REVISTA CÁTEDRA

# Perspectivas de la producción científica en las universidades del Ecuador

## *Perspectives of scientific production in the universities of Ecuador*

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## Resumen

El presente artículo surge de la necesidad de conocer la situación de la producción científica en índices nacionales e internacionales de las universidades ecuatorianas desde el año 2003 al 2017. Estos índices revelan la desventaja de las universidades a nivel nacional e internacional. Las Instituciones de Educación Superior (IES) ecuatorianas se encuentran en puestos inferiores a nivel Iberoamericano (IBE), Latinoamericano y el Caribe (LAC) con respecto al número de publicaciones que han realizado. La investigación sobre los índices de creación científica de las IES del Ecuador permite vislumbrar el estado actual de la problemática. Además, en 2008 el Gobierno de Ecuador implementa una reforma de

Educación Superior para incentivar la creación científica. Por consiguiente, el propósito del estudio es analizar el estado de producción científica entre las diez mejores universidades ecuatorianas, a nivel nacional e internacional desde el año 2003 al 2017. Asimismo, determinar la influencia de la reforma de Educación Superior del 2008 en cuanto a la producción científica de las IES. La metodología empleada en esta investigación es de carácter inductivo-deductivo, apoyada en la revisión bibliográfica y la hermenéutica. Se concluye que en el período 2003-2013 la Universidad San Francisco de Quito publicó más contenido científico a nivel nacional mientras que en 2013-2017 fue la Universidad de las Fuerzas Armadas. También, se evidencia que las universidades subieron su producción investigativa a nivel IBE, LAC y nacional. Con estos datos se busca evidenciar los efectos de la implementación de políticas públicas que regulen la producción científica en las IES.

## Palabras Clave

Escritura científica, índices, normativa, universidad.

## Abstract

This article arises from the need to know the situation of scientific production in national and international indices of Ecuadorian universities from 2003 to 2017. These indices show the disadvantage of universities at the national and international level. Ecuadorian Higher Education Institutions (HEIs) are in lower positions at the Ibero-American (IBE), Latin American and Caribbean (LAC) level with respect to the number of publications they have made. Research on the scientific creation indices of HEIs in Ecuador allows to glimpse the current state of the problem. In addition, in 2008 the Government of Ecuador implements a reform of Higher Education to encourage scientific creation. Therefore, the purpose of the study is to analyze the state of scientific production among the top Ten Ecuadorian Universities, nationally and internationally from 2003 to 2017. Likewise, to determine the influence of the 2008 Higher Education reform regarding the scientific production of HEIs. The methodology used in this research is inductive-deductive, supported by literature review and hermeneutics. It is concluded that in the period 2003-2013 the San Francisco de Quito University published more scientific content at the national level, while in 2013-2017 it was the University of the Armed Forces. Also, it is evident that the universities raised their research production at IBE, LAC and national levels. With these data we seek to demonstrate the effects of the implementation of public policies that regulate scientific production in HEIs.

## Keywords

Writing scientist, index, regulations, university.

## 1. Introduction

The level of scientific production refers to the ability of people, institutions and bodies that are part of society and disseminate information on some research on a specific topic. This research has been oriented as one of the academic activities that Higher Education Institutions (HEIs) must promote in their professors and future professionals. In recent years, research has been carried out on the number of scientific publications conducted in Ecuador by HEIs, revealing a poor development of scientific articles among Ecuadorian HEIs at national and international level; they have also denoted little contribution to the scientific field and the development of society. Castillo and Powel (2019) mention that this problem may be due to "the lack of scientific culture and appropriate policies that promote research, in addition to the lack of priority on research in universities" (p.1). In other words, the

country's lack of scientific output was due to the fact that there were no organisms regulating scientific research within the HIEs before 2008. It is also because the State did not allocate monetary funds to the research area. Finally, within HIEs, students and researchers did not have a research culture.

In 2008, the Ecuadorian State implemented the reform of Higher Education in order to try to increase the rates of scientific production at the universities. At the same time, it created a set of strategies and projects to improve research in the country. However, the impact of the reforms and strategies implemented with respect to scientific production has not yet been deeply studied. There are very few articles that analyze the number of scientific publications of Ecuador's leading HIE from 2003 to the present day. Therefore, it is necessary to conduct a thorough search of bibliographic sources that provide up-to-date and relevant information to the research to be carried out.

The reports published by SCImago Institutions Rankings (SIR) present the production and scientific contribution of HIEs at the Latin American, Ibero-American and Caribbean levels. As a result, concrete data on scientific production have been obtained with respect to HIEs in Ecuador. This ranking "offers a classification of institutions according to the number of jobs indexed in Scopus (...) based on three key factors: research, innovation and social impact" (SIR Iber, 2019, p.4). The research component has been used in this investigation, since it allows to know the number of scientific publications conducted by each university according to the periods mentioned in the report.

This component measures "the institutional capacity to generate scientific products and disseminate them through recognized channels of scientific communication" (SIR Iber, 2019, p. 24). However, one difficulty presented in the research process was that the data found in SIR Iber correspond to the scientific production of "Andorra, Spain, Portugal and Latin American countries" (SIR Iber, 2019, p.5); for this reason, it was necessary to extract only the information regarding the HIEs of Ecuador, taking into account the top ten universities in the country.

The problem of the poor scientific dissemination of the Ecuadorian HIEs has influenced the position they occupy at the Ibero-American (IBE), Latin American and Caribbean level and at the national level. According to Witter (quoted by Piedra y Martínez, 2007) scientific production is:

> The way in which a university or research institution is present when it comes to science; it is a basis for the development and a way of overcoming dependence between countries and regions in the same country; it is a vehicle for the improvement of the quality of life of the inhabitants of a country, it is a way of being present not only today, but also tomorrow (p.34).

Therefore, the situation in Ecuadorian universities before 2008 has prevented them from reaching relevant positions within scientific production at national and international level. On the other hand, the low level of research prevented higher education institutions from being part of the solutions to certain problems in Ecuador or worldwide.

Consequently, this article is relevant since it is intended to be carried out on the rates of scientific creation within the ten best Ecuadorian universities from 2003 to 2017. This will allow to know the role of Ecuadorian universities at the Ibero-American (IBE), Latin

American and Caribbean level and at the national level in the development and increase of knowledge that allows the improvement of society. The study on this problem helps to reveal new perspectives on changes in scientific production and reveals the impact of state intervention.

The intention of this research is to show that the scientific output of the top ten Ecuadorian universities has risen considerably in recent years, thanks to the reform and public policies established by the national government and the various regulatory and control bodies. The top ten universities, according to QS World University Rankings 2020 compared were: Universidad San Francisco de Quito, Escuela Superior Politécnica del Litoral, Pontificia Universidad Católica del Ecuador, Escuela Politécnica Nacional, Universidad Central del Ecuador, Universidad de Cuenca, Universidad de las Fuerzas Armadas, Universidad Técnica Particular de Loja, Universidad de Especialidades Espíritu Santo, Universidad de las Américas.

The purpose of this article is to analyze the state of scientific production among the top ten Ecuadorian universities, nationally and internationally during the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017 based on the results of SIR Iber. To this end, the idea is to find answers to:

- What was the number of scientific publications during the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017 of each of the ten HIEs?
- Which HIEs led the scientific production index during these periods?
- Was there an increase in the number of scientific publications since the Higher Education Reform?

It also seeks to determine the influence of higher education reform in 2008 on scientific creation.

Regarding the structure and content of the article, section 2 presents the concepts related to the research. Section 3 shows the review of the various bibliographic sources related to the scientific production of the universities of Ecuador. Section 4 specifies the methodology used to develop this research. Section 5 shows the results of scientific production of Ecuador's top 10 universities during the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017 based on SIR Iber results and scientific production before and after the 2008 higher education reform. Section 6 presents the conclusions in accordance with the results obtained.

## 2. Related concepts

### 2.1. Epistemological background of scientific production in Ecuador

From the origins of the university in Ecuador until approximately the year 2000, the Higher Education System has undergone several changes. The most significant with regard to educational quality arises in 2002 with the emergence of the Council for Evaluation and Accreditation of Higher Education of Ecuador (CONEA), which assessed the situation of scientific research and production within the HIEs in Ecuador. Epistemological horizons related to scientific production can be understood by presenting a brief review of the history of the Higher Education System in Ecuador.

The existence of a Higher Education System has its origins in 1596 with the creation of the University of San Fulgencio in charge of the Clergy, whose "main purpose was the education of the creoles" (Pacheco and Pacheco, 2015, par. 7). At this stage of the higher education system the priority was to educate people from prestigious and Spanish families based in

America. Back then, higher education was the privilege of few, and it was mainly aimed at the most aristocratic families of the country and those men who considered priesthood a way of life.

From 1822 to 1830 with the beginning of the Independent Republic, the University of San Fulgencio became the Central University of Ecuador (Universidad Central del Ecuador) and by 1869 the National Polytechnic School (EPN - Escuela Politécnica Nacional) was created, whose purpose was "to teach according to the practical and technical needs of the country" (Pacheco and Pacheco, 2015, parr. 8). This institution was founded during the presidency of García Moreno and was very well received as the first center of teaching and scientific research in the country. With the EPN, Ecuador would see the possibility of technical and industrial development.

After several years, at the beginning of the twentieth century with the advent of the Industrial Revolution, Ecuador changed its vision and sought the "incorporation of citizens into social production and development through the study of sciences, practice and research" (Pacheco and Pacheco, 2015, parr. 9). In the 1930s and 1940s, Ecuador issued the Higher Education Act which allows universities to become technically and administratively independent of the State. In 1998, Ecuador's Political Constitution was drafted, allowing neoliberal politicians to privatize access to third-level education.

After so many years of university history, in 2002 the National Council for Evaluation and Accreditation of the Universities of Ecuador (CONEA) takes office. This public entity, in accordance with the Organic Law on Higher Education issued in 2000, makes a first approach to the assessment of educational quality in Higher Education Institutions (HEIs).

## 2.2. Scientific production of Ecuador regarding the rules of control organisms of Institutions of Higher Education

The regulations seek to increase the scientific production, thus one of its policies is to determine that the resources of private and public universities are earmarked to develop research and disseminate the results. For example, Article 35 provides that institutions of the Higher Education System may additionally and preferably access the public resources for the pre-allocation for research, science, technology and innovation established in the corresponding law" (LOES, 2010a, p. 21); i.e. the state is committed to universities to provide financial resources that cover the costs of research projects. For the allocation of economic resources, the state will take into account the academic excellence assessment criterion evaluated by the CACES. According to this criterion, HIEs will receive between 3 and 10 % of the total amount.

In this law, universities also commit to allocate a percentage of the resources given for research publications. This is stipulated in Article 36 as follows:

> Allocation of resources for publications, scholarships for professors and research. Public and private higher education institutions will allocate at least six per cent (6%) in their budgets indexed publications, postgraduate scholarships for their professors and research under the national development regime. The National Secretariat for Higher Education, Science, Technology and Innovation will ensure the implementation of this provision (LOES, 2010a, p. 21).

This article highlights the economic incentives given to researchers and professors to perform their work, in addition to the responsibility of the National Secretariat of Higher Education, Science, Technology and Innovation so that this can be fulfilled. However, these are not the only sections concerning the scientific production boost, there are a number of articles throughout the Organic Higher Education Act that seek to promote the research. For example, to promote scientific programs in order to foster the development of the country.

The responsibilities given to higher education institutions with respect to scientific research in addition to the constant control of the State must rely on them. Thus, the Higher Education System must establish bodies to monitor the quality of universities. Article 353 states that:

> 1. A public body for the planning, regulation and internal coordination of the system and the relationship between its various actors with the Executive Function.
> 2. A public technical body for the accreditation and assurance of the quality of institutions, careers and programs, which may not be composed of representatives of the institutions subject to regulation (Constitución de la República del Ecuador, 2008a ,159).

Among the points that agencies will take to measure the educational quality of the third level of education will be the generation of research of each university, which allows the article to be executed. This is how agencies such as CACES, SENESCYT and CES are created to regulate Ecuadorian Higher Education Institutions. These will also implement standards that force universities to take scientific production as a priority work for the academic life.

### 2.2.1. Board for Higher Education Quality Assurance (CACES)

To ensure the quality of higher education, the State has promoted the establishment of bodies to evaluate, accredit and promote the quality of the Higher Education System (HIEs) in Ecuador. To achieve this end, the Board of Higher Education Quality Assurance is created (CACES).

This body established by the State began its functions in 1989 under the name of the National Council of Universities and Polytechnic Schools (CONUEP). CONUEP carried out the evaluation process, which concluded that "there is no higher education system in Ecuador [...] in the strict sense, but a set of university institutions independent of each other with certain cooperation at the administrative level..." (CONUEP 1992, p. 29, cited by CACES, 2018, p. 11).

After this evaluation process carried out by CONESUP, in 2002 this body takes the name of the National Council for Evaluation and Accreditation (CONEA), which undertakes a new process of evaluation and accreditation of HEIs from all over the country. In 2011, this body is named as the Council for Evaluation, Accreditation and Quality Assurance of Higher Education (CEAACES), which continued to carry out the processes of evaluation, accreditation and quality assurance of HEIs in the country.

Finally, in 2018 this body is called the Council for Quality Assurance of Higher Education (CACES), and according to the official website of the CACES (2019) it is responsible for:

> Regulate, coordinate and plan participatory processes of accompaniment, evaluation, accreditation and qualification to ensure the

> quality in higher education institutions, focused on the balance of teaching, research, innovation and linkage with society (p.1).

Whatever the case, all the agencies have had the task of carrying out evaluation processes aimed at ensuring educational quality in all higher education institutions in Ecuador.

#### 2.2.1.1. Higher Education Quality Assurance Council (CACES) Regulations on the Scientific Production of Higher Education Institutions

CONEA in 2002 (now CACES) began the process of evaluating the country's HEIs based on five criteria: academia, academic efficiency, organization, infrastructure and research. "The level achieved in the generation of scientific knowledge" was evaluated based on the research criterion (Pacheco and Pacheco, 2015, sec. The new Assessment and Categorization). In July 2008, the National Assembly of Ecuador issued the Constituent Mandate No.14 whose main objective was to commission the "CONEA to develop an assessment of the institutional performance of all the Higher Education Institutions (HEIs) of Ecuador in order to purge the system" (Rojas, 2011, p. 61). The results of the reports of Mandate No. 14 (2009) on the role of universities in the training of researchers show that:

> The research function is the weakest of the Higher Education System (SES), presenting itself as serious in private universities. In this way, the need arises to encourage the training of professors at the PhD level in order to achieve an improvement in the quality of higher education (Rojas, 2011, p. 61).

The results presented in the report allowed CACES to "generate institutional reflections and learning to improve the processes in its charge and respond to the country's current SES needs" (CACES, 2019, p.2), establishing a balance between teaching, research, scientific production, innovation and link with the society.

### 2.2.2. Secretariat of Higher Education, Science Technology and Innovation (SENESCYT)

The Secretariat for Higher Education, Science, Technology and Innovation (SENESCYT) is "the Ecuadorian Government entity that exercises public policy in higher education, science, technology and innovation" (SENESCYT, 2019, sec. The Secretariat). Likewise, it is responsible for governing "public policy in the fields of Science, Technology, Innovation and Ancestral Knowledge; it coordinates and articulates actions between the academia, research, public and private productive sectors" (SENESCYT, 2019, sec. The Secretariat). The Undersecretariat of Science, Technology and Innovation is within this institution, in which the Undersecretariats of Scientific Research and Innovation and Transparency of Technology are located.

#### 2.2.2.1. Undersecretariat of Scientific Researh

The Undersecretariat of Scientific Research is responsible for managing the country's public policy of scientific research. On the website the responsibilities based on the scientific production can be observed, which are:

> b) Advise the General Under-Secretary for Science, Technology and Innovation on the definition of activities that promote the scientific research.
> c) Exercise the guiding of public policy for the scientific research.
> e) Approve, evaluate and finance the scientific research plans, programs and projects of this Secretariat.

> f) Validate and endorse the research projects proposed by the actors of the National System of Science, Technology, Innovation and Ancestral Knowledge.
> g) Accredit researchers and research institutions for the development of scientific activities in the country.
> h) Promote and articulate scientific research networks.
> i) Articulate the actors of the National System of Science, Technology, Innovation and Ancestral Knowledge for the production of scientific research (sec. Undersecretariat for Scientific Research).

The information highlighted above is related to the purpose of promoting scientific research in HEIs. For example, advising the Under-Secretary to promote scientific research and the approval of research projects are some of the relevant aspects that SENESCYT conducts for the development of scientific research within the country's HEIs.

#### 2.2.2.2. Undersecretariat for Innovation and Technology Transfer

There are certain powers and responsibilities to be fulfilled by the General Under-Secretary for Science, Technology and Innovation. The one related to the country's scientific production is stated in section i) To follow up on scientific production, programs and research projects funded by the Secretariat.

These powers and responsibilities of each Undersecretariat belonging to SENESCYT arise from the provisions of the LOES, where in Chapter 3, COORDINATION OF THE HIGHER EDUCATION SYSTEM WITH THE EXECUTIVE FUNCTION, Art 182, literal g, is stablished that "from the national government, scientific and technological research policies must be created according to the development needs of the country, as well as the incentives for universities and polytechnic schools to develop them, without under-compliance with their domestic policies" (LOES, 2010a, p. 30).

The organization of this public entity has allowed a better development and fulfillment of the functions that it has as the rectory of public policies related to higher education. In this way, the legal framework governing the SES is complemented by complying with the constitution of the republic, as regards the bodies that must govern the Higher Education System.

### 2.2.3. Higher Education Council (CES)

The Higher Education Council or also known as CES is one of the agencies that govern the Higher Education System, and that has "as a mission the planning, regulation and internal coordination of the Higher Education System of Ecuador, and the relationship between its different actors with the Executive Function and Ecuadorian society" (Council of Higher Education, 2012, institution section). It is responsible for leading Ecuadorian universities through a series of regulations.

This institution approved in 2017 an academic regulation responsible for regulating academic degrees and everything related to it. One of the titles establishes a number of laws around the research activity. For example, Article 72 states:

> Research for learning. The organization of learning at each level of higher education training will be based on the relevant research process and will propose the development of knowledge and attitudes for the scientific, technological, humanistic and artistic innovation, as follows:
> 1. Research in higher technical education, superior technology and their equivalents. - It will be developed in the training of creation, adaptation

> and technological innovation, through the mastery of exploratory research techniques. Artistic careers should incorporate research into technologies, models and artistic production activities.
> 2. Research in higher education. - It will be developed in the framework of the training field of epistemology and the research methodology of a profession, through the development of exploratory and descriptive research projects (Reglamento de Régimen Académico, 2017, p.31).

The universities, careers and professors will have the responsibility to add to the program the research subject, in order to provide research tools to future professionals. In addition, it is a question of complying with the law that HEIs must generate science. The knowledge students receive on the development of research projects, types of research, methodologies, techniques, tools among others will help to increase the number of publications in the country. Therefore, the investigative task is prevented from being carried out superficially and for other purposes, such as accumulating documents rather than generating knowledge.

## 2.3. University Reform in Ecuador

The arrival in the Presidency of the Republic of Ecuador of economist Rafael Correa Delgado in 2007 marked a before and after in the Higher Education System. In the years before 2007 "research was not part of the curricula, the few that were carried out responded to scientific concerns of professors and generally became a thesis of degree or doctorate" (Rivera-García, et al., 2017, parr. 6). The country's research reality was totally flawed and needed to be changed. The Higher Education model in Ecuador takes a turn in 2008 with the new Constitution of the Republic of Ecuador. In Title VII, Article 350 states that:

> The higher education system aims at the academic and professional training of students with a vision born from the sciences and humanities, so that it is based on scientific and technological research, innovation, promotion and dissemination of ancestral knowledge and cultures, depending on solving the country's problems, in relation to the objectives of the development regime (p. 162).

This provision promotes and requires higher education to be linked to the country's scientific and technological research. To achieve this, it was necessary to implement a new Higher Education Act, which took effect in October 2010. This new LOES in Article 13 determines the functions of the Higher Education System, including the literals:

> b) Promote the creation, development, transmission and dissemination of science, technology and culture.
> d) Strengthen the exercise and development of teaching and scientific research at all levels and modalities of the system (LOES, 2010, p. 6).

With the new vision of the Higher Education System raised in the Constitution of the Republic of 2008 and the Organic Law on Higher Education of 2010, it was necessary to propose a new legal framework governing higher education in Ecuador. This legal framework would be made up by the National Secretariat for Higher Education, Science, Technology and Innovation (SENESCYT); Council for Higher Education (CES) and the Higher Education Quality Assurance Council (CACES). The latter would be in charge of the evaluation and categorization of the Universities of Ecuador.

## 3. Related works

In 2013, a seminar held at Escuela Politécnica Nacional presented a comparative bibliometric analysis of Ecuador worldwide and some universities in the country. The results show that until 2012 Ecuador has indexed with Scopus 3649 and on the Web of Knowledge 3573 scientific articles. On the other hand, the most prolific Institutions of Higher Education are Universidad San Francisco de Quito in the first place, Pontificia Universidad Católica del Ecuador in second place and t Escuela Politécnica Nacional in third place. The seminarian concludes that Ecuador needs a National Science and Technology Plan that motivates the production of projects and research to achieve a change in the productive matrix (Bruque, 2013).

In another research conducted in 2015, a comparison was made of Universidad San Francisco de Quito with other universities in Ecuador. The results awarded by Sir Ibero-America 2015 showed that the USFQ is the university with the highest number of scientific production, becoming one of the 200 most productive higher education institutions in Ibero-America. Finally, the author concluded that the USFQ provides 74.14% of high-ranking publications and that 82.89% are in collaboration with international institutions, revealing the prestige that USFQ is acquiring nationally and globally (DFCH,2015).

In 2015, a study on scientific research was developed in Ecuadorian universities, in which the author addresses one of the main problems of students at the national level and especially of higher education. The results of this research relate the Ecuadorian University with the government and the investment it makes for Higher Education Institutions. On the other hand, it is proposed that academic and scientific production is surrounded by prejudice. The study concluded that higher education must be truly changed, letting behind the American university model of the 1960s (Ayala, 2015).

In 2016, a research conducted a study on the perspective of the dissemination of knowledge of Ecuador at the national, regional and global levels. The results determined that Ecuador ranks 82 worldwide with 3 662 scientific documents, ranked 13th at the Latin American level. Finally, a comparison is made between the ranking of Ecuadorian universities with the highest number of indexed publications in the period 2009-2013. The list of five institutions of Higher Education with more numbers of articles is mentioned following the order:

1. Universidad San Francisco de Quito with 422 scientific articles in Scopus
2. Pontificia Universidad Católica del Ecuador with 319 scientific articles in Scopus
3. Escuela Politécnica Nacional del Ecuador with 152 scientific articles in Scopus
4. Universidad Técnica Particular de Loja with 143 scientific articles in Scopus
5. Escuela Politécnica del Litoral with 137 scientific articles in Scopus

Finally, the authors conclude that the trends at the national, regional and global levels demonstrate the importance that universities granted to research and the dissemination of results (Méndez, García and Ortega, 2016).

In a study in 2016, an analysis of the level of scientific production of the leveling professors of Universidad de Guayaquil was carried out until the first semester of the same year. The results confirmed that 42 professors, 28 men and 14 women, have published scientific papers, or 17.5% of the University's professors. Due to the problem encountered, the researchers conclude that it is necessary to systematize knowledge to achieve the development of multidisciplinary skills and multidimensional thinking of professors in order to generate innovations and new research (Reiban-Barrera and Vera-Cedeño, 2016).

A study presented in 2017 compared the number of scientific articles between Universidad Técnica Particular de Loja, Universidad Nacional de Loja and Universidad Politécnica del Litoral. The results determined that the UTPL has published 544 articles since 2012, UNL has published 102 scientific articles while Escuela Politécnica del Litoral has published 531 since 2011. Therefore, the author of this research concludes that there is a marked evidence of an increase in scientific production due to the investment that the Government made in Higher Education (Añazco, 2017).

The research presented in 2017 by the Cuban Journal of Higher Education analyzes scientific research in Ecuadorian universities as a priority of the current education system. The results of this research indicated that until the seventies Ecuadorian universities lacked the investigative component and although from the 1980s the Ecuadorian state promoted scientific research through various organizations, Ecuadorian universities were able to meet the expectations identified by the rupture between teaching and research. Therefore, it concludes that despite the changes generated in scientific research within universities, general development is not sufficient. In addition, there is no total understanding by all members of the Higher Education Institutions about the actions to be taken to increase academic production in their classrooms (Rivera-García et al., 2017).

In 2018, a research related to the scientific production of the Ecuadorian University is presented in order to know the scientific academic production in the universities of Ecuador and everything related to the training of research work in higher education institutions. The results indicate that scientific production increases when there are properly prepared professionals, also that research has managed to solve problems in the field of science, improving the performance of professionals related to the scientific production. Therefore, it was concluded that the increase in the scientific production in recent years was thanks to the intervention of some entities related to Higher Education (Cabrera et al., 2018).

In 2019, an analysis of the Scientific Production of the Universities of Zones 3, 5 and 8 of Ecuador is carried out. This study compared the scientific production of Universidad Estatal de Milagro, Universidad de Guayaquil, Universidad Nacional del Chimborazo and Universidad Estatal de Bolívar. The results show that in 2015 la Universidad Nacional del Chimborazo was the one with more scientific publications with a total of 84 documents, and by 2017 it maintained the first place with a total of 190 publications. This study concluded that scientific output had increased in 2017 at all universities in Zones 3, 5 and 8. (Pacheco et al., 2019).

## 4. Methodology

The steps used in this research are described below:

1. **Selecting the type of research of the methodology:** This research was exploratory, thus a thorough review of the literature related to the subject was necessary. This study handled an inductive-deductive qualitative methodology based on the use of hermeneutics for the interpretation of data obtained from the literature review.
2. **Selection of a representative sample of Higher Education Institutions:** 10 Ecuadorian universities were selected by taking into account the list provided by Diario El Comercio on the 15 best Ecuadorian universities according to the QS World University Rankings 2020. These higher education institutions were qualified based

on 8 criteria, which are: the institution's academic reputation, employer reputation, student-faculty relationship, the PhD staff, the international research network, citations for research, faculty research and the impact on the Internet (El Comercio, 2020).

The universities selected were: Universidad San Francisco de Quito, Escuela Superior Politécnica del Litoral, Pontificia Universidad Católica del Ecuador, Escuela Politécnica Nacional, Universidad Central del Ecuador, Universidad de Cuenca, Universidad de las Fuerzas Armadas, Universidad Técnica Particular de Loja, Universidad Espíritu Santo, Universidad de las Américas.

3. **Selection of bibliographic sources:** in order to know the number of scientific productions of the 10 universities, it was necessary to search for reliable data sources. Having reviewed several bibliographic sources, it was agreed that the data would be obtained from the 2010, 2012, 2015 and 2017 editions of the Ibero-American Ranking SIR. It is necessary to emphasize that each edition issued by the Scimago institutions ranking presents reports grouped in quintiles. Therefore, the periods taken into account for this study are: 2003-2008, 2006-2010, 2009-2013 and 2013-2017. These reports were taken thanks to the approximate sequencing between 2003-2017. Other reports did not allow compliance with the purpose of this study as they omitted important years and prevented proper sequencing of data.
4. **Comparison of Ecuadorian universities:** to contrast data between universities it was decided to draw up tables and graphs that helped to see the number of publications in a five-year period. In this way, it was observed whether there was an improvement or decrease in the number of scientific articles produced. It also sought to see some change in the position that the Higher Education Institutions occupied at the national, Ibero-American and Latin American levels. Finally, in order to establish possible development between universities, it was decided to compare the periods 2003-2008 and 2006-2010.

# 5. Results

## 5.1. Scientific productions indexed in Scopus in a five-year period

The Scimago institutions rankings (SIR) is the bibliographic source from which data was extracted on scientific publications produced by Ecuadorian universities in the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017. SIR (2010) "is presented as a tool for analysis and evaluation of the research activity of Higher Education Institutions in Ibero-America" (p.1). In other words, the reports presented make it possible to know the current situation of a country and universities with regard to the creation of scientific articles that help the development of a society. Data submitted for a five-year period can serve as benchmarks for the planning or implementation of possible solutions for the increase in the scientific production in a country.

| **Universities** | **Periods** | **2003-2008** | **2006-2010** | **2009-2013** | **2013-2017** |
|---|---|---|---|---|---|
| **Universidad San Francisco de Quito** | | 200 | 318 | 422 | 836 |
| **Escuela Superior Politécnica del Litoral** | | 3 | 71 | 137 | 730 |
| **Pontificia Universidad Católica del Ecuador** | | 118 | 221 | 319 | 571 |

| | | | | |
|---|---|---|---|---|
| **Escuela Politécnica Nacional** | 113 | 133 | 152 | 691 |
| **Universidad Central del Ecuador** | 50 | 59 | 103 | 348 |
| **Universidad de Cuenca** | 32 | 51 | 91 | 503 |
| **Universidad de las Fuerzas Armadas** | 0 | 19 | 53 | 884 |
| **Universidad Técnica Particular de Loja** | 17 | 53 | 143 | 732 |
| **Universidad Espíritu Santo** | 0 | 0 | 34 | 222 |
| **Universidad de las Américas** | 0 | 8 | 90 | 245 |

Table 1. Number of publications made by each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus within the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017. Adapted from: (SIR, 2010,2012,2015 and 2019)

The first period taken into account is from 2003 to 2008. During this time, the SIR has compiled the number of scientific articles written by each of Ecuador's universities indexed in Scopus. For the preparation of the report, "scientific publications included in the Scopus citation index produced by ESLEIVER have been analyzed" (SIR, 2010). It is important to remember that the data presented in the ranking correspond to Latin America, hence to create the following figure it was necessary to extract only the information regarding the Institutions of Higher Education of Ecuador. Figure 1 shows the top ten universities in Ecuador and the number of publications they had in these years.

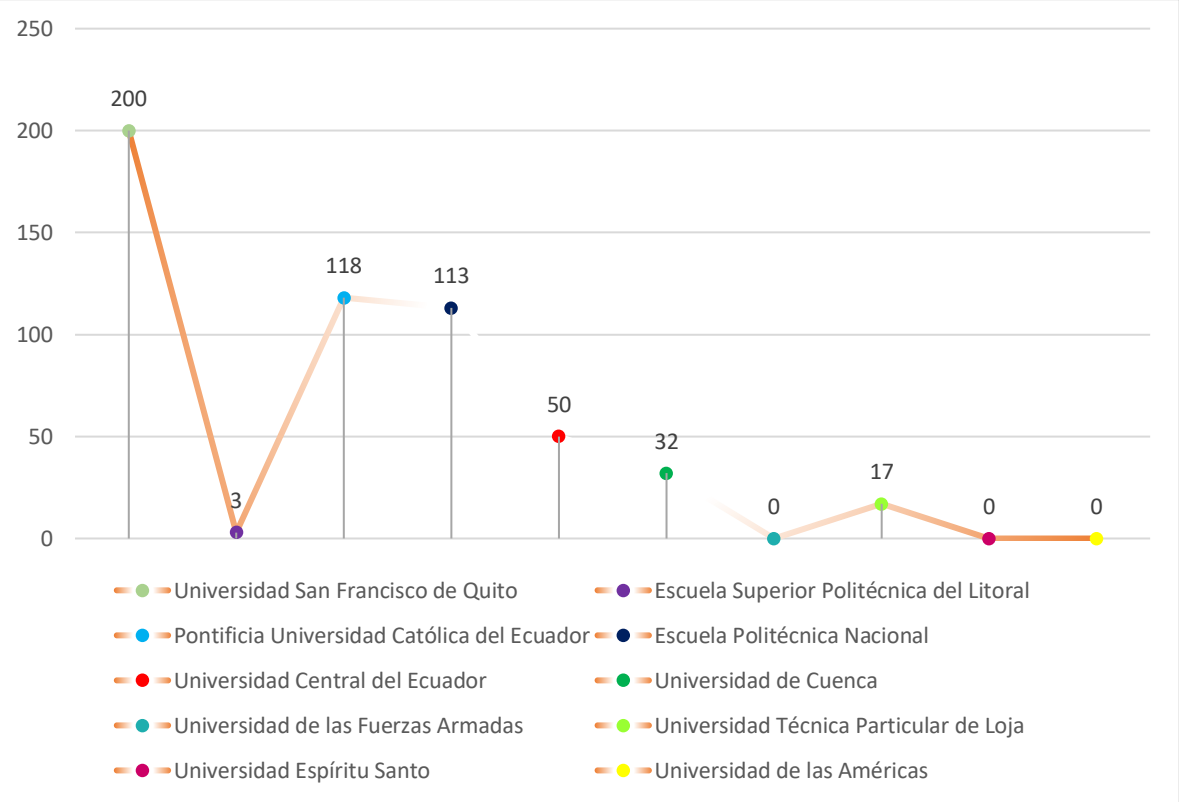


Figure 1. Number of publications in each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus within 2003-2008.

After a careful observation of Figure 1, it can be contrasted that the three universities with the most publications in the period 2003 to 2008 were San Francisco de Quito (USFQ), la Pontificia Universidad Católica del Ecuador (PUCE) and Escuela Politécnica Nacional (EPN). USFQ ranked first with 222 publications, subsequently PUCE took second place with 118 publications and in the third place the EPN with 113 publications. As for the others, Universidad Central del Ecuador has 50 scientific articles, Universidad de Cuenca made 32 scientific articles, Universidad Técnica Particular de Loja 17 scientific articles and Escuela Politécnica del Litoral only 3 publications. While the Universities with zero scientific production were Universidad de las Fuerzas Armadas, Universidad Espíritu Santo and Universidad de las Fuerzas Armadas.

The second period taken into account is from 2006 to 2010. During this time, the SIR compiled the number of scientific articles written by each of Ecuador's universities. For the preparation of the report "all scientific production present in the Scopus database, prepared by Elsevier, 2016 has been analyzed in the period 2006-2010 and each publication and citation found has been associated with the institution or corresponding institutions" (SIR, 2012). It is important to indicate that the data presented in the ranking correspond to Latin America; to elaborate the following figure it was necessary to extract only the information regarding the universities of Ecuador. Figure 2 shows the top ten universities in Ecuador and the number of publications they had within this period.

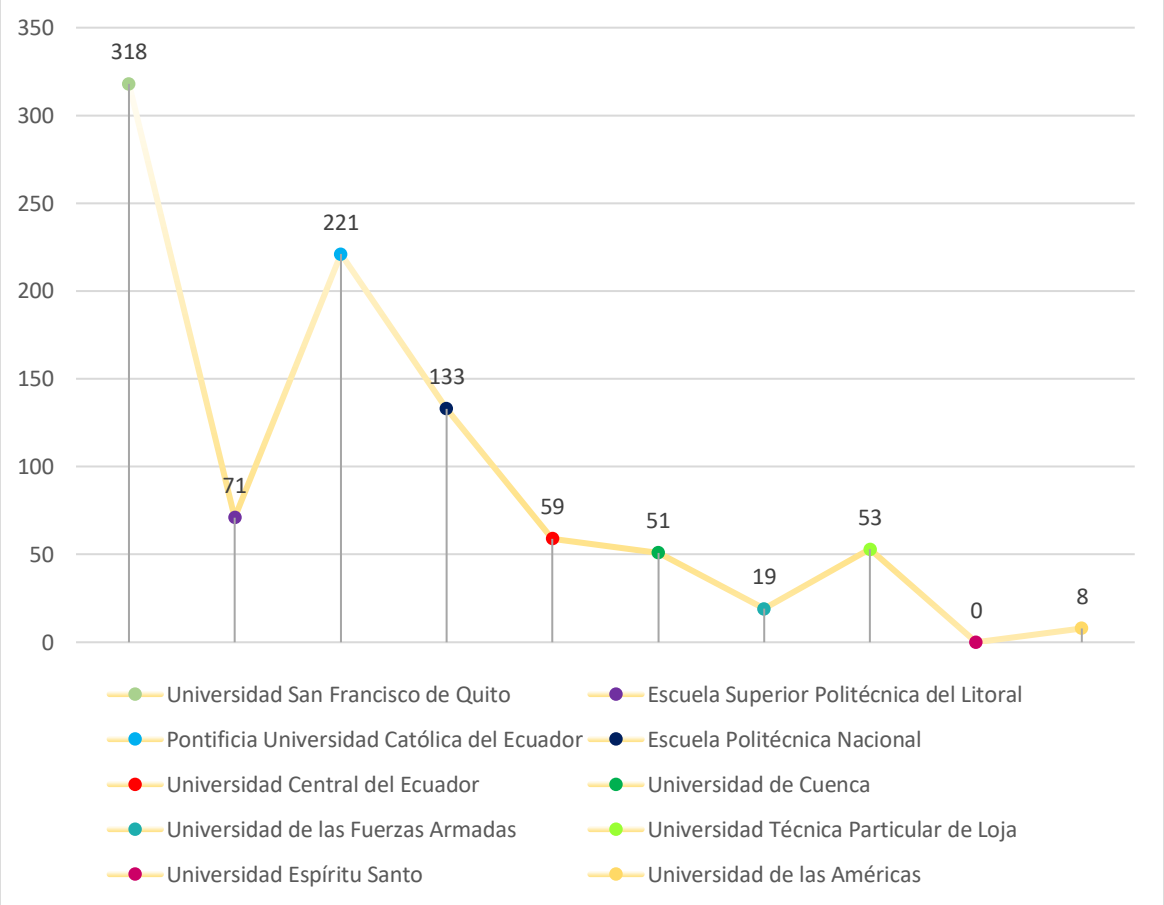


Figure 2. Number of publications by each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus in the period 2006-2010.

In the figure above it can be contrasted that the three universities with the most publications during the years 2006-2010 were Universidad San Francisco de Quito, occupying the first place with a total of 318 publications, followed by Pontificia Universidad Católica del Ecuador with a total of 221 publications and Escuela Politécnica Nacional in third place with a total of 133 publications. On the other hand, the Higher Education Institutions with less scientific production were Universidad de las Américas with a number of publications equal to 8 and Universidad Espíritu Santo with a non-existent scientific production during this period.

During 2009-2013, the SIR compiled the number of scientific articles that have been written in each of Ecuador's universities. It is important to indicate that the data presented in the ranking correspond to Latin America, reason for which it was necessary to extract only the information related to the Institutions of Higher Education of Ecuador. Figure 3 shows the top ten universities in Ecuador and the number of publications they had within this period.

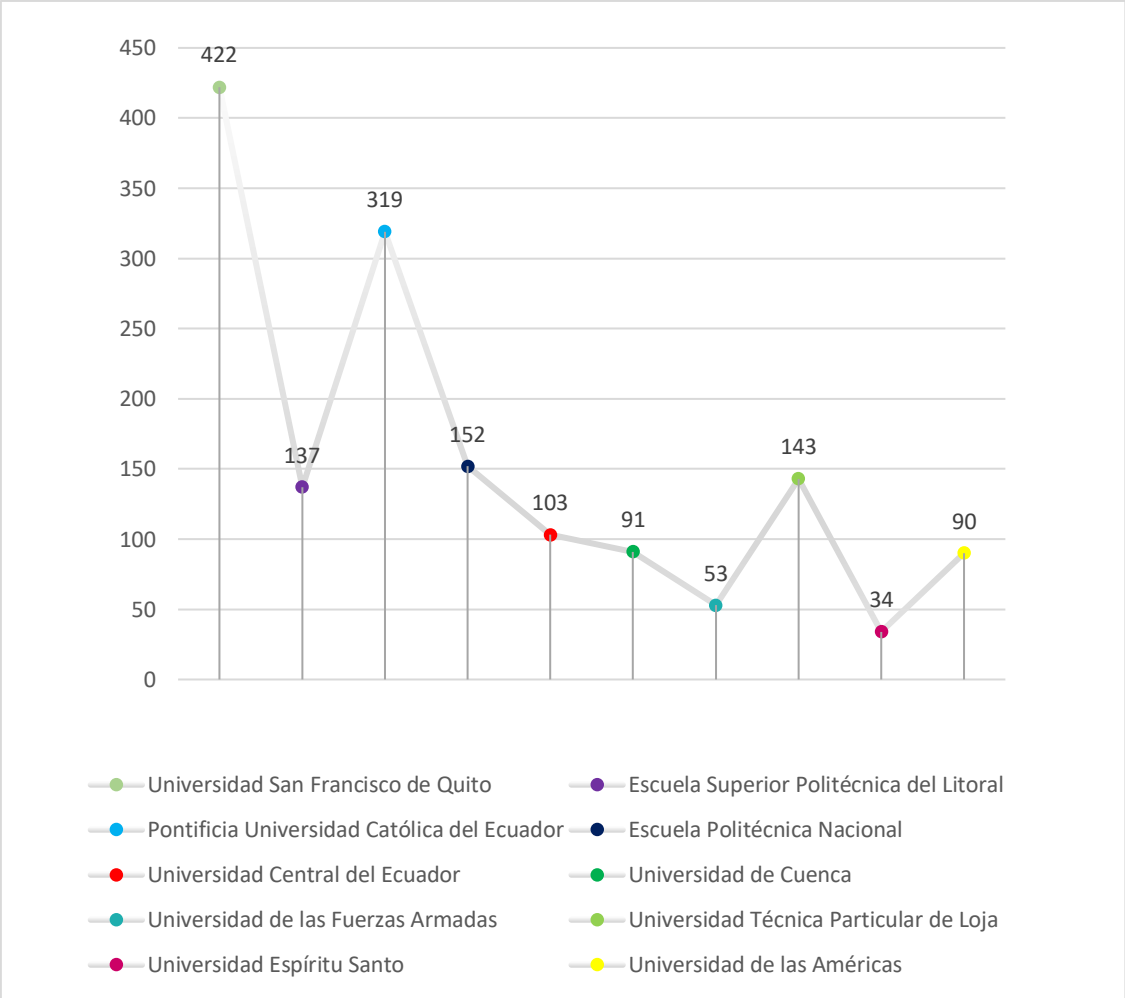


Figure 3. Number of publications by each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus from 2009-2013.

In Figure 3 it can be contrasted that the universities with the most publications during the years 2009-2013 were Universidad San Francisco de Quito occupying the first place with a total of 422 publications, followed by Pontificia Universidad Católica del Ecuador with a

total of 319 publications and Escuela Politécnica Nacional in third place with a total of 152 publications. On the other hand, the Institutions of Higher Education with less scientific production were Universidad Espíritu Santo with a total of 34 publications and Universidad de las Fuerzas Armadas with a number of publications equal to 53.

The last period taken into account for this study was from 2013 to 2017. During this time the SIR analyzes "the institutional capacity to generate scientific products and disseminate them through recognized channels of scientific communication" (SIR, 2019, p. 24). It is important to indicate that the data presented in the ranking correspond to all Latin America, thus it was necessary to extract only the information regarding the Institutions of Higher Education of Ecuador. Figure 4 shows the top ten universities in Ecuador with the corresponding number of scientific publications during the latter period.

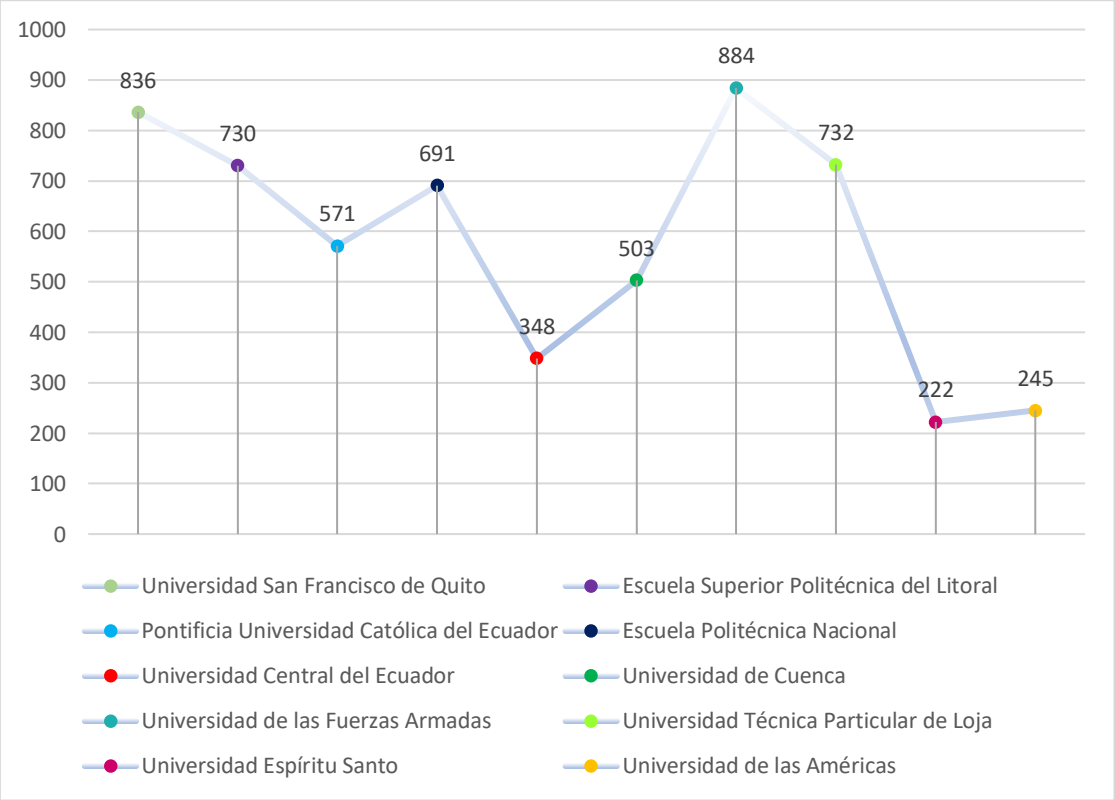


Figure 4. Number of publications by each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus within the period 2013-2017.

In Figure 4 it can be contrasted that the universities with the most publications during the years 2013-2017 were la Universidad de las Fuerzas Armadas with a total of 884 publications, secondly, Universidad San Francisco de Quito with 836 publications and thirdly Universidad Técnica Particular de Loja with a total of 732 publications. On the other hand, it is also contrasted that the Universities with the least scientific production in this period were Universidad de las Américas with a number of publications equal to 245 and Universidad Espíritu Santo with a total of 222 publications in Scopus.

## 5.2. Ecuadorian universities according to their position at the national and Latin American level in a five-year period

Since 2009 SCImago Research Group publishes two types of reports: SIR world and SIR Iber. This latest report "shows the scientific activity exclusively of Andorra, Spain, Portugal, and Latin American countries" (SIR, 2019, p. 5). For the measurement of scientific production, SIR takes into account three aspects: research, innovation and social impact. The research aspect is intended to measure "the institutional capacity to generate scientific products and disseminate them through recognized channels of scientific communication" (SIR, 2019, p. 24). This scientific production capacity of each Higher Education Institution has allowed it to position itself within the ranking. Table 2 shows the top ten Universities of Ecuador during the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017 and the position they occupy at the Ibero-American, Latin American and national level.

| **Period** | **2003-2008** | | | **2006 -2010** | | | **2009-2013** | | | **2013-2017** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Universities** | IBE | LAC | CO | IBE | LAC | CO | IBE | LAC | CO | IBE | LAC | CO |
| **Universidad San Francisco de Quito** | 244 | 167 | 1 | 258 | 181 | 1 | 267 | 190 | 1 | 240 | 164 | 2 |
| **Escuela Superior Politécnica del Litoral** | 556 | 446 | 1 | 493 | 394 | 4 | 405 | 318 | 5 | 258 | 180 | 4 |
| **Pontificia Universidad Católica del Ecuador** | 291 | 205 | 2 | 305 | 224 | 2 | 304 | 222 | 2 | 291 | 206 | 6 |
| **Escuela Politécnica Nacional** | 297 | 211 | 3 | 392 | 303 | 3 | 394 | 307 | 3 | 263 | 183 | 5 |
| **Universidad Central del Ecuador** | 362 | 269 | 4 | 520 | 421 | 6 | 439 | 343 | 6 | 371 | 282 | 9 |
| **Universidad de Cuenca** | 399 | 300 | 6 | 552 | 449 | 9 | 439 | 352 | 7 | 305 | 220 | 7 |
| **Universidad de las Fuerzas Armadas** | 00 | 00 | 0 | 746 | 628 | 12 | 476 | 388 | 9 | 232 | 156 | 1 |
| **Universidad Técnica Particular de Loja** | 457 | 351 | 1 | 546 | 443 | 7 | 400 | 313 | 4 | 257 | 178 | 3 |
| **Universidad Espíritu Santo** | 00 | 00 | 0 | 00 | 00 | 0 | 405 | 406 | 1 | 434 | 342 | 1 |
| **Universidad de las Américas** | 00 | 00 | 0 | 938 | 808 | 17 | 504 | 415 | 14 | 421 | 329 | 10 |

Table 2. Position of each of the ten Institutions of Higher Education of Ecuador according to their scientific production in Scopus at the Ibero-American (IBE), Latin American and Caribbean (LAC) level and within the country (CO). Adapted from: (SIR, 2010, 2012, 2015 and 2019).

## 5.3. Scientific production before and after the Higher Education Reform of 2008

In 2008 in the mandate of Economist Rafael Correa Delgado, the country began a series of significant changes, as the so-called "Education Revolution", which proposed a radical transformation in the Higher Education System. Universities in Ecuador in terms of research and scientific production before 2008 performed poorly. Rojas (2011) says "the research function is the weakest of the Higher Education System" (p. 61). With the new educational model implemented in the universities of Ecuador, the component of research and scientific production in the Higher Education Institutions would improve markedly. Figure 5

contrasts the increase in scientific output of the country's top 10 universities before and after the 2008 education reform.

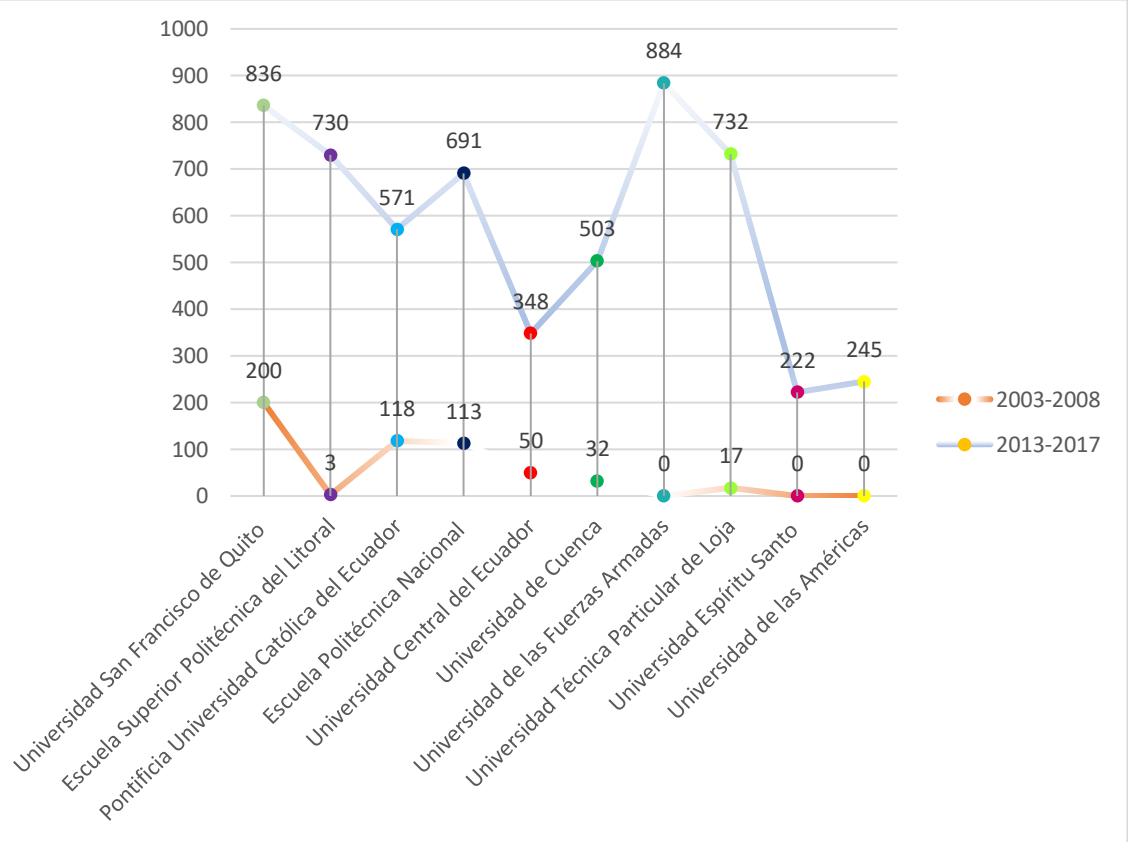


Figure 5. Comparison of the number of publications by each of Ecuador's ten most representative Higher Education Institutions indexed in Scopus between 2003-2008 and 2013-2017

Figure 5 compares the number of scientific outputs of Ecuador's most representative universities before and after 2008. During the period 2003-2008 the three universities with the greatest scientific production were Universidad San Francisco de Quito with 200 publications, Pontificia Universidad Católica del Ecuador with 118 publications and Escuela Politécnica Nacional with 113 publications. The increase in scientific production is contrasted with the results of the five-year period 2013-2017, during which these universities significantly increase the number of scientific publications. Thus, Universidad San Francisco de Quito makes 636 more publications reaching a total of 836 publications, Pontificia Universidad Católica del Ecuador reaches 571 publications and Escuela Politécnica Nacional reaches 691 publications.

On the other hand, the comparison of Universities with less scientific production during 2003-2008 were Universidad Espíritu Santo and Universidad de las Américas, both with a non-existent scientific production in this period. However, in the period 2013-2017 both universities increase their scientific production with a total of 222 and 245 publications in the Scopus database, respectively.

## 6. Discussion of the results

Figure 1 presented the number of publications by each of Ecuador's ten most representative Higher Education Institutions (HEIs) indexed in Scopus within 2003-2008. Based on these

results, it is observed that the number of publications of these universities is low. During this period, there were a total of 533 publications among the ten HEIs of which 431 publications belong to only three HEIs, such as Universidad San Francisco de Quito, Pontificia Universidad Católica del Ecuador and Escuela Politécnica Nacional. Moreover, scientific production during this period was not significant compared to the other seven HEIs, as seen in the data presented in Figure 1, the remaining seven universities did not reach 100 publications indexed in Scopus.

Figure 2 presented the number of publications made by each of Ecuador's ten most representative Higher Education Institutions (HEIs) indexed in Scopus during 2006-2010. During this five-year period, in 2008, the new higher education reform came into force and the scientific production began to increase in each of the HEIs. This statement is corroborated in Figure 2, because all HEIs except Universidad de Especialidades Espíritu Santo significantly increase the number of publications, as is the case of Universidad San Francisco de Quito that in this period indexed in Scopus 318 publications, i.e., with respect to the previous five-year period it increased a total of 118 publications.

Figure 3 presented the number of publications made by each of Ecuador's ten most representative Higher Education Institutions (HEIs) indexed in Scopus during 2009-2013. Based on these results, it is noted that the number of publications from these universities increased significantly compared to the previous five-year period. From the ten HEIs in Ecuador, only four Universities did not reach the hundred publications indexed in Scopus; however, they were significantly exceeded compared to previous periods. Among these Institutions are: Universidad de Cuenca, Universidad de las Fuerzas Armadas, Universidad de Especialidades Espíritu Santo and Universidad de las Américas.

Figure 4 presented the number of publications by each of Ecuador's ten most representative Higher Education Institutions (HEIs) indexed in Scopus during 2013-2017. Based on these results, none of the ten HEIs have fewer than 200 publications indexed in Scopus. It is also clear that Universidad de las Fuerzas with a total of 884 publications ranks first during this period, it is further confirmed that the 2008 higher education reform had a significant influence on scientific production, since this HEIs in the five-year period 2003-2008 did not have any publication indexed in Scopus.

Figure 5 compared the number of publications by each of Ecuador's top ten Higher Education Institutions (HEIs) indexed in Scopus during the periods 2003-2008 and 2013-2017. This comparison was made in order to determine whether the 2008 higher education reform had a significant influence on the scientific output of each of Ecuador's HEIs. Based on the results, it is observed that this reform had a positive and significant impact on the scientific production of these HEIs. This statement can be corroborated by looking at the data of Universidad de Especialidades Espíritu Santo (UEES), Universidad de las Américas (UDLA) y la Universidad de las Fuerzas Armadas (ESPE). These HEIs in the period 2003-2008 were not listed in the SIR Iber as they had a scientific production equal to zero. This reality changed during the period 2013-2017, as Universidad de las Fuerzas Armadas ended up positioning itself first with a total of 884 publications, displacing Universidad San Francisco de Quito. As regards the UEES and UDLA their scientific production increased, and for this period the number of publications would be 222 and 245, respectively.

## 7. Conclusions

The data revealed that during the period 2003-2008, 2006-2010 and 2009-2013 the leading universities in scientific production indexed in Scopus were Universidad San Francisco de Quito, la Pontificia Universidad Católica del Ecuador and Escuela Politécnica Nacional. On the other hand, Universidad Espíritu Santo and Universidad de las Américas were the Higher Education Institutions that reflected significantly poor scientific output during these periods. Finally, during the years 2013-20017 the universities with higher scientific production vary in relation to previous periods. Thus, Universidad de las Fuerzas Armadas positions in number one, followed by Universidad San Francisco de Quito and Universidad Técnica Particular de Loja. Howeer, Universidad Espíritu Santo and Universidad de las Américas remain as the Higher Education Institutions with lower scientific production.

The number of publications indexed in Scopus during the periods 2003-2008, 2006-2010, 2009-2013 and 2013-2017 has not allowed Ecuadorian universities to position within the top 100 at the Ibero- American and Latin American levels. However, it has been evident that they have made progress within the ranking of universities established by SIR. Although Higher Education Institutions, such as Universidad San Francisco de Quito and Pontificia Universidad Católica del Ecuador have not changed their status even with the increase in publications. The remaining eight universities have risen dramatically on the list of Ibero-American universities. According to the latest results of 2017, the leading university in publications at the national level is Universidad de las Fuerzas Armadas, and then Universidad San Francisco de Quito.

With the new model of Higher Education implemented since the 2008 Higher Education reform, the scientific output of universities at the national level improved markedly. Thus, Universidad San Francisco de Quito moved from 200 publications to 636 publications registered in Scopus. Similarly, Pontificia Universidad Católica del Ecuador moved from 118 publications to 571 publications. Escuela Politécnica Nacional moved from 113 publications to 691 publications indexed in Scopus. As for the Universities with the lowest number of scientific publications before the 2008 reform are Universidad Espíritu Santo and Universidad de las América; however, these improved markedly from 2009, since 2017 they record 222 and 245 publications in Scopus, respectively. This data reveals further increase in scientific production, which means that more topics are addressed and that HEIs in Ecuador are involved in the generation of scientific knowledge.

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