

PUBLIC UNIVERSITIES AND REGIONAL ECONOMY IN ECUADOR: A PANEL DATA STUDY

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Abstract

The study analyses the impact of public universities on economic activity in sixteen provinces of Ecuador (2015 to 2020), using fixed and random effects panel data, whose selection was based on the Hausman test. The impact of the number of teachers, undergraduate and graduate student enrolment, number of scholarships, executed budget and number of careers (demand side), in addition to published research, number of polytechnic schools and supply of medicine (knowledge side) in each of the regions is evaluated. There is a direct relationship between the gross value added of production and the number of universities, careers, undergraduate students, and budget allocated. The number of published research papers was not statistically significant.

Keywords: public universities, regional economics, territorial development, budget universities, [development of Ecuador](#), panel data

JEL: I25, I23, C23, O54

1. Introduction

Universities play a fundamental role in the territorial development of a region or country, in what has been called the "third mission". Their impact goes beyond higher education, as they contribute to the generation of knowledge, innovation, economic growth, and the improvement of the quality of life of the communities in which they are located. In this third mission, universities have joined forces with local actors, both public and private, to strengthen economic activity through processes of building governance, networks, and social capital in which they enjoy a strategic position for strengthening the social fabric and human capital (Hudson, 2006). Universities play a key role in promoting sustainable development in their regions.

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Through research and education, they can address the environmental and social challenges facing a community (Alberti et al., 2015; Torres et al., 2010). They can collaborate with businesses and organizations to develop innovative solutions to sustainability-related problems. These collaborations can lead to the creation of recent technologies, products, and services that benefit both the local community and the environment (Borda, 2012).

They are research and development centres and have a fundamental role in generating knowledge and promoting innovation. Through scientific and technological research, universities can generate advances that drive the economic and social development of a region (Hermannsson et al, 2017; Pastor et al., 2019). Universities have the capacity to transfer that knowledge to society through the training of highly skilled professionals. Higher education provides students with the skills and knowledge needed to address real-world challenges, which in turn drives innovation and entrepreneurship in the region (Herrera, 2020).

In addition to formal education, universities also provide opportunities for personal and professional development through training programs, scholarships, and extracurricular activities. These opportunities help students acquire soft skills, such as teamwork, communication, and leadership, which are essential in today's work environment.

Universities have a significant impact on the local economy by generating employment, attracting investment, and fostering entrepreneurship. The presence of a university in a region attracts students, academics, and administrative staff, which in turn drives demand for local goods and services (Florax and Folmer, 1992; Pellenbarg, 2007; Torres et al., 2010; Lilles and Røigas, 2017).

These impacts are usually grouped using different criteria, which according to Torres et al. (2010), those associated with the creation of ventures, innovation ecosystems or technology transfer could prevail, although Florax and Folmer (1992) manage to classify them in addition to their effect (political, demographic, economic, infrastructure, cultural, educational and social), into those on the demand side, direct or not, short term, and those on the knowledge side, or long term (Torres et al., 2010).

In the first case, the effects on spending "are those that derive from spending by universities (as an institution, students, teaching and research staff and administrative and service personnel)" (Torres et al., 2010, p. 176), stimulating the production of goods and services in the area, consumption and investment, which translates in the short and long term into an increase in the economic activity of the territories.

This direct spending from the higher education institution through the budget, or through spending by students and academic and administrative staff, also generates an impact on salaries, employment, taxes and even investment in infrastructure, whether public or private.

The expenditures made lead to an increase in demand in certain sectors. For example, spending by universities in the higher education system leads to an increase in demand in the economic sectors that supply them with goods and services (demand for consumption and investment), which consequently increases production.

This increase in production in the economy is called a direct effect. In essence, these direct impacts are the result of activities that would not have taken place in the absence of the higher education system (Pastor et al., 2016).

The direct economic impact derives from the expenditures made by the university in the locality, so that if the university did not exist these expenditures would not be generated. While the indirect economic impact is produced by the cyclical turn of money in spending, since the economic sectors that receive money demand towards other sectors for their products, thereby diversifying the economy (Torres et al., 2010; Duch et al., 2011; Aldás et al., 2018; Pastor et al., 2019).

Indirect impacts occur when the economic sectors that directly receive the increase in demand generate indirect effects on other sectors, since they need to buy more from their suppliers to satisfy the increase in production. In turn, suppliers will generate greater demands to the rest of the economic sectors and thus initiate an iterative process on the rest of the economy, therefore, the sum of the demand increases derived from this iterative process is called indirect effect (Pastor et al., 2013).

The direct and indirect impacts referred to above will have a drag or induced effect on the rest of the economic activity, which is known as the multiplier effect. The chain of effects is called the income multiplier and is closely related to the Keynesian concept of multiplier (Pastor, et al., 2019).

Kotosz et al. (2015) incorporates to these three effects, direct, indirect and induced, a fourth, which he calls catalyst, and is related to the companies that are created in the territory product of the presence of universities, so he keeps only in the indirect impact, the increase in the production of companies that were already making life in the region. The total impacts associated with an increase in final demand attributable to the existence of the higher education system are obtained as the sum of the direct, straight, and induced impacts (Pastor, et al., 2019).

In the second case, the effects on the knowledge side are the least explored and are related to the development of human capital in the region, such as improvements in the performance and productivity of workers, innovations, patents, research and development (Torres et al., 2010; Alves et al., 2015; Schubert and Kroll, 2016; Marrocu et al., 2022).

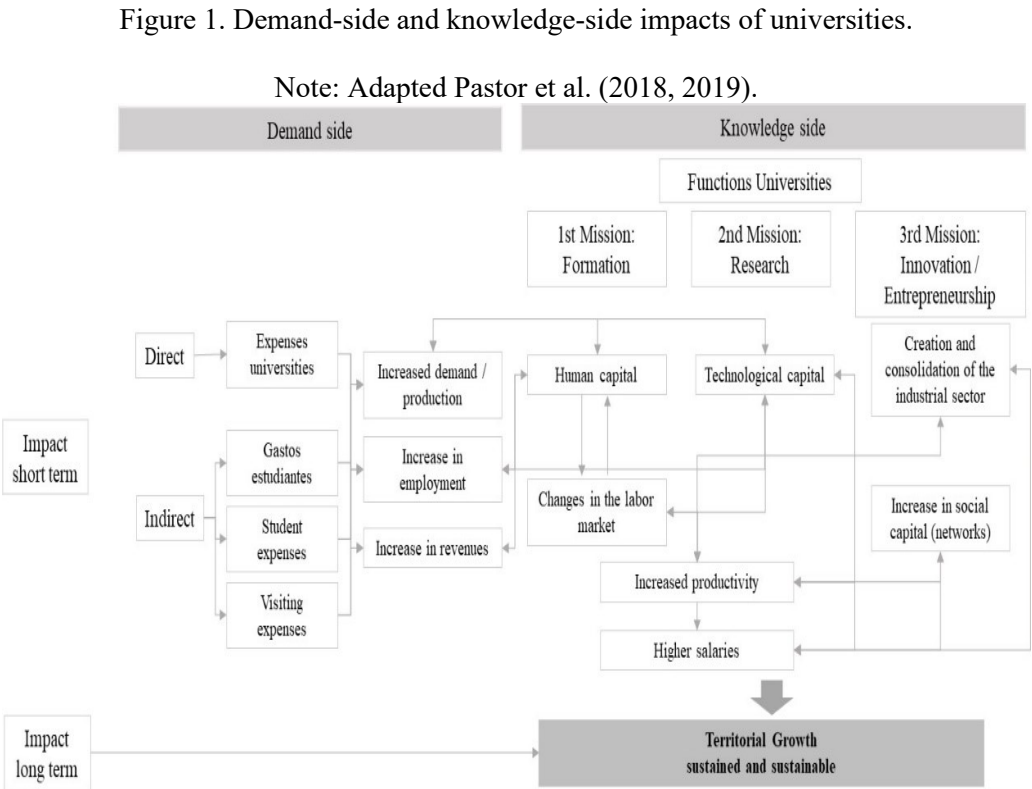
Thus, the long-term or supply-side impact is related to what has been mentioned as the third mission of universities. Indeed Pastor et al. (2018) establishes according to the literature a first mission associated with the development of human capital through graduates, which has an impact on employment, salary, tax revenue.

A second mission related to research activity, with which it contributes to the creation of technological capital, through research and knowledge transfer, raising productivity. Finally, the third mission involves the vision of an entrepreneurial university that leads to an increase in public and private spending, employment, and income. These three missions contribute in an interrelated way, with the economic growth of the territory (Pastor et al, 2018).

In addition to this proposal of the three missions, Uyarra (2010) proposes five models that try to explain the role that the university can assume, explaining the university as a knowledge factory, the relational university, the entrepreneurial university, the systemic

university, and the committed university. In the first three cases the role is associated with knowledge, while the systemic university encourages innovation and entrepreneurship and, finally, it is the committed university that refers to impact in terms of development.

Regardless of the models or the classification used, both the demand-side impacts, which are usually considered short-term, and the long-term knowledge-side impacts are interrelated in a complex web, generating effects on the territory that can be tangible, such as increased employment, the business fabric, technification, revenue and even consumption, as shown in Figure 1.



As indicated, demand-side impacts are generated by university spending through budget execution, which, together with student spending (Carrascal et al., 2021), the spending of teachers and employees themselves, as well as visitors, have an impact on demand (consumption), stimulating production and with-it employment and even tax collection levels, which in turn will generate positive effects on the budget allocation of the educational system.

Although these effects are usually evaluated in the short term, since their results can be evidenced in the same academic period, there are effects associated with knowledge that require structural changes, linked to the three missions of higher education institutions.

These structural changes are usually medium and long term and seek to improve in a sustained and sustainable manner the economic activity of the territory on which the institutions have an impact. The changes are related to the improvement of human capital and its implications in the labour market, which are reflected in higher employment, salaries, and revenue, through increases in productivity, which is attributed to the first mission of universities: training.

This first mission is leveraged and reinforced with the increase in technological capital driven by university research (second mission), which should be oriented towards solving the problems of the territory, contributing to improving its conditions and the use of resources, through more technology. These higher levels of technological capital stimulate productivity, strengthen the business fabric, employment, salaries, and revenue, in the presence of strengthened human capital.

Authors such as Dembereldorj et al. (2018) warn about the importance of research in universities, as a mechanism to generate indirect impacts on territorial development but emphasize that it is not important the research itself, nor the volume, but the quality of the research. In fact, Chu, and Liu (2020) in their study establish that research universities do not necessarily promote development in the regions, like the conclusions obtained by Bonander et al. (2016).

Finally, the third mission of universities is linked to innovation and entrepreneurship, as universities are part of entrepreneurship ecosystems in conjunction with the public and private sector, which conditions the added value of productive processes and constitutes a competitive advantage for new businesses, contributing to their sustainability.

All these structural changes lead to better conditions in the region, raising in a sustained manner the gross domestic product, human and technological capabilities, and the social capital essential for trust, governance, networks, and lasting relationships, with which benefits are generated through access to resources.

It is also necessary to consider the non-tangible effects associated with both the individual and the collective, which are not linked to the market, as proposed by Pastor et al. (2019). This short and long-term process reduces gender gaps, promotes participation in community and political management in the territory, social mobility, reduces insecurity and even encourages sustainability processes through greater sensitivity to environmental preservation.

Studies using different methodologies show this impact, direct, indirect, tangible, or not, of universities. Studies such as those of Pastor et al. (2013, 2016, 2016, 2018, 2019) for university institutions in Spain stand out, or that of Garrido (2007), who concludes that the university population increases the flow of expenses in university resident localities.

Castro et al. (2005) states that economically developed countries invest in their universities to attract foreign investment and new companies with more production; clear examples are the United States, Great Britain, and France, which maintain research and development (R&D) networks that have led to increases in production and employment indicators.

Similarly, Daza (2012) categorizes the presence of universities as relevant in the development of a country in all important aspects, training, innovation, economy, welfare, among others. He also warns of the situation of Latin American countries, particularly Colombia, where investment in higher education institutions is relatively low, which conditions their real growth rate.

Borda (2012) also ratifies the importance of universities for industry and production, not only because of the consumption or demand they make, but also because of the contribution in human capital providing a trained workforce, linked to the first mission of the university.

Also, Borda (2012) emphasizes the third mission that should be developed through the model called "the triple helix" where "the university, industry and government form a reciprocal relationship that tends to improve the functioning of the parties for joint development" (p. 364).

Duch et al. (2008) in their study calculates the separate effects of different universities on functions in the regional economy, human capital creation, research, and technology transfer. It includes a panel data set of activities and their effects on the economy at the provincial level.

The economic estimation of Duch et al. (2008) is based on information for 47 public universities and includes 34 Spanish provinces; the empirical results suggest that regional growth is positive according to the human capital created by universities.

Methodologically, in most of these studies, to verify the fact that universities influence the economy of their locality, an input-output analysis is proposed in which the demand of universities (expenditure and consumption) generates production, marketing, income and employment (outputs) (Torres et al., 2010; Duch et al., 2011; Aldás et al., 2018; Pastor et al., 2019; Nauffal (2019).

There are also other proposals such as that of Kotcosz et al. (2015) which is based on the missions of the university; in the case of training and research, a multiplier approach is suggested, while, for the third, a set of indicators, although there is a warning about the problems of the conceptualization of impact, calculations and their limitations, as well as those indicators to be used.

Given all the above-mentioned impacts, in the short and long term, governments make efforts to promote higher education, since there is empirical evidence that the development of human capital is a fundamental factor in generating growth and economic development. Despite this, within the framework of budgetary restrictions in Latin America, and particularly in Ecuador, it has been decided to reduce the resources allocated to the education system, especially in higher education.

In Ecuador, since 2018, decisions have been oriented to cut the budget in different areas, eliminating and reducing student and professionalization scholarships, technification and investments. This situation worsened because of the covid-19 pandemic, decreasing the budget by 10% in 2020, which represented between 97 and 98 million dollars. While in the years 2021-2022 the budget allocation was not fulfilled and for the year 2023, only 18 million dollars were increased, but only 33 institutions were benefited and even the allocation to 15 others was decreased.

In Ecuador, the Higher Education System (SES) is composed of universities, polytechnic schools, and public and private institutes, which are regulated by the Secretariat of Higher Education, Science, Technology, and Innovation (SENESCYT) and legally protected under Article 35 of the Constitution of Ecuador (2008).

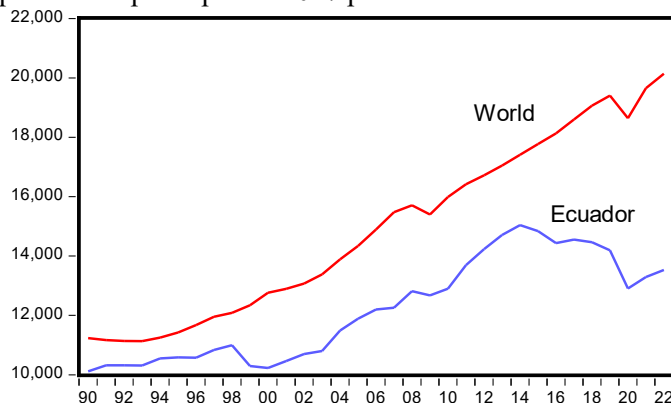
There are 60 universities and polytechnic schools in Ecuador, of which 33 are public, 19 are private (self-financed) and 8 are private (co-financed or supported by the public sector). Given that a large part of this academic offer is derived from institutions financed with public resources and that there is no research that attempts to evaluate their impact in the regions, the question arises as to whether these universities and polytechnic schools generate direct and indirect effects, at least in the short term (demand side), in the territories (provinces) in which they develop their activities, despite the budgetary restrictions they have experienced in recent years.

In addition, the possible influence of research measured through scientific publications, on the knowledge side, as well as the number of programs offered and the presence of medical schools, is analysed.

2. Economic Development and Regional distribution of Population in Ecuador.

Graph 1 shows the evolution of real Gross Domestic Product per capita in Ecuador, for the period 1990-2022, in comparison with World average.

Graph 1. GDP per capita at 2017 prices and PPPs: Ecuador and World



Source: Elaborated from World Bank data (Dollars at 2017 prices and Purchasing Parities)

We may notice little increase for the period 1990-2000, an important increase for the period 2000-2015, and a decrease for 2015-2022.

A comparison of indicators of development in Ecuador with American and World averages, show that the production per capita in manufacturing industry decreased for the period 2000-2010 and experienced moderate increase for 2010-2015.

Several international studies, like Guisan(2017), present an important support to Kaldor's views on the great importance of industry for the increase of non-industrial real production. It seems to be important for Ecuador to foster manufacturing and other activities that had an important role on economic development.

Universities had an important role because economic development increases the demand of highly skilled workers, many of them with university degree, particularly in Sector services, which usually experience a great increase with industrial development.

Universities research may have also important positive impact on national and regional development, contributing to the development of studies in natural, social and human sciences that may have a positive effect on economic activities.

The analysis of provincial and regional development is important in order to policies for poverty diminution and increase of opportunities of employment and quality of life. Ecuadorian Government has published interesting information on the evolution of provinces and cantons in the study by Cabrera et al(2015)

3.Methodology to determine the effect of public higher education institutions

To determine the short-term effect of public higher education institutions, data on the gross value added of production (GVA) of each province (territorial division in Ecuador) was used as the dependent variable and on which we tried to identify the effects of the variables available in the SENESCYT databases: number of university enrolment, allocated budget, unique institutions in the province, polytechnic schools, medical career, number of teachers, number of publications and scientific research, number of careers, students with scholarships, students with postgraduate degrees.

Since a time, series from 2015 to 2020 was analysed, for each of the provinces (individuals) estimation through static panel data was used. Dynamic estimation was not possible due to the time horizon in which the data were available.

The main characteristic of panel data estimations is associated with heterogeneity, which can come from individuals or from time; in the first case, fixed effects through panel ordinary least squares should be used, while in the second case, random effects by generalized least squares should be used.

The presence of heterogeneity generates biased estimates in the sense that the unobservable heterogeneity that forms part of the regression error is correlated with the explanatory variables. The way the problem is addressed differs depending on whether the estimation is fixed effects or random effects.

In the case of fixed effects estimation, the difference of each variable with respect to its mean is estimated. While in the case of random effects the difference is with respect to the mean weighted by a factor. The selection between fixed effects or random effects is determined through the Hausman test, whose null hypothesis establishes that the best estimate is that of random effects.

If the null hypothesis is rejected and the fixed effects estimation is selected in which the heterogeneity comes in this case from the provinces, the presence of heteroscedasticity must be validated with the modified Wald test for panel (Greene, 2000) and the autocorrelation through the serial correlation test for panel (Wooldridge, 2002; Drukker, 2003).

If the presence of either or both two problems is detected, it is necessary to correct the estimation of fixed effects by robust or generalized least squares, eliminating autocorrelation or heteroscedasticity.

The equation to be estimated for both effects is given by:

$$y_{it} = \beta_1 x_{1it} + \dots + \beta_k x_{kit} + u_{it} \quad (1)$$

Where y_{it} is the gross value added in a region or an economic activity and, x_{kit} are the explanatory variables:

- students enrolled in undergraduate in universities in the province;
- students enrolled in graduate programs in universities in the province;
- budget of universities in the province;
- provinces with only one university;
- provinces with polytechnic schools;
- provinces with universities that offer the medical program;
- number of total teachers;
- number of articles published by universities in the province;
- number of undergraduate programs offered by universities in the province;
- students with scholarships in universities in the province.

With respect to individuals, as the dependent variable is GVA, 16 provinces were considered that have public universities or polytechnic schools, so that the explanatory variables will be the sum of each of the institutions located in the territory.

These 16 provinces are given by: Bolivar, Carchi, Napo, Pastaza, Chimborazo, Cotopaxi, Imbabura, Santa Elena, Tungurahua, Azuay, El Oro, Esmeraldas, Los Rios, Manabí, Guayas, and Pichincha.

3. Results

To understand the behaviour of the heterogeneity of the data, we analyse the deviation between provinces and the deviation over time, which could explain the differences in the results over time or on the contrary between individuals, giving rise to different estimates. For each of the variables, the averages among all the provinces are shown, evidencing an average gross value added for the entire period of USD 5,315 million (MM), although there are provinces such as Guayas and Pichincha (economic and political capital, respectively) that exceed USD 25,000 MM, which explains the greater heterogeneity among provinces than over time, which is observed in the deviation.

With respect to the explanatory variables, the behaviour is repeated in terms that the heterogeneity between provinces is greater than the changes over the study period, as shown by the higher deviation in the first case than in the second. The average number of undergraduate students was 20,760, of which 1,399 received scholarships, while the average number of graduate students was only 866. This small number of students enrolled in graduate programs is related to the restrictions established during the period by the regulatory bodies for the approval of fourth level programs, so that many of the universities were unable to offer new master's degrees.

The average budget allocated to educational institutions per province was USD 67.7MM, with provinces such as Pichincha and Guayas with their educational institutions, budgets have exceeded USD 250 MM, while in others such as Carchi their average is in just USD 8 MM. This situation is evidence of unequal budget distribution, which is not associated with demand, since there is a high proportion of students in most higher education institutions that must move from one province to another to enter the system. Budgetary restrictions tend to be more noticeable in universities that are not located in large cities, limiting their growth and quality.

It is also possible to identify those one out of every four provinces has only one university or polytechnic school, which restricts results in terms of students and budget, while 62.5% of the provinces have public higher education institutions that offer medical degrees.

For the period, on average, the provinces had 903 teachers and 173 published articles, which implies an average rate of less than 1 article for every five teachers. This rate has tried to be increased through public policies, generating incentives through budget allocation.

Budgetary limitations in the research area of universities hinder the development of projects, especially technological ones, together with the limited presence in national and international networks and the excessive teaching load, which reduces the hours assigned to research in many cases to a couple of hours per week.

To estimate the effect of the variables analysed on provincial GVA, four models were estimated, in which explanatory variables have been gradually incorporated, with the aim of identifying whether their significant behaviour is maintained as additional variables are included.

Model 1 considers only the budget of the universities, model 2 the group of variables associated with the number of students and teachers, model 3 adds the number of undergraduate programs, the existence of a university in the province, polytechnic schools and medical careers, and finally, model 4 the knowledge variable associated with the publication of scientific articles. These estimations were performed for fixed effects (Table 1) and random effects (Table 2).

When analysing the fixed effects model, it is observed that the possibility of working with variables such as the existence of a single university, polytechnic schools in the province or the medical career is lost, because they are zero-one variables (dichotomous) that do not change over time due to the form of estimation (difference of values with respect to the mean) and they cancel each other out. In the estimation of random effects, they are preserved. The Wooldridge test for serial correlation identifies autocorrelation problems since the null hypothesis of no autocorrelation is rejected.

The modified Wald test for panel heteroscedasticity also reveals problems of non-constant variance. The presence of these problems generates biased estimates, which makes it impossible to analyse the relationships from the estimated coefficients. The correction of both problems through generalized least squares for panel is required.

Table 1. Panel data estimation for fixed effects

	Model 1	Model 2	Model 3	Model 4
Variable Independent	Coefficients	Coefficients	Coefficients	Coefficients
Budget for universities in the province	0.0032* (0.0018)	0.0027 (0.0019)	0.0030 (0.002)	0.0031 (0.0021)
Students enrolled in undergraduate programs		-35.161** (14.781)	-37.234** (15.096)	-36.140** (16.000)
Students enrolled in graduate programs		-62.997 (78.953)	-93.454 (89.487)	-90.927 (90.809)
Students with scholarships		-133.938** (62.003)	-154.944** (68.511)	-151.740** (70.501)
Number of teachers		457.096*** (150.347)	462.715*** (151.011)	454.881*** (156.171)
Number of undergraduate programs			3159.68 (4321.59)	3515.73 (4645.36)
Number of papers published				-110.107 (504.34)
Constant	5098246*** (133427.2)	5679126*** (400716.5)	5583937*** (422524.2)	5552911*** (448387.6)
N (Observations)				96
N (Group)				16
Adjusted R2	0.8477	0.7321	0.6632	0.6381
Over time	0.0353	0.2968	0.3019	0.3023
Between groups	0.9007	0.8356	0.7900	0.7827
Test F	2.89*	6.33***	5.33***	4.52***
F-test (pooled)	423.45***	357.17***	342.55***	329.56***
Autocorrelation	285.87***	20.985***	7.569**	9.237***
Heteroscedasticity	1.3e5***	94723.58***	69721.98***	73694.02***

Note: Significant less than 1% (***), between 1% and 5% (**) and between 5% and 10% (*). Values in parentheses correspond to standard errors.

With respect to the random effects estimates necessary to compare them with fixed effects through the Hausman test, they show in all models the significance of the budget in explaining GVA, which does not change despite the incorporation of additional variables in each estimate (Table 2).

Table 2. Random effects panel estimation

	Model 1	Model 2	Model 3	Model 4
Variable Independent	Coefficients	Coefficients	Coefficients	Coefficients
Budget for universities in the province	0.0076*** (0.0027)	0.0149*** (0.0029)	0.0070*** (0.0024)	0.0072*** (0.0024)
Students enrolled in undergraduate programs		75.310*** (20.3631)	-5.0590 (18.033)	-3.8696 (18.370)
Students enrolled in graduate programs		-79.325 (135.031)	-112.126 (112.124)	-96.458 (109.995)
Students with scholarships		-208.346* (106.224)	-201.694** (86.124)	-178.172** (85.773)

Number of teachers	949.651*** (246.064)	615.319*** (186.824)	552.859*** (187.949)
Number of undergraduate programs		5566.957 (5429.07)	7117.33 (5608.97)
Provinces with only one university		9628971*** (1785299)	9596814*** (1867487)
Provinces with universities offering medicine		5416279*** (1561352)	5375999*** (1633662)
Provinces with Polytechnics		5869235*** (1775169)	5849602*** (1855468)
Number of papers published			-583.329 (604.877)
Constant	4799128*** (1016330)	2229439** (932217.5)	-2804477** (1237577)
N (Observations)			96
N (Group)			16
Adjusted R2	0.8477	0.8517	0.7504
Over time	0.0353	0.0461	0.2373
Between groups	0.9007	0.8588	0.7514
Test Wald	7.86***	48.12***	120.67***
Test Breusch Pagan	87.89***	128.85***	132.92***
Hausman	5.08**	112.06***	20.26***

Note: Significant less than 1% (***), between 1% and 5% (**) and between 5% and 10% (*). Values in parentheses correspond to standard errors.

When the results of the Hausman test are analysed, whose null hypothesis states the preference for random effects, it is rejected in all the models, so that the estimate that best reflects heterogeneity is given by fixed effects. Given that these estimates present problems of autocorrelation and heteroscedasticity, it is necessary, to have unbiased results, to conduct the correction by means of generalized least squares, the results of which are shown in table 3.

Table 3. Estimation of fixed effects corrected by generalized least squares.

	Model 1	Model 2	Model 3	Model 4
Variable Independent	Coefficients	Coefficients	Coefficients	Coefficients
Budget for universities in the province	0.0882*** (0.0038)	0.0244*** (0.0063)	0.2413*** (0.0040)	0.0239*** (0.0041)
Students enrolled in undergraduate programs		170.921*** (26.570)	109.972*** (25.278)	107.915*** (24.802)
Students enrolled in graduate programs		-138.414 (179.243)	-75.545 (68.004)	-73.157 (68.069)
Students with scholarships		-199.329 (140.782)	-201.209 (138.891)	-200.913 (136.176)
Number of teachers		340.436** (145040)	-2.7861 (297.434)	34.638 (299.320)
Number of undergraduate programs			33164.32*** (9337.36)	32829.43*** (9131.62)
Provinces with only one university			2269543*** (775652.2)	2336892*** (784210.3)

Provinces with universities offering medicine	-454610 (426521)	-412335.7 (429941.3)		
Provinces with Polytechnics	497951.8 (382996.3)	525790.9 (389524.5)		
Number of papers published			-88.7312 (822.999)	
Constant	-659366.1 (411333.1)	-352177.6** (145040)	-510607.2 (344607)	-526940.4 (351120.1)
N (Observations)				96
N (Group)				16
Test Wald	534.10***	307.45***	496.03***	477.3***

Note: Significant less than 1% (***), between 1% and 5% (**) and between 5% and 10% (*). Values in parentheses correspond to standard errors.

The estimation results of the four models indicate that the university budget is statistically significant and with a positive sign, so that an increase of USD 1 raises provincial GVA by 0.08 to 0.02 cents, as is commonly reported in the literature in terms of short-term demand-side effects.

The number of undergraduate students enrolled was also significant in all the models in which it was included, showing, as expected, a direct relationship, implying that at least for each additional student GVA rises by USD 107.92. We also manage to identify direct and significant relationships with the number of undergraduate programs offered and with the existence of only one university in the province.

In the first case, the offer of an additional degree program on average can increase the provincial GVA by USD 33,000, while having a university increases it by slightly more than USD 2 million.

4. Discussion

The results evidence that the presence of universities positively affects economic activity in the provinces, as posited by several authors (Florax and Folmer, 1992; Pellenbarg, 2007; Torres et al., 2010; Lilles and Rõigas, 2017; Pastor et al., 2013, 2016, 2018, 2019; Kotosz et al., 2015; Daza, 2012; Borda, 2012), at least on the short-term demand side.

Thus, confirming the hypothesis that established that the presence of universities in a region has a positive effect on its economic activity, through budget execution, student enrollments, number of careers and the presence of the institution itself, but not in relation to the number of articles published.

The reasons for these results are based on the evolution experienced by higher education in Ecuador in the last three decades, starting with the achievement of university autonomy with the enactment of the Higher Education Law in 1988. This was followed by a decentralization process since 1995, in which the so-called "regional universities" were created. These universities were established in different provinces of the country, with the aim of bringing higher education closer to local communities and fostering regional development (Pacheco, L. and Pacheco, R., 2015).

The emphasis in recent years has been on access and equity through public policies. Scholarship and educational credit programs have been established, as well as entrance

quotas for disadvantaged socioeconomic groups. These measures have sought to reduce the economic and social barriers that impede access to higher education.

In the last decade, regulatory bodies have placed special interest in evaluation and accreditation processes, also encouraged by the aspiration to enter international rankings. These processes seek to guarantee the quality of the education offered and promote continuous improvement. Institutions must undergo periodic evaluations to obtain or renew their accreditation, both as an institution and by program (Raza, 2019; Cabrera, 2020).

Finally, efforts have focused on internationalization, promoting student mobility and academic collaboration with foreign institutions. Cooperation agreements have been established and student and faculty exchange programs have been promoted to strengthen training and research.

As for the second and third missions, greater emphasis has been placed on scientific research and technological development in the higher education system. Incentives have been created to promote research, postgraduate programs have been strengthened and research centers have been established in strategic areas.

It is important to mention that an important characteristic of the system is its dependence on state funding. The state is one of the main sources of funding for higher education in Ecuador. It provides funding to universities and polytechnic schools. This funding is important to ensure that higher education is accessible to all, regardless of their financial situation, and to promote access and equity.

Despite major changes, the higher education system in Ecuador faces serious challenges with respect to funding, quality, and planning. Some institutions have been created without adequate quality controls. This has generated concerns about the quality of the education provided and the relevance of academic programs (Cabrera, 2020).

These elements may contribute to explain the results obtained, since a greater number of institutions in the territory, as well as a greater number of undergraduate programs and therefore of students, which has been the characteristic in recent years of the Ecuadorian higher education system, translates into greater demand for goods and services that lead to stimulate production, generating more employment on the supply side.

These effects via expenditures should also be stimulated by the number of teachers and graduate students. The results show that these two variables were not statistically significant in explaining provincial GVA. In the case of teachers, this may be because they are from the territory itself and do not have to incur additional expenses to move and reside in the area, which is the case for students, at least undergraduate students.

In the case of graduate students, as mentioned above, the approval process for fourth level studies has been very rigorous, at least during the period under study, and the policy of the regulatory body is to establish long evaluation processes for the accreditation of programs, limiting the possibility of generating or expanding the offer at this level.

Regarding the impacts on the knowledge side, being the number of publications, the available variable used, it is necessary to understand that universities in Ecuador, at least until the accreditation processes of 2012 and then in 2019, were universities that responded to the first mission of training, but not to the second (research) and much less to the third (innovation).

These accreditation processes and the parameters of budget allocation are those that have encouraged the formulation and implementation of research projects with the consequent dissemination through scientific publications; progress has been made on this path, but there is still a long way to go, as it seems more a requirement to be fulfilled than trying to respond to the problems of the territory.

It is nowadays, with the innovative approaches to both quantitative and qualitative evaluation, that emphasis has also been placed on the processes of social innovation and entrepreneurship as an additional mission of higher education institutions in Ecuador.

Progress in this area is associated with the creation of research centres or institutes, changes in structure and governance, mandatory budget allocation in this area and scientific products by professors, but greater investment in research infrastructure, greater allocation of research hours to professors who have an excessive teaching load, incentives for the formation of national and international networks and mobility are still pending.

These limitations are reflected in the results obtained in the estimations in relation to scientific articles, which did not turn out to be statistically significant, indicating that the effects on the knowledge side require structural and long-term changes to generate results, as proposed by authors such as Bonander et al. (2016), Dembereldorj et al. (2018), Chu and Liu (2020), who emphasize quality and not quantity.

The results of the research indicate that there is a positive impact of public universities on the economic activity of the provinces of Ecuador, as proposed by authors such as Florax and Folmer (1992), Pellenbarg (2007), Torres et al. (2010), Lilles and Røigas (2017); mainly because it increases the production derived from a greater demand. This demand in the first place derives from the execution of the budget of the educational institutions themselves, from the existence of the institution in the province and from the greater number of careers offered.

But also, this stimulus to demand is centred on the direct and indirect expenditure made by students: more students, more expenditure, greater demand, and production, with the consequent generation of employment and tax revenue.

It is important to note that the only variable considered on the knowledge side associated with the second mission of higher education institutions, which is research, was not statistically significant in any of the models incorporated.

Thus, the number of articles published has no impact on the economic activity of the provinces. There are multiple reasons for this, the first of a statistical nature is that the effects on the knowledge side require a long-term analysis that the time series used does not allow; the second is related to the impact in terms of solving the problems of the territory where the research is carried out; the third is the low investment in research, which means that the average rate of articles published per province is less than 1 for every 5 teachers.

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Annex: Indicators of Development and Territorial Distribution of Population

Indicators of Development in Ecuador in comparison with America and the World.

Tables A1 and A2 present a comparison of several development indicators in Ecuador, America and the World Average, based in the international statistics and studies cited in the book by Guisan(2024).

Table A1. Production per inhabitant: QMH and QNMH for 2000-2015

	Real ValueAdded per capita: Manufacturing (QMH)			Real Value-added per capita: Non Manufacturing (QNMH)		
	2000	2010	2015	2000	2010	2015
Ecuador	1043	936	1208	4448	6265	7077
America	1579	1634	1733	7410	9279	10366
World	1651	1723	2048	7786	10045	11424

Note: Dollars, constant prices and purchasing parities of 2005. Source: Elaborated from Source: Elaborated by Guisan(2024), from World Bank Indicators and other statistics.

Data show the great important of increasing Manufacturing due to its positive effects on the increase of Non-Manufacturing real value-added. The development of other industrial sectors, tourism and other activities has usually also a positive effect on real income per capita.

Table A2. Production per capita in years 1995 and 2019 (in Dollars at constant prices of year 2017) and Development Indicators around year 2019

Country	PH 95	PH 19	Tyr 19	X1	X2	X4	X5	X6	X7	X8
Ecuador	8576	11371	8.9	5.76	4.12	4.89	4.5	5.4	14.9	5.85
America	12636	19748	9.2	6.12	4.82	4.72	4.7	6.1	16.32	17.3
World	7752	16135	8.8	5.35	5.0	4.80	4.6	6.0	28.41	6.20

Note: Values of PH (GDP per capita) in Dollars at constant prices and PPPs of year 2017. Tyr is the average years of schooling, X1 to x6 are indicators of quality of life in decimal Scales. X7 is an indicator of Pollution and X8 of violence measured by homicides rate. The last 2 rows are non-weighted averages of 25 American countries and 164 countries or Territories. Source: Elaborated by Guisan(2024) from the international sources there indicated

PH indicates real Gross Domestic Product per head. Data The indicators X1=Life Satisfaction, X2=Voice of Citizens, X4=Peace, X5=Politica Stability and X6=(Freedom) are in decimal Scale. X7=PM2.5 is an indicator of Pollution per cubic meter of air. X8 is the Homicides rate per 100 thousand inhabitants. The Averages rows (America and World) present the non-weighted averages).

At the Entry 47 of the Blog on World Development of the Euroamerican Association, <https://euroamericanassociation.blogspot.com>, there are tables that present a comparison of the indicators of table 2 for different groups of countries by level of income per capita.

Territorial distribution of Population

INEC 2023, indicates that the Population of Ecuador increased by 2.5 million in the period 2010-2022. Total population amounted to 16.9 million people in Census of 2022, which later was revised to 17.7 million (in the update of February of 2024). In the provincial map of INEC of year 2022, 28583 inhabitants correspond to the Galapagos islands, and 16871417 to the other provinces, as they appear in the map

Table A3.1. Provinces with more than 700 thousand inhabitants in Ecuador, year 2022

Province	Pop	%	Area	Density	Capitañ	Population
<u>Azuay</u>	801 609	4,73%	8310	96,47	<u>Cuenca</u>	361 524
<u>El Oro</u>	714 592	4,22%	5767	123,92	<u>Machala</u>	288 072
<u>Guayas</u>	4 391 923	25.93%	15 515	283,07	<u>Guayaquil</u>	2 650 288
<u>Los Ríos</u>	898 652	5,31%	7205	124,72	<u>Babahoyo</u>	98 251
<u>Manabí</u>	1 592 840	9,40%	19 428	81,99	<u>Portoviejo</u>	244 129
<u>Pichincha</u>	3 089 473	18,24%	9536	323,98	<u>Quito</u>	1 763 275

Source: INEC. Census of 2022. [More information at Wikipedia.](#)

Table A3.2. Provinces with more than 300 and less than 700 thousand inhabitations in Ecuador

Province	Population	%	Area	Density	Capital	Population
<u>Chimborazo</u>	471 933	2,79%	6500	72,61	<u>Riobamba</u>	177 213
<u>Cotopaxi</u>	470 210	2,78%	6108	76,98	<u>Latacunga</u>	77 267
<u>Esmeraldas</u>	553 900	3,27%	15 809	35,04	<u>Esmeraldas</u>	155 487
<u>Imbabura</u>	469 879	2,77%	4712	99,71	<u>Ibarra</u>	157 941
<u>Loja</u>	485 421	2,87%	11 063	43,88	<u>Loja</u>	203 496
<u>Santa Elena</u>	385 735	2,28%	3690	104,53	<u>Santa Elena</u>	54 565
<u>Tungurahua</u>	563 532	3,33%	3386	166,42	<u>Ambato</u>	177 316

Source: INEC. Census of 2022. [More information at Wikipedia.](#)

Table A3.3. Provinces with less than 300 inhabitants, in Ecuador

<u>Bolívar</u>	199 078	1,48%	3945	50,46	<u>Guaranda</u>	30 755
<u>Cañar</u>	227 578	1,34%	3231	70,41	<u>Azogues</u>	35 763
<u>Carchi</u>	172 828	1,34%	3780	45,71	<u>Tulcán</u>	56 719
<u>Galápagos</u>	28 583	0,17%	8010	3,57	<u>Puerto Baquerizo Moreno</u>	7290
<u>Morona Santiago</u>	192 508	1,14%	25 690	8,00	<u>Macas</u>	22 398
<u>Napo</u>	131 672	0,78%	12 543	10,50	<u>Tena</u>	29 724
<u>Orellana</u>	182 166	1,08%	21 692	8,40	<u>El Coca</u>	51 281
<u>Pastaza</u>	111 915	0,66%	29 641	3,78	<u>Puyo</u>	33 325
<u>Santo Domingo de los Tsáchilas</u>	492 969	2,91%	3770	130,76	<u>Santo Domingo</u>	334 826
<u>Sucumbíos</u>	199 014	1,17%	18 084	11,00	<u>Nueva Loja</u>	55 627
<u>Zamora Chinchipe</u>	110 973	0,66%	10 584	10,48		

Source: INEC. Census of 2022. [More information at Wikipedia.](#)