


**IMPACT OF PHDs TRAINED IN EUROPE AND NORTH AMERICA ON THE
PRODUCTIVITY OF SCIENTIFIC RESEARCH: EVIDENCE FROM LATIN AMERICA**

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| ARTICLE INFO | ABSTRACT |
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| <p>Article history:</p> <p>Received 09 June 2023</p> <p>Accepted 06 September 2023</p> | <p>Purpose: The main purpose of this study is to analyze the differences in research productivity between doctoral degree holders from European and North American universities, and doctoral degree holders from Peru.</p> |
| <p>Keywords:</p> <p>Internationalization of Higher Education; Business Education; Scientific Productivity.</p> | <p>Theoretical framework: Internationalization of higher education has become a phenomenon of great relevance in recent years (Romani et al., 2021), allowing an increasing number of doctoral researchers to study in foreign countries. However, little evidence has been generated in Latin America.</p> |
|  | <p>Design/Methodology/Approach: The study uses an explanatory approach based on data mining that analyze data from 863 researchers from 24 public and private universities in Perú, according to the two categories of productivity (high and low) defined by the National Scientific Research Agency.</p> |
| | <p>Findings: The results show that of all the factors analyzed, the country of doctoral study is the most important variable in predicting the scientific productivity of researchers. This situation is confirmed when analyzing the number of publications made by researchers according to their category, where a clear tendency in favor of researchers who studied abroad can be seen.</p> |
| | <p>Research, Practical & Social implications: The results suggest that international academics are more likely to publish in top-tier journals. Also, the results may be applicable to other countries, but more studies are going to be necessary.</p> |
| | <p>Originality/Value: The results of this investigation are relevant, because studies about the academic internationalization effects on scientific productivity are scarce and no previous studies about this topic have been conducted in Latin America.</p> |
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**IMPACTO DOS PHDS FORMADOS NA EUROPA E AMÉRICA DO NORTE NA PRODUTIVIDADE
DA PESQUISA CIENTÍFICA: EVIDÊNCIAS DA AMÉRICA LATINA**

RESUMO

Objetivo: O principal propósito deste estudo é analisar as diferenças na produtividade de pesquisa entre portadores de doutorado de universidades europeias e norte-americanas, e portadores de doutorado do Peru.

Referencial teórico: A internacionalização do ensino superior tem se tornado um fenômeno de grande relevância nos últimos anos (Romani et al., 2021), permitindo que um número crescente de pesquisadores doutorados estude em países estrangeiros. No entanto, poucas evidências foram geradas na América Latina sobre esse tema.

Desenho/Methodologia/Abordagem: A pesquisa utiliza uma abordagem explicativa, baseada na mineração de dados que analisa informações de 863 pesquisadores de 24 universidades públicas e privadas no Peru, levando em consideração a classificação de sua produtividade (alta ou baixa) definida pela agência nacional de pesquisa científica.

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Resultados: Os resultados indicam que, entre todos os fatores analisados, o país a onde foi feito o estudo do doutorado é a variável mais importante na previsão da produtividade científica dos pesquisadores. Além disso, ao analisar o número de publicações feitas pelos pesquisadores de acordo com sua categoria, observa-se uma clara tendência em favor dos pesquisadores que estudaram no exterior.

Pesquisa, Implicações práticas e Sociais: Os resultados sugerem que pesquisadores internacionais têm maior probabilidade de publicar em revistas de alto impacto. Além disso, os resultados podem ser aplicáveis a outros países, mas serão necessários mais estudos sobre o assunto.

Originalidade/Valor: Os resultados desta investigação são relevantes, pois os estudos sobre os efeitos da internacionalização acadêmica na produtividade científica são escassos e não houve estudos prévios sobre esse tema realizados na América Latina.

Palavras-chave: Internacionalização do Educação Superior, Educação em Negócios, Produtividade Científica.

IMPACTO DE LOS PHDS FORMADOS EN EUROPA Y NORTEAMÉRICA EN LA PRODUCTIVIDAD CIENTÍFICA: EVIDENCIA DE LATINOAMÉRICA

RESUMEN

Propósito: El objetivo principal de esta investigación es analizar las diferencias en la productividad científica entre los investigadores que obtuvieron su doctorado en Europa o Norteamérica y los que lo obtuvieron en Perú.

Marco teórico: En los últimos años, la internacionalización de la educación superior se ha convertido en un fenómeno de gran relevancia (Romani et al., 2021), permitiendo que un gran número de investigadores con doctorado estudien en países extranjeros. Sin embargo, se han realizado pocas investigaciones al respecto.

Diseño/Metodología/Enfoque: La investigación emplea un enfoque explicativo, basado en la minería de datos que analiza información correspondiente a 863 investigadores de 24 universidades públicas y privadas en Perú, tomando en cuenta la clasificación de su productividad (alta o baja) definida por la agencia nacional de investigación científica.

Conclusiones: Los resultados muestran que, entre los factores analizados, el país donde realizaron el doctorado es el factor más importante al predecir la productividad de los investigadores. Además, al analizar el número de publicaciones realizadas, se evidencia una tendencia favorable hacia aquellos investigadores que estudiaron en el extranjero.

Implicaciones de la Investigación: Los resultados sugieren que los investigadores internacionales tienen más posibilidades de publicar en las mejores revistas. Además, los resultados podrían ser aplicables a otros países, pero se necesitarán realizar más estudios al respecto.

Originalidad/Valor de la investigación: Los resultados de la investigación son relevantes debido a que los estudios sobre los efectos de la producción científica en la internacionalización académica son escasos y no se han realizado a nivel de Latinoamérica.

Palabras clave: Internacionalización de la Educación Superior, Educación en Negocios, Productividad Científica.

INTRODUCTION

The internationalization of higher education has become increasingly important in recent decades (Van der Wende, 2007; Romani et al., 2021). In Latin America, this process is still in its early stages in most countries (Malaver Rodríguez, 2016; Quintero-Quintero et al., 2022). In the case of business schools, internationalization is considered one of the most important factors for positioning in rankings and obtaining accreditation (Avolio and Benzaquen, 2020), which leads to an increase in the competitiveness and credibility of institutions (Miles et al., 2015). Therefore, the internationalization of higher education is no longer a goal (de Wit, 2020); instead, it is a process to improve the quality of education (Jibeen and Khan, 2015).

Internationalization can be viewed from different perspectives: student experience (Crosling et al., 2008; Kedia and Englis, 2014; Guo and Guo, 2020), teacher recruitment and international mobility (Jepsen et al., 2014; Tan, 2020), institutional positioning and reputation (Cattaneo et al., 2016) as well and the generation of commercial advantages (Altbach and Knight, 2007). Comparatively, the number of studies aimed at assessing the scientific productivity of international academics is small compared with the perspectives described above. Measuring scientific productivity is essential in academic management decision-making processes (Gralka et al., 2019), to ensure the highest efficiency in resource allocation (Johnes, 2006).

Although the literature reports studies on scientific productivity (Nafukho et al., 2019; Dhillon et al., 2015; Kwiek, 2016), there are a limited number of articles that focus on obtaining a doctoral degree (Shin et al., 2014; Baloch et al., 2021). According to the information compiled by the authors, there are no studies developed in Latin America regarding the impact of teachers' internationalization on scientific productivity. In Peru, the hiring of academics with doctoral degrees obtained in Europe or North America has increased steadily over the last five years based on the University Law, which is oriented toward improving higher education quality.

Therefore, this article is the first study developed in Latin America related to the impact of internationalization on the scientific productivity of business schools, comparing two groups of researchers: PhDs with studies in Peru and PhDs with studies in Europe or North America. This study contributes to the generation of new evidence in the field of scientific productivity in higher education. The findings of this study have practical implications for public policy and decision-making processes at Latin American and Peruvian universities. Moreover, the results provide valuable insights for research administrators to optimally allocate resources.

THEORETICAL FRAMEWORK

Baruch et al. (2007) define the phenomenon called "brain drain," where highly qualified researchers leave their countries of origin to emigrate in search of better job opportunities. This phenomenon becomes even more evident when researchers have developed their doctoral training in developed countries and then find better career prospects if they stay in the nations where they emigrated. According to Romani and Carneiro (2019), researchers seek greater autonomy and job security, job opportunities, and social approval.

According to Chen (2022), universities located in economically developed regions have a more rigid faculty-selection process, where their recruitment criteria favor candidates with training in foreign universities. Employers are highly selective and evaluate the potential of researchers based on the quantitative metrics of scientific production. Similarly, Jung (2018) indicates that, in the case of South Korean research universities, they are more interested in hiring PhDs with degrees obtained outside South Korea, which leaves researchers with foreign studies in a position of relative advantage compared to their peers who did not study outside the country. Ackers (2008) suggests that international academic mobility is generated by the internationalization strategies universities worldwide have to ensure the quality of educational services. However, Chen and Lo (2013) argue that internationalization is the only way to ensure institutional survival rather than a search for excellence.

Developing countries have higher rates of new students entering higher education than European countries (Schofer and Meyer, 2005), which implies that the demand for academics is increasing over time. Nevertheless, it is relevant to note that the publication of scientific articles is not (by itself) a simple way of guaranteeing the prestige of an academic unit. In contrast, past reputation seems to be more important than academic productivity in assessing how stakeholders view universities (Keith and Babchuk, 1998).

When analyzing the career development of researchers, Canal-Domínguez and Wall (2014) suggested that male PhDs have higher economic incomes than women, although the latter value other non-monetary aspects of the employment relationship to a greater extent.

According to De Filippo et al. (2009), there is a strong relationship between academics' international mobility and scientific productivity. One of the most widely used metrics in bibliometrics to measure the scientific production of researchers is the h-index proposed by Hirsch (2005). This metric summarizes the number of articles and citations obtained by these works in a simple way.

An issue highlighted by Jonkers (2013) is that, at similar levels of scientific productivity, female researchers take longer to be promoted, although it is noted that international work experience has a positive effect on the chances of being promoted. However, Goodacre et al. (2021) pointed out that gender is not a relevant variable in the promotion of higher categories. Kim (2017) states that international academic mobility of researchers is mainly generated by the interest of universities in accelerating their knowledge generation trajectories. From the perspective of university decision-makers, Luczaj and Kurek-Ochmanska

(2021) indicate that cultural diversity, lack of qualified personnel, and academic improvement are the most important factors for the incorporation of foreign researchers.

On the other hand, Mok and Han (2016) state that one of the impacts of low scientific productivity is expressed in the fact that students look for study options in foreign countries to the extent that they have economic possibilities. A relevant aspect of the internationalization of scientific production is related to the publication of scientific articles in English. Li and Xue (2021) indicate that this situation is relevant for the insertion of Chinese universities as world-class institutions, to the extent that it attracts high-profile researchers by finding appropriate spaces to develop in this language.

Experiences abroad allow researchers to have a more global perspective when teaching, which is highly relevant for business schools (Miglietti, 2015). Santos et al. (2016) analyzed the offers of researchers in Portugal and suggested that, contrary to what the scientific community believes, the demand for PhDs is higher than the supply, which shows that institutions can attract talent from abroad to meet the unsatisfied demand. Baloch et al. (2021) presented a case study on scientific productivity in public universities in Pakistan, where they analyzed the difference between PhDs who obtained their degree in the same country and PhDs who graduated abroad, finding that PhDs who graduated abroad were not more productive in terms of publication of articles in scientific journals and books.

These results contrast with the findings of Mamiseishvili and Rosser (2010), which indicate that in U.S. research universities, foreign academics are significantly more productive than nationals in research but less productive in teaching and service. Similarly, Corley and Sabharwal (2007) conclude that foreign researchers in the United States are more productive than those born in the same country, although they also point out that the average salaries and levels of job satisfaction are lower among scientists from foreign countries. In French business schools, the approach has been to examine scientific productivity as a relevant factor for international reputation. In this sense, productivity is understood as an aspect that positively influences the attraction of international researchers in the framework of the transformation of business schools with a focus on research (Thietart, 2009). According to Kyvik and Aksnes (2015), increases in scientific productivity are due to factors such as the new generation of better-qualified researchers, academic collaboration among peers, and the introduction of better incentive structures.

Jonkers and Cruz-Castro (2013) state that another effect of the internationalization of research is that it increases the space for collaboration between researchers from different

countries while increasing the probability of articles being published in journals with a high impact factor. Along these lines, Baruffaldi and Landoni (2012) postulate that the internationalization of researchers has a double effect in which both the country of origin and the receiving country benefit from scientific collaboration networks. On the other hand, scientific productivity is impacted by the tendency to publish in journals that do not have peer reviews, a situation that is accentuated in countries that do not have English as their native language (Bentley, 2015). Barjak and Robinson (2008) raise another aspect of the internationalization of research related to the diversity of research teams, where the most successful teams are those that collaborate with scientists from other countries in the production of joint articles. This finding supports the idea of promoting international mobility.

Context of the Peruvian University System

Peru has a higher education system comprising 141 universities and four graduate schools. The Peruvian university system has undergone major changes over the last 25 years because of various regulatory modifications. In 1983, the University Law No. 23733 was enacted to regulate various matters related to university activities. One aspect considered by this law was the introduction of the National Council of Rectors (ANR), a public body responsible for assessing, coordinating, and guiding university activities in the country. Subsequently, in 1995, Law No. 26439 was enacted, which created The National Council for the Authorization of University Operations (CONAFU), an autonomous body of ANR, to evaluate the creation of new universities.

As of 1996, the country had 67 universities (public and private), the year in which Legislative Decree No. 882 (Law of the Promotion of Investment in Education, dated November 9, 1996) was enacted, after which 83 institutions (60 private and 23 public) were created from that date until December 2012, when Law No. 29971 was enacted, which established the moratorium (cessation) for the creation of public and private universities for five years.

However, in 2014, there was an exception to this regulation, granting university status to five institutions and bringing the total number of universities in Peru to 145. According to Castro and Yamada (2013), the 1996 decree was identified as the trigger for an explosion in the offer of university education, which has not been accompanied by an increase in quality. This is shown by the number of university students enrolled in 2013, which amounted to 1,029,174, of which 68.8% belonged to private universities.

Thus, in accordance with the purpose of the moratorium law of 2012, the Peruvian State enacted University Law No. 30220 in 2014, which replaced the old law of 19983. In Law No. 30220, the National Superintendence of Higher University Education (SUNEDU) replaced ANR. One of the most important functions of SUNEDU is to carry out the licensing process to verify compliance with basic quality conditions and authorize the operation of universities.

The licensing process was initiated in 2016 and concluded in 2022. This process concluded with 95 institutions authorized to operate in the country, while 50 institutions lost their operating licenses; therefore, they are currently in a progressive closure stage, a process that should be concluded in 2025. Table 1 shows the breakdown of the number of authorized universities according to their typology (public or private), where a high proportion of private universities were not authorized to continue providing educational services in Peru.

Table 1 - Authorized universities in Peru, by type of university

| | Public | Private | Total |
|----------------|-----------|-----------|------------|
| Authorized | 47 | 48 | 95 |
| Not authorized | 2 | 48 | 50 |
| Total | 49 | 96 | 145 |

Source: Prepared by the authors (2023)

Regarding incentives for PhD education in Peru, it is important to mention that CONCYTEC (Peruvian public agency for scientific research) in an agreement with the World Bank since 2018 provided financial resources to 10 public and private universities in order to support doctoral programs in strategic areas for Peru (CONCYTEC, 2018). On the other hand, the Peruvian government has also launched the Pronabec Bicentennial Generation Scholarship that offers 30 scholarships for PhDs, where eligible foreign institutions need to be ranked among the top 400 worldwide.

METHODOLOGY

This project uses an explanatory approach based on data mining, the central objective of which is to detect patterns in the data (Fayyad et al., 1996) and generate new knowledge based on the information obtained in different processes.

The study population was composed of a sample of 863 researchers in the field of Business and Management belonging to 24 Peruvian universities, from which we have information related to their country of origin, university where they obtained their PhD degree, academic position, type of university, and data related to their scientific production. Of these 24 institutions, 15 were authorized to operate, while nine were in the process of closing. These

institutions were selected based on the existence of active undergraduate, master's, and PhD programs in the areas of Business and Management.

Data for the study were obtained from the collection of information published on open websites, such as the National Council for Science, Technology, and Technological Innovation of Peru (CONCYTEC), academic databases such as Scopus and Google Scholar, and the websites of the universities that were considered for this study. Information was collected between March and June 2022.

Machine Learning (also called Data Science or data mining according to context) encompasses a series of modeling techniques oriented to different organizational requirements (prediction of results, text analysis, artificial vision, voice recognition, etc.), which can be applied to different tasks (Saxena et al., 2023) in business environments (Jordan and Mitchell, 2015; Alotaibi, 2023). In the education sector, the use of these techniques can be appreciated in tasks such as predicting the academic performance of students (Castrillón et al., 2020), while Salloum et al. (2018) presented a text-mining approach to extract information from research articles. Regarding Accreditation and Quality, Nunez et al. (2021) used a data mining approach to classify media content generated by universities in Peru and Chile.

The processes carried out by machine learning include not only the study but also the construction of models that analyze certain amounts of data in order to find relationships and patterns among them. All this is achieved through the application of certain learning algorithms, where the models adjust their parameters to find the desired patterns and use them to make predictions or make accurate classifications in new information inputs. (Alzubi et al., 2018).

The learning algorithms used in machine learning are divided into three classifications:

- *Supervised learning*: Algorithms that perform prior learning based on a system of labels associated with data that allow them to make decisions or predictions.
- *Unsupervised learning*: Algorithms that have no prior learning. They analyze databases to find patterns that facilitate their organization.
- *Reinforcement learning*: Algorithms that learn from experience. This makes them capable of making optimal decisions in different situations according to trial-and-error processes where correct decisions are sought.

In this study, after deleting a series of variables that did not add substantial value to the model, 11 attributes related to aspects linked to scientific productivity were considered, where the dependent variable Y is the category of the researcher according to her official CONCYTEC registration. This variable has two possible values: "high" or "low", according to public

information. All the variables of the study were qualitative; therefore, the use of Machine Learning tools is appropriate for this type of analysis. Descriptions of the variables studied are presented in Table 2.

Table 2 - Description of the study variables

| Name of Variable | Type | Description |
|-------------------|-------------|--|
| Pais_estudio | Qualitative | Country where the researcher completed his PhD studies |
| Area_Conocimiento | Qualitative | Knowledge area of PhD studies, according to OCDE |
| Jerarquia_Docente | Qualitative | Professor's academic ranks (full professor, associate professor, assistant lecturer, instructor) |
| Tipo_Universidad | Qualitative | Type of University (public or private) |
| Dedicacion | Qualitative | Contribution status (full-time, part-time) |
| Clases_Maestria | Qualitative | Teaching classes in Master program (yes or no) |
| Clases_Pregrado | Qualitative | Teaching classes in Undergraduate program (yes or no) |
| Clases_Doctorado | Qualitative | Teaching classes in PhD program (yes or no) |
| Genero | Qualitative | Gender of researcher |
| Autorizada | Qualitative | Authorized university to operate (yes or no) |
| Productivity | Qualitative | Category of the researcher (high / low productivity) |

Source: Prepared by the authors (2023)

For the analysis of this study, we used the Random Forest algorithm, introduced by Breiman (2001), which consists of a technique for segmenting entities from a collection of data according to statistical criteria, based on methods used in the use of decision trees. Decision trees begin with a basic question, from which a series of questions can be elaborated to determine an answer. The questions constitute the decision nodes in the tree, acting as a means of partitioning the data. Thus, each question helps an individual to arrive at a final decision, which would be indicated by the leaf node. Decision trees seek to find the best split to create subsets of data and are usually trained using the classification and regression tree (CART) algorithm (Mantas et al., 2019). Some metrics can be used as well, one of these is the Gini coefficient (Strobl et al., 2007)

Decision trees can also be prone to bias and/or overfitting. However, when several decision trees form a set processed by the random forest algorithm, they are able to predict more accurate results, especially when the individual trees are not correlated with each other. The random forest algorithm uses feature randomization to create an uncorrelated forest of decision trees. This clustering of features generates a random subset of features which in turn guarantees a low correlation between decision trees. While decision trees consider all possible feature splits, random forests only select a subset of those features. (Breiman, 2001).

Random forest algorithms have three main hyperparameters, which must be configured before training:

- Node size

- Number of trees
- Number of sampled features

The random forest algorithm is composed of a set of decision trees, and each tree in the set is composed of a data sample drawn from a training set with replacement, called the bootstrap sample. Of that training sample, one-third is set aside as test data, known as the out-of-bag (oob) sample, which we will return to later. Then, another instance of randomness is injected through feature clustering, which adds more diversity to the data set and reduces the correlation between decision trees (Ibrahim, 2019; Ibrahim, 2020). One of the advantages of Random Forest is its better performance and accuracy compared to other algorithms, such as Neural Networks, Support Vector Machines or Decision Trees, in addition to its specific applications in the higher education sector (Beulac and Rosenthal, 2019), which are oriented to the prediction of results in processes such as admission, dropout, and course selection. Thus, Random Forest is a highly effective tool for analyzing different phenomena.

Data Processing

Data analysis was performed with RStudio software version 2022.07, using packages such as *caret*, *RandomForest* and *e1071*, among others. Prior to the application of machine learning techniques, cleaning and sorting tasks were performed to ensure data integrity, with a specific focus on the treatment of extreme data (outliers) that could have an impact on the model.

A total of 231 researchers in the area of Business and Management were officially certified in Peru as academics with high scientific productivity. 90 of these researchers obtained their highest degree in Europe or North America, and 141 in Peru. The distribution of researchers by sex is shown in Table 3. It shows that female are the 33.3% of the sample, a clear minority. Also, that from that sample of only woman, only the 20% have a high category of productivity. If we contrast the percentages of female and male in a high category of productivity, it is show that female researchers are the 25% of the whole sample.

Table 3 - Number of researchers by gender and category

| | Category of Productivity | | |
|--------------|--------------------------|------------------|--------------------|
| | High (n = 231) | Low (n = 632) | Total (n = 863) |
| Female | 59 | 229 | 288 |
| Male | 172 | 403 | 575 |
| Total | 231 | 632 | 863 |

Source: Prepared by the authors (2023)

RESULTS AND DISCUSSION

Bivariate Analysis

In the first stage, an analysis of two variables to determinate the relation between them was developed around the category of scientific productivity (high/low) and the country where the PhD degree was obtained (Peru/foreign country), based on the data presented in Table 4. By complementing this information with Tables 5 and 6, the results show that, of the total sample of doctorates in Peru, 21.9% have a high category of productivity, while the percentage rises to 40.7% for the sample of doctorates abroad. Researchers with PhD degree obtained abroad produced a greater number of publications, where on average they published 2.12 articles in the period 2019 - 2021, a figure that contrast with the productivity of researchers with studies in Peru, having published on average 0.33 articles for the study period.

When further analyzing these results, it can also be seen that researchers with a PhD degree obtained abroad have published a greater number of scientific articles with higher impact factors than researchers with a PhD degree obtained in Peru. In the year 2019, the articles of researchers that studied their PhD in Perú were 32% of the whole of scientific production, the next year were 33.9%, and finally, in 2021 they were the 28% of the whole sample of articles published that year. Also, it is important to note that the sample of articles was different each year, and the increment follow the tendency of up and down of the percentages of the articles of researchers that studied their PhD in Perú.

Additionally, table 6 takes the total amount of articles of 2019, 2020 and 2021. It can be seen that the researchers with PhD studies in Peru with a high productivity made the 27% of the sample. In contrast, the researchers with PhD studies abroad concentrated the 60.9% of articles published. The researchers with PhD studies in Peru and low productivity made the 4% of the sample and the researchers with PhD studies abroad and low productivity made the 7.6% of published articles. The final aspect considered in the analysis was the level of international collaboration in the publications of both groups, verifying that researchers with a degree obtained abroad have a higher degree of internationalization in their academic activities.

Table 4 - Number of researchers by category and country of study

| Country of PhD degree | Category of Productivity | | |
|-----------------------|--------------------------|------------------|--------------------|
| | High (n = 231) | Low (n = 632) | Total (n = 863) |
| Abroad | 90 | 131 | 221 |
| Peru | 141 | 501 | 642 |
| Total | 231 | 632 | 863 |

Source: Prepared by the authors (2023)

Table 5 - Number of articles, by year and by place of PhD studies

| | 2019 | 2020 | 2021 | Total |
|---------------------|------------|------------|------------|------------|
| PhD studies in Peru | 47 | 98 | 70 | 215 |
| PhD studies abroad | 99 | 191 | 179 | 469 |
| Total | 146 | 289 | 249 | 684 |

Source: Prepared by the authors (2023)

Table 6 - Number of articles, by category and place of PhD studies

| | Published Articles |
|---|--------------------|
| High Productivity – PhD studies in Peru | 186 |
| Low Productivity – PhD studies in Peru | 29 |
| High Productivity – PhD studies abroad | 417 |
| Low Productivity – PhD studies abroad | 52 |
| Total | 684 |

Source: Prepared by the authors (2023)

Binary Classification Analysis

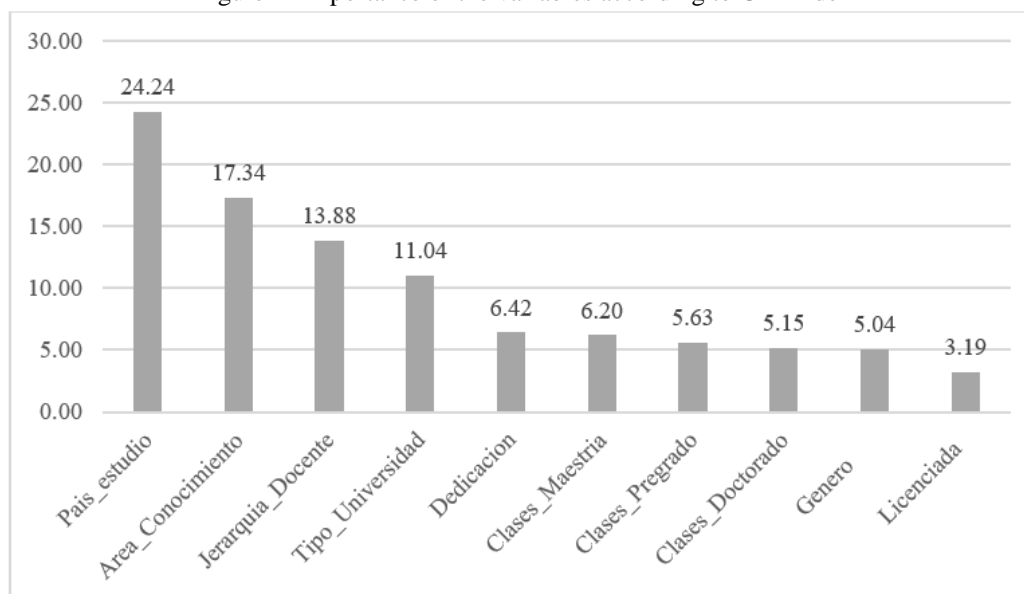
To determine the importance of the internationalization of PhD studies in the category of scientific productivity of researchers, the Random Forest algorithm was applied, because by the nature of this type of model (ensemble), it is possible to measure which factors have more influence on the output results (category of scientific productivity); thus, they will be considered to explain the model better and be more important (Schonlau and Zou, 2020). There are two ways to measure this relevance: the mean decrease in impurity (MDI) and mean decrease in accuracy (MDA) (Nembrini et al., 2018).

In this study, the first of these was used through the measurement of the Gini index, which is the most commonly used statistics for finding classification attributes of different nodes of the tree. Gini importance values provide a relative ranking of the features, with higher values indicating more important features in terms of reducing impurity and improving the separation between classes. The result of this methodology can be visualized with the “Gini importance” and may be considered as a general indicator of the relevance of each variable (Menze et al., 2009).

Figure 1 shows the results obtained after calculating the Gini index for the model input variables. This shows that the most important variable in the category of scientific productivity is the country of PhD studies, followed by the knowledge area of PhD studies and the professor’s academic ranks. Something interesting is that the variable teaching classes in undergraduate program was a more important variable than teaching classes in PhD program. Also, the least important variable according to Gini index was the variable if the university was authorized to operate.

This confirms the results obtained in the bivariate analysis. Additionally, it is possible to appreciate that aspects such as the area of knowledge of the researchers have considerable relevance as well as the teaching rank. Another variable that may be highlighted in the analysis is the type of university to the extent that it was verified that private universities have the highest relative proportion of researchers with PhD degrees obtained abroad.

Figure 1- Importance of the variables according to Gini index



Source: Prepared by the authors (2023)

From the results obtained, it can be demonstrated that researchers who obtained their PhD degree abroad are more likely to have high scientific productivity than those who obtained their PhD degree in Peru. In this regard, researchers with a foreign PhD degree have published a greater number of referenced articles in the last three years than researchers with a national PhD degree. These results are consistent with the study published by Jonkers and Cruz-Castro (2013), which indicated that Argentine researchers with studies abroad performed better than those who studied in Argentina. However, the results are contrary to those of Baloch et al. (2021), who found no differences between foreign and local doctoral degree holders in Pakistan. It is relevant to highlight that all participants in the study performed in Pakistan came from public universities. Another limitation of this study is related to the fact that the authors did not mention the countries/regions where foreign degree holders received their doctoral degrees.

Access to PhD training in foreign universities allows academic networks to be published in high-impact journals (Barjak and Robinson, 2008). This situation is due to the fact that the

most successful teams are those that collaborate with scientists from other countries in the production of joint articles, emphasizing the value of international mobility.

In this respect, Li and Yan (2015) state that PhD training has a direct impact on the quality of scientific production to the extent that they have the highest standards of knowledge production, as well as consolidated research teams. Therefore, it is relevant that the Peruvian Government more actively promotes the creation of scholarship programs for the training of specialized human capital to ensure the continuous improvement of the university system in relation to scientific productivity. Likewise, the results show that researchers with PhD training abroad have a greater propensity for international collaboration through participation in research networks and contact with supervisors and colleagues, leading to better prospects for scientific productivity, which is consistent with the findings of Jonkers and Tijssen (2008). From this point, it is relevant to assess the mechanism of resource allocation for researchers with a national PhD degree, so that they may participate in international events that provide them with access to academic networks abroad.

Emerging economies rely on increasingly specialized knowledge and seek to recruit more private-sector researchers, competition for staff with doctorates usually intensify. Current problems of retaining staff, which are already causing concern could worsen, perhaps even leading to a vicious circle in which universities could not compete with the private sector for human capital and thus not develop and sustain the capacity needed for good doctoral education. (Jorgensen, 2012). So highly capable researchers are more likely to apply to places where their skills are better rewarded.

Also, there is to take in consider that Academics' satisfaction with their primary employment at research organizations, namely opportunities for creative expression and development, has a positive correlation with productivity. Academics' publication activity can be buoyed not only by a high level of pay, but also stimulating working conditions that include opportunities for creative expression and a certain degree of academic freedom. (Fursov, et al. 2016). It's important to note this because, it is common in Latin American countries that qualified researchers usually emigrate to other countries looking for better job opportunities. So, it is natural to conclude that the more successful strategies are expected at those universities that seek to provide their employees with the necessary conditions for professional development by offering material incentives as well as the possibility of integration into a global professional community.

For most institutions, doctoral education was seen as a “very important” part of their internationalisation strategy. Respondents increased internationalisation at their institutions in a variety of ways, such as attracting international staff and students, providing institutional support for cross-border activities, or engaging in joint or collaborative programmes or research and in ad hoc mobility (Jorgensen, 2012)

On the other hand, Hermes-Lima, et al. (2007) points out that rather than prioritizing more qualitative forms of evaluation of the productivity of scientists and projects, several of those government agencies appear to be giving undue emphasis to quantitative evaluation of the numbers of publications by individual scientists. This generates increased pressure on the scientific community to publish as many articles as possible, likely at the expense of publishing more complete or innovative works that could have higher impact in the scientific literature.

Finally, the study found that the gender of researchers has a significant impact on scientific productivity, since when evaluating the individual production of women and men, a difference in favor of the male gender is observed, which is consistent with results obtained in studies such as those of Ghabban et al. (2018) and Musiige and Maassen (2015), who suggested that this situation may be due to the family responsibilities of female researchers. In the case of Peru, a country with a predominant culture of discrimination and exclusion of women, where hostile environments and reduced female protection still exist, the impact may be seen in the lower participation of female researchers in international academic collaboration networks. Therefore, it is necessary to generate more space to close this gap and allocate public resources to promote the career development of female researchers.

CONCLUSION

Studies on the analysis of scientific research productivity have been conducted in different countries. However, studies that measure the impact of foreign doctoral degree holders are scarce, and no previous studies have been conducted in Latin America. Therefore, it is necessary to conduct future research to measure the impact of doctoral studies on scientific productivity in nations other than European and North American countries.

This study found that researchers with doctoral degrees in Europe and North America were more productive than their Peruvian counterparts. The findings suggest that international academics have stronger ties with research groups abroad and are more likely to publish in top-tier journals. Limitations of this study are centered on the fact that the data were collected in the Scopus and Google Scholar databases, leaving aside other sources, such as Web of Science,

to carry out this review of scientific information. Furthermore, Peru was chosen because of the lack of research on scientific productivity in universities.

The results of this study may also be applicable to other Latin American, African, and Asian countries, although they might be different. Future studies can examine the effects of academic internationalization (i.e., hiring researchers with doctoral degrees from Europe or North America) on scientific productivity in various institutional contexts to produce new data on this subject.

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