ESTUDIOS / *RESEARCH STUDIES*

Exploring the Determinants of Research Output: A Proposed Typology of University Researchers in Ecuador

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Cómo citar este artículo/Citation: Dávila, G. A.; Puertas-Bravo, L.; Armijos-Valdivieso, R.; Avolio-Alecchi, B. (2022). Exploring the Determinants of Research Output: A Proposed Typology of University Researchers in Ecuador. *Revista Española de Documentación Científica*, 45 (3), e333. https://doi.org/10.3989/redc.2022.3.1884.

Abstract: The purpose of this research is to describe the research profile of university professors in Ecuador, considering their research output, individual factors (academic qualification level and period of time at the institution) and institutional factors (time invested in research). The cluster analysis was applied to a sample of 538 Ecuadorian academics. Five researcher profiles with different levels of scientific production were identified: (1) lecturers, (2) stars, (3) high potential, (4) low potential and, (5) underused. Our findings indicate that the number of hours allocated by the university for research activities per se is not a determinant of the university research output. Research results suggest that the university authorities in Ecuador should establish specific strategies, based on the five profiles, to increase individual research output. The study delivers specific guidelines for enhancing decisions about the allocation of resources to improve individual research output in the universities.

Keywords: Research output; universities; cluster analysis; institutional factors; individual characteristics.

Explorando los Determinantes de la Producción de Investigación: Tipología de los Docentes Investigadores en una Universidad en Ecuador

Resumen: El propósito de esta investigación es describir el perfil investigador de los profesores universitarios en Ecuador, en función de los niveles de producción de investigación, de factores individuales (nivel de calificación académica y período de permanencia en la institución) y factores institucionales (tiempo invertido en investigación). Se aplicó el análisis de clusters a una muestra de diferentes niveles de producción científica: (1) profesores, (2) estrellas, (3) alto potencial, (4) bajo potencial y, (5) infrautilizado. Los hallazgos indican que el número de horas asignadas por la universidad para actividades de investigación, per se, no constituye un determinante de la producción de investigación de los docentes. Los resultados de la investigación sugieren que las autoridades universitarias en Ecuador deben establecer estrategias específicas, basadas en estos cinco perfiles, para incrementar la producción de investigación individual. El estudio ofrece pautas específicas para mejorar las decisiones sobre la asignación de recursos para mejorar la producción de investigación individual en las universidades.

Palabras clave: Producción de investigación; universidades; análisis de cluster; características individuales; factores institucionales.

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1. INTRODUCTION

Universities have a fundamental role in the social, cultural, economic and technological progress of countries. Their role not only encompasses teaching aimed at training the skills of human capital through different academic programs, but they also play a fundamental role in the generation and transfer of knowledge for the social and economic progress of countries (Ab Aziz, 2012).

The generation of knowledge is usually measured through research production, which comprises all the published work of academics (books, book chapters, journal articles, papers in conference proceedings, research grants awarded and patents). A more precise definition of research output is to include the scholarly impact of the research by using bibliometrics such as citation counts, citation rates, h-index and others (Heng et al., 2020). The research output is mainly generated by developed countries. According to *Scimago Journal* and *Country Rank (2021),* during 1996 - 2020, ten countries in the world represented 65.7 per cent of all the publications (United States, China, United Kingdom, Germany, Japan, France, India, Italy, and Canada). The United States generated 24.5 per cent of the scientific production, and China, 11.5 per cent. In Latin America, the countries with the highest scientific production were Brazil (1.77 per cent, 14th place) and Mexico (0.59 per cent, 28th place).

In this context, the study of the factors that influence the research output of university professors is a topic of interest in the literature. Many studies have investigated research productivity and performance of academics in developed countries and in China (Carayol and Matt, 2006; Ghabban et.al. 2019). For example, Ballesteros-Rodríguez et al. (2020) studied the factors that influence the research output of Spanish academics, according to their knowledge, skills and conditions, and identified four profiles: high vocational academics, motivated academics, self-starter academics and reactive academics. Also, Villanueva-Felez et al. (2013) identified the researcher profiles in Spain based on the characteristics of the individual's network of social links and his or her research output. However, only few studies considered the contexts of emerging countries. In Latin America, some studies have been carried out in Brazil (Pires et al., 2020; Falaster et al., 2016) and Ecuador (Castillo and Powell, 2019; Álvarez-Muñoz and Pérez-Montoro, 2015). In the Brazilian context, Falaster et al. (2016) analyzed the scientific production of new doctoral programs in management and the possible relationship between the scientific output of the graduates and the doctoral program ranking. In Ecuador, Castillo and Powell (2019) and Álvarez-Muñoz and Pérez-Montoro (2015) studied the scientific impact of Ecuadorian publications during the periods 2006-2015 and 2000-2013, respectively.

In Latin America, the Ecuadorian context is particularly interesting to study because it has been the country that has moved up the most positions in the last 10 years (2010-2020) in the *Scimago Journal* and *Country* Rank (2021), going from 460 (2010) to 54,941 (2020) published articles. In the world, it moved up 37 positions in 2020 (position No. 66) and in Latin America, it moved up 5 positions (position No. 7). One of the possible factors that influenced the growth of research output in Ecuador is related to a series of policies aimed at improving the quality of higher education institutions, which were characterized by their focus on teaching, the lack of professors with doctoral studies and professors with low or non-existent scientific production. In 2010, the Higher Education Act (2010) was enacted, which established policies to increase scientific productivity, create incentives, scientific transfer programs and research funding (Castillo and Powell, 2019). These reforms included the need to incorporate a greater number of full-time professors, and the implementation of requirements such as the participation in research projects and indexed articles for both the admission and the promotion of professors (Johnson, 2017).

This study aims to describe the research profile of full-time professors at a university in Ecuador, according to individual and institutional variables that may affect their individual research output. The study seeks to understand the differences in productivity of university professors in the context of an emerging country, where conditions have been created to improve individual research output in terms of quantity and quality. The conditions and results described in this study could be considered to characterize and make decisions in similar contexts of other emerging countries.

The second section of this paper is the theoretical framework. The third section presents the research methodology. Section 4 is dedicated to analyzing the data, while section 5 discusses the results obtained. Section 6 presents the conclusions and finally, section 7 discusses the limitations of this research and concludes with recommendations for future research.

2. THEORETICAL FRAMEWORK

According to the theory of firm resources and sustained competitive advantage (Barney, 1991),

competitive differentiation depends on how organizations use their resources to produce a valuable and sustainable result over time. In the case of the scientific output, the institutions have various resources such as the research skills of professors, their experience and the research time as elements that contribute to achieving the expected levels of research output.

Research output, the current focus in higher education institutions (Rodríguez Jiménez et al., 2019), is about the execution of theoretical and applied studies leading to the publication of indexed papers, patent registrations or other publications (Hedjazi and Behravan, 2011). Most research studies about scientific production use the number of articles published as the dependent variable; as García (2009) pointed out, "historically, one of the most important sources of dissemination of scientific knowledge and academic production are publications" (p.19). Likewise, the study of Lariviere and Costas (2016) on the relationship between research production and its impact indicates that "only journal articles are included since the unit analyzed is the individual researcher" (p. 3).

The study of scientific output began with Lotka (1926), who determined that few researchers are responsible for the vast majority of publications while most researchers contribute with few publications. Based on this study, several studies have analyzed the factors that directly or indirectly influence the research output. Fox (1983) proposed that individual characteristics, environment and accumulative advantage influence individual scientific output. Jung (2012) said that in order to explain research production, individual-level variables, such as demographic characteristics and psychological traits, should be analyzed first because these characteristics are essential to understand the academic life of professors. Several studies (Webber, 2011; Wills et al., 2011; García, 2009; Betsey, 2007; Blan et al., 2005; Carayol and Matt, 2003; Ramsden, 1994; Faver and Fox, 1986; Fox, 1983) include a great number of special characteristics of researchers that may influence their production levels. The most significant characteristics used to explain variations in research output and included in a the majority of studies are: gender, age, education, academic rank, discipline, and work habits.

Moreover, Fox (1983) proposed to include environmental factors as variables that also influence the production levels. Following this model, other studies have developed and identified the factors that should be taken into account and that are related to the researcher's environment.

In order to explain the different levels of research production, the literature suggests considering the following characteristics related to the research environment: (a) size of the department or research group, (b) time allocated to do research, (c) resources, (d) research networks, (e) awards and opportunities, and (f) leadership.

Furthermore, several researchers suggest that individual characteristics interact with institutional aspects to determine levels of research output (Hassan et al., 2008; Jung, 2012). This study is not intended to determine the factors that influence research production but proposes to analyze the profiles of university professors on the basis of their individual research output, considering three individual factors: (a) the academic qualification and two organizational-related variables, (b) the teaching experience in the institution, a variable related to the researcher's age; and (c) the time invested in research. Professors are the main resource that universities have and their time needs to be properly managed. This is important considering that universities in emerging countries used to be resource-constrained (Wickramasinghe and Malik, 2018). The individual factors are described below.

2.1 Academic qualification

The academic degree of the researchers is a critical factor when analyzing their individual production because learning enables the acquisition of relevant knowledge that influences production levels. Hassan et al. (2008) found that academic qualification is the most important factor that explains the research output of researchers. In fact, the qualification of human capital has an influence on individual scientific output, as knowledge acquired in specialized higher education (e.g. a doctoral degree) enhances the competences, skills and motivation of professors to do research (Rodgers and Neri, 2007). Wills et al. (2011) also identified doctoral formation as a factor contributing to the increase of research output. Callaghan (2015) indicated that human capital refers to any investment that is made in learning and related said capital to the increased levels of production. Therefore, the literature suggests that academic qualification is an important factor that explains research output.

2.2 Time invested in research

The time that professors invest on research activities is a key factor in the generation of publications (Morrisey and Cawley, 2008; Escobar-Pérez, García-Meca and Larrán-Jorge, 2014).

Although many studies indicate that teaching and research activities are complementary, in practice these activities may conflict with each other, as professors allocate time and hours to each of them. This distribution may even justify the existence of job strain among professors with both teaching and research responsibilities (Fox, 1992). Similar studies (Hassan et al., 2008; Wills et al., 2011) show that the teaching hours assigned to researchers are negatively correlated with the number of publications and even with the number of citations of these publications. Jung (2012) pointed out that there are several studies showing that the more time invested on teaching activities, the lower the research output will be in terms of quantity and perhaps quality. In other words, in order to increase the levels of research output, we must consider a decrease in the teaching activity of the researcher (Hassan et al., 2008). Therefore, the literature suggests that the allocation of hours for research may influence the individual research output (Rueda-Barrios and Rodenes-Adam, 2016).

2.3 Period of time at the university

Teaching experience can be an element influencing individual research output. One of the first studies to consider this factor is the one developed by Allinson and Stewart (1974), who concluded that said difference occurs mainly due to the cumulative advantage of the researchers. Jung (2012) found that the researcher's years of experience explain much of the variation in research output. In the same context, the study by Wills et al. (2011) found that one of the characteristics that explain individual research output is the working experience in academic institutions.

Callagham (2015) subsequently studied research output in the context of higher education across different forms of human capital experience and found that the years of experience at an institution is significantly associated with the individual research output. Meanwhile, Salinas-Ávila et al. (2020) identified that human capital is a fundamental aspect for generating knowledge in universities, and emphasized that professors' motivation to carry out research, keeping up to date in their areas of study and gaining experience doing research are key factors for achieving better results.

3. METHODOLOGY

This research study was carried out in an Ecuadorian university listed in position No. 8 in the Scimago Institutions Rankings (2020) among 20 Ecuadorian academic institutions included in

this ranking. The institution offers undergraduate programs in areas such as humanities, social sciences, experimental science, health sciences and engineering & architecture. It has one of the largest number of students in Ecuador, approximately 45 thousand students. Its size and its position in the Scimago Institutions Rankings (2020) made this institution an appropriate sample to analyze the Ecuadorian context. In terms of types of research, the academic institutions in emerging countries tend to focus all efforts on the development of scientific papers, which represent almost the total of the research outputs. The efforts focused on the development of patents and startups, as well as their related results is not significant when compared with academic papers.

For developing this study, we analyzed academic papers of 538 full-time professors published in journals indexed in the Web of Science and Scopus databases in the period 2014-2019. The publications were obtained from the research records of the university analyzed and compared with the databases previously mentioned. These records are confidential and were provided by the Research Dean to the authors of this study through an agreement.

The description of the profiles considered three variables: the time invested in research, the time in the institution during the analyzed period (2014-2019) and the academic qualification level. In order to determine the time invested doing research, we used the number of hours per week that each professor is officially assigned in his or her educational institution. To facilitate the calculations, a research unit was defined as 4 hours per week, the values of this variable were between 0 and 10. The professor's period of time at the institution during the analyzed period was measured in years (1-6) and the data were collected from the academic information system of the university. The same system also showed the academic qualification level, assigning values from 1 to 4 for bachelor's degree, master's degree, doctoral studies and doctoral degree, respectively. Finally, the productivity of the professor was measured through the average annual number of academic papers published in journals indexed in the Scopus and Web of Science databases.

The information was analyzed in two phases. First, in order to identify the different professor profiles according to the study variables, we used the cluster analysis, a technique that groups observations into similar or "statistically close" groups (Ketchen and Shook, 1996). This technique allows the identification and formation of groups

with similar characteristics and is used to study configurations in different populations (Gruber et al., 2010; Youndt et al., 2004). The study followed the clustering procedure recommended by Ketchen and Shook (1996) and Hair et al. (2006). The procedure starts with the use of a hierarchical algorithm to define the number of clusters and their centers. This information is then used as a starting point to assign observations to each cluster using non-hierarchical algorithms.

In the second phase, once the profiles and the professors have been identified, the research output was statistically compared to verify the existence of significant differences between the profiles. A one-way ANOVA was used to explore the differences in research output between the groups identified. If the variances were not consistent, a Welch ANOVA (a technique that allows statistical comparison of means between two groups) was used. Then, we performed a cross-validation using two different post hoc criteria (Tamhane T2 and Games-Howell tests, both with significance at $p < 0.05$), since the sizes of the groups--in this case the clusters--are unequal (Moder, 2010).

4. RESULTS

According to the two-step clustering procedure recommended by Ketchen and Shook (1996) and Hair et al. (2006), hierarchical clustering was first applied to determine the appropriate number of clusters. Ward cluster and complete linkage solutions were applied and compared, both of which suggest that the five-cluster solution was optimal. The group centroids from the hierarchical procedure were then used as initial clustering seeds to perform the k-means clustering procedure. Table I presents the grouping of professors according to the variables used, as well as the research output. The grouping solutions were consistent for each of the different approaches, indicating a solid and generalizable clustering solution.

The analysis based on non-standardized variables was later performed, as it allowed clearer interpretations of the resulting cluster solutions based on our scales and the Ward method. The results show statistically significant differences between the groups for each of the characteristics analyzed as evidenced by the F-test $(4,496) = 37.82$, $\rho = 0.000$ for the academic qualification level; $F (4,533) = 126.96$, $\rho = 0.000$ for the time invested in research; $F (4,533) = 226.30$, $\rho = 0.000$ for the period of time at the university. The Tamhane T2 and Games-Howell tests revealed that the academic qualification level is statistically and significantly different in each of the clusters (with ρ values varying between 0.00 and 0.03). Regarding the time invested in research, group 4 is statistically and significantly higher than group 5 ($\rho=0.00$); group 5 is statistically and significantly higher than groups 1 ($\rho=0.00$), 2 ($\rho=0.04$) and 3 ($\rho=0.00$); while there are no statistically significant differences between groups 1 and 2 ($\rho=0.45$), and 2 and 3 ($\rho=0.88$). Regarding the period of time at the university, groups 4 and 5 are statistically similar ($\rho=0.11$) and higher than group 1 ($\rho=0.00$), which is statistically higher than groups 2 ($\rho=0.00$) and 3 ($\rho=0.00$), which are statistically similar ($\rho=0.31$).

Table I: Professors' clusters, according to the analysed variables

	Cluster Means (*)				
	1	**2**	**3**	**4**	**5**
Dependent variable					
Academic papers per year (d)	0,25	4,81	0,56	0,50	0,58
Clustering variables					
Academic qualification level (a)	1,72	3,00	2,02	1,51	2,64
Time invested in research (b)	1,83	2,27	2,18	5,00	3,59
Time of permanence at the university (c)	5,69	3,45	2,83	5,98	5,92
Gender					
% Women	55%	27%	51%	65%	49%
Cluster size (N)	244	11	120	43	120
(a) 1=bachelor's degree, 2=master's degree, 3=doctoral studies, 4=doctoral degree (b) Number of hours per week assigned to do research, each research unit is 4 hours per week, so the values of this variable are between 0 and 10. (c) Number of years in the analysed period (2014-2019) (d) Average number of academic papers published in journals indexed in Scopus and Web of Science.					

Table II: Comparison of academic papers published by professors in each cluster

Cluster (i)	Academic papers published (annual average)	Differences between clusters (i-j) (p-values between quotes)				
		Cluster (j)				
		1	2	3	4	5
1	0,25	-				
2	4,81	4.55 (0.00)	-			
3	0,56	0.30 (0.00)	-4.25 (0.00)	-		
4	0,50	0.25 (0.00)	-4.31 (0.00)	-0.5 (0.57)	-	
5	0,58	0.32 (0.00)	-4.23 (0.00)	0.02 (0.79)	0.08 (0.43)	-

After verifying that the groups of researchers are statistically different, we proceeded to verify differences in the "performance" of these groups, i.e. the differences in the mean number of academic papers published annually in each group. The F-test (4, 533) = 101.74, $p=0.00$, shows that there is a significant statistical difference between the groups. The post hoc tests (Table II) show that cluster 2 presents the highest mean number of academic papers published annually, which is statistically and significantly higher than clusters 3, 4 and 5 ($p=0.00$ in all cases); and that at the same time the means in these clusters are statistically and significantly higher than in cluster 1 ($p=0.00$ in all cases). The clusters identified are described below.

Cluster 1. This cluster has 244 people (55% women) and is characterized by the fact that it includes professors who have been at the university during almost all the period analyzed. Most of them have a master's degree (134), and a smaller number are pursuing doctoral studies (45), or have attained a doctoral degree (65). Of this group of professors, 123 allocate 8 hours per week to do research and 54, dedicate 12 hours per week. The majority of them (206) work or were working at the university during the 6 years of the period analyzed (2014-2019); and only a smaller portion (38) worked between 3-5 years. On average, each professor publishes 0.25 indexed academic papers annually, a statistically significantly lower number compared to the other groups. Due to the characteristics of this group, they could be referred to as "lecturers", given that they mainly carry out teaching tasks and have a low level of research.

Cluster 2. This group is the smallest in terms of the number of professors (8 men and 3 women) and stands out because they present the highest annual average of indexed academic papers (average of 4.81, above the total average of the

analyzed population of 0.51), despite allocating approximately 11 hours per week to research. With regard to the period of time at the university in the period analyzed (2014-2019), this is consistent (3.5 years on average). The academic qualification level of this group is the doctoral degree. This is a very outstanding group in terms of their research results, which we could call "stars".

Cluster 3. This cluster comprises 120 people, 40 of them hold doctoral degrees and 51% are women. The average annual number of academic papers is 0.56. Of this number, 65 people have 12 hours per week to do research, 29 have no hours dedicated to do research, and 21 have 8 hours. This group includes professors with little time at the university (40 have three years, 28 have one year and 27 have two years). The results of this group, which we may call "high-potential group", suggest that they are professors with the potential to improve their research output.

Cluster 4. This group comprises 43 professors (65% women) with an annual average of 0.50 academic papers. Almost all of them (42) worked at the university during the 6 years analyzed. All have 20 hours per week dedicated to research and have master's degrees (21) or are pursuing doctoral studies (42). Professors in this group should receive special attention, since they would be expected to have a higher individual research output.

Cluster 5. In this group, people have an annual average of 0.58 academic papers. From a total of 120 people (49% women), 112 have worked at the university during the 6 years analyzed and the remaining 8 have worked during 5 or 4 years. Additionally, most of the people in this group (83) have 12 hours per week to do research; 36 have 20 hours and one has 8 hours. The majority of this group have doctoral degrees (77) and the remaining (43) are currently pursuing doctoral

Figura 1. Identified clusters
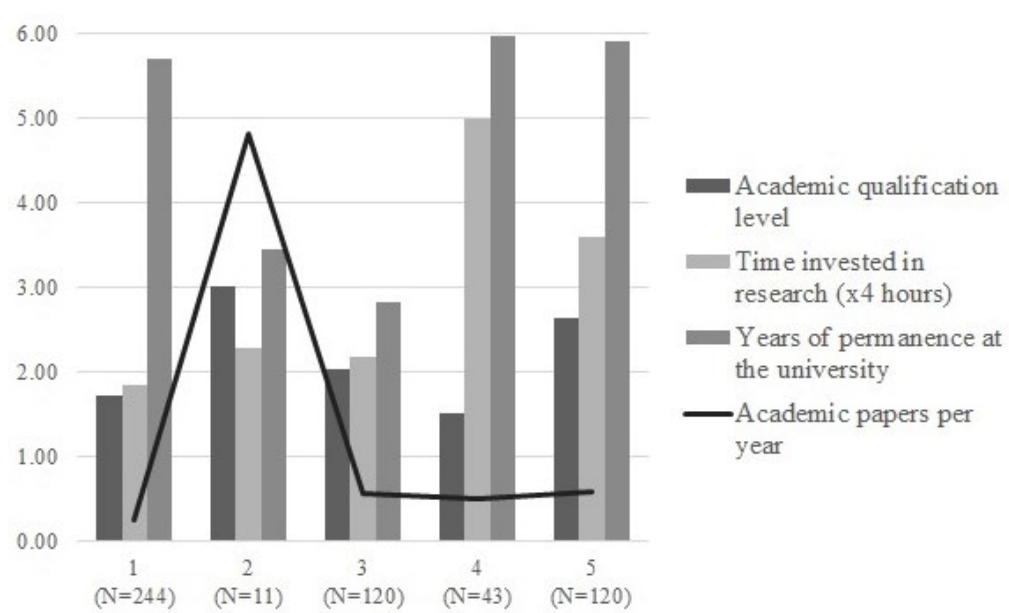
studies. This group differs from others because most of the professors have a doctoral degree and therefore it is expected that because of their competencies they will achieve a higher research output.

Figure 1 shows the clusters with the values of each of the variables analyzed that influence the research production.

5. DISCUSSION

This study analyzed the profile of professors based on three variables related to their research productivity: the time invested in research, the period of time at the institution and the academic qualification level, in a private university in Latin America.

The results indicate that the number of hours that the university allocates for research activities per se is not a determinant of the university research output. This is evident mainly in cluster 2, referred to as the "star" professors, which has the highest level of productivity despite having a number of hours per week assigned to do research that is much lower compared to clusters 4 and 5, and it is statistically similar to clusters 1 and 3. Although previous literature indicates that time invested to do research is a key determinant of professors' scientific output, this variable affects the outcome when it acts in association with other individual and organizational capabilities (Carayol and Matt, 2006). This finding supports the study of Gaus et al.

(2020), who pointed out that individual factors are significant variables that must be combined with institutional factors to determine the productivity of academics and these factors should intersect with researchers' abilities to find forms of collaboration to publish. It is also important to take into account that, given that the study considered the number of hours per week that each professor is officially assigned in his or her educational institution, it is also possible that the professor invests a greater number of hours to do research apart from his or her assigned hours.

Likewise, the professors' profile revealed three levels of professor research output: Cluster 2 presented the best performance; cluster 1 presented the lowest performance; and clusters 3, 4 and 5 presented a low performance, although superior to cluster 1. The analysis of these three levels of research productivity allows us to propose some strategies that can be adopted to optimize the performance of each professor based on his or her profile.

Cluster 1 – The "Lecturers". The research output of this group (0.25) is statistically significantly lower than the other four groups. Clusters 3, 4 and 5 have statistically similar performance, with 0.56, 0.50 and 0.58 academic papers per year on average. The characteristics of this cluster lead us to think that its members have a tendency and have an important participation in the teaching process, which is one of the essential activities of universities. According to Laabs (1987), people with these characteristics

are important for innovating and executing learning development programs through tasks such as defining learning roadmaps and developing instructional materials. Laabs (1987) also highlights the possibility of creating comprehensive programs to develop research skills in this group of people.

Cluster 2 – The "Stars". The professors of cluster 2 have a higher level of research productivity than the other groups (4.81 academic articles per year on average). The 11 researchers in cluster 2 confirm the observations of Lotka (1926), who points out that normally few researchers are responsible for a significant and great number of publications. The reasons of this high productivity may be more complex to identify and explain than those of an average researcher (Prpić, 1996); however, the study of highly productive professors has been receiving increasing attention from academics.

Although studies in developed contexts (Pinheiro, 2017) conclude that gender does not influence research productivity, other studies found significant differences in research output in favor of men (Mayer and Rathmann, 2018). The predominance of male professors in cluster 2 (8 out of 11) shows a gap in men and women's productivity that had already been observed in previous studies (Prpić, 1996; Healey and Davies, 2019). While the predominance of female professors in the clusters with medium or low productivity varies from 49% to 65%, and their presence in the group of "stars" professors only reaches 27%. This finding is in line with Prpić (1996), who identified a lack of female presence in the group of elite researchers. Similarly, another study in Peru evidenced that outstanding researchers, or *brokers* of collaboration, are mostly men (Málaga-Sabogal and Sagasti, 2021). The literature has provided several explanations for this gender gap. For example, Aguinis et al. (2018) identified the existence of institutional mechanisms of incremental differentiation that may constrain the productivity of female professors. Likewise, Lerchenmueller and Sorenson (2018) found that women have lower rates of promotion to Lead Researcher than men. Therefore, it is essential to overcome these sources of inequality, especially in emerging countries. Regarding individual factors, Mayer and Rathmann (2018) highlighted the existence of different productivity patterns between men and women, where the latter do not need to publish in the most competitive journals to satisfy their aspirations. Recent studies identified relevant gender-related issues that suggest that the gender variable should be included in future analyses, specially focused on emerging countries (Pinheiro, 2017; Mayer and Rathmann, 2018; Healey and Davies, 2019).

In terms of research networks, previous studies indicated that high-performing researchers had international experiences that allowed them to develop research networks with outstanding researchers (Gao and Liu, 2020). The results of this study are consistent with these previous studies, since all the professors in cluster 1 have completed their doctoral studies in international educational institutions. Also, these professors are usually characterized by their experience, competencies, research groups and a network of contacts that help them produce remarkable results, which could be even greater if they would receive financial support to do research, according to previous studies (Goldfarb, 2008; Ebadi and Schiffauerova, 2016). For Abramo et al. (2019), it is increasingly important to develop collaborations with colleagues from their own and other universities, especially with more experienced researchers, which allows access to resources and funding for their projects. The study carried out by Ebadi and Schiffauerova (2016) in Canadian universities identified a positive and direct relationship between levels of research funding and number of resulting scientific publications. An increase in funding could have a similar effect on researchers in this group, considering that we can compare their production to that of researchers in developed countries.

Cluster 3 – The "High-potential group". Despite having a much lower research productivity than professors in group 2, this group has the third best productivity among all the groups (0.56) and it is statistically similar to groups 4 and 5. The profile of these professors, characterized by their high qualifications (on average, they are pursuing a doctoral degree) and their short time at the university (3 years on average), make them professors with high potential. Indeed, several studies show that the implementation of peer mentoring has contributed to increase research productivity (Jacelon et al. 2003; Cameron et al., 2007; Browning, Thompson and Dawson, 2017). Browning et al. (2017) highlighted that the productivity of these researchers may be enhanced by receiving assistance to develop grant applications and by being part of an active research group. This is because these professors are generally skilled at conducting general research tasks (identifying a research problem or literature reviews), but less skilled when conducting specific qualitative or quantitative research tasks (designing a sample, controlling the sample, or choosing the most appropriate methods and software for analysis) (Cameron et al., 2007). The latter skills can be acquired and assimilated, after a period of working together with a more experienced peer (e.g.,

from group 1) who has already mastered specific research techniques within a methodological area and field. The implementation of these mentoring practices requires the prior existence of an adequate structure that fosters trust, collaboration, teamwork, interdisciplinarity and, especially, a critical and actionable peer review of the work (Jacelon et al., 2003). A parallel institutional measure is to establish supervision mechanisms to evaluate individual productivity and manage the time allocated to do research (a little more than 8 hours on average).

Cluster 4 – The "Low potential" group. This group presents strong opportunities for improvement, considering that despite having the highest number of hours assigned to do research (20 per week), they have a productivity (0.50 publications per year) far behind from the professors of group 2. According to previous studies (Enders, 2005; Prpić, 1996) this low productivity may be associated with the absence of doctoral degrees in this group, i.e., with opportunities related to the formation of these professors, most of whom are still pursuing a doctoral degree (42) or have just completed a master's degree (21). It is important to close the gap in the qualification of these professors, since the early completion of doctoral studies seems to be related to their future scientific output (Prpić, 1996). Doctoral programs allow the development of research competencies and international co-authorship networks that in the medium term tend to increase the productivity of professors.

Cluster 5 – The "Underused" group. This group also has a low productivity (0.58), considering that they have an average of 14.4 hours per week to do research and most of them (77 out of 120) have doctoral studies. Prpić (1996) first suggested that the need to obtain a PhD is also valid in this group because there are 43 professors who do not have the said degree. Later, the author determined that the formation in specific research techniques, such as instrument design, data validation techniques, and quantitative analysis, is also fundamental for the PhDs in this group. These techniques improve the quality of the results and consequently the productivity of publications, since they improve data processing capabilities and also facilitate interaction with other researchers (Cameron et al., 2007). Academics suggest that this research training, whenever possible, should follow a model that crosses the borders of interdisciplinarity, i.e., that it be guided by an interdisciplinary vocation. According to Cheng et al, (2009), the articulated use of research techniques from different disciplines increases the probability of achieving novel results,

and consequently, the probability of improving productivity in scientific publications. Finally, international collaboration should be focused on this cluster, because it plays an important role for improving productivity, especially in universities from emerging countries (Castillo and Powell, 2020). Our results support this fact, as we confirmed that while 69% of publications of the "Stars" cluster are result of international collaboration, and only 44% of them have the same condition in this "Underused" cluster.

6. CONCLUSIONS

The aim of this study was to describe the research profile of university professors in an emerging context, based on individual research output, the time invested to do research, the period of time at the institution and the level of academic qualification attained.

Although some previous studies were focused on examining the profiles of the researchers, none has focused on studying them in the context of the educational system of an emerging country such as Ecuador, which is in a transition process in terms of its approach to research. Traditionally, Ecuador, like other Latin American countries, has not prioritized the generation of knowledge in universities. However, some structural reforms in recent years have created the conditions to improve the individual research output of the faculty, both in quantity and quality. This paper aims to explain this research gap by proposing a typology to understand the professors in terms of their research profiles.

The study identified five groups of professors according to their research profiles: (1) lecturers, (2) stars, (3) high potential, (4) low potential and, (5) underused. The first group (cluster 1) has the largest number of professors, the lowest scientific production and a high average period of time at the institution. The second group (cluster 2) has the highest level of formation and maintains outstanding productivity, despite a moderate-to-low allocation of office hours dedicated to do research. The results also showed that the clusters 3, 4 and 5 have similar levels of scientific production, but differ in some aspects. Cluster 3 shows greater potential because they dedicate less time to research and have fewer years at the institution. Cluster 4 has the lowest level of training and much more time dedicated to do research; and Cluster 5 is characterized by having higher qualifications, a lot of time working at the institution and an intermediate level of hours dedicated to do research.

Our results show that, in emerging countries, there are different profiles of professors characterized by their levels of scientific production. The typology presented allows to manage research resources according to the characteristics of each group. Allocating more time to research and having doctoral training does not necessarily guarantee greater research output, so it is necessary to create specific strategies according to the needs of each group.

7. IMPLICATIONS

The study contributes to a better understanding of the various professors' profiles, their characteristics and their performance. Based on the study findings, several implications were drawn, which led some recommendations so that academic authorities can implement strategies aimed at increasing individual research output in terms of quantity and quality.

First, the study showed that the five profiles identified have different characteristics, different productivity, and consequently, their management requires the implementation of different strategies according to the characteristics of each profile. Second, the recognition of professors with superior scientific production (cluster 2) and the establishment of explicit retention strategies for this group are fundamental. The main challenge for this group is to facilitate access to internal or external financing and the promotion of regional and international cooperation networks. Third, there is a significant group of professors (cluster 1) who, despite their lower scientific production, play a fundamental role in teaching. These professors can contribute to universities with activities oriented to the innovation of educational models, new pedagogical models and teaching materials. Fourth, to increase the individual research output of professors with high academic qualifications and less time at the university (cluster 3), the implementation of mentoring programs, incorporation in international research networks, participation in research groups and more hours assigned to research can be effective support strategies. Fifth, academic authorities should focus on reducing the formation gaps of professors in clusters 4 and 5, given that doctoral formation is associated with higher scientific productivity. Professors in these clusters who already have doctoral degrees require formation in specific research techniques, which will allow them to improve their scientific production (which is low compared to cluster 2) and develop active collaboration networks. Sixth, the results show the need to design systematic and specific actions to close gender gaps, which are mainly evident in the group with the highest productivity (cluster 2). Finally, the large samples of clusters 4 and 5, that are composed of professors with an average number or a high number of hours allocated to do research and a low number of articles per year, highlight the need for the implementation of a systematic and periodical process for the assessment of the time allocated to do research.

8. LIMITATIONS AND FUTURE RESEARCH

The study has some limitations. For example, it only involved one private university in Ecuador, which is why some caution is required to extrapolate these results. We suggest more studies using data from other institutions and regions in order to have the overall picture regarding research productivity of professors in emerging countries. Also, this study excludes important variables such as the participation of professors in research networks and their access to national or international funding, which may be relevant to define their profiles in an emerging environment. Moreover, the hours dedicated to do research have been measured considering the official allocation of hours indicated by the educational institution and research productivity has not taken into account the impact factor of academic publications.

By considering scientific papers as research outputs, we excluded other valuable results of the research process such as patents, development of startups or presentations in conferences. The last one is a variable that may be included in future analysis, since universities in emerging countries do not focus their efforts on the production of patents and startups.

Further research may also identify and quantify the impact of each variable analyzed (academic qualification level, time invested to do research and period of time at the institution) on the research productivity of the professors in each cluster identified. In addition, future research should include in the analysis, demographic, behavioral and motivational factors that could impact the research output such as gender, teamwork and tendency of the professor to do research. Rueda-Barrios and Rodenes-Adam (2016) indicated that the resulting technological capital is a factor that influences research production and therefore it would be important to study whether this factor influences the identified clusters.

Finally, since this was a cross-sectional study, we could not analyze the evolution of the research experience of each professor. Further longitudinal studies may focus on analyzing this phenomena, as well as on the effects of events such as promotions,

postdoctoral projects or organizational changes on the individual research productivity.

9. ACKNOWLEDGMENTS

AGRADECIMIENTOS

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