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Influence of the salaries of the academic personnel of the co-financed universities on the number of scientific publications

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Abstract

Purpose: The purpose of this paper is to examine the influence of the salaries of the academic staff of the co-financed universities of Ecuador on the number of scientific publications in Scopus, which is the indicator of research performance and quality.

Design/methodology/approach: The paper uses a quantitative approach, using panel data analysis techniques, especially fixed-effects and random-effects models, to analyze the relationship between the salaries of the different academic career levels (graduate teaching assistants, adjunct instructors, and professors) and the number of publications in Scopus. The paper uses a log-log specification to ensure parameters' linearity and facilitate interpretation.

Findings: The paper finds a significant positive relationship between the salaries of adjunct instructors and the number of publications. It also identifies the universities where each academic career level contributed the most to the growth of publications.

Research limitations/implications: The paper has some limitations, such as the lack of data on other characteristics of the academic staff that may affect their research productivity, such as gender, age, work experience, teaching hours, or administrative duties. The paper also focuses on a specific set of co-financed universities in Ecuador during a given period, which may limit the generalization of the results to other universities or countries.

Practical implications: The paper has some practical implications for policymakers and university administrators who are interested in improving the research performance and quality of the co-financed universities. The paper suggests that increasing academic salaries may not necessarily lead to higher scientific productivity unless they are accompanied by other measures that enhance the quality and quantity of research inputs and outputs. For example, policymakers may consider providing more funding and support for research infrastructure, equipment, materials, training, dissemination, and collaboration. They may also design more effective incentive schemes that reward academic staff based on their research performance and impact rather than their seniority or rank.

Social implications: The paper has some social implications for society and academia. The paper shows that scientific production varies across different fields of study, departments, and schools of the co-financed universities. This may indicate that some fields have more resources, incentives, or opportunities for research than others. It may also reflect the different research cultures and expectations of each field. The paper also shows that scientific production contributes to the advancement of knowledge and innovation in various fields that are relevant to social and economic development, such as medicine, computer science, and engineering, among others.

Originality/value: The paper is original and valuable because there is a lack of literature that examines the influence of academic staff salaries on scientific production in co-financed universities in Ecuador. The paper uses panel data analysis techniques and econometric models to test the hypothesis that higher salaries lead to higher scientific productivity.

Keywords: Salary, Scientific production, Academic personnel, Panel data, Ecuador

Jel Codes: I23, J31, O15, C23

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1. Introduction

Ecuador's co-financed universities are higher education institutions that receive part of their resources from the state and part from contributions from their students and other stakeholders. According to the Higher Education Council (CES), there are eight co-financed universities in the country: Universidad Laica Vicente Rocafuerte, Universidad Politécnica Salesiana, Universidad Católica de Santiago de Guayaquil, Universidad de Azuay, Universidad Tecnológica Equinoctial, Universidad Técnica Particular de Loja, Pontificia Universidad Católica del Ecuador, and Universidad Católica de Cuenca.

The tendency of universities to favor academics with better publications to the detriment of teaching has negative consequences on creativity and innovation in higher education. On the one hand, this tendency generates excessive pressure on researchers, who are forced to constantly publish to maintain their prestige and career, which can affect the quality and originality of their work (Plume & van Weijen, 2014; Becker & Lukka, 2023). On the other hand, this trend discourages dedication and commitment to teaching, which is considered a secondary activity and less valued than research. In addition, this trend can lead to a disconnection between research and the social and educational needs of the environment, as well as a lack of dissemination and transfer of the knowledge generated. Therefore, a change in academic performance evaluation systems is required, which recognize and stimulate the integration of research and teaching, as well as creativity and innovation in both fields (Plume & van Weijen, 2014; Becker & Lukka, 2023).

Studying the influence of the salaries of academic staff at co-financed universities on the number of scientific publications would be relevant for several reasons: scientific publications are an indicator of knowledge production, academic quality, and the contribution to the national and global development of universities (Cuadrado, 2020). Co-financed universities receive part of their resources from the State and another part from contributions from their students and other actors, which implies a commitment to accountability, transparency and social relevance (Consejo de Educación Superior, 2020). There is little information on the salary regime and ranking of the academic staff of co-financed universities, as well as on their working conditions, training, productivity and impact. Therefore, conducting a study on this topic would generate evidence to improve public policies, institutional practices and working conditions of academic staff at co-financed universities, as well as to promote scientific research and development in the country.

The relationship between faculty salaries and research productivity has been explored in various contexts, but there is a lack of research specifically focused on co-funded universities in Ecuador. The existing literature examines the correlation between faculty salaries and scientific output. Pham, Nguyen and Springer (2021) conducted a meta-analysis of 37 studies, leaving a research gap on merit pay in research at universities. This study is complemented by that of Jørgensen et al., who analyze salaries and research quality at public universities, leaving two research gaps. The first gap is related to the skills that increase research productivity, and the second gap is the need to analyze this behavior in other funding models.

The scientific literature for the Ecuadorian case is evident in Armijos-Valdivieso, Avolio-Alecchi and Arévalo-Avecillas (2022) and Herrera-Franco, Montalván-Burbano, Mora-Frank and Bravo-Montero (2021), who analyze research performance at Ecuadorian universities. However, these studies may not specifically delve into the co-funded university model and its unique financial structure (Castillo & Powell, 2020).

The research gap lies in that co-funded universities in Ecuador face different funding challenges compared to public or private institutions. Understanding the link between salary and performance in this context could offer insights such as salary adjustments as a strategy to improve performance in these universities. The need for the article lies in its potential to inform policymaking in higher education. By examining how salary influences scientific output, the study provides valuable insights that could guide the design of more effective incentive schemes for academic staff. These schemes could, in turn, improve research performance and impact, fostering creativity and innovation in higher education. Therefore, the practical implications of this study are significant as it could contribute to improving higher education policies not only in Ecuador, but potentially in other similar contexts as well.

The aim of the study is to determine the influence of faculty salaries on the number of scientific publications. Ecuador has experienced a notable increase in scientific production in recent years, ranking sixth in Latin America and the Caribbean with the highest number of articles published in Scopus, the largest database of scientific literature worldwide (Moreira-Mieles, Morales-Intriago, Crespo-Gascón & Guerrero-Casado, 2020). According to a recent study, Ecuador went from publishing 372 documents indexed in Scopus in the period 1920-1990, to 29,833 documents in the period 1991-2020 (Herrera-Franco et al., 2021). This increase is largely due to public policies for the promotion and financing of scientific research promoted by the Ecuadorian government since 2008. However, this quantitative growth has not necessarily translated into an increase in the quality and impact of Ecuadorian scientific production, which still presents challenges such as low international visibility, thematic and geographical concentration, and poor articulation with the productive and social sectors. The paper delves into the impact of academic staff salaries on the number of scientific publications at co-funded universities in Ecuador, a topic that has not been widely explored in previous works. While previous studies have examined research performance indicators and the influence of remuneration on research output, this paper uniquely investigates the relationship between these two aspects within the context of Ecuador's higher education system.

This paper is structured as follows: The paper begins with an introduction to the role of co-funded universities in Ecuador and the impact of academic salaries on scientific publications. It then presents a theoretical framework that discusses research performance indicators, remuneration for research output, and the relationship between research performance and academic remuneration. The methodology section details the study design, data sources, variables, and model specification. The results section is divided into descriptive results and econometric model results, presenting the association between salaries and the number of academic publications. The discussion section interprets the results and their implications for salary studies and policymaking. The article concludes by summarizing the main findings, discussing the limitations of the study, and suggesting directions for future research ones.

2. Theoretical Framework

2.1. Research Performance Indicators in the Academic Field

Research performance indicators are essential tools for evaluating and comparing academic research productivity (Reddy, Gupta, A., hite, Gupta, Agarwal, Prabhu et al., 2020). The h-index is a bibliometric indicator that objectively characterizes the impact of an author's scholarship (Svider, Pashkova, Choudhry, Agarwal, Kovalerchik, Baredes et al., 2013; Casciato, Cravey & Barron, 2021; Wang, Chu & Dubois, 2021). It is a widely used tool that can be considered by academic departments for decisions related to hiring and faculty advancement. The National Institutes of Health (NIH) has developed a new, field-normalized, article-level metric called the relative citation ratio (RCR) that adjusts for field-specific citation rates and measures individual contributions. The RCR is preferable to the h-index because it is field-normalized and measures individual contributions.

There is a surprising lack of consensus on productivity's meaning, measurement, and how to compare the productivity of one academic to another (Duffy, Jadidian, Webster & Sandell, 2011; Hook & Vera, 2020). Most productivity metrics, such as publication count, citation count, or some combination of the two, were substantially different across academic fields. Metrics on scientific publications and their citations are easily accessible and are often referred to in assessments of research and researchers.

Citation analysis is widely used to evaluate the performance of individual researchers, journals, and universities. Its outcome plays a crucial role in ranking applicants for an academic position. The h-index is a widely used indicator reflecting both scientific productivity and its relevance in medical fields (Franco, 2013; Giora, & Bobbio, 2021).

Finally, we have the h-index and RCR, which are two widely used metrics that can be considered by academic departments for decisions related to hiring and faculty advancement. Citation analysis and impact factors are also widely used to evaluate the performance of individual researchers, journals, and universities. However, there is a surprising lack of consensus on productivity's meaning, measurement, and how to compare the productivity of one academic to another.

2.2. Remuneration for Research Production on Teachers

Remuneration for research production on teachers is an important topic in the field of education. In terms of incentivizing research and teaching achievements. Wang (2016) and Dang (2019) suggest establishing a reward system that recognizes teachers who have made important achievements in teaching activities, research cooperation, and education cooperation. This can be done by providing strong recognition awards and ensuring that workload evaluation and remuneration systems encourage teachers to actively participate in practical teaching activities and research (Tao, Oliver, Malca, Mejia & Mejia, 2023).

However, it is worth noting that the current incentive structures in academia often prioritize research productivity over teaching excellence. Sabagh and Saroyan (2014) and Mikulioniene and Rapolienė (2020) argue that teaching excellence is not sufficiently rewarded compared to research productivity and service activities. This is supported by Zheng (2023), who states that research is often seen as an opportunity while teaching is seen as a burden. This imbalance in incentives can lead to a lack of emphasis on teaching quality and may hinder the development of effective teaching practices.

Furthermore, the design of pay systems can influence faculty behavior. Shaw and Gupta (2007) explored the impact of pay dispersion (salary variation) on faculty performance. Their findings suggest that high pay dispersion and clear communication on performance-based pay increases can lead to higher retention of high performers in research. However, Millones-Goméz, Yangali-Vicente, Arispe-Alburqueque, Rivera-Lozada, Calla-Vásquez, Calla-Poma et al. (2021) argue that this approach can negatively impact average performers. Alternatively, seniority-based pay increases might incentivize average performers but could discourage high performers from exceeding expectations (Shaw & Gupta, 2007).

These studies highlight the complexity of balancing research productivity, teaching excellence, and faculty remuneration. Future research should explore ways to design reward systems that incentivize both research and teaching excellence. Additionally, investigating the impact of factors like institutional culture and workload management on faculty behavior is crucial to fostering a more holistic approach to faculty evaluation and reward.

2.3. Research Performance and Academic Remuneration

Literature in the past has shown that there is a relationship between research performance and academic remuneration (Ramsden, 1994; De Fraja, Facchini & Gatherwood, 2016; Groen-Xu, Boes, Teixeira, Voigt & Knapp, 2023). Academic remuneration can be in the form of salary, funding, or staff support. Studies reveal a strong link between academic success and salary. Publications, grants received, and high-quality teaching are all key factors that universities consider when setting faculty pay. This is because these achievements demonstrate a professor's ability to contribute to the institution's reputation, research funding, and student success (Euwals & Ward, 2005; Shah, Monahan & Shumaker, 2019). The study also found that a large financial penalty for time out of the profession exists, which explains away the gender salary gap (Euwals & Ward, 2005). The relationship between teaching and research has been investigated, and some evidence supports the idea that teaching and research are complementary (Cadez, Dimovski & Zaman, 2017). Cadez et al., (2017) also found that academic salaries are unregulated, and the outcome of the official research evaluation of universities is one of their key financial and academic concerns. The study found that the greater the difference between the value of a discipline's outside opportunities and its academic salary, the weaker its research performance. In conclusion, research has shown that academic remuneration is related to research performance, and factors such as publication, grant receipt, teaching quality, and outside opportunities can impact academic remuneration and research performance.

The theoretical underpinning of this study is based on existing literature that has demonstrated a relationship between research performance and academic compensation. Studies mentioned in the theoretical underpinning, such as those by Ramsden (1994), Cooper (2019), De Fraja et al. (2016), and Euwals and Ward (2005), have found that factors such as publication, grant receipt, and teaching quality are important determinants of remuneration in academia. In this regard, the study is based on a theoretical perspective that considers academic remuneration as an important factor in research performance. The hypothesis put forward, that faculty salaries positively influence the number of scientific publications is derived from this theoretical perspective and is supported by the existing literature. Therefore, the study's theoretical foundation is based on the literature that has demonstrated a relationship between research performance and academic remuneration.

2.4. Construct Validity, Internal Validity, External Validity and Reliability.

The framework further explores the role of remuneration in incentivizing research and teaching achievements, highlighting the current tendency to prioritize research productivity over teaching excellence.

The methodology's choice of models is justified by the need to examine the individual effects of faculty salaries on the number of publications per university. The study employs panel data analysis techniques, specifically fixed-effects and random-effects models, which are well-suited for handling the study's data structure and research objectives. These models can control for unobserved time-invariant characteristics of the universities that may influence the number of publications.

The study's objective is to determine the influence of faculty salaries on the number of scientific publications. This objective is directly related to the next section, which specifies the data sources and variables, the model specification, and the validity and reliability of the study. The data for the study were obtained from a sample of eight co-financed universities in Ecuador, and the variables include the number of articles published in Scopus and the salaries of graduate teaching assistants, adjunct instructors, and professors.

The study proposes a log-log model, which uses the natural logarithms of both dependent and independent variables. This model is useful when the relationship is not linear in the parameters, and it allows the coefficients to be interpreted as elasticities. The study also ensures construct validity, internal validity, external validity, and reliability, making it a robust examination of the relationship between academic staff salaries and the number of scientific publications. Thus, the theoretical framework and methodology are closely interconnected and collectively contribute to achieving the study's objective.

Construct validity refers to whether the measurement instrument actually measures the construct it is intended to measure. In this case, the construct is the relationship between academic staff salaries and the number of scientific publications. The studies mentioned by Ramsden (1994) and De Fraja et al. (2016) have shown that there is a relationship between research performance and academic remuneration, which can be in the form of salary, funding, or staff support. In addition, Euwals and Ward (2005) found that publication, receipt of grants, and teaching quality are important determinants of remuneration in academia. These findings provide a sound theoretical basis for the construct of the present study, which is the relationship between academic staff salaries and the number of scientific publications.

Internal validity refers to whether the results of the study are reliable and free of bias. In this case, a panel data analysis approach was used and a regression model that considers unit-specific effects and idiosyncratic errors was applied. The choice between a fixed-effects model and a random-effects model was determined by statistical tests, increasing the study's internal validity. External validity refers to whether the study results can be generalized to other populations or contexts. In this case, the study focused on a specific set of co-funded universities in Ecuador during a given period. Therefore, external validity may be limited, and caution should be exercised when generalizing the results to other universities or countries. Reliability refers to the consistency and stability of the measurements over time. In this case, data were collected over a five-year period, increasing the study's reliability. In addition, using a log-log approach to ensure linearity in the parameters also increases the reliability of the results.

3. Methodology

3.1. Data Source and Variables

The data for this study was collected from two main sources. The salary data was obtained directly from the budget of eight co-financed universities in Ecuador, specifically from the part of expenses for salaries and wages of professors. Salaries refers to the monthly gross remuneration of teachers. These universities were Laica Vicente Rocafuerte University (LVRU), Salesian Polytechnic University (SPU), Catholic University of Santiago de Guayaquil (CUSG), University of Azuay (UA), Equinoccial Technological University (ETU), Private Technical University of Loja (PTUL), Pontifical Catholic University of Ecuador (PCUE), and Catholic University of Cuenca (CUC).

The number of scientific publications was obtained from Scopus, a bibliographic database containing abstracts and citations for academic journal articles. The data was sorted by year in the database. The main variables in this study are the number of articles published in Scopus (LPUB), the salary of graduate teaching assistants (LAUX), the salary of adjunct instructors (LAGRE), and the salary of professors (LPRIN).

The sample consists of data from these eight co-financed universities in Ecuador over a five-year period from 2016 to 2020. The average number of professors at the eight co-financed universities is 240, of which only 10 percent have master's and Ph.D. degrees. Therefore, the sample taken for the study is the total universe, since the salary data and the number of publications of all the teachers in these eight co-financed universities are used. The data includes the salaries of different types of faculties and the number of scientific publications. One must collect similar data from the chosen universities or institutions to replicate this experiment. This includes the salaries of the different types of faculties and the number of scientific publications from Scopus. Please note that replicability might be affected by the availability and accessibility of the data from the chosen universities or institutions.

3.2. Model Specification

The article used two estimation strategies; the first sought two models to determine the individual effects between faculty salaries and the number of publications per university (Heng, Hamid & Khan, 2020; Prakhov & Rudakov, 2021; Zhu, 2021). In this sense, the following equations are proposed:

Model 1: $LPUB = \beta_0 + \beta_1 LAUX + \varepsilon$ (1)

Model 2: $LPUB = \beta_0 + \beta_1 LAGRE + \varepsilon$ (1)

Model 3: $LPUB = \beta_0 + \beta_1 LPRIN + \varepsilon$ (1)

Where:

LPUB: Number of articles published in Scopus.

LAUX: Salary of graduate teaching assistants.

LAGRE: Salary of adjunct instructors.

LPRIN: Salary of professors.

ε: Term of error.

The second model that will be used to analyze the influence of the salaries of the academic staff of the co-financed universities on the number of scientific publications. The model is a panel data regression with four variables: the number of articles published in Scopus (LPUB), the salary of graduate teaching assistants-LAUX (Prakhov & Rudakov, 2021), the salary of adjunct instructors-LAGRE (Zhu, 2021), and the salary of professors-LPRIN (Heng et al., 2020).

This study uses panel data analysis techniques as the methodology to address various issues and improve the robustness of the estimation results. The first step is applying panel data analysis, a technique that uses cross-sectional time-series data. This means that the same units are observed over time, and the variables are measured repeatedly for each unit. This technique allows the capture of the dynamics and heterogeneity of the data and controls for omitted variable bias that may affect the results.

The second step is to use an error component model, which splits the error term into two parts: a specific cross-sectional unit effect (a_i) and an idiosyncratic error (u_it). The former represents the unobserved heterogeneity that is constant over time but varies across units, while the latter is the random error that varies over time and across units. The inclusion of these components helps to reduce the omitted variable bias and to obtain more consistent estimates.

The third step is to choose between a fixed-effects model and a random-effects model, depending on the nature of the cross-sectional unit effects. A fixed-effects model assumes that these effects are correlated with the explanatory variables and, therefore, they need to be eliminated from the model. This can be done by using within transformation, which subtracts the mean of each variable from each observation. The fixed-effects model provides unbiased and consistent estimates, but it may suffer from inefficiency and loss of degrees of freedom. A random-effects model assumes that these effects are independent of the explanatory variables and, therefore, they can be treated as random variables. This allows the use of a generalized least squares (GLS) estimator, which is more efficient than the ordinary least squares (OLS) estimator. The random-effects model is suitable for cases where the cross-sectional units are randomly selected from a large population, and where there is no interest in estimating the individual effects.

The fourth step is to select the best model between fixed-effects and random-effects models based on whether the cross-sectional unit effects are correlated with the explanatory variables. A common test to compare these models is the Hausman test, which examines the null hypothesis that the individual effects are independent of the explanatory variables. If this hypothesis is rejected, then the fixed-effects model is preferred. If not, then the random-effects model is more efficient.

The fifth step is to specify the econometric model that will be used in this study. The model is a log-log model, which uses the natural logarithms of both dependent and independent variables. This transformation helps to achieve linearity in parameters, which is one of the assumptions for OLS estimation. The log-log model also has an advantage of interpreting the coefficients as elasticities, which measure the percentage change in one variable due to a percentage change in another variable.

Based on this context, the authors of the study chose to use panel data analysis techniques, specifically fixed-effects and random-effects models, for several reasons:

- Data Structure: The data collected for this study is structured as panel data, which consists of multiple entities being observed over a period. Panel data models are specifically designed to handle this type of data and can account for individual heterogeneity.
- Individual Effects: The study aims to determine the individual effects between faculty salaries and the number of publications per university. Fixed-effects and random-effects models are well-suited for this purpose as they can control for unobserved time-invariant characteristics of the universities that may influence the number of publications.

Other models and techniques, such as time series analysis and causality tests, were not used due to the nature of the data and the research question. These techniques require a large amount of data and are more suitable for data where the statistical properties do not change over time. In this study, the data spans only 5 years and the focus is on the relationship between salaries and publications, which may be influenced by a variety of changing factors.

Therefore, the chosen methodology aligns with the data structure, the research question, and the objectives of the study. It allows the authors to effectively examine the influence of salaries on scientific publications while accounting for the unique characteristics of the universities.

Based on the above, the following model with panel data is proposed as follows:

$$LPUB = \beta_0 + \beta_1 LAUX + \beta_3 LAGRE + \beta_2 \boldsymbol{LPRIN} + \varepsilon \ (1)$$

The use of natural logarithms for the variables on both sides of the econometric specification is called a log-log model. This model is useful when the relationship is not linear in the parameters, because the logarithmic transformation generates the desired linearity in the parameters (it should be remembered that linearity in the parameters is one of the OLS assumptions).

4. Results

This section is divided into descriptive results and the results of the econometric models. The first part presents the shares of publications by career and by co-funded university, followed by scatter plots in order to observe the association between salaries and the number of academic publications by the co-funded universities. The second part presents the results of the econometric models, where the individual effects by university among the study variables are observed, and finally the panel data models are analyzed.

4.1. Descriptive Results

Scientific area	CUC	CUSG	ETU	LVRU	PCUE	PTUL	SPU	UA
Arts and Humanities				5%				
Biochemistry, genetics and molecular biology	3%	9%	8%		7%	4%		4%
Decision Science							3%	
Materials Science							2%	
Environmental Science	3%		3%	9%	8%	8%	2%	5%
Agricultural and Biological Sciences	3%	6%	5%	9%	24%	12%		13%
Computer Science	11%	4%	11%	2%	9%	21%	27%	17%
Decision Sciences		4%	4%	5%				
Social Sciences	7%	7%	4%	34%	6%	11%	7%	7%
Energy	7%		4%	2%			9%	4%
Pharmacology, toxicology and pharmaceutics	11%							2%
Physics and astronomy						3%	4%	
Engineering	12%	5%	11%	18%	5%	9%	24%	15%
Chemical Engineering							2%	
Immunology and microbiology		4%			5%			
Mathematics	5%		6%	2%	3%	4%	9%	6%
Medicine	27%	29%	19%		14%	3%		10%
Multidisciplinary					2%			
Business, management and accounting		9%		14%				
Neuroscience		3%						
Chemistry						4%		
Other	12%	22%	25%		17%	21%	12%	18%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 1. Percentage of publications by universities

The Table 1 shows the percentage of publications by scientific area and by university in Ecuador. The data covers eight universities and 19 scientific areas. The total number of publications for each university is 100%. The most prominent area of publication for CUC is medicine, which accounts for 27% of its total publications. This is followed by engineering (12%) and computer science (11%). CUC has a higher percentage of publications in medicine than any other university in the table. CUC also has a significant percentage of publications in pharmacology, toxicology and pharmaceutics (11%) and energy (7%).

The main area of publication for CUSG is also medicine, which represents 29% of its total publications. This is the highest percentage of publications in medicine among all the universities in the table. CUSG also has a high percentage of publications in biochemistry, genetics and molecular biology (9%) and business, management and accounting (9%). CUSG has a lower percentage of publications in engineering (5%) and computer science (4%) than most of the other universities in the table.

The main area of publication for ETU is computer science, which accounts for 11% of its total publications. This is the same percentage as CUC and UA, but lower than SPU and PTUL. ETU also has a high percentage of publications in engineering (11%) and medicine (19%). ETU has a lower percentage of publications in social sciences (4%) and agricultural and biological sciences (5%) than most of the other universities in the table.

The main area of publication for LVRU is social sciences, which represents 34% of its total publications. This is the highest percentage of publications in social sciences among all the universities in the table. LVRU also has a high percentage of publications in engineering (18%) and agricultural and biological sciences (9%). LVRU has a lower percentage of publications in computer science (2%) and mathematics (2%) than most of the other universities in the table.

The main area of publication for PCUE is agricultural and biological sciences, which accounts for 24% of its total publications. This is the highest percentage of publications in agricultural and biological sciences among all the universities in the table. PCUE also has a high percentage of publications in environmental science (8%) and computer science (9%). PCUE has a lower percentage of publications in medicine (3%) and engineering (5%) than most of the other universities in the table.

The main area of publication for PTUL is computer science, which represents 21% of its total publications. This is the second highest percentage of publications in computer science among all the universities in the table, after SPU. PTUL also has a high percentage of publications in mathematics (9%) and engineering (9%). PTUL has a lower percentage of publications in environmental science (2%) and energy (2%) than most of the other universities in the table.

The main area of publication for SPU is computer science, which accounts for 27% of its total publications. This is the highest percentage of publications in computer science among all the universities in the table. SPU also has a high percentage of publications in engineering (24%) and mathematics (6%). SPU has a lower percentage of publications in medicine (2%) and social sciences (7%) than most of the other universities in the table.

The main area of publication for UA is engineering, which represents 15% of its total publications. This is the same percentage as CUC, but lower than LVRU, ETU and SPU. UA also has a high percentage of publications in computer science (17%) and agricultural and biological sciences (13%). UA has a lower percentage of publications in medicine (10%) and social sciences (7%) than most of the other universities in the table.

In summary, the table shows that the most common areas of publication among the eight universities in Ecuador are medicine, computer science and engineering. However, there are also significant differences in the distribution of publications by scientific area and by university. Some universities have a more balanced profile of publications across different areas, while others have a more specialized or concentrated profile of publications in one or a few areas. The table also reveals some gaps or opportunities for further research in some areas, such as neuroscience, chemistry and multidisciplinary studies.

These results show opportunities for improvement for all the co-financed universities used in this study, since there are many challenges that these universities might experience, such as research quality, funding availability, competition levels, and topic relevance. at the Pontifical Catholic University as was seen, there's a lot of work to do particularly in the environmental sciences and biochemistry, genetics, and molecular biology fields, due to their low percentage. The University of Azuay on the other hand excels in computer science and engineering, aligning with its research-oriented vision. The Catholic University of Cuenca emphasizes medicine, while the Catholic University of Santiago de Guayaquil focuses on medicine and life sciences. Laica Vicente Rocafuerte University emphasizes social sciences, and Salesian Polytechnic University and Equinoccial Technological University prioritize computer science, engineering, and medicine. The Private Technical University of Loja excels in computer science, while also contributing significantly to agricultural and biological sciences. These findings provide insights into each university's mission, strengths, and areas for potential enhancement.

In the following figure we have a dispersion graph in which we have the relationship between salaries and publication numbers for graduate teaching assistants, adjunct instructors, and professors. For graduate teaching assistants, an increased salary corresponds to fewer Scopus publications, possibly due to heightened workload. Conversely, adjunct instructors and professors on the other hand, show a positive correlation, suggesting that higher salaries motivate adjunct instructors and signify the quality of professors, potentially linked to prestigious institutions with elevated publication standards in Scopus.

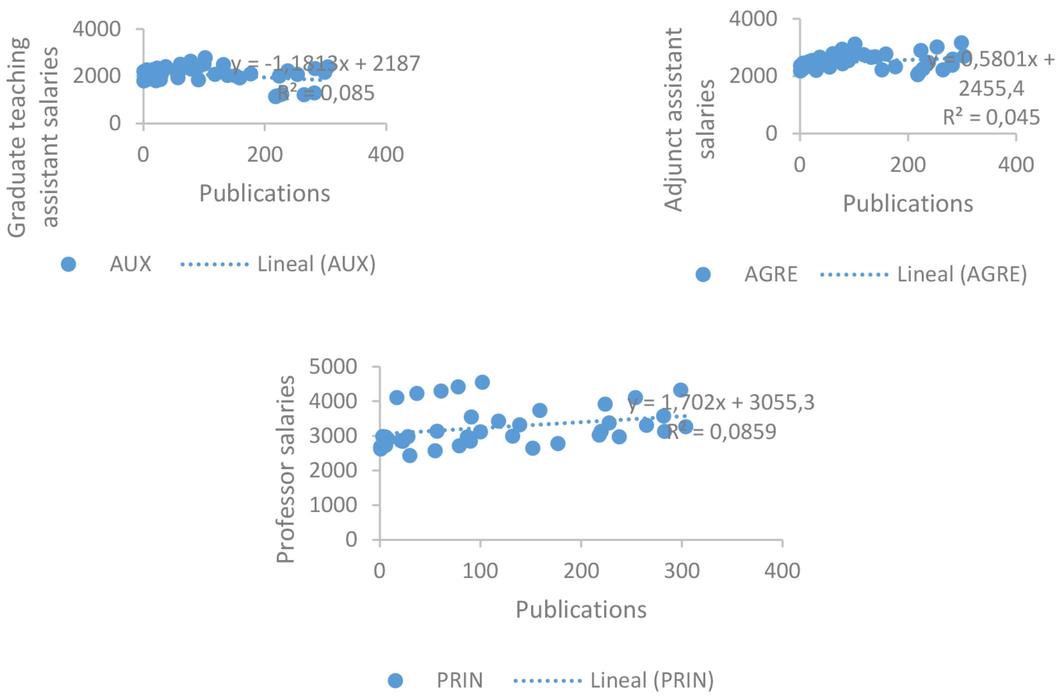

Figure 1. Dispersion chart between the number of publications and the salaries of adjunct instructors

4.2. Model Results

The diagnostic tests shown in Table 2 were performed to validate the proposed models. The results showed that both models presented autocorrelation and heteroscedasticity problems. In this sense, to mitigate these problems, the Newey West tests were used to correct these problems. The Newey-West method is a technique used to correct for both heteroscedasticity and autocorrelation in the error terms of a regression model. This method provides consistent estimates of the covariance matrix of the model parameters in the presence of heteroscedasticity and autocorrelation. As a matter of fact, all econometric models meet the regression assumptions. In regression analysis, two key assumptions are homoscedasticity and no autocorrelation. Homoscedasticity refers to the assumption that the variance of the errors is constant across all levels of the independent variables. Heteroscedasticity, the violation of this assumption, means that the variance of the errors differs across levels of the independent variables. This can lead to inefficient and biased estimates of the regression coefficients. Autocorrelation, also known as serial correlation, refers to the correlation of a variable with itself over successive observations. The assumption in a regression model is that the errors are not autocorrelated. Violation of this assumption can also lead to inefficient and biased estimates. Both assumptions are crucial for the validity of the standard errors, confidence intervals, and hypothesis tests associated with the regression coefficients.

Diagnostic Tests	Model 1 (p-value)	Model 2 (p-value)	Model 3 (p-value)
Breusch-Godfrey (Autocorrelation)	0.001534*	0.00164*	0.001189*
Durbin-Watson (Autocorrelation)	1.554e-06*	1.839e-06*	7.482e-07*
Breusch-Pagan (Heteroscedasticity)	0.02107**	0.02098**	0.02561**
NCV Test (Heteroscedasticity)	0.00040746**	0.00040896**	0.0013803**

Note: *: Presence of Autocorrelation and **: Presence of heteroscedasticity

Table 2. Diagnostic tests

Once the models have been validated, we proceed with the estimation of the individual effects of the co-funded universities, with respect to the publications of scientific articles and each of the salary levels. In this sense, Table 3 shows the results of the models, where first of all, it can be noted that all variables are significant, given that their t-values are greater than the critical t-value at the 95% confidence level of 1.96. The results of the econometric models that evaluate the individual effects of the salaries of the different academic career levels and the number of publications suggest that the universities where graduate teaching assistants contributed to the highest growth in their publications are: Equinoctial Technological University and University of Azuay, with coefficients of 79.44% and 79.08% respectively. At the group level, it is observed that for every 1% increase in their salaries, teaching assistant's publication also increases by 10.6%, being statistically significant in all standard confidence levels.

Regarding the adjunct instructors, the results suggest that the universities where the adjunct instructors contributed with the highest growth in publications are Laica Vicente Rocafuerte University and Equinoctial Technological University, with coefficients of 72.01% and 71.53%, respectively. At the group level, it is observed that for every 1% increase in the salaries of adjunct instructors, the publication of articles increases by 9.47%, being statistically significant.

Finally, regarding professors, the results suggest that the universities where they contributed with the highest growth in their publications are the University of Azuay and Laica Vicente Rocafuerte University, with coefficients of 72.93% and 71.72%, respectively. At the group level, it is observed that for 1% increase in the professor salaries, there's an increase of about 9.18% in the publications of the articles, being statistically significant at all confidence levels.

Universities	Graduate teaching assistants	Adjunct instructors	Professors
Grouped model	10.6 (5.796)	9.477 (5.831)	9.181 (5.678)
Pontifical Catholic University of Ecuador	75.312(5.417)	70.276 (5.424)	70.7 (5.284)
University of Azuay	79.086 (5.522)	71.287 (5.526)	72.931 (5.388)
Catholic University of Cuenca	76.196(5.504)	70.275 (5.514)	69.886 (5.367)
Catholic University of Santiago de Guayaquil	77.771 (5.495)	69.616 (5.495)	68.31 (5.345)
Laica Vicente Rocafuerte University	78.565 (5.696)	72.012 (5.722)	71.722 (5.571)
Salesian Polytechnic University,	76.198 (5.411)	68.566 (5.403)	67.935 (5.258)
Equinoccial Technological University	79.44 (5.597)	71.533 (5.61)	70.226 (5.459)
Private Technical University of Loja	69.678 (5.371)	67.453 (5.391)	68.82 (5.257)

Note: Values in parentheses represent the calculated t-values and these are compared to the critical t-value at 5% which is 1.96

Table 3. Results of econometric models.

Once the individual effects of the variables were studied, the pooled effects were estimated using the panel data. Table 4 shows the coefficients of the variables estimated through the pooled model, the fixed and random effects. The three models presented, Ordinary Least Squares (OLS) or Grouped Model Regression, Fixed Effects Regression, and Random Effects Regression, each serve a unique purpose in econometrics with their assumptions and use cases. OLS is the most basic type of regression, which assumes that errors are independently and identically distributed and there is no correlation between the independent variables and the error term. It's often used as a baseline model to compare with more complex models. On the other hand, Fixed Effects Regression is used when we want to control for variables that vary between entities but do not change over time. In your case, this could be characteristics specific to each university that do not change over the period of 2016 to 2020. The fixed effects model controls for these time-invariant characteristics by allowing the intercept to differ across universities. Lastly, Random Effects Regression is used to control variables that vary between entities and may also change over time. It assumes that the entity's error term is not correlated with the predictors, allowing time-invariant variables to play a role as explanatory variables.

The results suggest that the salaries of graduate teaching assistants and adjunct instructors are significant (according to their t-values) for the pooled model. Additionally, the random effects regression estimated that the salary of adjunct instructors is significant (according to its z-values). Finally, the fixed effects model shows that no variable is significant.

Presenting all three estimations provides robust data analysis as each model has different assumptions and is suitable for different scenarios. By presenting all three, it can demonstrate the robustness of the results of these different assumptions. Regarding choosing between these models, several statistical tests can be used, such as the Hausman test. This test checks the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If the null hypothesis is rejected, it suggests that the fixed effects model is more appropriate.

Wages	**Regression of the grouped model (t-value)**	**Fixed Effects Regression (t-value)**	**Random Effects Regression (Z-value)**
Constant	-47.6704 (-2.753)		65.5353 (-5.276)
LAUX	-4.493 (-2.823)	-18.7099 (-0.27)	-4.5015 (-1.283)
LAGRE	12.011 (4.872)	24.1883 (0.37)	13.1253 (1.976)
LPRIN	-1.007 (2.383)	1.9898 (0.27)	0.97523 (0.031)

Note: the values in parentheses represent the calculated t-values (group and fixed effects model) z-values (random effects) and these are compared to the critical t-value and z-values at 5% which is 1.96

Table 4. Panel data model

The following diagnostic tests were used to select the best model: the Lagrange FF multiple tests, the individual F test or effects over time, and the Hausman test for panel models. In this sense, the Lagrange test suggests using the fixed effects on the OLS model, while the F test maintains that the random effects should be used on the pooled model. Finally, the Hausman test shows a p-value of 0.9364, therefore, the null hypothesis of choosing the fixed effects is rejected, and it is concluded that the random effects should be used.

Test	**p-Value**
Lagrange FF Multiplier Tests for Panel Models	6.639e-12
F Test for Individual and/or Time Effects	3.011e-09
Hausman Test for Panel Models	0.9364

Table 5. Model selection tests

The selected model's coefficients can be interpreted as follows: the 1% increase in adjunct instructor salaries leads to a 13.12% increase in scientific publications. The other variables, such as adjunct instructor salaries and professor salaries, are not statistically significant.

5. Discussion and Conclusion

This section explores the key findings of the study and their broader implications within the academic landscape. Contrary to the initial hypothesis, our results demonstrate that salary increases for tenured professors and graduate teaching assistants (GTAs) did not lead to a statistically significant rise in scientific publications (García-Romero, 2012). Only adjunct instructors showed a positive and significant association between salary increases and publication growth. These findings suggest that the impact of salary on research productivity might vary depending on the academic position. Different faculty categories may be driven by distinct incentives and face unique trade-offs when allocating their time and resources between research and teaching activities.

For comparative purposes, we considered the work of Mittal, Feick and Murshed (2008), who explored the financial rewards associated with publishing in marketing. Their research, along with studies in other disciplines, identified a positive correlation between publications and faculty salaries. While our findings regarding professors and GTAs differ, the significant rise in publications observed with adjunct instructors aligns with this broader literature. This shared emphasis on research productivity as a factor influencing both salaries and academic success highlights the need for a more nuanced understanding of the specific context within our study (Ecuadorian universities) and how it may influence faculty behavior.

Furthermore, the research by Choi (2023) on faculty salaries and gender equity, though focused on linguistics, provides valuable insights. Their inclusion of a variable for faculty union presence underscores the importance of institutional factors beyond just salaries in determining faculty compensation. This resonates with our study's emphasis on the impact of salaries on publication growth, suggesting a broader theme where various factors like gender, unions, and institutional dynamics can all influence faculty salaries and productivity.

Additionally, Rawls' (2015) investigation into the relationship between faculty research productivity and library investments is relevant. Their findings establish a positive link between an institution's research output and its investment in library resources. This aligns with our study's emphasis on the impact of salaries on publication growth, suggesting that broader investments in research resources, beyond just direct compensation, can contribute to enhanced research outcomes and faculty productivity.

This study investigated the influence of professor salaries on scientific article publication in Ecuador's co-funded universities. The findings contribute to understanding the relationship between academic income and research productivity. Scientific output varied across disciplines and universities, reflecting inherent differences in research focus and resource availability. Fields like medicine, computer science, and engineering emerged as particularly productive, highlighting their societal relevance and potential for technological advancement.

Econometric models revealed a positive and significant association between salaries and publications for adjunct instructors and professors. This suggests that higher salaries may enhance research output by motivating faculty, reflecting their expertise, or facilitating access to research resources.

Interestingly, a negative association was found between graduate teaching assistant salaries and publications. This warrants further investigation, as it could indicate that higher salaries for this category might reduce research motivation or increase workload, hindering research productivity.

The study also identified universities where specific academic career levels contributed most significantly to publication growth. This offers valuable insights into the strengths and weaknesses of each institution's research focus. The employed models were validated through diagnostic tests, bolstering the confidence in the results' reliability and robustness.

However, the grouped effects analysis for co-funded universities showed that only a 1% increase in adjunct instructor salaries led to a statistically significant (13.12%) increase in publications. This analysis's lack of significance for graduate teaching assistants and professors warrants further exploration.

This study provides valuable insights into the complex relationship between professor salaries and scientific publication in Ecuador's co-funded universities. The findings suggest that while salary increases can positively impact research output for some faculty categories, additional factors require further investigation, particularly for graduate teaching assistants.

5.1. Theoretical Implications

The main findings for university, such us research funding and resource allocation, the importance of targeted investments in faculty salaries and research resources to enhance publication productivity. Universities may need to consider the unique incentives and motivations of different faculty categories when designing salary structures and resource distribution policies. The positive correlation between adjunct instructors' salary increases and publication growth suggests that professional development programs focusing on adjunct faculty could be beneficial. Universities could invest in workshops, mentorship programs, and other support mechanisms to foster research productivity. The varied impact of salary increases on different faculty roles underscores the need for a balanced approach to incentives. Universities should explore a combination of salary increases, research grants, and other benefits to motivate research output across all faculty ranks.

Otherwise, Public administrations could use these findings to inform policies related to higher education funding and faculty compensation. Understanding the differential impact of salary increases on various academic positions can help in designing more effective and equitable funding strategies. Governments might consider providing additional support to adjunct faculty through grants, subsidies, or other financial incentives to boost research productivity. This approach could help mitigate disparities in research output across different types of academic appointments.

Likewise, Managers should take into account the nuanced relationship between salary and research productivity when evaluating faculty performance. Incorporating metrics that reflect both research output and teaching effectiveness can provide a more comprehensive assessment of faculty contributions. The findings suggest the need for strategic planning that aligns salary policies with institutional research goals. Managers could develop tailored strategies to enhance research productivity among different faculty categories, ensuring that salary increases are effectively translated into research output. Organizational Culture: Fostering a research-oriented organizational culture that values and rewards research productivity across all faculty levels can contribute to overall institutional success. Managers should focus on creating an environment that supports research activities and recognizes the diverse contributions of faculty members.

5.2. Practical Implications

The main practical implications such us, revising salary structures to better support adjunct instructors can enhance publication productivity. Providing research grants and resources tailored to the needs of different faculty roles. Investing in continuous professional development, especially for adjunct faculty, to boost research output. Funding Policies: Developing equitable funding strategies that recognize the distinct needs of different academic positions. Offering additional grants and subsidies to adjunct faculty to promote equity in research productivity. Implementing performance metrics that include both teaching and research contributions. Aligning salary incentives with institutional research goals to optimize faculty productivity. Promoting a culture that values research and supports all faculty members through adequate resources and incentives.

5.3. Limitations and Future Lines of Research

Among the limitations of the study, it is worth mentioning that there is no database with the characteristics of the teaching staff such as gender, age, work experience, average hours of teaching per month, and proportion of presence in administrative meetings, among other contributing factors such as variables explaining scientific productivity. It would be convenient to consider as an additional limitation of the documentation that only 8 universities in Ecuador have been the focus of the research, given that these comprise the total number of co-financed universities. In this sense, the present study did not consider public and private universities.

Research should be conducted on the determinants of the individual scientific performance of the teaching staff of the co-financed universities to find an answer to what characteristics professors must have to influence greater productivity.

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