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ORIGINAL ARTICLE

Scientific production of Peru and Ecuador: A comparative bibliometric analysis

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ABSTRACT

Objective. This study compared the scientific production of Peru and Ecuador between 1996 and 2024, analyzing its evolution, impact, and growth based on bibliometric indicators derived from SCImago Journal & Country Rank (SCImago).

Design/Methodology/Approach. A descriptive and comparative bibliometric study with a quantitative approach was developed. The data were obtained from SCImago in June 2025, based on information from Scopus. The indicators of production (total and citable documents), impact (total citations, H-index, and citations per document), and growth (annual production, growth rates, and global and regional participation) were analyzed. The period covered 1996-2024 and allowed for the evaluation of longitudinal trends linked to scientific and institutional reforms in both countries.

Results/Discussion. Peru had a higher cumulative output (77,771 documents) than Ecuador (60,731), as well as a higher impact in terms of total citations, citations per document, and H-index. However, Ecuador experienced rapid growth between 2016 and 2020, temporarily surpassing Peru in annual output. Starting in 2021, Peru regained and expanded its leadership, reaching a maximum difference of 2,706 documents in 2024. Both countries increased their share of global production: Peru reached 0.26% and Ecuador 0.19% in 2024.

Conclusions. Peru maintains a structural advantage in volume and scientific impact, while Ecuador's growth shows remarkable dynamism, although less sustainable over time. Both countries have improved their international presence, but they require stable policies and sustained investment to consolidate their competitiveness in the regional and global context.

KEYWORDS: bibliometrics; scientific production; Peru; Ecuador; SCImago; scientific growth.

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1. INTRODUCTION

Scientific production serves as a pivotal metric for evaluating a nation's advancement, competitiveness, and capacity for innovation. In the context of a globalized, knowledge-based economy, the generation of new scientific and technological knowledge not only drives economic growth but also contributes to solving complex social and environmental problems (Turpo-Gebera *et al.,* 2021). Consequently, the assessment of scientific endeavors through bibliometric indicators has emerged as a strategic instrument in the formulation of public policies, the allocation of resources to research and development (R&D), and the evaluation of academic and research institutions' performance (Flores-Fernandez & Aguilera-Eguia, 2018; Solano López *et al.,* 2009). Zacca-González *et al.* (2014) posit that Latin America has witnessed a notable escalation in scientific productivity in recent decades, though this trajectory has exhibited variations among individual nations. Overall, the region has gone from accounting for approximately 2% of global scientific production in the 1990s to around 5% today. This growth has been primarily driven by Brazil, which accounts for over 60% of regional output, but also by the dynamism of medium-sized countries such as Mexico, Argentina, Chile, and Colombia. However, considerable disparities persist among nations, reflecting variations in the magnitude of their economies, investment in R&D, and the development stage of their national innovation systems.

Within the Andean Community, Peru and Ecuador are two case studies of particular interest. A close examination of the historical, cultural, and geographical affinities shared by these two nations reveals a complex tapestry of interconnectedness. These nations possess medium-sized economies, with GDP per capita ranging from approximately $6,000 to $7,000 (Banco Mundial, 2024). They are confronted with shared development challenges, including poverty, inequality, and a high degree of reliance on natural resources. However, in recent decades, these countries have pursued divergent paths in the development of their science and technology systems. Peru, with a population of approximately 33 million, has experienced sustained economic growth over the last two decades. However, the investment in R&D has ranged between 0.10% and 0.15% of GDP, which is well below the Latin American average (0.7%) and the minimum recommended by UNESCO (1%). Despite this limitation, Peru has implemented significant reforms in its university and scientific system, including the establishment of the National Superintendency of Higher University Education (SUNEDU) in 2014, which has instituted more rigorous quality standards for universities, and the strengthening of the National Council for Science, Technology, and Innovation (CONCYTEC) as the governing body of the science and technology system (Roa González, 2025).

Ecuador, with a population of approximately 18 million, experienced a period of intensive investment in higher education and research during the administration of Rafael Correa (2007-2017). During this period, investment in R&D exceeded 0.4% of GDP. This period was distinguished by the implementation of assertive policies, including the Prometeo scholarship program, which attracted prominent foreign scientists, the closure of institutions with substandard academic standards, and the development of new scientific infrastructure. However, following the change of government in 2017, investment in science and technology declined, which has had an impact on the vitality of the system (Hernández Lara, 2025). Despite the progress achieved, both Peru and Ecuador continue to exhibit significant lag in comparison to the leading countries in the region, including Brazil, Mexico, and Argentina. These countries allocate between 1% and 1.3% of their GDP to R&D and have much more established scientific systems with greater capacity for innovation (UNESCO, 2024). A comparison of scientific production between neighboring countries allows for the identification of the strengths and weaknesses of each system, as well as their growth trajectories and opportunities for collaboration. This type of analysis is especially valuable in a scenario where science is globalized, competition for resources and visibility has intensified, and regional cooperation is emerging as a strategic way to enhance joint development.

A number of studies have examined the scientific evolution of Peru and Ecuador, either separately or as part of more extensive analyses.

For instance, Herrera-Franco *et al.* (2021) conducted a study of Ecuador's scientific production from 1920 to 2020, concluding that it had undergone rapid growth since 2011. Conversely, Turpo-Gebera *et al.* (2021) examined the Peruvian case within the broader South American context, underscoring its consistent advancement, despite persistent disparities compared to leading nations. Concurrently, Limaymanta Alvarez *et al.* (2020) conducted a direct comparison between the two countries for the period 2009-2018, revealing that, although Peru had accumulated greater total output, Ecuador had exhibited more pronounced dynamism in recent years. However, there is a paucity of studies that update this comparison with recent and far-reaching bibliometric indicators that incorporate the changes observed up to 2024. The relevance of this study is multifaceted. First, it updates bibliometric data to include the most recent 5 years (2020-2024), a period marked by the COVID-19 pandemic on global scientific systems. Second, it conducts a longitudinal analysis of nearly three decades, allowing for the identification of long-term trends and the evaluation of the impact of scientific policies implemented at different times. Third, it contextualizes the progress made by Peru and Ecuador within the Latin American and global landscape, offering a broader comparative perspective. In conclusion, the study offers significant insights to science policymakers by elucidating the most efficacious strategies for fostering scientific growth in both countries and the region.

This study aims to address this lacuna by conducting a comparative bibliometric analysis of scientific production in Peru and Ecuador between 1996 and 2024. The primary objective of this study is to evaluate and contrast the evolution of production, impact, and growth of scientific activity in both countries, and to answer key questions: What has been the growth trajectory of scientific production over these three decades? Which nation has accumulated a greater scientific volume and impact? Do significant differences exist in their growth patterns and thematic specialization? The results of this study will provide an updated and detailed overview of the scientific landscape in Peru and Ecuador. Moreover, the results will provide concrete evidence to guide more effective science policies.

2. METHODOLOGY

A descriptive and comparative bibliometric study with a quantitative approach was conducted to analyze scientific production in Peru and Ecuador. Bibliometrics is the discipline that utilizes mathematical and statistical methodologies to analyze such output and evaluate its impact. This approach furnishes an objective and quantitative perspective on research activity, facilitating the identification of trends, patterns of collaboration, and areas of greatest development. The data for this study were obtained from SCImago Journal & Country Rank (SCImago) in June 2025. SCImago is a publicly accessible portal that uses data from Elsevier's Scopus database to provide bibliometric indicators on journals and countries. SCImago was selected as the data source because of its extensive coverage and international recognition. SCImago processes information from more than 40,000 journals indexed in Scopus, covering all areas of scientific knowledge. This portal has been utilized in numerous bibliometric studies at the regional and global levels (García-Pachón & Arencibia-Jorge, 2014; Zacca-González *et al.,* 2014), thereby ensuring the comparability of this study's results with those of previous research. Furthermore, SCImago provides annually updated data, enabling the capture of the most recent trends in scientific production. The analysis period encompassed January 1, 1996, to December 31, 2024, thereby facilitating a longitudinal examination of nearly three decades. For the purpose of comparison, the following bibliometric indicators were selected in accordance with standard practices in scientific evaluation studies:

- Production indicators:
  - *Total documents:* Total number of publications registered for each country.
  - *Citable documents:* Articles, reviews, and conference presentations, which are the types of documents that are most frequently cited.
- Impact indicators:
  - *Total citations:* Total number of citations received by published documents.
  - *H-index:* Measures the productivity and impact of citations from a set of publications. A country has an H-index if it has

published H articles that have each received at least H citations.
    - *Citations per document:* Average number of citations received per published document, an indicator of average impact.
- Growth indicators:
    - *Temporal evolution of annual production:* Number of documents published per year.
    - *Annual growth rate:* Percentage change in the number of documents from one year to the next.
    - *Participation in global and regional scientific production:* Percentage of each country's output relative to the total for Latin America and the world.

The data analysis was executed in a series of stages. Initially, the raw data for the indicators corresponding to Peru and Ecuador were extracted and tabulated from the SCImago portal. Subsequently, the growth rates and percentage differences for each indicator were calculated. To facilitate comprehension of the trends and patterns identified, comparative tables and graphs of temporal evolution were generated. The graphs were created using the Matplotlib library in Python, following the criteria of clarity and visual precision. The analysis was complemented by a review of the relevant literature to contextualize the results and discuss their implications. The selected period of analysis (1996-2024) is particularly relevant because it coincides with significant transformations in the science and technology systems of both countries. In the Peruvian context, this period encompasses the establishment of the National System of Science, Technology, and Technological Innovation (SINACYT) in 2004, the implementation of the novel University Law in 2014, and the formation of SUNEDU. In Ecuador, it encompasses the implementation of the Organic Law of Higher Education (LOES) in 2010, the Prometeo scholarship program, and reforms to the university system that resulted in the closure of institutions with substandard academic quality. These institutional milestones have exerted a direct influence on scientific production, and longitudinal analysis facilitates the evaluation of their effects. The standard formula was used to calculate growth rates:

$$\text{Growth rate} = [(\text{Final value} - \text{Initial value}) / \text{Initial value}] \times 100$$

The annual growth rates were calculated by comparing each year's output with that of the previous year. Cumulative growth was calculated by comparing the value of the last year of the period with that of the first. These metrics identify not only the volume of growth but also its speed and sustainability over time. It is imperative to acknowledge the methodological limitations inherent in this study. First, Scopus's geographical and linguistic coverage is biased towards publications in English and from developed countries, which could lead to an underestimation of scientific production in Spanish or published in non-indexed regional journals. Second, bibliometric indicators measure output and impact in terms of publications and citations; however, they do not take into account other important dimensions of scientific activity, such as technological innovation, patents, knowledge transfer, or the social impact of research. Third, the H-index and citations per document are influenced by factors such as the size of scientific communities, citation practices in different disciplines, and the time elapsed since publication. Despite these limitations, bibliometric indicators remain valuable and widely accepted tools for the comparative evaluation of national scientific systems.

3. RESULTS

A thorough analysis of bibliometric data from Peru and Ecuador for the period 1996-2024 reveals significant disparities in their trajectories of scientific production, impact, and growth. The most salient results are presented below.

3.1. Production and cumulative scientific impact

With respect to cumulative output, Peru has a substantial advantage over Ecuador. As illustrated in Table 1 and Figure 1, Peru has published a total of 77,771 documents, which is 28% more than Ecuador's 60,731. This discrepancy of 17,040 documents is substantial and indicative of the Peruvian scientific system's more pronounced historical consolidation. Peru's advantage is consistently maintained in the impact indicators: A comparative analysis reveals that Peru surpasses Ecuador in total citations (1,131,441 versus 745,765), representing a 52% increase in citations; in citations per document (14.55 versus 12.28); and, notably, in the H-index (340 versus 243), with a 97-point discrepancy, equivalent to 40% more. The H-index is a particularly revealing metric, as it combines two important dimensions of scholarly impact: productivity and influence. An H-index of 340 for Peru signifies that the nation has published a minimum of 340 articles that have garnered 340 or more citations each, thereby indicating a substantial volume of production and a considerable corpus of influential research. The 97-point disparity in the H-index indicates that Peru possesses a cumulative advantage in establishing a robust foundation of high-impact research. While the average citation rate in Peru is only 2.27 points higher than in Ecuador, the average impact is 18% higher, suggesting that Peruvian publications receive more citations on average than their Ecuadorian counterparts.

According to the available statistics, Peru is ranked sixth among Latin American countries, while Ecuador is ranked seventh. This relative position is significant because it places both countries in an intermediate group of Latin American nations, above countries such as Cuba, Venezuela, and Uruguay, but still far behind regional leaders such as Brazil, Mexico, Argentina, Chile, and Colombia. The discrepancy between the top performers and the rest of the field is substantial. Brazil, the regional leader, has 1,527,999 documents, which is almost 20 times more than Peru. Colombia, in fifth place, has 207,998 documents, which is almost three times more than Peru.

Indicator	Peru	Ecuador	Difference
Total documents	77,771	60,731	+17,040 (28%)
H-index	340	243	+97 (40%)
Citations per document	14.55	12.28	+2.27 (18%)
Latin America ranking	6	7	−1 position

Table 1. General bibliometric indicators for Peru and Ecuador (1996-2024).
Source: Prepared by the authors based on data from SCImago Journal & Country Rank (2025).

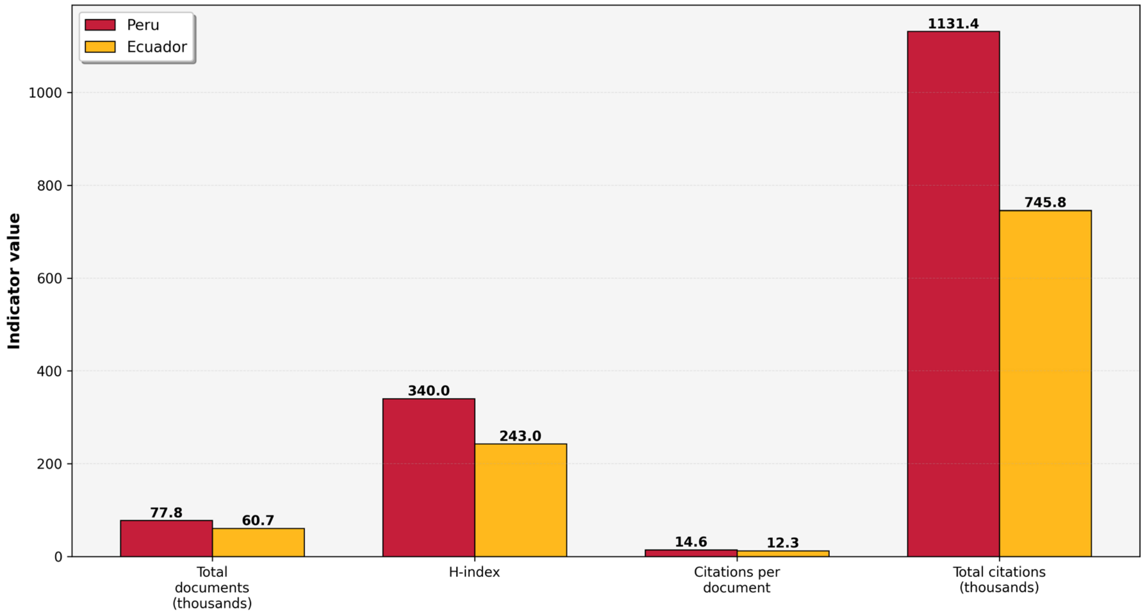

Figure 1. Comparison of main bibliometric indicators between Peru and Ecuador (1996-2024).

3.2. Evolution and growth of scientific production

Figure 2 illustrates the evolution of annual scientific production in both countries, unveiling a captivating dynamic of convergence and divergence. Exponential growth has been observed in both countries, especially since 2015, a period that corresponds with significant institutional reforms in both countries. Ecuador demonstrated a higher total percentage growth than Peru during the specified period (8261% versus 5287%), with a notable increase from 101 documents in 1996 to 8445 in 2024, while Peru went from 207 documents to 11,151 during the same period. A significant landmark was achieved in 2016, when Ecuador's annual production, amounting to 2,549 documents, exceeded that of Peru, which stood at 2,519 documents. This marked the first instance in which Ecuador surpassed Peru in terms of document production, with a narrow margin of 30 documents. This Ecuadorian surge was not an isolated event; rather, it marked the onset of a 5-year period (2016-2020) during which Ecuador consistently maintained an annual production output that exceeded that of Peru. In 2017, a marked increase in the discrepancy was observed, with 3,738 documents produced in Ecuador as compared to 3,050 in Peru, indicating a 688-document disparity. The peak of this Ecuadorian advantage was reached in 2018, when Ecuador produced 4,744 documents, 1,117 more than Peru.

However, beginning in 2021, a shift in trend was observed. It is evident that Peru has regained the leading position in terms of document production, with a total of 8,457 documents recorded in comparison to Ecuador's 6,351. Furthermore, Peru has consistently widened the gap in subsequent years, indicating a persistent trend in its leadership in document production. In 2024, Peru registered 11,151 documents, in contrast to Ecuador's 8,445, marking a discrepancy of 2,706 documents, which is the most significant disparity documented throughout the entire period of analysis. This shift in trend indicates that Ecuador experienced explosive growth over a brief period, while Peru has exhibited a greater capacity for sustainability and acceleration over an extended timeframe. A more detailed analysis, divided into subperiods, reveals interesting patterns. From 1996 to 2010, both countries demonstrated moderate growth, with Peru sustaining a consistent lead. From 2011 to 2015, Ecuador experienced an acceleration in its economic growth, thereby reducing the gap with Peru in terms of economic development. From 2016 to 2020, Ecuador underwent a period of significant economic growth, characterized by remarkable expansion rates. In the period spanning from 2021

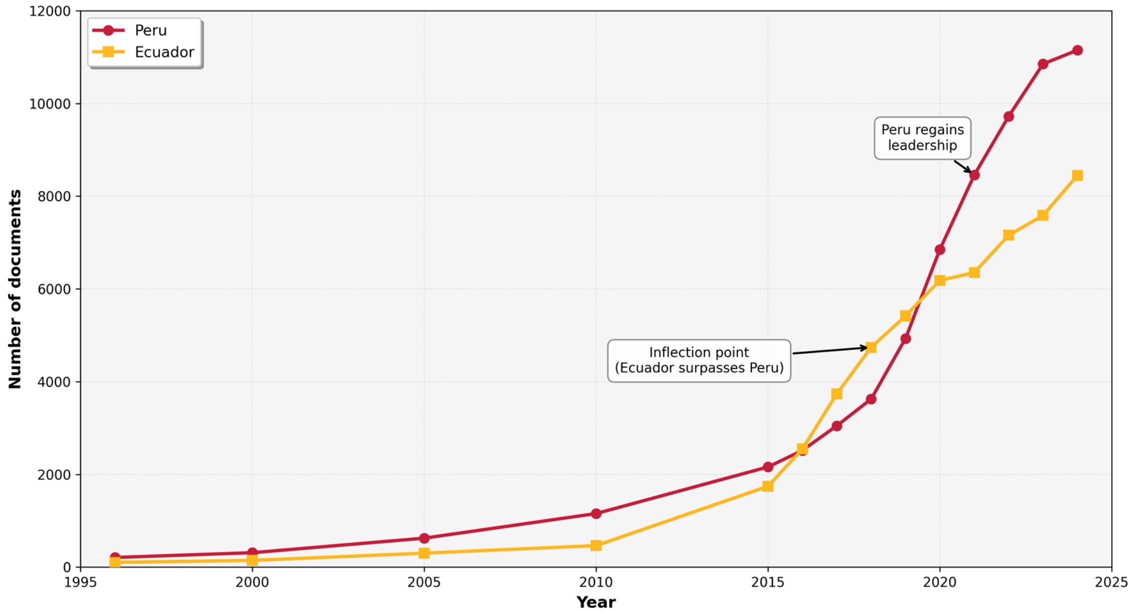

Figure 2. Evaluation of annual scientific production of Peru and Ecuador (1996-2024).

to 2024, Peru has experienced a notable resurgence in its economic output, characterized by consistent growth rates that have facilitated not only the country's recovery but also its attainment of levels of production that significantly surpass those of Ecuador.

Figure 3 presents the annual growth rates since 2016, offering a more dynamic perspective on the phenomenon. Ecuador demonstrated remarkable economic growth, with rates of 46.2% in 2016 and 46.6% in 2017, which significantly exceeded those of Peru, which were 16.6% and 21.1%, respectively. These extraordinary rates are indicative of the impact of aggressive investment policies in higher education and research implemented in Ecuador during the Rafael Correa administration. Such policies include the Prometeo scholarship program, which attracted high-level foreign scientists, and the closure of low-quality universities, which concentrated resources in more competitive institutions. However, in the subsequent years, Ecuador's economic growth experienced a significant decline, as evidenced by the decline in the growth rate depicted in Figure 3. In 2018, the growth rate decreased to 26.9%, and in 2019, it further declined to 14.3%. Conversely, Peru experienced an acceleration, with rates of 36.1% in 2019 and 38.8% in 2020. The Peruvian educational system has undergone significant changes in recent years, particularly with the implementation of university reforms initiated by the 2014 University Law. These reforms have coincided with a period of strengthening of the SUNEDU, which has established more rigorous quality standards and promoted research as a fundamental pillar of higher education. The year 2021 proved to be a particularly critical juncture for both nations. Ecuador experienced its lowest growth rate of the period (2.8%), a development that may be attributable to the impact of the economic and political crisis, as well as reduced investment in science and technology. Conversely, Peru exhibited robust growth of 23.5%, enabling it to reestablish its preeminent standing. In subsequent years, both countries exhibited more moderate growth rates, with Peru ranging between 2.7% and 15%, and Ecuador between 6% and 12.7%. The overall slowdown in 2024 (Peru, 2.7%; Ecuador, 11.4%) may be attributable to saturation effects, budget constraints, or the effect of a higher basis of comparison.

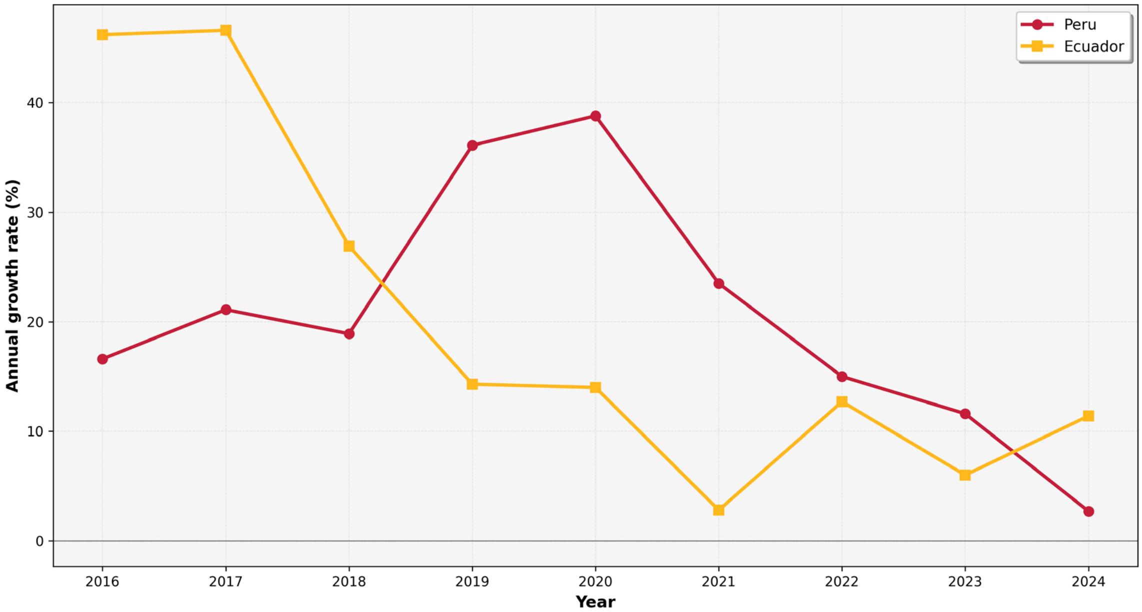

Figure 3. Annual growth rate of scientific production (2016-2024).
Source: Prepared by the authors based on data from SCImago Journal & Country Rank (2025).

Table 2 provides a synopsis of the evolution of annual production, delineating three discrete periods: the initial period of Peruvian dominance (1996-2015), the subsequent period of Ecuadorian leadership (2016-2020), and the final period of

Peruvian resurgence (2021-2024). It is noteworthy that the absolute difference between the two countries reached its historic high in 2023, with a discrepancy of 3,270 documents, representing a 43% gap in favor of Peru.

Year	Peru	Ecuador	Difference	Leader
1996	207	101	+106 (Peru)	Peru
2000	310	144	+166 (Peru)	Peru
2005	624	300	+324 (Peru)	Peru
2010	1,155	463	+692 (Peru)	Peru
2015	2,161	1,744	+417 (Peru)	Peru
2016	2,519	2,549	+30 (Ecuador)	Ecuador
2017	3,050	3,738	+688 (Ecuador)	Ecuador
2018	3,627	4,744	+1,117 (Ecuador)	Ecuador
2019	4,935	5,420	+485 (Ecuador)	Ecuador
2020	6,849	6,180	+669 (Perú)	Ecuador
2021	8,457	6,351	+2,106 (Perú)	Perú
2022	9,723	7,156	+2,567 (Perú)	Perú
2023	10,854	7,584	+3,270 (Perú)	Perú
2024	11,151	8,445	+2,706 (Perú)	Perú

Table 2. Evolution of annual scientific production in Peru and Ecuador (selected periods).
Note: The period 2016-2020 (highlighted) marks Ecuador's leadership in annual output.
Source: Prepared by the authors based on data from SCImago Journal & Country Rank (2025).

3.3. Participation in the regional and global context

The observed growth in scientific production in both countries is reflected in their increasing participation in the global and regional context, which represents a significant achievement for nations that have historically had a limited presence in global science. Peru's share of global production exhibited a marked increase, rising from 0.02% in 1996 to 0.26% in 2024, representing a 13-fold growth (Figure 4). Ecuador, for its part, exhibited a 19-fold increase, rising from 0.01% to 0.19% during the same period. While these percentages may appear unremarkable in absolute terms, they signify substantial progress when taking into account the initial state and relative magnitude of these nations.

A thorough examination of the evolution of global participation over time reveals the presence of several distinct periods. From 1996 to 2010, the participation rates of both countries remained at a minimal and relatively stable level. Peru exhibited fluctuations between 0.02% and 0.05%, while Ecuador demonstrated variations between 0.01% and 0.02%. A marked acceleration was observed beginning in 2015. Peru's percentage increased from 0.07% in 2015 to 0.26% in 2024, indicating a steady and sustained growth trajectory. Ecuador, which experienced an accelerated economic expansion from 2015 to 2019, exhibited a notable shift in its growth trajectory. Initially, the country's economy grew from 0.06% in 2015 to 0.16% in 2020. However, subsequent years witnessed a moderation in its growth rate. Within the context of Latin America, Peru has solidified its standing in sixth place, while Ecuador holds the seventh position. This is a noteworthy development, as both countries have surpassed nations with a longer scientific tradition, such as Cuba and Venezuela, in terms of recent scientific production. For several decades, Cuba has been a scientific leader in Latin America, particularly in the fields of biotechnology and medicine. However, it has recently been surpassed by Peru and Ecuador in terms

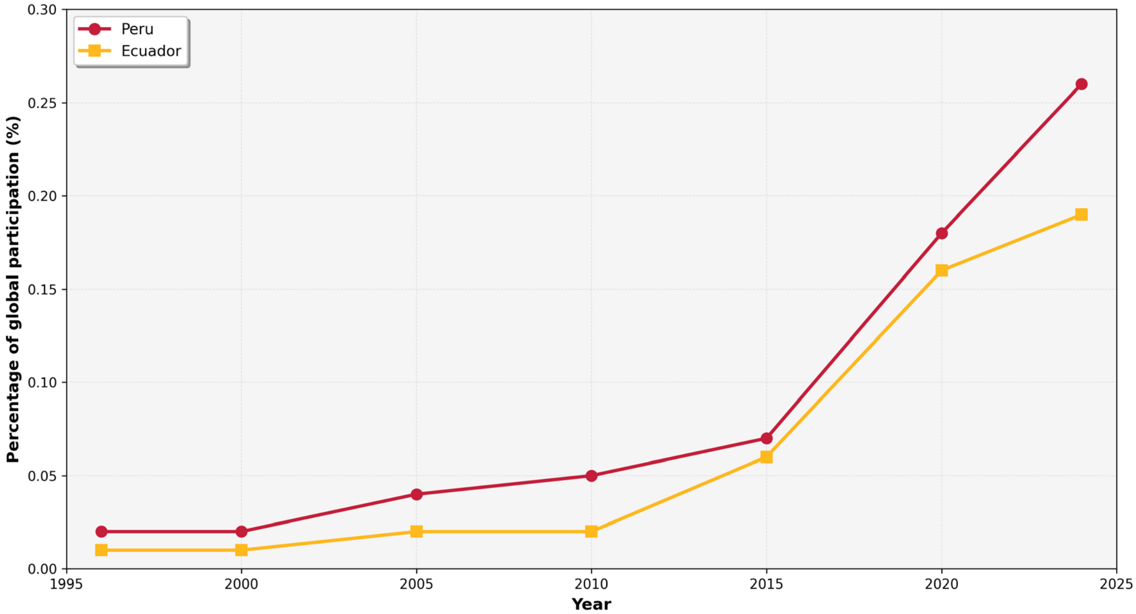

Figure 4. Evolution of participation in global scientific production (1996-2024).
Source: Prepared by the authors based on data from SCImago Journal & Country Rank (2025).

of cumulative scientific production. In the 1970s and 1980s, Venezuela possessed one of the most advanced scientific systems in the region. However, due to the economic and political crises it has faced, the nation has since experienced stagnation and decline.

Figure 5 provides a contextual framework for understanding the position of Peru and Ecuador within the ranking of the top 10 countries in Latin America. Brazil's supremacy is unmistakable, with a staggering 1,527,999 documents, constituting approximately 60% of the region's

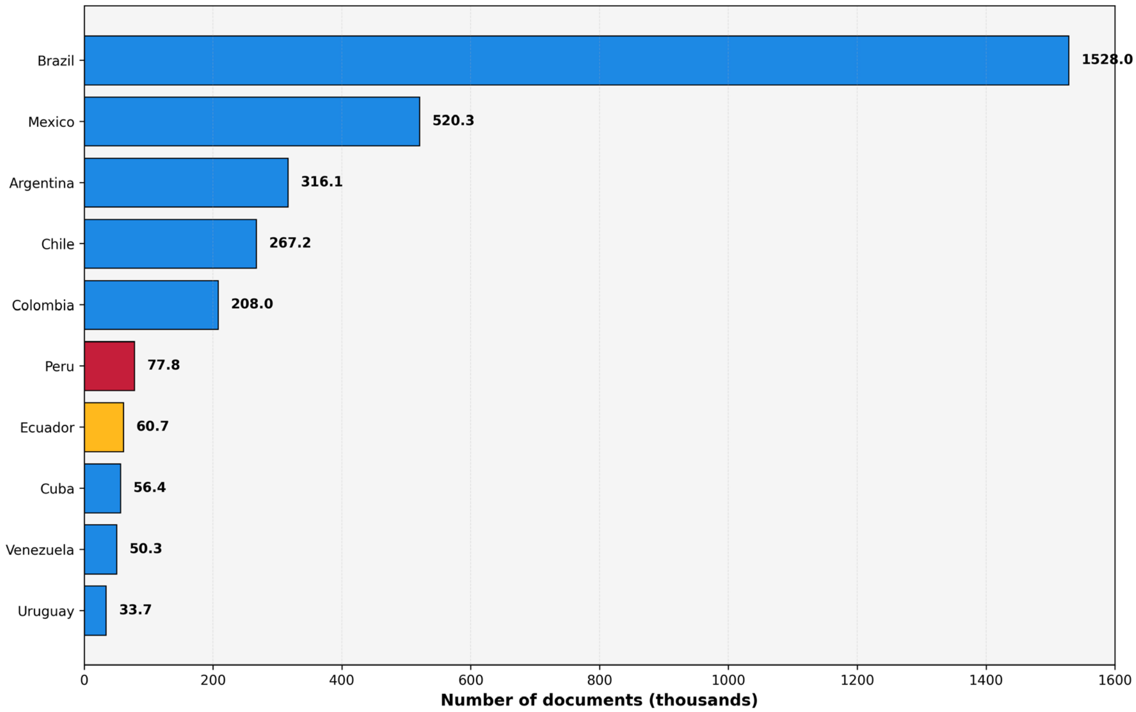

Figure 5. Scientific production of the top 10 Latin American countries (1996-2024).

aggregate production. According to the most recent data, Mexico has the second-highest number of documents, with a total of 520,267. It is followed by Argentina, which has 316,119 documents; Chile, with 267,237 documents; and Colombia, with 207,998 documents. Peru, with 77,771 documents, accounts for approximately 3% of Latin American production, while Ecuador, with 60,731 documents, accounts for around 2.4%. Collectively, Peru and Ecuador account for approximately 5.4% of Latin America's scientific production, a proportion that is noteworthy when considering that both countries account for approximately 10% of the region's population.

3.4. Trend analysis and projections

The analysis of these trends enables the identification of patterns and the projection of future scenarios. Maintaining average growth rates for the 2020-2024 period would allow Peru to reach between 13,000 and 14,000 documents per year by 2026, while Ecuador could reach between 9,500 and 10,000 documents. However, it is imperative to exercise discernment when interpreting these projections, as scientific advancement is not a linear process and is influenced by numerous external factors, including the availability of funding, political stability, and economic crises. A salient feature pertains to the cyclical convergence and divergence exhibited by the two nations. From 1996 to 2015, the discrepancy in production between the two nations remained relatively stable, with Peru generating approximately twice the number of documents that Ecuador did. However, between 2016 and 2020, this gap underwent a significant narrowing, even reaching a temporary reversal. Since 2021, the disparity has widened once more, albeit with a divergent dynamic, as both countries have attained notably higher production levels than in the preceding period. A comparative analysis of growth trajectories reveals that Peru has followed a model of "sustained growth," marked by gradual yet consistent increases, while Ecuador has followed a model of "big bang," with periods of explosive growth followed by stabilization. A critical evaluation of both models reveals that each possesses distinct advantages and disadvantages. The Peruvian model offers greater predictability and sustainability; however, it may be more time-consuming to implement. The Ecuadorian model has been shown to facilitate expeditious progress; however, it is more susceptible to the repercussions of external shocks and political transformations. The repercussions of the COVID-19 pandemic on scientific productivity in these nations warrant particular consideration. Contrary to prevailing assumptions, both countries demonstrated notable economic growth in 2020, a development that may be attributed to a surge in research activities related to public health, epidemiology, and the social sciences in the context of the pandemic. In 2020, Peru witnessed its most significant annual growth rate of 38.8%, while Ecuador maintained a positive growth trajectory of 14%.

4. DISCUSSION

The results of this comparative bibliometric analysis reveal a complex dynamic in the scientific production of both countries. Despite Peru's historical dominance in terms of output volume and cumulative impact, Ecuador's rapid growth, particularly from 2015 to 2019, has profoundly reshaped the scientific landscape of the Andean region. Ecuador's achievement of a higher annual output than Peru in 2016 signified the efficacy of its assertive investment policies in higher education and research, exemplified by the Prometeo scholarship program (Secretariat of Higher Education, Science, Technology, and Innovation [SENESCYT], 2019). This finding is consistent with the study by Limaymanta Alvarez *et al.* (2020), who predicted that Ecuador would continue to produce more than Peru over the next decade. Concurrently, Narayan *et al.* (2023) demonstrated that South American scientific production, in its totality, exhibited sustained growth that was associated with institutional reforms and academic mobility programs. Nevertheless, Peru's recovery of leadership from 2021 onwards suggests greater resilience and consolidation of its science and technology system. The sustained economic growth Peru has experienced in recent years can be attributed to several factors, including the establishment of the SUNEDU and the augmentation of research grants administered by the CONCYTEC. Peru's superior performance in impact indicators, including the H-index and citations per document, indicates that its scientific production, in addition to its sheer volume, exerts a more substantial influence on the international scientific community. This phenomenon could be associated with an increased level of international collaboration, as observed by Da Costa (2024), who identified Peru as a leader in international collaboration among Andean countries. Additionally, this trend could be linked to the consolidation of universities as prominent centers of scientific production in the region, as emphasized by Flores Rivera (2025).

Despite the remarkable growth of both countries, it is imperative to contextualize their achievements within the broader regional and global frameworks. Within the context of Latin America, Peru and Ecuador have yet to achieve the status of regional scientific powers comparable to Brazil and Mexico. Brazil, with a population of over 210 million and R&D investment exceeding 1.2% of GDP, produces almost 20 times more documents than Peru, while Mexico, with similar R&D investment, produces 6.7 times more. This is evidenced by the substantial outperformance of Chile and Argentina, which allocate more than 0.5% of their GDP to R&D, over Peru and Ecuador (Red de Indicadores de Ciencia y Tecnología, 2024; UNESCO, 2024). This phenomenon can be attributed, at least in part, to the structural funding gaps that have been identified by Limachi Apaza (2025b). Apaza's research indicates that countries that implement intermittent science and technology policies tend to exhibit diminishing returns in their scientific productivity. A particularly illuminating aspect of the analysis is the examination of citations per document. Peru (14.55) and Ecuador (12.28) are below the average for countries such as Argentina (20.92), Chile (20.40), Uruguay (21.47), and even Venezuela (17.40) (Scimago Research Group, 2024). Despite the successful augmentation of their production capacity, both nations continue to grapple with issues pertaining to the quality and impact of their research endeavors. As indicated by Joshi (2014) and García-Villar and García-Santos (2021), citations per document serve as indirect indicators of academic recognition. These citations must therefore be interpreted in conjunction with other quality parameters, including the impact factor, international collaboration, and methodological innovation. The lower values observed in Peru and Ecuador may be indicative of a higher proportion of applied or local research with reduced international visibility, or a specialization in subject areas with lower citation rates (Bornmann & Haunschild, 2019).

The most productive subject areas identified by Limaymanta Alvarez *et al.* (2020) —occupational and environmental health for Peru and educational research and environmental sciences for Ecuador— reflect both national priorities and niches of specialization that could be further developed. Peru's geographical and ecological diversity affords it comparative advantages in research domains including biodiversity, mining, health in high-altitude areas, and tropical diseases. Ecuador has demonstrated notable strengths in environmental sciences and pedagogy, particularly evident in the Galapagos Islands, which is indicative of the country's commitment to education as a catalyst for development (Rodríguez *et al.,* 2022). Furthermore, according to Limachi Apaza (2025a), academic mobility and international cooperation act as catalysts to increase the impact and visibility of scientific production in contexts of low structural investment. Da Costa's (2024) analysis of international collaboration provides further insight into the disparities in impact. Peru, with 60.1% international collaboration, leads among Andean countries, which could partly explain its higher H-index and greater number of citations per document compared to Ecuador. International collaboration has been demonstrated to increase the visibility of publications, as well as facilitate access to resources, advanced methodologies, and broader citation networks. As Flores Rivera (2025) cautions, the reinforcement of Andean academic networks and the enhancement of leadership within public universities in knowledge generation are imperative for sustaining long-term scientific advancement.

The observed dynamics between Peru and Ecuador also give rise to questions regarding the sustainability of scientific growth. The case of Ecuador demonstrates that substantial economic growth can be accomplished expeditiously through substantial investments and comprehensive structural reforms. However, the subsequent deceleration indicates that sustaining that momentum necessitates sustained investment, political stability, and institutional continuity (Banco Mundial, 2024). Peru, with its more gradual yet consistent growth trajectory, offers a compelling case study. It demonstrates that the consolidation and enhancement of institutional capacities can yield equally effective long-term outcomes. As Lundvall *et al.* (2022) contend, a unidirectional progression to scientific development is implausible; the efficacy of either "big push" or "incremental growth" strategies is contingent upon the prevailing political, economic, and institutional context.

5. CONCLUSION

This comparative study has revealed complex dynamics and divergent trajectories in scientific production in Peru and Ecuador. While Peru consolidates its leadership based on sustained growth and greater impact, Ecuador demonstrates the potential of intensive investment to accelerate scientific development, albeit with challenges in terms of sustainability. However, both countries have made significant progress and face the common need to strengthen their science and technology systems in order to compete on the regional and global stage. Future research could delve deeper into the analysis of thematic specialization, the impact of international collaboration on research quality, and the relationship between R&D investment and scientific results at the institutional level.

Conflict of interest

The authors declare that there is no conflict of interest.

Contribution statement

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Statement of data consent

The data generated during this study have been included in the manuscript.

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