1985-2016. The available information represents a panel data to be estimated by each region's fixed effects.

The paper is structured as follows. The second section contains figures that allow depicting Spanish university, while section three offers information about the database. Section four contains the empirical framework, whereas section five offers estimate results. Finally, section 6 gathers the most relevant conclusions.

The Spanish university: number of university centres and enrolment development

Spain was one of the first countries to have a university together with Italy, France and England. Ten of the current public universities were set up during the 13th, 14th and 15th centuries (Simancas 2016). However, a common legal regulation to all universities was not fixed until the Pidal Plan (1845), established by the central Government and integrated within the Public Administration. This model was consolidated by the University Act of 1943 (in force until 1970), which places Spain within the group of European countries with a higher education unified system, where no other types of entities, except for universities, are included in the higher education sector. The approval of the Constitution in 1978 meant a step further for a new university era during which the basic features of Spanish university were defined through three laws under a democratic system. The University Reform Act (LRU) of 1983 designed a new educational policy that made university admissions easier; selection criteria were relaxed, and education costs for students were reduced thanks to fee reduction and the incorporation of short-cycle degrees, which lowered university education costs. This low-cost structure could only be supported by a massive entry of students in order to take advantage of the economies of scale (Perotti 2007). These changes have meant an important increase in enrolments since the 80s, compared to the minimum growth in previous decades. After LRU, the University Organic Law (LOU, 2001) and the Organic Law that modified the University Organic Law (LOMLOU, 2007), were designed to boost competence among universities for higher quality and excellence. For such reason, they committed to diversifying university networks, thus promoting private universities instead of the public one, whose last university centre was opened in 1998.

Even though the basic feature of the Spanish university network is the supremacy of the public university, this has been losing relevance in terms of enrolments to the private one since the academic year 1997-1998, as a result of the liberal policies promoted by conservative governments. These governments encouraged opening private facilities, which grew from four in the Academic year 1985-86 to thirty-two in the Academic year 2015-16, while the number of public university centres was not increased (Table 1).

By fields of knowledge, Social and Legal Sciences meant around 50% of enrolments in both university types. However, in relation to the rest of fields of knowledge, while private universities have been focused on Health Sciences, public universities offer a more balanced education.

In relation to their presence in the Autonomous Region[3], Table 2 shows that the public university has had a homogenous presence around the national territory (except for the autonomous cities of Ceuta and Melilla) during the analysed period and have increased their presence in the two most populated Autonomous Regions of Spain (Andalucía and Cataluña). On the other hand, private universities have undergone a remarkable expansion around the national territory, moving from being present in four Autonomous Regions in 1985 to being in eleven at the end of the analysed period (Madrid is the Autonomous Region with the highest number of private universities).

(TABLE 1 HERE)

(TABLE 2 HERE)

Data sources.

The analysed period began in 1985 and finished in 2016, which was the last year providing the necessary information to generate this research. The year 1985 was chosen for two reasons; in economic terms, year 1985 meant the beginning of the current Spanish economic development, as it was the last transitional year before joining the EU in 1986. In terms of educative policy, 1985 came immediately after the most important university educational reform in the history of Spain (LRU of 1983), which built the foundations of the current Spanish university system.

Data related to the university system have been obtained from information provided by the Ministry of Universities, except for data related to Ceuta and Melilla as they do not have their own university and are very small territories[4].

[3] Spain is divided into 17 Autonomous Regions (NUTS2 level following Eurostat), eleven of which are divided into provinces (NUTS3). The cities of Ceuta and Melilla, in northern Africa, are classified as Autonomous Cities.

[4] A specific case is that of students enrolled in UNED, *Spanish Open University*, located in the Autonomous Region of Madrid, and whose students are found all around Spain. Given that there is no available information related to their location for the analysed period, we have proceeded to distribute UNED students among the Autonomous Regions according to their population share weight.

RegData database, generated by De la Fuente (2017), is the source of economic and population-related information, and is posted on its website by FEDEA (www.fedea.net). A constant price-bass GDP series is built out of this database for year 2010 at NUTS2 level (Autonomous Region) using the *Spanish Regional Accounts* (CRE), and a series of population living in Autonomous Regions using data from the *Economically Active Population Survey* (EPA). Both CRE and EPA are generated by *National Statistics Institute* (www.ine.es).

The information obtained allows the construction of a data panel for the period 1985-2016.

Empirical framework

The underlying model tries to measure the impact of higher education on regional economic growth. This model is within what Sianesi and Van Reenen (2003) call ‘new growth economics’ theories. In contrast to the traditional neo-classical Solow growth model, these models, sometimes called ‘Barro regressions’, emphasise the endogenous determination of growth rates, which are determined within the model (and can thus be affected e.g. by government policies), instead of being driven by exogenous technological progress. For such reason, it normally exploits cross-country variation in the data to estimate, rather than impose the parameters (output elasticities) of the aggregate production function.

Basic model

In econometric terms, the basic model is:

$$\Delta\ln\left({}^{GDP}\!/_{L}\right)_{i.t} = \alpha_1 \Delta\ln(es)_{i.t} + \varepsilon_{i.t} \qquad (1)$$

where *i* refers to the Autonomous Region, $\Delta\ln\left({}^{GDP}\!/_{L}\right)_{i.t}$ in the interannual variation rate of the GDP per capita logarithm in that year *t*; $\Delta\ln(es)_{i.t}$ is the interannual variation rate of the enrolment logarithm, and ε is the error term. Given that both the dependent and independent variables are measured by the variation rates of the values taken in the logarithm, the estimated coefficient for the *es* variable is understood as an elasticity.

GDP per capita has been used as an economic growth indicator given the generalized agreement of its convenience: GDP per capita is an important indicator of economic performance and a useful unit to make comparisons of average living standards and economic well-being. As any other macroeconomic indicator, it has its own limits, for example the fact that it does not take into account income distribution in an economic area.

The total number of enrolments, that is, university students stock, has been used as a higher education level indicator for each year and for each autonomous region. Therefore, enrolment growth rate measures new students joining tertiary education each year after discounting exits (either because students obtain the degrees or because they drop out their studies). The analysis of the available official data and of prior research allows defining the stable dropout rates as the working hypothesis for the analysed period. Then, it means that the interannual growth rates are systematically corrected by the dropout effect. That is, if a given percentage of students drop every year, then, in a year t, when correcting dropouts between t and t-1 shall effectively include the future dropout of students enrolled in year t.

The use of the number of enrolments as the higher education level indicator is considered as an advantage that allows quantitatively assessing a region's university offer[5], which could not be done when using the number of universities instead, as Valero and Van Reenen (2019) do. The best measurements would be in terms of the education output, but due to the difficulties in obtaining such measurements, input measurements are normally used (Sianesi and Van Reenen 2003). Following De Meulemeestert and Rochat (1995), with a variable measuring a stock of graduates it would be difficult to disentangle the contribution of formal education from the experience acquired on the job. Likewise, to explain total economic output based on public expenditure on higher education might be misleading by confounding public inputs with public outputs.

Finally, fixed-effect estimation techniques have been used, which according to Sianesi and Van Reenen (2003), prevent the analysis of the impact on growth of variables that do not change much over time. Besides, Gennaoili et al. (2013) consider that the effects of

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[5] It has not been possible to control higher education quality because information for all universities and all academic years is not available.

education and institutions are difficult to disentangle across regions (both variables are endogenous and the potential instruments for them are correlated), however by using region fixed effects we avoid identification problems caused by unobserved region-specific factors.

According to Sianesi and Van Reenen (2003), Gennaoili et al. (2014), and Valero and Van Reenen (2019), as income grows, educational standards rise, but we cannot be confident that economic growth is caused by higher educational standards. There are in fact reverse causality problems with education. When longitudinal datasets are available, one possibility is to use lags of the endogenous variables as instruments.

Considering the foregoing, the model to estimate would be:

$$\Delta \ln \left({}^{GDP}/_{L} \right)_{i.t} = \alpha_1 \Delta \ln (es)_{i.t-n} + \varepsilon_{i.t} \quad (2)$$

where *i* refers to the Autonomous Region, $\Delta \ln \left({}^{GDP}/_{L} \right)_{i.t}$ is the interannual variation rate of GDP per capita algorithm for year *t*, $\Delta \ln (es)_{i.t-n}$ is the interannual variation rate of the enrolment logarithm for the period *t-n*, and ε is the error.

Anyway, it seems reasonable to introduce lagged enrolment variation rates in the model: today's economic growth is the result of an increase in previous enrolments, as some time is needed to finish university education and obtain an employment. Therefore, the question is how long the variable must be lagged. Regardless the country analysed, there is no ideal number of years. Lilles and Rõigas (2017) consider that, given that there are not many quantitative studies on those indirect effects, it is not clear when do these effects occur and what the correct number of lags is. Therefore, they used five lags as maximum due to their relatively short time period (1998–2008). Valero and Van Reenen (2019) use a 5-year lag, as they understand it is the generally accepted and needed period to finish university education, and so, they set Barro (2012) and Gennaioli et al. (2014) papers as examples. However, they point out the fact that the effect of university education can be extended longer than 5 years. For the whole of the educational levels, Dias and Tebaldi (2012) identify human capital growth effects on GDP growth 10 years later; Breton and Breton (2016) consider that the increase in schooling years takes 40 years to have an impact on GDP growth; and Marconi (2018) defends that the effect of secondary education is only transferred to GDP growths when workers are within the 45-64 year-old gap.

Two factors must be considered in case of university education in Spain:
1º The length of different kinds of degree granted by Spanish universities. During the period analysed (1985-2016), there were different degrees living together, which lasted for different periods: Diploma (3 years), Degrees (3 or 4 years) and Bachelor Degree (5 or 6 years).This means that the variable that gathers enrolments should be entered in the model to estimate 6-years lag at least[6].

2º The time graduates take to find a job in Spain. Empiric evidence shows that Spanish graduates, compared to their European peers, need more time to find a job and develop their professional careers (Salas 2007; Kivinen and Nurmi 2014; Canal and Rodríguez 2019). Therefore, there would be a greater lag when transferring the impact of increasing enrolments on the economic growth. Table 3 shows university graduate unemployment rates for Spain and for a series of reference countries of the European Union, and allows us to conclude that Spanish university graduates have historically undergone greater difficulties to join the labour market than their European peers (Mora et al. 2000).

(TABLE 3 HERE)

Therefore, if we consider the length of university degrees and the time it takes Spanish graduates to join the labour market, we may conclude that the stated lag for the variable gathering the number of enrolled students should be longer than 6 years. Following Valero and Van Reenen (2019) criterion, since tertiary education impact could take place over a longer period of time, we consider 8 years to be a conservative approach. Graph 1 plots the average annual growth in regional GDP per capita (on the y-axis) on the average annual growth of enrolments (on the x-axis) with an 8-year lag, over the whole time period. The graph seems to show a positive relation between both growth rates, as it can

[6] According the figures stated by the Ministry of Universities, the number of students enrolled as new students of the new Bologna Plan was 1.3% of the total number of enrolled students for the first year of the Bologna Plan (2008-2009 Academic Year). Given that entering the effect of the number of enrolled students in estimates is lagged 8 years, the last year from which data are taken is year 2008. Given the residual relevance of the number of enrolled students in the Bologna Plan that year, no reference to the effect education changes caused by this Plan might have, has been included.

be understood from the increasing slope of the trend line (0.19). In any case, the causal relationship must be determined based on the econometric estimate outcomes.

(FIGURE 1 HERE)

On the other hand, it must be taken into account that each Autonomous Region has different social and economic features that may influence their decision of enrolling at the University and therefore, the economic growth. For this reason, an extended model is proposed to include a series of control variables for each Autonomous Region:

$$\Delta\ln\left({}^{GDP}/{}_{L}\right)_{i.t} = \alpha_1\Delta\ln(es)_{i.t-n} + \alpha_2 X_{i,t-n} + \alpha_3\Delta lnZ_{i,t-n} + \alpha_3\Delta\text{lnu}_{i.t} + \varepsilon_{i.t} \quad (3)$$

where i refers to the Autonomous Region , $\Delta\ln\left({}^{GDP}/{}_{L}\right)_{i.t}$ is the interannual variation rate of the GDP per capita logarithm for year *t*, $\Delta\ln(es)_{i.t-n}$ is the interannual variation rate of the enrolment logarithm for the period *t-n*; $X_{i,t-n}$ will be a vector of observable variables that characterize the social and economic situation of the Autonomous Regions during the enrolment period *t-n* (population, GDP per capita, and percentage of population with university studies in order to calculate human capital stock level); $\Delta lnZ_{i,t-n}$ a vector of variables that gather the cycle and demographic trend during the period *t-n* (interannual variation rate of unemployment logarithm and interannual variation rate of population logarithm); $\Delta lnu_{i.t}$ is the interannual variation rate of unemployment logarithm at a moment *t*, which is meant to reflect the cycle effect for the period *t*; being ε the error.

Five models will be estimated based on this econometric specification. Starting with a basic model where the only independent variable is enrolments during the period *t-n* (Model 1), the introduction of the following control variables shall allow assessing the explanatory capacity that university education has on the economic growth. Therefore, Model 2 includes the variables that characterize the social and economic features of the Autonomous Regions for the period *t-n*; Model 3 adds the variable that approximate human capital level at the Autonomous Region for the period *t-n*; Model 4 includes those variables that control for the economic cycle for the period *t-n* and in the moment when the growth of GDP per capita is assessed (*t*). Finally, Model 5 adds the variable controlling for demographic trends for the period *t-n*.

Sample checks: heterogeneity

In spite of the included controls for different socio-economic features of Autonomous Regions, one single equation estimate establishes the same enrolment effect for all Autonomous Regions. However, this coefficient is expected to differ among regions, given the existence of socio-economic differences among them. For example, Di Liberto (2008) thinks that it is also convenient to carry out an estimate of the effects of education in Italy by gathering regions into two groups: North-Centre (wealthy regions) vs South (poor regions).

For such purpose, Autonomous Regions have been divided into three groups depending on the average GDP per capita for the whole analysed period: Group 1 includes the traditionally wealthiest regions (Madrid, Cataluña, País Vasco, Navarra); Group 2 includes those Regions with a GDP per capital higher than the national average but lower than those in Group 1 (Aragón, Rioja, Baleares); and Group 3 with the rest of Autonomous Regions (Cantabria, Valencia, Asturias, Castilla y León, Castilla La Mancha, Canarias, Murcia, Galicia, Andalucía, Extremadura). The model to estimate now would be:

$$\Delta\ln\left({GDP}/{L}\right)_{i,j,t} = \alpha_1\Delta\ln(es)_{i,j,t-n} + \alpha_2 X_{i,j,t-n} + \alpha_3\Delta lnZ_{i,j,t-n} + \alpha_3\Delta\ln\mathrm{u}_{i,j,t} + \varepsilon_{i,j,t} \quad (4)$$

where *j=1,2,3* refers to the group Autonomous Region *i* belongs to.

Sample checks: spillover effects

Given that workers want to return on their investment in higher education, some of them are expected to move outside the Autonomous Region where their university is located. In the Spanish case, a great amount of research identifies the existence of geographical mobility constrains for the labour force, which leads to little mobility within the national territory. This low mobility also covers short distances. There is sufficient literature to confirm this migratory pattern during the last quarter of the 20th Century (see Bentolila 2001; Ródenas and Martí 2005; Alcaide 2007). The turn of the century did not seem to have meant a change in this behaviour according to official statistics. Given that job seeking is normally the main reason for domestic migrations, it was decided to use the official figures provided by the Servicio Público de Empleo Estatal (SEPE) *[Public Service for Employment Search]*, that gather all employment contracts done in Spain since the beginning of the current century. If we consider 2016 figures as an example (last year in this paper's analysis), exit rates of workers from their Autonomous Region (workers moving to other Autonomous Regions to start a new job, out of the total of workers remaining working in the Autonomous Region plus those who leave), was 9%, whereas that of workers holding a university degree was not that different (10.8%) and almost equal to that of workers with no studies (10.7%). On the other hand, the "2014 Survey on Labour Insertion of University graduates" drafted by INE, analysed the transition to the labour market of those Spanish university graduates who enrolled the academic year 2009-10. In this case, data indicate that 14% of university graduates left the autonomous region where they studied in order to work in another Autonomous Region (Pérez 2018).

The question is, do Spanish workers move to *any* Autonomous Region in order to work? SEPE (2016) stated that 75% of workers moved out to their neighbouring autonomous region, or to Madrid if this was not among nearby regions. This seems to indicate that the two first decades of 21st century are copying the pattern observed at the end of 20th century by Ródenas and Martí (2005), who concluded that any migration movement beyond the limit of a province (NUTS3) was to nearby places mainly located in neighbouring provinces, regardless their belonging to the same Autonomous Region (NUTS2) or not. SEPE does not provide information about the Autonomous Regions of destination in relation to workers holding university degrees. However, it is reasonable to suppose that their migratory behaviour should follow the same trend observed in workers as a whole[7].

Taking all this into account, an estimate of spillover effects is proposed, which will be based on an annual exit rate of 14% among university graduates to nearby autonomous regions or Madrid. It should be considered that keeping a 14% exit rate for the whole

[7] Moran Index values for econometric estimate variables stated the existence of a very low spatial autocorrelation, thus supporting the validity of this assumption of the behaviour of workers who graduated from university.

series would mean entering a bias in favour of university graduate mobility, which should be higher as we would get closer to the beginning of the series, given that mobility rates were lower at that time (Alcaide 2007). This is meant to avoid any doubt on a conservative treatment of university graduate mobility. The model to estimate now would be:

$$\Delta\ln\left({}^{GDP}/_{L}\right)_{i.t} = \alpha_1\Delta\ln(es)_{i.t-n} + \alpha_2\Delta\ln(es)_{f,t-n} + \alpha_3X_{i,t-n} + \alpha_4\Delta lnZ_{i,t-n} + \alpha_5\Delta\text{lnu}_{i.t} + \varepsilon_{i.t} \quad (5)$$

where *i* refers to the Autonomous Region, $\Delta\ln\left({}^{GDP}/_{L}\right)_{i.t}$ is the interannual variation rate of GDP per capita logarithm in year *t*, $\Delta\ln(es)_{f,t-n}$ is the interannual variation rate of the logarithm referring to the average number of enrolled students in neighbouring autonomous regions or Madrid for the period *t-n*, being ε the error term.

Sample checks: fields of knowledge.

Research papers normally estimating the impact of higher education on the economic growth do not take into account the composition effect. This means that the same effect is assigned to the different fields of knowledge workers can be educated in. However, De Meulemeester and Rochat (1995) consider that higher education can or cannot promote growth, depending, on the one hand, on the relative balance between directly (for example, engineering) and indirectly growth-promoting disciplines (for example, teachers) and, on the other hand, on the proportion of graduated students engaged in non-rent-seeking activities. On the other hand, Murphy et al. (1991) find that the relative importance of engineering in education has a positive impact on growth, while the relative importance of legal studies has a negative effect. It has to be said, however, the former effect is not statistically significant, while the latter just borders significance. Finally, Bonaccorsi et al. (2019), in a paper on the impact of higher education on local development, consider that the impact does strongly depend on specific disciplines or bases of knowledge.

The information provided by the Ministry of Universities allows distinguishing between those enrolled according to five fields of knowledge: Social and legal Sciences; Engineering and Architecture; Arts and Humanities; Health Sciences; and Sciences. This breakdown will mean a new contribution by making it possible to identify the potential impact of the type of university education on regional growth. For this reason, the model to be estimated now is:

$$\Delta\ln\left({}^{GDP}/_{L}\right)_{i.t} = \alpha_1\Delta\ln(es)_{i.j,t-n} + \alpha_2 X_{i,t-n} + \alpha_3\Delta lnZ_{i,t-n} + \alpha_3\Delta\ln\mathrm{u}_{i.t} + \varepsilon_{i.t} \quad (6)$$

where *i* refers to the Autonomous Region, $\Delta\ln\left({}^{GDP}/_{L}\right)_{i.t}$ is the interannual variation rate of GDP per capita logarithm in year *t*, $\Delta\ln(es)_{i.j,t-n}$ is the interannual variation rate of the logarithm referring to the number of enrolled students in the field of knowledge *j* in the period *t-n*, being ε the error term.

Estimate results

Main results

Once the 8-year time lag has been established in order to include the impact of enrolment growth, we have proceeded to estimate those five models in order to see if the effect of enrolments can be altered by including controls that will allow us to better identify the socioeconomic situation of each Autonomous Region. All models have been estimated using fixed effects in order to control for the unobservable features of the Autonomous Regions that remain unchanged along time. A robust error estimate has been specified to control for the potential existence of heteroscedasticity (Table 4).

(TABLE 4 HERE)

Model 1 uses the lagged growth of enrolled students as the explanatory variable of the economic growth, without additional controls. As it can be seen, the estimate coefficient is 0.035 and significant.

In order to control for the fact that the richest Autonomous Regions are more likely to need more highly qualified workers, GDP per capita have been added to Model 2, referring to the time when students decide to enrol. The *Lagged population* variable controls the fact that a higher number of enrolments in an Autonomous Community may be directly caused by higher population levels. As a result of introducing these control variables (both variables have a significant impact, thus being almost null), the estimated coefficient of enrolments remarkably decreases to 0.019, and its effect on economic growth continues being statistically significant.

Given that enrolment growth may be positively related to the educational level of the Autonomous Regions, Model 3 adds the percentage of population with university education as the control variable (children whose parents graduated from university are more likely to go to University (Archer et. al 2003)). We observe that the coefficient value of the control variable increases slightly in this model and continues being significant.

Model 4 incorporates the growth of the lagged unemployment rate logarithm in order to control for the effect the economic cycle may have on the decision of investing in human capital, as well as the growth of the unemployment rate logarithm at a moment *t* in order to control for the current effect of the cycle on the GDP per capita growth observed. As it can be observed, both variables have a significant impact, while their sign is in line with economy theory predictions: unemployment rate variation at a moment *t* brings cycle's effect on the independent variable closer in a counter-cyclical manner; unemployment rate variation at a moment *t-n* introduces cycle's effect on enrolment decision in the model, and the corresponding effect on the dependent variable at the moment *t*. The consequence of introducing both variables is the reduction of the enrolment coefficient to 0.014. In spite of the reduction of the enrolment coefficient, the effect continues being statistically significant. On the hand, in relation to the R^2 overall value, model adjustment improves significantly.

Model 5 includes the lagged growth of the population logarithm in order to control that GDP per capita growth negatively depends on population growth. It has a remarkable and significant impact as expected (Valero and Van Reenen (2019) see the same effect for this variable). In this case, the coefficient of enrolments maintains its value and its effect continues being significant: 10% increase in the number of higher education students means 0.12% increase in GDP per capita. Model adjustment improves again and shows greater R^2 (intra groups, between groups and for the whole dataset).

Therefore, we may conclude that the variable that gathers enrolments shows high robustness, defined as a relationship that remains significant and of the same sign when including different sets of other regressors, or using slightly different data, samples or methodologies (Sianesi and Van Reenen 2003).

Finally, following Valero and Van Reenen (2019), the effect caused by the increase in high-quality human capital is expected to generate long-lasting effects on economic growth, due to the human capital accumulation effect that means including successive cohorts of university students to the labour market. But measuring this effect is limited by the fact that extending the analysis period also increases the number of variables affecting economic growth, whose information is not always available. Anyway, Table A1 of the Appendix shows different distributed lag structures, and states that, in general, 8-year lag is a reasonable summary of the data.

Heterogeneity

Table 5 shows Model 5 results for the three groups of Autonomous Regions[8].

(TABLE 5 HERE)

Results indicate a significant enrolment growth effect in all groups, which is greater in the case of the poorest regions

(0.081) than the richest ones (0.065), or even higher than the national average one (0.012). These results seem to indicate that university education becomes an efficient tool for social cohesion as it contributes to reduce the economic gap among regions. This outcome is opposed to that obtained by Di Liberto (2008), who split Italy into two regions (the rich North-Centre, the poor South), as he did not detect this effect on Italian higher education, while he did in primary education.

Spillover effects

Table 6 shows that the variable gathering the average growth of enrolments in neighbouring Autonomous Regions or Madrid turns out to be only significant in Models 1, 2 and 3.

(TABLE 6 HERE)

This result seems to be in line with the little likelihood of Spanish labour force to move within the national territory. Besides, it is important to point out that including this variable does not remarkably vary the effect of the enrolment growth in each Autonomous

[8] Model 1 to 4 estimates are available to the reader.

Region, thus underpinning the idea of how little influence those influxes of graduates from other Autonomous Regions have on regional growth.

Fields of knowledge.

The results (Table 7) confirm the importance of the composition effect, as, in general, field of knowledge variables exercise a significant effect in all models. Taking the Arts and Humanities field as reference, Model 5 results show that the growth of enrolled students in the field of Health Science does not affect the regional economic growth, but it indeed has an impact on the rest of models. The fields of Science and Social Science exercises a similar positive effect on GDP per capita growth (a 10% increase in students enrolled in Science increases GDP per capita by 0.21%, whereas in case of Social Sciences the growth is 0.16%), and higher that the one observed for the whole analysis of all fields (0.12%). Finally, enrolments in Engineering and Architecture have a positive impact in all models, while its magnitude is highly reduced (in Model 5, a 10% increase in students enrolled in this field, increases GDP per capita by 0.08%).

(TABLE 7 HERE)

The low impact of Engineering and Architecture studies on regional growth seems initially surprising, and may be for two reasons mainly. First of all, it may be due to the high dropout rate of students compared to other fields of knowledge, according to the data provided by the Ministry of Universities. Secondly, it may be due to its decreasing relevance in relation to the whole university offer due to the decreasing number of enrolments since 2002. In relation to the latter, the Human Capital Theory can be used as a possible explanation. This theory says that university students' choice of a given field of knowledge depends on the expected net return: on the investment side, the necessary intellectual effort to pass those studies seems to be more high each time, given the low level of maths knowledge of students enrolling Spanish universities, as it has been revealed by the PISA report since 2002; as far as return is concerned, given that the Spanish productive structure is based on small and medium enterprises, it does not seem to be able to offer wages that compensate for the demanding intellectual effort, which will work for making this field of knowledge less attractive.

Conclusions

This research provides empirical evidence on the effect that higher education has on the regional economic growth. For this reason, we have proceeded to analyse a panel of data with information corresponding to Spanish Autonomous Regions from 1985 to 2016. By defining an 8-year time-lag as the variable measuring student enrolment growth, the results indicate that first of all, as an average, a 10% increase in the number of enrolled students generates an increase of regional GDP per capita of 0.12%. Besides, this result is robust as the variable effect remains significant and of the same sign when including different sets of other regressors. This outcome is in line with the one reached by Valero and Van Reenen (2019), who obtained a higher effect (0.4%), taking, though, a heterogeneous base of regions and using the number of universities as higher education level proxy.

The outcomes of this research seem to support European higher education policy. According to the European Commission, higher education institutions (HEIs) are crucial partners in delivering the European Union strategy to drive forward and maintain sustainable economic growth. The ET 2020 PLA (seminars organised within the framework of the Open Method of Coordination for the Working Group on the Modernisation of Higher Education) on "Higher Education Institutions as centres of regional development and innovation" confirm the continuing policy interest and focus on higher education as centres of regional development and innovation. European policy supports HEIs' regional role. The Agenda for the Modernisation of Higher Education (European Commission 2017) emphasises the regional knowledge triangle, combining research, education and innovation. In this context, the "triple helix" model (Etzkowitz and Leydesdorff 1995) of regional collaboration and innovation (government-business-HEIs) must continue to dominate over a more broad-based engagement that includes the local population and civil society ("quadruple helix").

In order to boost HEIs impact, the Europe 2020 strategy has set a target according to which 40% of young Europeans should have a higher education qualification by 2020 (Poelman and Dijkstra 2018). The regional spread of higher education institutions is an important dimension of the EU's agenda to the goals of the European 2020 strategy (European Commission 2020). On the one hand, a broader geographical coverage lowers costs and barriers for student's access to higher education. Denzler and Wolter (2010), validated the well-documented influence of the distance between home and university in choosing university studies, and how an uneven distribution of opportunities to access university may impact on the use of human capital to its full potential. Therefore, a geographical diffusion of university studies offer is expected to contribute to building ‘more inclusive’ higher education systems, since students from lower social classes are more penalized as they need to move to another region for tertiary education, which generates substantial commuting and accommodation costs (Eurostudent 2019). On the other hand, having universities geographically close is a major advantage for firms and social actors that make use of research inputs, as these partnerships provide direct knowledge flows. Therefore, the presence of one or more HEIs in a region is an asset that helps foster knowledge flows along education, research and business in order to promote a balanced development among European regions. Spain has clearly led its university polity in this direction, thus promoting university presence in all Autonomous Regions. As a consequence, universities are currently found in all Spanish provinces (NUTS3), either its headquarters or satellite campuses. However, there are two main questions coming from this dispersal policy, which must lead to policy makers’ reflection. First of all, to what extent is this policy is profitable for the society? Public funding for higher education is under increasing scrutiny, and there are growing demands for HEIs to demonstrate their value, contribution and benefit to the economy and society (Kehm 2007). The issue of an increasing public expenditure on HEIs comes from the fact that, given that higher education investment promotes economic growth, it could be concluded that it is better for the Autonomous Regions to keep a higher number of university at all times. In fact, this seems to be the grounds presented many regional leaders as a strategy to obtain votes from families who would have to spend an important percentage of their income to finance university studies away from home. However, the geographical diffusion of higher education also entails the risk of generating additional costs by diluting scarce resources across a too wide range of institutions and localisations (ETER 2019). Therefore, this continuous university expansion policy must undergo a deep profitability analysis so as not to put HEIs sustainability into danger. In the second place, HEIs development at regional level has the immediate effect that young people do not leave the region to carry on with their studies, and probably, due to boosting that university-local firm relationship, it will also promote graduates to remain in their regions. Likewise, competence among regions in terms of both the size of university offer and its diversity and quality, discourage students’ mobility around the national territory, as it will cut opportunity costs. For example, Faggian et al. (2007) found that Scottish and Welsh students who managed to enrol a high-quality university in their home region were less likely to move away for higher education purposes. These behaviour hypothesis seems to be like this in Spain, and may cause an undesirable effect when considering that the geographical mobility of people encourages a more balanced economic and social development.

Future research should evaluate the effect on student mobility that the increase in the variety of bachelor and master degrees can generate. That is, not only the geographical expansion of the University can simplify the movement of students between different geographical areas, but also the increase in the variety of content of the degrees by adapting the offer of University studies to the specific needs of the labour market of each region.

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References

Aghion, P., Meghir, C., & Vandenbussche, J. (2006). Growth, distance to frontier and composition of human capital. *Journal of Economic Growth*, 11(2), 97–127

Alcaide, I. (2007). *Evolución de la población española en el siglo XX, por provincias y comunidades autónomas*. Volumen I. Fundación BBVA. Bilbao

Barro R. J. (2012). Convergence and Modernization Revisited. *NBER* Working Paper 18, 295

Bentolila, S. (2001). Las Migraciones Interiores en España. *FEDEA* Working Paper 2001-07

Bonaccorsi, A., Biancardi, D., Sánchez-Barrioluengo, M., & Biagi, F. (2019). Study on higher education institutions and local development. *Joint Research Centre*. Publications Office of the European Union. Luxembourg

Breton, T., & Breton, A. (2016). Education and growth: where all the education went. *Universidad EAFIT. Working paper CIEF 014327.*

Canal, J.F., & Rodríguez, C. (2019). University education and transition into the labour market during the financial crisis. Spanish evidence. *Quality in Higher Education*, 25 (2), 155-170

De La Fuente, A. (2017). Series largas de algunos agregados económicos y demográficos regionales: Actualización de RegData hasta 2016. *FEDEA* Working Paper 2017/26

De Meulemeestert, J.L., & Rochat, D. (1995). A causality analysis of the link between higher education and economic development. *Economies of Education Review*, 14(4), 351-361

Denzler, S., & Wolter, S. (2010). Distance to University and study decisions: a research note. *Swiss Political Science Review*, 16 (4), 807–09

Di Liberto, A. (2008) Education and Italian regional development. *Economics of Education Review*, 27, 94–107

Dias, J., & Tebaldi, E. (2012). Institutions, human capital, and growth: the institutional mechanism. *Structural change and Economic Dynamics*, 23, 300–312

Drucker, J., & Goldstein, H. (2007). Assessing the regional economic development impacts of universities: a review of current approaches. *International Regional Science Review*, 30(1), 20-46

European Tertiary Education Register (ETER) (2019). *The regional structure of European Higher Education*. Analytical Report 4/2019. European Commission. Brusels.

European Commission (2017). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions on a renewed EU agenda for higher education*. COM/2017/0247 final. Brussels.

European Commission (2020). *Communication from the Commission. Europe 2020. A strategy for smart, sustainable and inclusive growth*. Brussels.

Eurostudent (2019). *Eurostudent VI. Overview and selected findings. Social and economic conditions. of students in Europe*. Available at www.eurostudent.eu.

Faggian, A., McCann, P. & Sheppard, S. (2007). Human capital, higher education and graduate migration: an analysis of Scottish and Welsh students. *Urban Studies*, 44(13), 2511-2528

Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2013). Human capital and regional development. *The Quarterly Journal of Economics*, 128 (1), 105–164

Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2014). Growth in regions. *Journal of Economic Growth*, 19, 259–309

Hanushek, E., & Wößmann, L. (2010). *Education and Economic G*rowth. In Peterson P, Baker E, McGaw B (ed.) International Encyclopedia of Education. Elsevier, Oxford, 2, 245-252

Hanushek, E. (2013). Economic growth in developing countries: The role of human capital. *Economics of Education Review*, 37, 204–212

Kehm, B.M. (2007). Quo vadis doctoral education? New European approaches in the context of global changes. *European Journal of Education,* 42, 307–319.

Kivinen, O., & Nurmi, J. (2014). Labour market relevance of European university education. From enrolment to professional employment in 12 countries. *European Journal of Education*, 49 (4), 558–74

Lilles, A., & Rõigas, K. (2017). How higher education institutions contribute to the growth in regions of Europe? *Studies in Higher Education*, 42(1), 65–78

Lodde, S. (1997). Human capital and growth in the European regions. Does allocation matter? *Centre for North South Economic Research,* Working Paper CRENoS 199706

Lucas, R.E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22, 3–42.

Marconi, G. (2018.) Education as a long-term investment: the decisive role of age in the education-growth relationship. *Kyklos*, 71, 132–161

Mora, J.G., García-Montalvo, J., & García-Aracil, A. (2000). Higher education and graduate employment in Spain. *European Journal of Education*, 35, 229–237

Murphy, K.M., Shleifer, A., & Vishny, R.W. (1991). The allocation of talent: implications for growth. *The Quarterly Journal of Economics,* 106, 503-530

Pérez, F. (2018). *Itinerarios de inserción laboral y factores determinantes de la empleabilidad*. Fundación BBVA. Bilbao

Perotti, L. (2007) Institutional change in the Spanish higher education system. *European Journal of Education*, 423, 411-423

Poelman, H., & Dijkstra, L. (2018). Access to universities in the EU: a regional and territorial analysis. *Regional Focus* 1/2018.

Ródenas, C., & Martí, M. (2005). El nuevo mapa de las migraciones interiores en España: los cambios en el patrón de los sesenta. *Investigaciones Regionales*, 6, 21-39

Salas, M. (2007). The transition from higher education to employment in Europe: the analysis of the time to obtain the first job. *Higher Education,* 54, 333-360

Sianesi, B., & Van Reenen, J. (2003) The returns to education: macroeconomics. *Journal of Economic Surveys,* 17(2), 157–200

Simancas, E., & García, M. (2016). Historia de un secuestro: de la Iglesia a la marca. Evolución histórica de la universidad en España. *Chasqui. Revista Latinoamericana de Comunicación*, 133, 173-190

Valero, A., & Van Reenen, J. (2019). The economic impact of universities: Evidence from across the globe. *Economics of Education Review*, 68, 53–67.

TABLES

Table 1. Enrolments by type of university and field of knowledge. Number of public and private universities. Period 1985-2016*

		1985-1986	1990-1991	1995-1996	2000-2001	2005-2006	2010-2011	2015-2016
Public Universities								
Enrolled students.								
	Social and Legal Sciences	364,304	568,568	760,401	705,493	638,507	637,533	573,864
	Engineering /Architecture	131,675	212,488	318,298	360,459	343,682	318,199	249,058
	Arts and Humanities	140,952	121,141	144,326	149,542	125,706	138,449	143,652
	Health Sciences	95,165	92,708	102,083	99,204	99,464	152,703	211,803
	Sciences	65,500	85,481	124,493	123,024	97,238	89,633	91,557
	Total	797,596	1,080,386	1,449,601	1,437,722	1,304,597	1,336,517	1,269,934
No. of Universities		30	35	44	48	48	50	50
Private Universities								
Enrolled students								
	Social and Legal Sciences	13,803	18,577	33,028	59,654	75,120	109,495	138,729
-	Engineering /Architecture	4,818	7,572	14,150	30,199	34,176	37,711	23,171
	Arts and Humanities	6,281	5,032	3,739	6,309	6,755	7,913	9,927
	Health Sciences	3,240	3,958	6,435	17,221	18,099	34,214	57,860
	Sciences	675	713	1,523	4,069	3,706	4,012	2,738
	Total	28,817	35,852	58,875	117,452	137,856	193,345	232,425
No. of Universities		4	4	10	18	23	26	32

Source: Ministry of Education and Vocational Training. *Information is provided every 5 years due to lack of space

Table 2. University presence by Autonomous Region. Period 1985-2016*

	1985-1986		1990-1991		1995-1996		2000-2001		2005-2006		2010-2011		2015-2016	
	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private
Andalucía	5		5		8		10		10		11		11	1
Aragón	1		1		1		1		1	1	1	1	1	1
Asturias	1		1		1		1		1		1		1	
Canarias	2		2		2		2		2		2		2	2
Cantabria	1		1		1		1		1		1		1	1
Castilla La Mancha	1	1	1	1	1		1		1		1		1	
Castilla y León	3		3		4	1	4	3	4	4	4	4	4	5
Cataluña	3		4		7	2	7	4	7	5	7	5	7	5
Extremadura	1		1		1		1		1		1		1	
Galicia	1		3		3		3		3		3		3	
Baleares	1		1		1		1		1		1		1	
La Rioja					1		1		1		1	1	1	1
Madrid	4	1	5	1	5	5	6	6	6	7	7	8	7	8
Murcia	1		1		1		2	1	2	1	2	1	2	1
Navarra		1	1	1	1	1	1	1	1	1	1	1	1	1
País Vasco	1	1	1	1	1	1	1	2	1	2	1	2	1	2
Valencia	3		3		4		4	1	4	2	4	3	4	4
Ceuta														
Melilla														
UNED**	1		1		1		1		1		1		1	

Source: Ministry of Education and Vocational Training. *Information is provided every 5 years due to lack of space. **National Online University is present in all Autonomous Communities

Table 3. Unemployment rates: total and higher education. 1995-2015

	1995	2000	2005	2007	2010	2013	2014	2015
Germany								
Total	8.2	8.0	11.3	8.8	7.1	5.3	5.1	4.7
Higher education	5.0	4.3	5.6	3.9	3.1	2.4	2.5	2.4
Spain								
Total	22.8	13.9	9.2	8.3	20.0	26.2	24.6	22.2
Higher education	17.9	10.9	6.8	5.3	11.2	16.1	14.8	13.3
France								
Total	11.9	10.3	8.5	7.7	8.9	10.0	10.4	10.4
Higher education	7.4	5.6	5.9	5.2	5.3	6.0	6.4	6.4
Italy								
Total	11.8	11.0	7.8	6.2	8.5	12.3	12.9	12.1
Higher education	7.6	6.2	6.2	4.5	5.8	7.3	8.0	7.2
Portugal								
Total	7.4	4.0	8.0	8.5	11.4	17.0	14.5	12.9
Higher education	4.1	2.8	6.3	7.5	7.1	12.8	10.1	9.3
United Kingdom								
Total	8.8	5.6	4.8	5.3	7.9	7.7	6.3	5.4
Higher education	4.4	2.5	2.6	2.6	4.1	4.0	3.2	3.0

Source: Eurostat. Labour Force Survey. Tertiary education: Tertiary education (levels 5-8, ISCED-11). 1995 is the first year Eurostat offers this indicator.

Table 4. Panel data estimate (fixed effects). Dependent variable: growth rate of the GDP per capita logarithm.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Constant	0.002	*	0.005	*	0.006	*	0.004	*	0.004	*
	(0.0001)		(0.001)		(0.002)		(0.001)		(0.001)	
Lagged growth of enrolments	0.035	*	0.019	*	0.020	*	0.014	*	0.012	*
	(0.019)		(0.008)		(0.008)		(0.003)		(0.003)	
Lagged population			0.001	*	0.001	*	0.001		0.001	
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged GDP per capita			-0.001	*	-0.001	*	-0.001	*	-0.001	*
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged percentage of population with university studies					0.011		-0.013	*	-0.002	
					(0.010)		(0.005)		(0.007)	
Lagged unemployment rate growth							0.018	*	0.024	*
							(0.004)		(0.003)	
Unemployment rate growth							-0.095	*	-0.097	*
							(0.008)		(0.008)	
Lagged population growth									-0.542	*
									(0.096)	
R^2 within	0.06		0.23		0.23		0.60		0.61	
R^2 between	0.08		0.07		0.11		0.05		0.30	
R^2 overall	0.05		0.06		0.05		0.49		0.49	
Nº observations	391		391		391		391		391	

Note: * Significance at 5%.

Table 5. Panel data estimate (fixed effects). Dependent variable: growth rate of GDP per capita logarithm. Autonomous Regions grouped according to GDP per capita.

	Group 1		Group 2		Group 3	
Constant	0.003		0.003	*	0.003	**
	(0.002)		(0.002)		(0.002)	
Lagged growth of enrolments	0.065	*	0.011	*	0.081	*
	(0.014)		(0.001)		(0.025)	
Lagged population	0.001		0.001		0.000	
	(0.0001)		(0.0001)		(0.000)	
Lagged GDP per capita	-0.001		-0.001	*	-0.001	
	(0.0001)		(0.0001)		(0.001)	
Lagged percentage of population with university studies	0.003		0.017	*	0.001	
	(0.018)		(0.009)		(0.012)	
Lagged unemployment rate growth	0.012		0.019	*	0.031	*
	(0.015)		(0.003)		(0.003)	
Unemployment rate growth	-0.103	*	-0.071	*	-0.105	*
	(0.009)		(0.013)		(0.009)	
Lagged population growth	-0.466		-0.737	*	-0.574	*
	(0.337)		(0.056)		(0.182)	
R^2 within	0.70		0.65		0.62	
R^2 between	0.01		0.75		0.82	
R^2 overall	0.64		0.55		0.62	
No. observations	92		69		230	

Note: * Significance at 5%.
Group 1: Madrid, Cataluña, País Vasco, Navarra. Group 2: Aragón, Baleares, La Rioja. Group 3: Cantabria, Valencia, Asturias, Castilla y León, Castilla La Mancha, Canarias, Murcia, Galicia, Andalucía y Extremadura.

Table 6. Panel data estimate (fixed effects). Dependent variable: growth rate of the GDP per capita logarithm. The neighbouring effect of enrolment growth is included.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Constant	0.001	*	0.004	*	0.006	*	0.004	*	0.003	*
	(0.0001)		(0.001)		(0.002)		(0.001)		(0.001)	
Lagged growth of enrolments	0.029	*	0.020	*	0.021	*	0.014	*	0.013	*
	(0.013)		(0.008)		(0.008)		(0.003)		(0.00)	
Average lagged growth of enrolments in neighbouring Autonomous Regions	0.075	*	0.043	*	0.046	*	0.009		0.012	
	(0.020)		(0.012)		(0.013)		(0.006)		(0.008)	
Lagged population			0.001	*	0.001		0.001		0.001	
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged GDP per capita			-0.001	*	-0.001	*	-0.001	*	-0.001	
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged percentage of population with university studies					0.019	*	-0.017	*	0.002	
					(0.009)		(0.005)		(0.007)	
Lagged unemployment rate growth							0.017	*	0.023	*
							(0.004)		(0.003)	
Unemployment rate growth							-0.094	*	-0.095	*
							(0.008)		(0.008)	
Lagged population growth									-0.559	*
									(0.096)	
R^2 within	0.18		0.26		0.26		0.60		0.62	
R^2 between	0.04		0.07		0.18		0.06		0.40	
R^2 overall	0.17		0.07		0.11		0.52		0.53	
No. observations	391		391		391		391		391	

Note: * Significance at 5%

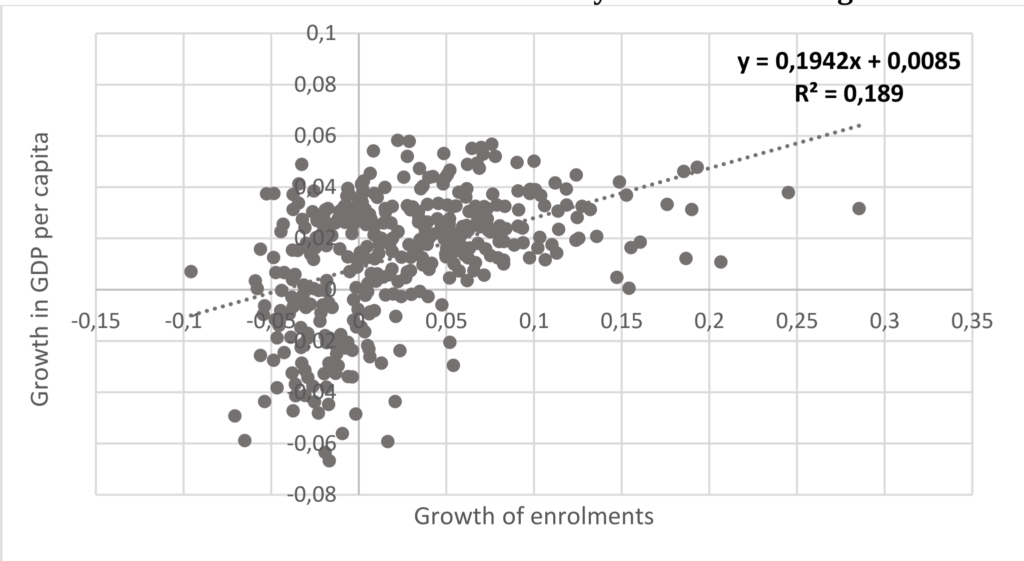
Table 7. Panel data estimate (fixed effects). Dependent variable: growth rate of the GDP per capita logarithm. The effect of enrolment growth by field of knowledge.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Constant	0.001	*	0.004	*	0.006	*	0.004	*	0.003	*
	(0.0001)		(0.001)		(0.002)		(0.001)		(0.001)	
Lagged growth in Health Science enrolment	0.019	**	0.031	*	0.030	*	0.015	**	0.011	
	(0.011)		(0.014)		(0.014)		(0.007)		(0.007)	
Lagged growth in Science enrolment	0.040	*	0.026	**	0.027	*	0.023	*	0.021	*
	(0.017)		(0.014)		(0.014)		(0.007)		(0.007)	
Lagged growth in Engineering and Architecture enrolment	0.029	*	0.014	*	0.014	*	0.009	*	0.008	*
	(0.006)		(0.005)		(0.005)		(0.003)		(0.003)	
Lagged growth in Social Science enrolment	0.078	*	0.048	*	0.053	*	0.014	*	0.016	*
	(0.015)		(0.012)		(0.012)		(0.007)		(0.009)	
Lagged population			0.001	*	0.001		0.001		0.001	
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged GDP per capita			-0.001	*	-0.001	*	-0.001		-0.001	
			(0.0001)		(0.0001)		(0.0001)		(0.0001)	
Lagged percentage of population with university studies					0.014		-0.011	*	-0.001	
					(0.010)		(0.006)		(0.007)	
Lagged growth of unemployment rate							0.018	*	0.024	*
							(0.004)		(0.003)	
Lagged unemployment rate							-0.093	*	-0.095	*
							(0.008)		(0.008)	
Lagged population growth									-0.506	*
									(0.102)	
R^2 within	0.22		0.26		0.27		0.61		0.62	
R^2 between	0.11		0.05		0.21		0.04		0.57	
R^2 overall	0.14		0.07		0.13		0.54		0.60	
No. observation	391		391		391		391		391	

Note: * Significance at 5%.** Significance at 10%. Field of knowledge of reference: Arts and Humanities

FIGURES

FIGURE 1. Growth rates. One observation by Autonomous Region. 1985-2016



Source: Regdata and National Statistics Institute

APPENDIX

Table A1. Distributed lag specifications

	(1) Coef. (St. Dev.)		(2) Coef. (St. Dev.)		(3) Coef. (St. Dev.)		(4) Coef. (St. Dev.)		(5) Coef. (St. Dev.)		(6) Coef. (St. Dev.)	
8 years lagged growth of enrolments	0.013	*	0.009	*	0.008	*	0.007	*	0.009	*	0.010	*
	(0.004)		(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
6 years lagged growth of enrolments			-0.002		-0.005	*	-0.002		-0.004		-0.001	
			(0.001)		(0.002)		(0.003)		(0.003)		(0.003)	
7 years lagged growth of enrolments					-0.007	*	-0.004	*	0.003		0.003	
					(0.001)		(0.002)		(0.003)		(0.003)	
9 years lagged growth of enrolments							-0.008	*	-0.006		-0.003	
							(0.003)		(0.003)		(0.003)	
10 years lagged growth of enrolments									0.007	**	0.007	
									(0.004		(0.005)	
11 years lagged growth of enrolments											0.001	
											(0.002)	
No. Observations	391		391		391		374		357		340	

Note: * Significance at 5%; ** Significance at 10%. The rest of the covariates present in the estimates have been omitted.

Column 1 shows GDP per capita growth rate is estimated based on 8-year lag explanatory variables of model 5; Column 2 adds 6-year lag explanatory variables; Column 3 adds 7-year lag explanatory variables; Column 4 adds 9-year lag explanatory variables; Column 5 adds 10-year lag explanatory variables; Column 6 adds 11-year lag explanatory variables. Estimate values for the variable gathering enrolment growth rate are the only ones shown for easy-reading purposes. As it can be observed in Table A1, the estimated coefficient for an 8-year lag is statistically significant for all proposed equations, while exercising a positive effect; a 6-year lag is statistically significant in equation 3 (with a negative sign); a 7-year lag is statistically significant in equations 3 and 4 (with a negative sign); a 9-year lag is statistically significant in equation 4 (with a negative sign); and a 10-year one is positive and statistically significant at 10% only in equation 5.