Factors that Influence the Individual Research Output of University Professors: The Case of Ecuador, Peru, and Colombia

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Abstract
The study analyzed the factors that influence the individual research output of university professors in Ecuador, Peru, and Colombia, using multinomial logistic regression technique. Results showed that previous research publications are the main factor that explains subsequent research production. Age, academic rank, time invested on research, resource allocation, recognition, and research leaders have also a direct effect on research output. A comprehensive model is proposed and implications for universities authorities are discussed.

Resumen
Usando la técnica de regresión logística multinominal este estudio analizó los factores que influyen en la producción de investigación individual de profesores universitarios en Ecuador, Perú, y Colombia. Los resultados indican que las publicaciones de investigaciones previas son el factor principal que explica la producción subsecuente de investigación. Edad, rango académico, tiempo invertido en investigación, asignación de recursos, reconocimiento y liderazgo en investigación tienen también un efecto directo en la producción de investigación. Se propone un modelo amplio y se discuten implicaciones para las autoridades universitarias.

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Introduction
Scientific research productivity has been linked to the intellectual wealth and economic progress of countries (Jaffe et al., 2020). Research output can be reflected in the results of scientific studies, which are disseminated through academic publications. The most commonly used indicator to measure research productivity is the publication of articles in indexed databases, which is a proof of excellence for universities (Albers, 2015; Heng et al., 2020). In this context, the study of the determinants of research output has drawn attention at an academic and regulatory level to understand how research performance in the university system could be improved (Bonaccorsi & Secondi, 2017).

The study of research output started with Lotka (1926) who proposed the inverse-square law with regard to unequal distribution of research productivity. In the last decades, research productivity has been a topic of interest for several scholars, who have focused on the analysis and distribution of the number of publications, and the factors that directly or indirectly influence the productivity. However, the results about the specific factors affecting the research output are still contradictory. Additionally, previous literature was mainly focused in developed contexts or emerging economies such as those of South Korea and China (Heng et al., 2020). Some researches on this topic have also been carried out in Latin America (Castillo & Powell, 2020; Contreras et al., 2006; Narváez & Burgos, 2011), but they have been mainly focused on analyzing research output without considering the factors that affect such process.

The world’s research output is mainly generated by developed countries: 47% of researchers in the world come from the European Union and the United States, while 3.6% of them are from Latin America (UNESCO, 2015). In recent years, Latin American universities have given more importance to research output. According to the Scimago Journal database, the South American countries with the highest growth in the number of scientific article publications (2015–2016) are Ecuador (183%), Perú (103%), and Colombia (53%). In 2012, Ecuador enacted a new Higher Education Law, through which it established public policy tools focused on increasing scientific productivity, visibility, and the volume of global contribution. Likewise, the Ecuadorian government created incentives, scientific and technology transfer programs, and funding to increase research output (Castillo & Powell, 2020). In 2014, Peru approved the University Law to regulate the foundation, operation, and supervision of universities. This reform has strengthened research production in Peruvian universities. Additionally, since 2001, regulations have been promoted in Colombia to introduce a model of wage incentive based on research productivity. In fact, research output has received greater importance in the region because there have been dramatic changes in the higher education systems (Van Hoof et al., 2013).
In this context, this study aims to analyze the factors that influence the individual research output of university professors in Ecuador, Peru, and Colombia. This research is relevant because it analyzes the factors affecting the individual research output in those countries and complements the efforts made in this region to increase the productivity.

**Theoretical Framework and Hypotheses**

Previous literature shows several factors potentially affecting individual research output (Heng et al., 2020). Some of those factors are the previous production or accumulative advantage, the individual characteristics of the researcher, and the institutional factors. In fact, many academics affirmed there is a positive relationship between those factors and the research output, but the results are still contradictory. Figure 1 shows the theoretical model of the study and the literature review is detailed below.

**Previous Research Output**

The first studies that analyzed research output (Cole & Cole, 1967; Lotka, 1926), showed differences in the intellectual production of professors. Later studies analyzed the factors that produced such differences and identified that the “accumulative advantage” or experience of professors is one of the causes (Allinson & Stewart, 1974). The “accumulative advantage” claims that productive scientists are likely to be even more productive in the future, while the productivity of those with low performance will decrease (Kwiek, 2016). Fox (1983) complemented this phenomenon stating that the accumulative advantage is often presented by different resources that researchers accumulate from their previous publications. In addition, although several studies focus on the previous scientific performance, there is no consensus on how the characteristics of the human capital affect the productivity (Ballesteros-Rodriguez et al., 2020).
In this sense, some studies claim that previous research output positively affects the productivity levels. For example, García-Cepero (2009) determined that the probability that a researcher may conduct research is related to the difficulty of starting the production process, that is, it is difficult to go from zero publications to one publication. Success in publishing is a fundamental drive to conduct more research and make more publications (Gaus et al., 2020; Kwiev, 2016). Additionally, Salinas-Ávila et al. (2020) identified that the motivation of the professor to conduct research, to be up to date about their field of study and develop research skills influence their research productivity.

**Individual Characteristics of the Researcher**

The most significant characteristics used to explain variations in research output are gender, age, academic qualification, academic rank, academic discipline, and work habits. Several studies found that male professors tend to publish more than their female colleagues in different disciplines (Gul et al., 2016; Hedjazi & Behravan, 2011; Jung, 2012). Sá et al. (2020) studied productivity among elite scientists and found that men outperform women in the number of publications, and receive substantially more citations. Several studies aim to explain the lower intellectual production of women throughout their careers caused by differences in family responsibilities, different patterns of time use, unequal resource allocation, different patterns in academic collaboration, and gender bias in peer-review (Sá et al., 2020). However, some studies contradict these results since they found that gender has no significant effect on research productivity indicators and women have production rates similar to their male peers (Khalil & Khalil, 2019). Moreover, previous studies show that there could be differences in research productivity by gender that depend on their academic fields. Webber (2011) found that the faculty in physical and life sciences produces 25% fewer peer-reviewed articles than the faculty in other fields or male faculty in the same discipline, and female faculty with one or more dependent children produce 8% fewer books and textbooks than female faculty without dependent children or male faculty.

As for age, some research show that production increases with age, but after a certain time it begins to decline. Abramo et al. (2016) explained this effect in researcher productivity as an inverted U, due to two opposite effects: the great amount of innovative ideas during the professional development stage of the researches and the increasing risk of becoming professionals with outdated skills and difficulties to find new research themes at the decline stage. In the same way, Backes-Gellner & Schilinghoff (2004) found that the productivity of professors tends to decrease after being promoted as a full professor. Some studies concluded that there is a significant relationship between research output and age (Hedjazi & Behravan, 2011; Khalil & Khalil, 2019). However, the results are still contradictory because other studies (Bland et al., 2005) did not find statistical evidence that there was difference in faculty research productivity due to age.

In terms of academic qualification, Kozhakhmet et al. (2020) found that research-related formation and development are positively associated with research
productivity. Several studies found that the academic rank is a significant predictor of research productivity because senior faculty members have higher research productivity than their junior counterparts (Hedjazi and Behravan, 2011; Khahil & Khahil, 2019). According to Bland et al. (2005), this occurs because research output is one of the main criteria for professors to be promoted.

Several authors concluded that there are significant inequalities in research output levels based on their academic disciplines (Álvarez & Montesi, 2020; Gaus et al., 2020; Jung, 2012; Webber, 2011). Findings from previous studies suggest that researchers in “hard” disciplines (e.g., natural sciences, engineering, and medical science) tend to publish more than researchers in “soft” disciplines (e.g., humanities, social sciences, and business) (Heng et al., 2020), and researchers in “soft” disciplines tend to publish more books than academic articles than researchers in “hard” disciplines (Jung, 2012).

Finally, previous studies consider that the work habits that researchers grow from the beginning of their careers, influence their future research productivity (Bland et al., 2005). In the same way, the skills they develop to properly administer and manage their time are essential to achieve good levels of productivity (Wills et al., 2011). However, other studies indicate that the causal relationship between habits and research productivity is uncertain (Fox, 1983).

**Environmental Characteristics**

The literature shows that the environment in which the researcher performs affects the levels of research output. Salinas-Ávila et al. (2020) mention the importance of institutional factors in developing a research culture aimed at promoting greater interaction and transfer of knowledge to society. Institutional factors include the size of academic departments, the faculty time dedicated to research and teaching, resource allocation, research networks, recognition, and leadership in research groups.

Regarding the impact of the size of the academic department on individual production, Carayol and Matt (2003) found that the size of the department negatively affects research output, while Hedjazi and Behravan (2011) concluded that, if the research group has more professors, higher levels of research output can be generated. On his side, Albers (2015) indicated that the size of the academic department is a potential factor in the creation of an environment that has an impact in the improvement of the number of professors’ publications.

In reference to the faculty time dedicated to research, Jung (2012) concluded that hours allocated to teaching are seen as a distraction from research, but not necessarily a pressure that decreases production. The author showed that the more time dedicated on teaching, the less research output there will be. Evidence from the studies reviewed suggests that efforts to increase levels of research output imply a decrease in the academic load (Hassan et al., 2008). According to Kwiek (2016), to have a high performance in scientific production, academics must focus their activities on doing research, and a high dedication to teaching does not allow them to obtain a higher research productivity.
Regarding resources allocation, studies showed that the resources invested by research organizations for doing research, including facilities, have a significant relationship with the research output (Bland et al., 2005; Hedjazi & Behravan, 2011). Wills et al. (2011) concluded that one of the institutional factors for improving the productivity levels of professors is the financial support allocated for research activities. Albers (2015) stated that not only resources should be allocated for research, it is also necessary to analyze how to achieve a correct allocation by universities and external organizations that finance those activities.

Research networks allow professors to maintain communication with their colleagues to strengthen research topics (Bland et al., 2005). Fox and Mohapatra (2007) stated that these networks can be formed between colleagues in the same department, with professors from other departments, or with other universities. Hedjazi and Behravan (2011) concluded that the institutional factor that explains most of the research output is the professor’s research network with other colleagues. Abramo et al. (2019) found that the relationship between collaboration and research performance has been widely studied, determining that collaboration plays a key role among the factors influencing research performance. Castillo and Powell (2020) analyzed Ecuadorian research productivity and found that collaboration from international cooperation produces higher scientific research outputs.

As for the recognition, Fox (1983) indicated that researchers who are rewarded and recognized show higher levels of production and those who are not, have a lower productivity. Also, Henry et al. (2020) found that academics completely satisfied with their annual KPI and monthly income increase their research productivity, while Lee (2020), in Korea, found that research productivity increases when the professors’ remuneration increases, but this was limited by the Law of Diminishing Returns. Several studies have also considered some leadership characteristics that influence research output yields. Bland et al. (2005) identified the following characteristics of research group leaders: being considered a scholar and role model for the group; make the group internalize the research objectives; assume critical leadership roles to administer resources; and develop an assertive-participatory governance.

Based on all these considerations, the following hypotheses are proposed:

- **H1**: The previous research output has a positive relationship in the individual research output of university professors from Ecuador, Peru, and Colombia.
- **H2**: The individual characteristics of the researcher (gender, age, academic qualification, academic rank, work habits, and academic discipline) influence the individual research output of university professors from Ecuador, Peru, and Colombia.
- **H3**: The characteristics of the environment (the size of the academic department, the time invested on research, the allocation of resources, research networks, recognition, and leadership in research groups) positively influence the variations in the individual research output of university professors from Ecuador, Peru, and Colombia.
Methodology

Data Collection and Sampling

This research study was carried out in Ecuador, Peru, and Colombia. These countries were selected for representing the highest growth rates of publications in the Scopus database in the South America region in 2016 to 2017. Universities were chosen based on the research output. In Ecuador, four universities accounted for 48% of academic output. In Peru and Colombia, three universities accounted for 63% and 53%, respectively, in the production of academic articles. The total full-time professors at the selected universities is 6,166. The size of the sample was determined by considering finite populations, with a margin of error of 5% and a confidence level of 95%, having obtained a result of 362 professors. Stratified random sampling with proportional allocation was applied to each university. A total of 3,671 invitations were sent to professors from selected universities, and a 14% of effectiveness (518) was achieved. The database of the faculty emails was obtained from the universities, with prior authorization from the academic authority. Participants signed the digital informed consent form about their voluntary participation in the study and the non-personally identifiable information agreement. Table 1 show the demographics characteristics of the sample.

Research output was measured through the publication of indexed articles in the Latindex, Web of Science, and Scopus databases. In addition, and in order to have information on the production of other research results of professors in the region, the publication of peer-reviewed books and patent registration was considered (Table 2). As can be seen, lower percentages of professors have significant levels of production and a representative number of professors do not get research results.

Measures

The study used the instrument of Bland et al. (2005). This questionnaire, developed by a committee of experts from the University of Minnesota School of Medicine, consisted of 56 questions, with many with sub-questions. The items were verified by specialists in faculty development and then they conducted a pilot test. With very few exceptions, the items were measured on a five-point Likert scale, ranging between “strongly disagree” (1) and “strongly agree” (5).

The questionnaire applied was written in Spanish. We used the double translation method to verify the consistency of the questionnaire when compared to the original. The translated data collection instrument was validated by a group of eight experts. To ensure content validity, each expert examined the relevance, writing, and meaning of each of the questions of the instrument. Some modifications in the drafting had to be made to adapt the instrument to Ecuadorian, Peruvian, and Colombian contexts. Amendments were made by the experts’ panel in order to address potential problems of comprehension and ambiguity. Some items were included in the instrument, related with the age, academic qualification, academic rank, academic discipline, time dedicated to
research and current (2016–2017), and previous (2010–2015) individual research output levels. The final questionnaire consisted of 59 questions. The questions correspond to the previous production independent variables, and individual characteristics of the researcher and institutional factors were measured on a five-point Likert scale, ranging between complete disagreement (1) and complete agreement (5) with the questionnaire statements. The research output dependent variable was measured through the number of academic articles in four categories: (a) zero, (b) one to two, (c) three to five, and (d) more than five academic articles.

The reliability of the measurements was evaluated prior to data analysis using Cronbach’s $\alpha$ coefficient. All items shown a general Cronbach’s $\alpha$ coefficient of 0.9458, indicating an acceptable level of reliability.

### Data Analysis and Results

A correlation analysis was performed (Table 3). It is emphasized that academic rank, time dedicated to research, and research networks are the factors with the highest levels of correlation, with the individual research output. The relationship of research output and gender have a negative relationship with moderate levels of significance. The correlation with the age and academic department size reveals insignificant levels of correlation, suggesting that these factors have no greater influence on research output in the context of Ecuador, Peru, and Colombia.

| Gender          | Frequency | Percentage (%) |
|-----------------|-----------|----------------|
| Men             | 284       | 54.8           |
| Women           | 234       | 45.2           |

| Academic discipline                          | Frequency | Percentage (%) |
|----------------------------------------------|-----------|----------------|
| Biological and medical sciences              | 117       | 22.6           |
| Technical sciences                           | 114       | 22.0           |
| Administrative sciences                      | 64        | 12.4           |
| Social sciences and humanities               | 51        | 9.8            |
| Educational sciences, philosophy, language, and literature | 38 | 7.3 |
| Basic sciences                               | 30        | 5.8            |
| Economics                                    | 30        | 5.8            |
| Psychology                                   | 30        | 5.8            |
| Other sciences                               | 44        | 8.5            |

| Degree             | Frequency | Percentage (%) |
|--------------------|-----------|----------------|
| Third level        | 6         | 1.2            |
| Major              | 14        | 2.7            |
| Master             | 213       | 41.1           |
| Doctorate          | 285       | 55.0           |
| Article production | 2016–2017 | 2010–2015 |
|--------------------|-----------|-----------|
|                    | Latindex | Scopus and web of science | Latindex | Scopus and web of science |
| No article         | 218      | 200       | 43.0    | 41.8    |
| 1–2 articles       | 176      | 172       | 34.7    | 35.9    |
| 3–5 articles       | 67       | 63        | 13.2    | 13.2    |
| More than 5 articles | 46    | 44        | 9.1     | 9.1     |
| Total              | 507      | 479       | 100.0   | 100     |
| Published books    |          |           |         |         |
| No. book           | 343      | 286       | 71.6    | 60.6    |
| 1–2 books          | 121      | 138       | 25.2    | 29.2    |
| 3–4 books          | 10       | 35        | 2.1     | 7.4     |
| More than 4 books  | 5        | 13        | 1.0     | 2.8     |
| Total              | 479      | 472       | 100.0   | 100     |
| Registered patents |          |           |         |         |
| No. record         | 469      | 429       | 91.8    | 90.7    |
| 1 Record           | 24       | 23        | 4.7     | 4.9     |
| 2 Records          | 12       | 7         | 2.4     | 1.5     |
| More than 2 records | 6      | 14        | 1.2     | 3.0     |
| Total              | 511      | 473       | 100.0   | 100     |
Multinomial Logistic Regression and Hypothesis Testing

This technique is based on a probabilistic model which defines: (a) the dependent variable $E(Y_i)$, which in this case is the individual production of publications, presented through the categories or ranges of production of research articles; (b) the probability of occurrence that characterize the dependent variable $p_i$, and (c) the explanatory variables $X_i$ that allow to analyze the effect that these have on the probabilities of the dependent variable. This technique is used to describe the relationship between a categorical response variable, in this case polytopic, and a set of explanatory variables that can be both categorical and quantitative and allows to examine a large amount of information, access to increasingly deeper, and more accurate levels of analysis (Freiberg et al., 2013). Estimates were made through STATA econometric software. Parameters are expressed in the following equations:

\[
\frac{p_1}{p_n} = \exp(Z_1) = \exp(\beta_{01}) \times (\exp(\beta_{11}))^{x_1} \times (\exp(\beta_{21}))^{x_2} \times (\exp(\beta_{n1}))^{x_n}
\]

\[
\frac{p_2}{p_n} = \exp(Z_2) = \exp(\beta_{02}) \times (\exp(\beta_{12}))^{x_1} \times (\exp(\beta_{22}))^{x_2} \times (\exp(\beta_{n2}))^{x_n}
\]

\[
\frac{p_i}{p_n} = \exp(Z_i) = \exp(\beta_{0i}) \times (\exp(\beta_{1i}))^{x_1} \times (\exp(\beta_{2i}))^{x_2} \times (\exp(\beta_{ni}))^{x_n}
\]

Where $\frac{p_i}{p_n}$ is the coefficient of probability; $p_i$ individual research output categories or ranges, raised in four production levels based on the number of published articles; $X_1, X_2, \ldots, X_i$ explanatory variables.

An important consideration in the application of this technique is the determination of the explanatory variables that are included in the model, the same ones that must contain useful information. To do this, the model was calculated with all the proposed

| Variables               | Latindex Production | Scopus and WoS Production | Published Books | Registered Patents |
|-------------------------|---------------------|---------------------------|-----------------|--------------------|
| Gender                  | -0.271              | -0.273                    | -0.176          | -0.240             |
| Age                     | 0.044               | -0.088                    | 0.089           | 0.073              |
| Academic qualification  | 0.316               | 0.484                     | 0.219           | -0.060             |
| Academic rank           | 0.257               | 0.252                     | 0.292           | 0.170              |
| Work habits             | 0.186               | 0.23                      | 0.189           | 0.292              |
| Academic department size| -0.001              | 0.053                     | 0.135           | 0.066              |
| Research time           | 0.342               | 0.507                     | 0.117           | 0.211              |
| Allocated resources     | 0.068               | 0.230                     | 0.048           | 0.007              |
| Research networks       | 0.247               | 0.333                     | 0.198           | 0.106              |
| Recognition             | 0.017               | 0.131                     | 0.123           | 0.089              |
| Leadership              | -0.04               | 0.131                     | 0.109           | 0.098              |

Table 3. Correlation Coefficients.
variables and then the variables which had no significance were discarded. Individual factors (gender, academic qualification, academic discipline, and work habits) did not present statistical significance. The institutional factors of the academic department size and research networks did not present significant statistics to explain the production of research articles. The process of selecting variables ended when none of the variables was discarded.

Estimates were made with 417 observations. The category “no article” was set as the reference category. The RRR statistic corresponds to each coefficient calculated in the regression and indicates the relative risk that the result will be presented in the comparison group relative to the reference group, when the explanatory variable being analyzed changes. For this model, the defined reference group is the production of no article (Table 4).

The variable that provides more information in the explanation of production is the previous production of research articles, which coefficients indicate that, in the face of

| Table 4. Multinomial Logistic Regression. |
|-------------------------------|-----------|-----------|-----------|
|                               | Coef.     | Std. error| p > |z|  | RRRR |
| Production 1–2 articles        |           |           |       |   |     |
| Previous research output      | 1.00      | 0.18      | .00  |   | 2.72 |
| Age                           | -0.40     | 0.09      | .00  |   | 0.67 |
| Academic rank                 | 0.36      | 0.20      | .07  |   | 1.43 |
| Allocated resources           | 0.28      | 0.15      | .06  |   | 1.33 |
| Recognition                   | 0.04      | 0.13      | .78  |   | 1.04 |
| Research time                 | 0.36      | 0.15      | .02  |   | 1.43 |
| Leadership in research groups | -0.33     | 0.13      | .01  |   | 0.72 |
| Constant                      | 1.44      | 0.85      | .09  |   | 4.20 |
| Production: 3–5 articles       |           |           |       |   |     |
| Previous production           | 1.39      | 0.21      | .00  |   | 4.03 |
| Age                           | -0.64     | 0.13      | .00  |   | 0.53 |
| Academic rank                 | 0.61      | 0.27      | .03  |   | 1.85 |
| Allocated resources           | -0.01     | 0.20      | .97  |   | 0.99 |
| Recognition                   | 0.34      | 0.19      | .07  |   | 1.40 |
| Research time                 | 0.74      | 0.18      | .00  |   | 2.10 |
| Leadership in research groups | -0.27     | 0.17      | .13  |   | 0.77 |
| Constant                      | -0.59     | 1.09      | .59  |   | 0.56 |
| Production: more than 5 articles|         |           |       |   |     |
| Previous production           | 2.00      | 1.24      | .00  |   | 7.40 |
| Age                           | -0.70     | 0.16      | .00  |   | 0.50 |
| Academic rank                 | 0.96      | 0.38      | .01  |   | 2.61 |
| Allocated resources           | 0.60      | 0.26      | .02  |   | 1.82 |
| Recognition                   | -0.01     | 0.24      | .98  |   | 0.99 |
| Research time                 | 1.07      | 0.22      | .00  |   | 2.90 |
| Leadership in research groups | -0.43     | 0.22      | .05  |   | 0.65 |
| Constant                      | -4.03     | 1.47      | .01  |   | 0.02 |
changes of a unit in previous research output, the probability of producing research articles, rather than not presenting any production, is increased for one or two articles in 1, for three to five articles in 1.39, and for a number greater than five articles in 2 units. When analyzing the RRR statistic, it is evident that, in the face of increases in previous production of articles, the relative risk that professors will have a higher volume of production of articles, rather than not presenting production, increases for the three production ranges in factors of 2.72, 4.03, and 7.40. Therefore, the more previous production of articles the professors present, the more likely they are to carry out research in later periods.

The model further determined that the individual characteristic explaining the production of research articles is the age of the professor. According to the values of the parameters, the ratio is inverse, that is, it is emphasized that professors who are in higher age ranges are more likely not to present production of articles. Academic rank, as an individual characteristic, was also significant. The results show that, for the three production ranges, the academic category positively influences the production of articles, that is, when the professor has a better academic status, the likelihood that professors will improve their production of articles increases.

The results suggest that the time invested on research is an important factor, as the coefficient was significant for the three publication ranges. Another institutional factor that has influence is the professors’ appreciation about the institutional resources available to carry out their research activities. This variable is shown significantly in the production range of one to two articles and in the range of more than five articles. That is, professors with higher levels of production have the perception that the resources available are sufficient for the development of their research.

In addition, the proposed model included the leadership in research groups component, which is shown to be significant in the different categories of article production. The results indicate that, in the face of greater perceptions of leadership in their departments, the likelihood of producing articles, rather than not producing, decreases for the three ranges of article production. That is, professors who achieve higher levels of research output have a lower perception of leadership in their departments. This situation arises because in order to achieve higher levels of research productivity, professors lower their expectation of leadership in research from their department heads.

Finally, the variable recognition and rewards have a significant coefficient for the production category of three to five articles. That is, when professors feel they have been recognized or rewarded for their research achievements, the relative risk of producing three to five articles, instead of not producing anything, increases by 1.40.

Table 5 shows the overall global adjustment of the model, through the Chi² statistic and its probability for each of the equations in the production model of research articles. The results of the overall hypothesis test show that, in all cases, there are significant effects of the variables included to explain variations in individual publication production. In most cases, the null hypothesis that there is no effect on research output should be rejected. Only the variable recognition and rewards has a lower Chi² value. However, it is not advisable to exclude it because, for some categories or production ranges, they show a significant effect.
Discussion

The results confirmed that the most important variable in the explanation of individual production of research articles in Ecuador, Peru, and Colombia is previous production. These findings confirm the concept of cumulative advantage to explain the differences in individual production of research articles (Restrepo & Urbizagásteigui, 2010), which indicate that an author with a large production is more likely to write more articles in the future than a less prolific author. The results therefore allow to accept the hypothesis that the previous research output has a positive relationship in the production of research articles.

Regarding hypothesis 2, the results found statistical significance in age and academic rank to explain the individual production of research articles. The developed model determines that the relationship of age and the individual research output is inverse, that is, productivity decreases as the age range of professors increases. These findings are consistent with Hedjazi and Behravan (2011) who determined a significant relationship between the age of researchers and their research output.

Additionally, there is evidence that there is a significant relationship between the individual research output and their academic rank. This finding confirms evidence found in previous studies in different settings, where academic rank is a significant predictor of a faculty member’s research productivity (Bland et al., 2005; Hedjazi & Behravan, 2011).

The results confirm that the gender was not statistically significant in the production of research papers. Previous literature suggests that there is conflicting evidence on the influence of gender on individual research output (Khalil & Khalil, 2019). Similar results were found by Webber (2011), who concluded that female researchers have production levels similar to those of their male peers but that there could be differences according to the academic discipline, mainly because no distinctions have been made in terms of the academic disciplines of women.

Table 5. Multinomial Logistic Regression Adjustment.

| Production of articles | Equations of article production |
|------------------------|--------------------------------|
| Variable               | Chi²  | Probability > chi² | Variable               | Chi²  | Probability > chi² |
| Previous research output| 70.87 | .000               | 1–2 articles           | 60.61 | .000               |
| Age                    | 29.55 | .000               | 3–5 articles           | 79.69 | .000               |
| Academic rank          | 8.19  | .042               | More than 5 articles   | 102.41| .000               |
| Research time          | 28.79 | .000               | Joint analysis         | 131.23| .000               |
| Allocated resources    | 9.73  | .021               |                          |       |                    |
| Recognition            | 4.47  | .214               |                          |       |                    |
| Leadership in research groups | 6.93  | .074               |                          |       |                    |
Regarding the academic qualification of professors, Wamala and Seembatya (2014) indicated that the non-existence of this relationship in developing country settings is explained by the fact that, upon completion of doctoral studies, graduates are likely to be more involved in consulting work than in academic production in order to have higher incomes than those obtained in higher education institutions in these countries. The academic discipline did not show statistical significance to explain the individual research output, unlike the evidence in other environments which indicates that researchers have different levels of production depending on their field of studies (Álvarez & Montesi, 2020; Gaus et al., 2020; Jung, 2012; Webber, 2011). The results obtained may be due that in the context studied, the different academic disciplines do not present differences in their research output. Finally, the results determine that work habits do not explain the individual research output. Similar results were found by Fox (1983), who stated the causal relationship between habits and research productivity is uncertain.

Regarding the third hypothesis, the results show that the time dedicated to research, the resources allocated, the recognition, and the leadership in research groups are factors that influence the productivity levels of publications. The distribution of the time that professors invest on essential universities activities (teaching, research, and service) is also important to achieve the expected results. As the variable time is limited, the dedication given to each of these activities contrasts with each other, therefore, professors who invest more hours teaching or in management have lower research results. The results confirm the findings of Morrisey and Cawley (2008), who found that professors with high levels of production show less teaching activity.

Regarding the resources allocated, the results confirm the findings found by Rodgers and Neri (2007), Carayol and Matt (2003), and Albers (2015), who stressed the importance of resource allocation for research output. Wills et al. (2011) also concluded that one of the institutional factors to improve the productivity levels is the proper allocation of resources for research activities. Regarding the variable recognition, previous studies found that feedback and recognition cause highly productive scientists to maintain greater increases in their production (Bland et al., 2005; Fox, 1983). Finally, leadership characteristics are noted in previous studies as a factor influencing research output. Wahab and Tyasari (2020) established that the leader must have research experience and possess skills to generate participatory management practices. Also, Bland et al. (2005) indicated that the group leader should be considered a model for generating better research results, which is confirmed in this study as perceptions of the leadership of researchers influence individual research output.

The characteristics of the environment that did not present statistical significance are the size of academic departments and research networks. Although some previous studies (Carayal & Matt, 2003) found that the size of the group is an important factor, other studies (Rodgers & Neri, 2007) concluded that the size of the department is not a contributing factor to the research output. These can be explained because the professor’s production is mainly done by individual efforts and in this sense, the number of professors who are part of the department does not influence individual production. In various studies, research networks are a variable that explains the production of
publications, however, results show that research network does not influence research output, which relates to what Bland et al. (2005) found who noted that having a network does not guarantee research productivity.

In conclusion, results showed that previous research publications are the main factor that explains subsequent research production. Age, academic rank, time invested on research, resource allocation, recognition for research, and research group leaders have also a direct effect on research output. Likewise, results show gender, academic qualification, academic discipline, size of the academic departments, and research networks were not statistically significant to explain the individual research output in universities of Ecuador, Peru, and Colombia. Figure 2 shows the conceptual model based on this study.

The study allows for a better understanding of the factors that affect individual research output in universities of Ecuador, Peru, and Colombia. Based on the study findings, several implications were drawn, which led to some recommendations for future practice. The results suggest that university authorities establish specific strategies to increase the individual research output. First of all, universities need to boost the culture of excellence in research by giving financial support for doctoral programs and non-monetary research awards. Second, they should attract, retain, and support high performing research professors through the identification of talented students in doctoral programs, financial incentives, and research funds. Third, enhance the integration of research and educational programs developing the mentoring chain (faculty—doctoral student), which connects senior researchers with junior researchers in order to collaborate and publish research projects. Fourth, establish research centers

**Figure 2.** Factors that influence the individual research output of University professors implications.
to promote innovation, internationalization, and intellectual production. Fifth, promote international collaboration, by inviting researchers from other countries to strengthen collaborative research networks. Sixth, encourage research by allocating internal funds for research projects and provide support to obtain external funding. Finally, allocate teaching hours based on research results, that is, to allow those professors who obtain higher research productivity more time to do so.

Limitations

Some limitations related to information access and reliability have been identified in research development. First, some research conducted by university professors can be disseminated through means, different from the academic articles, which leads to distortions in measuring research output. In addition, the analysis of the production of research articles was based on the number of research products, without considering the journal impact factors. Finally, the sample was limited to university professors from three countries. This limits the scope of generalization. Further studies in multiple contexts should be undertaken to expand the findings of this study.

Approaches for Future Research

For future research, it is suggested to deepen the study of the factors affecting the individual research output at a higher education level, including the scholarly impact of the research through citation counts, citation rates, h-index, and others. In addition, given that the research output comprises the published works of professors (books, book chapters, journal articles, papers in conference proceedings, awarded research grants, and patents), it is suggested to measure the individual research production through an index that integrates the different research works. It is also encouraged to conduct researches on the factors that influence the individual research output in specific disciplines, as well as in other educational institutions and countries in the region.

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