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ORIGINAL ARTICLE

Collaboration patterns in investment research: A two-decade analysis of Latin America's research landscape

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ABSTRACT

Objective. In this study, we utilized bibliometric techniques to identify patterns of scientific collaboration in Latin American investment research. By examining collaboration networks, we investigated the networks of authors, institutions, and countries involved in the research process.

Methodology. This study employed the Scopus database to examine the literature published over the past two decades (2005-2023). The collaboration networks were represented as a network of co-authorship and collaboration among research scholars. The walk-trap clustering algorithm was employed to visualize the collaboration networks, with a restriction to display labels for a maximum of 50.

Results. The international collaboration rate of authors was found to be 33.01%, indicating a relatively lower level of global collaboration. Despite a substantial research output over the last two decades, there needs to be more global interconnectedness. The *University of São Paulo in Brazil* and the *University of California* are the most collaborative among institutions. At the country level, Brazil is identified as the most collaborative nation among Latin American countries, engaging extensively in cooperative activities with both Latin American and other countries around the globe. This is indicative of a significant research emphasis in Brazil on the topic of investment. In addition, countries such as Trinidad and Tobago serve as a connecting link between Latin America and other regions, thereby underscoring their strategic role in fostering global research networks.

Conclusions. Fostering collaboration networks at the author, institutional, and country levels can enhance knowledge's global flow and interexchange.

Keywords: investment research; collaboration networks; bibliometric analysis; Latin America; co-authorship.

INTRODUCTION

The concept of investment is imbued with a multitude of nuances, contingent upon the scope under consideration. In practical terms, however, there exist three principal features: (a) investment characteristics, (b) explicit exclusion of certain assets, and (c) compliance with local laws (Shang & Wang, 2021). The published scientific research on this subject is extensive,

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which has led to the development of numerous bibliometric studies examining patterns of literature growth, thematic evolution, and impact. A review of the bibliometric literature on investment revealed several approaches of interest.

The initial approach is associated with green and sustainable investment. For example, Chițimiea *et al.* (2021) conducted a bibliometric and systematic review to identify the key drivers of green investment. Their analysis revealed that environmental policies, technological advancements, and financial incentives are among the most significant influences on this phenomenon. Kwilinski (2024) conducted a comprehensive bibliometric analysis of global green energy and investment research, identifying key trends, regions, and influential studies. Concurrently, Kapil and Rawal (2023) conducted a bibliometric and systematic review of sustainable, environmental, social, and governance (ESG) investing, identifying a notable surge in research driven by heightened awareness of sustainability and ethical considerations. The study delineates pivotal growth sectors within ESG investing, underscoring the influence of regulatory shifts and investor demand on the market.

Similarly, Shome *et al.* (2023) conducted a bibliometric analysis to identify trends in impact investment for sustainable development. Their findings revealed vital themes, including social impact measurement and the optimal balance between financial returns and social outcomes. The study highlights the growing significance of impact investment in achieving sustainable development goals. Raza *et al.* (2024) conducted a bibliometric analysis of global foreign direct investment (FDI) research focusing on climate change, thereby revealing an increasing alignment of FDI studies with environmental sustainability goals.

A second group of works has been oriented towards socially responsible investment. In this regard, Bulavinova *et al.* (2021) conducted a bibliometric analysis of research trends in responsible investment in sustainable development. The study revealed an increasing focus on integrating ESG criteria into investment strategies, thereby indicating a shift towards more ethical and accountable investment practices as part of the broader sustainable finance movement. Additionally, Rahman *et al.* (2020) conducted a bibliometric analysis of the literature on socially responsible investment (SRI) sukuk, demonstrating the growth of this niche within Islamic finance. The findings indicate a growing corpus of research dedicated to ethical investment, wherein financial objectives are aligned with social and religious tenets. This reflects an increasing demand for sustainable financial products. Chalissery *et al.* (2023) conducted a bibliometric analysis of socially responsible investment using thematic clustering, identifying significant research themes such as ESG integration and financial performance. The study underscores the evolving nature of SRI research, with an increasing focus on achieving a balance between ethical considerations and financial returns. Concurrently, Vorontsova *et al.* (2021) conducted a bibliometric analysis of the responsible investment categories, identifying evolving classifications and trends within the field. The study underscores the increasing diversification of responsible investment methodologies and the necessity for establishing uniform criteria for evaluating sustainability performance.

A second group of bibliometric studies has been oriented toward the nexus of foreign direct investment (FDI) and political risk. One notable example is the study conducted by Pan *et al.* (2022), which analyzed risk management in FDI, identifying common risk factors such as political and economic instability. The study offers insights into effective risk mitigation strategies, underscoring the necessity for comprehensive risk assessment in FDI decision-making. Jiang *et al.* (2021) employed bibliometric and qualitative methods to examine the political risk management of FDI in infrastructure projects in developing countries. In their 2021 study, da Silva-Oliveira and colleagues employed bibliometric and thematic content analysis to examine inward and outward foreign direct investment (FDI) in emerging economies. Their findings revealed the growing significance of emerging markets in global FDI flows. The study highlights these economies' distinctive challenges, including market volatility and political risks.

Nazzal *et al.* (2023) conducted an in-depth examination of FDI by multinational corporations in emerging economies, identifying pivotal trends and challenges, including political instability and market volatility. Nobanee *et*

al. (2024) conducted a comprehensive analysis of the research trends in foreign direct investment (FDI), identifying new themes and a notable shift in the literature towards a greater emphasis on economic impacts and sustainability considerations. The study offers a comprehensive overview of the current state of FDI research, emphasizing pivotal areas of focus and emerging trends.

A second group of studies has concentrated on the issue of investment risks and the implications for monetary policy. Bagow and Altaf (2023) employed a bibliometric methodology to investigate the nexus between monetary policy and corporate investment decisions. The study demonstrated that alterations in monetary policy considerably impact corporate investment, particularly during periods of economic turbulence. Bratiloveanu *et al.* (2023) employed bibliometric methods to examine investment risk across European Union states, identifying notable discrepancies in risk profiles shaped by economic, political, and financial elements. Yu *et al.* (2016) employed bibliometric analysis to assess research trends in low-carbon energy technology investment, identifying a growing emphasis on renewable energy and the pivotal role of government policies in influencing investment patterns. Finally, another approach, to a lesser extent, related to financial inclusion, literacy, and investment decision-making, such as the study of Pranajaya *et al.* (2024), employed a bibliometric approach to investigate the impact of financial inclusion on investment decisions. The findings indicate that greater access to financial services positively influences investment behavior. Enhancing financial inclusion can lead to more informed and effective investment decisions, thereby contributing to economic growth and development. Additionally, Yuvaraja and Perumandla (2024) conducted a bibliometric analysis of three decades of research on financial literacy and investment, emphasizing the pivotal role of financial literacy in influencing investment decisions. The study underscores the necessity for enhanced financial education to optimize investment outcomes and financial well-being.

In this study, we will utilize bibliometric techniques to identify patterns of scientific collaboration in Latin American investment research. By examining collaboration networks, we will investigate the networks of authors, institutions, and countries involved in the research process.

METHODOLOGY

Data extraction

This study employed the Scopus database to examine the literature published over the past two decades (2005-2023). The search was limited to the title, and the keyword "investment" was used to establish greater precision. The search equation was as follows:

> TITLE ("investment") AND PUBYEAR > 2004 AND PUBYEAR < 2024 AND (LIMIT-TO (AFFILCOUNTRY, "Brazil") OR LIMIT-TO (AFFILCOUNTRY, "Mexico") OR LIMIT-TO (AFFILCOUNTRY, "Colombia") OR LIMIT-TO (AFFILCOUNTRY, "Chile") OR LIMIT-TO (AFFILCOUNTRY, "Argentina") OR LIMIT-TO (AFFILCOUNTRY, "Peru") OR LIMIT-TO (AFFILCOUNTRY, "Ecuador") OR LIMIT-TO (AFFILCOUNTRY, "Uruguay") OR LIMIT-TO (AFFILCOUNTRY, "Venezuela") OR LIMIT-TO (AFFILCOUNTRY, "Cuba") OR LIMIT-TO (AFFILCOUNTRY, "Jamaica") OR LIMIT-TO (AFFILCOUNTRY, "Trinidad and Tobago") OR LIMIT-TO (AFFILCOUNTRY, "Paraguay") OR LIMIT-TO (AFFILCOUNTRY, "Costa Rica") OR LIMIT-TO (AFFILCOUNTRY, "Barbados") OR LIMIT-TO (AFFILCOUNTRY, "Panama") OR LIMIT-TO (AFFILCOUNTRY, "Bolivia") OR LIMIT-TO (AFFILCOUNTRY, "Puerto Rico") OR LIMIT-TO (AFFILCOUNTRY, "Dominican Republic") OR LIMIT-TO (AFFILCOUNTRY, "Nicaragua") OR LIMIT-TO (AFFILCOUNTRY, "Haiti") OR LIMIT-TO (AFFILCOUNTRY, "Honduras") OR LIMIT-TO (AFFILCOUNTRY, "Guatemala") OR LIMIT-TO (AFFILCOUNTRY, "El Salvador")). A total of 2254 articles appeared in search results. The search string is formulated so only articles published from Latin American countries appear. The complete records were downloaded and imported into the RStudio (R core team, 2021) for bibliometric analyses, and the collaboration network of authors, institutions, and countries was illustrated.

Data analysis

The data set was imported into the RStudio Package and subsequently analyzed using the Biblioshiny (Bibliometrix) application. The well-known Bibliometrix program, which operates within the RStudio environment —a well-established platform for statistical computing and graphics— was used for this analytical study. The software enabled the extraction of patterns, trends, and insights from the compiled data, thereby facilitating a comprehensive understanding of the academic environment of any given topic. A data review indicates that the term "investment" has been employed in the titles of 2,254 articles published between 2005 and 2023. The studies were conducted in 5,488 different academic institutions in 134 countries. 6,387 authors contributed to these publications, published in 1,283 different journals. The total number of citations for these publications was 23,236, as identified through a search on the Scopus database. Additionally, 6,391 keyword plus and 5,557 author's keywords were identified.

The collaboration networks were represented as a network of co-authorship and collaboration among research scholars. The walk-trap clustering algorithm was employed to visualize the collaboration networks, with a restriction to display labels for a maximum of 50. This approach focused on those with significant centrality or connections, ensuring nodes from other communities exhibited a repulsion determined by a factor of 0.05. The size of the labels represented the scientific output of a particular entity, while the size of the edges represented the links among the labels. The nodes are designated 1, 2, and 3 for authors, institutions, and countries, respectively, with an alpha transparency value of 1, ensuring a clear and visually appealing collaboration map. The network was constructed using the walk-trap clustering algorithm to identify the communities within the network.

Furthermore, the enhanced visualization facilitated a more readable and interpretable map while emphasizing significant collaborations and patterns. The association pattern was normalized to ensure that links (edges) between nodes (labels) were weighted according to the strength of their association or collaboration. The type of network layout was designated as "auto," which enabled the software to automatically illustrate the optimal design for the network's visualization. To prevent the visualization of self-loops, which would indicate that an entity was collaborating with itself, the option to allow loops was disabled. The "Remove multiple" option was set to "FALSE," enabling multiple edges between nodes to display. This indicates that all such edges will be displayed if an entity collaborates on more than one article. The network was then subjected to a process of elimination, whereby any isolated nodes or entities with no discernible collaborations were removed from the network. This resulted in a network comprising only interconnected nodes.

RESULTS

Collaboration of authors

The visualization of the collaboration network demonstrates that the more prominent labels correspond to higher centrality and that thicker edge lines indicate stronger and closer collaboration. A total of 11 different clusters of collaborating authors have been identified. The largest cluster (cluster 2; orange color) consists of six collaborating authors, with Oslina, F having the highest betweenness centrality of 4. The most collaborative authors are Moreno, R., Sauma, EE, Rutella, JR, and Domingues, EG, who have four collaborating partners. The most frequent collaborative partners are Domingues, EG, and Net, DP, followed by Sauma, EE, and Oren, SS (Fig. 1). Cluster 3 (red color) is the second largest cluster, comprising Moreno, R, Rudnick, H, Strbac, G, Sauma, EE, and Contreras, J. This cluster is more tightly grouped, with Moreno, R situated at the center. The cluster is moderately less central, as reflected by the betweenness centrality values. Moreno, R, has a betweenness centrality of 1 and a closeness centrality of 0.5, indicating that while Moreno, R is a highly influential figure within their cluster, his interconnectedness with the other cluster is moderate.

Cluster 1 (green) and Cluster 5 (blue) exhibit an identical number of nodes and four authors. Cluster 1 comprises Aquila G, Morosini F, Badin MRS, and Rutella, JR, while Cluster 5 includes Domingues EG, Neto DP, Alves AJ, and Calixto WP. In both clusters, most authors

exhibit a high closeness centrality of 1, indicative of their effective collaboration within the network. Nevertheless, none of the authors in this cluster have a high betweenness centrality value of 0, indicating that they primarily collaborate within their respective groups without interconnecting with other clusters. The remaining clusters (clusters 4, 5, 6, 7, 8, 9, 10, and 11) are smaller clusters comprising two nodes each. While these authors may be engaged in close collaboration on specific topics, as indicated by their closeness centrality value of 1, they do not appear to be interconnected with other authors outside of their respective clusters, as evidenced by their betweenness centrality value of 0.

The cumulative degree distribution graph of the author's social network depicts the proportion of authors with at least a certain number of collaborative links. It was observed that among the top 50 authors with at least one connection, only 60% showed a promising collaboration. Furthermore, there is a steep decline in the slope from node 5 to 20, which suggests that the cumulative degree of cooperation is between 0.6 and 0.4. This indicates that 40% of the authors in the collaboration network have few connections. The flattening of the slope, especially from node 20 onwards, suggests that, despite a lesser collaborative effort, most authors still maintain some level of collaboration (Fig. 2).

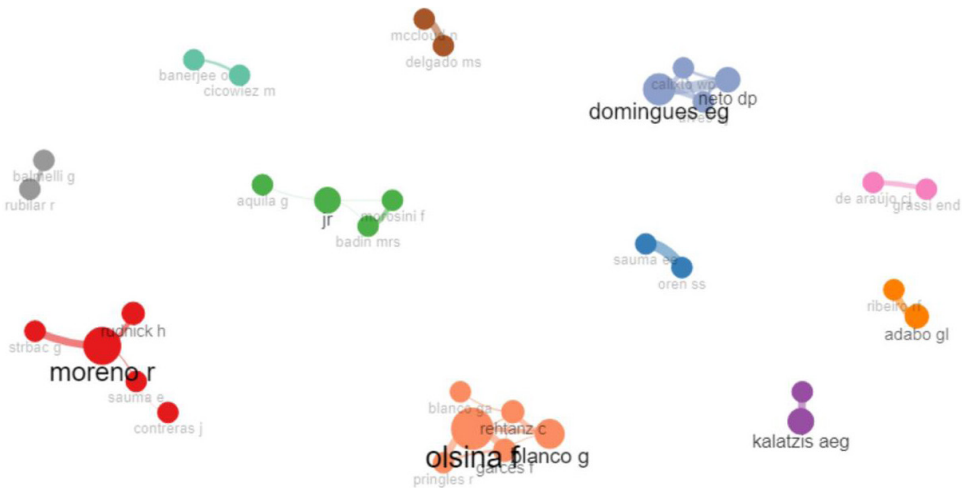

Figure 1. Collaboration network of authors.

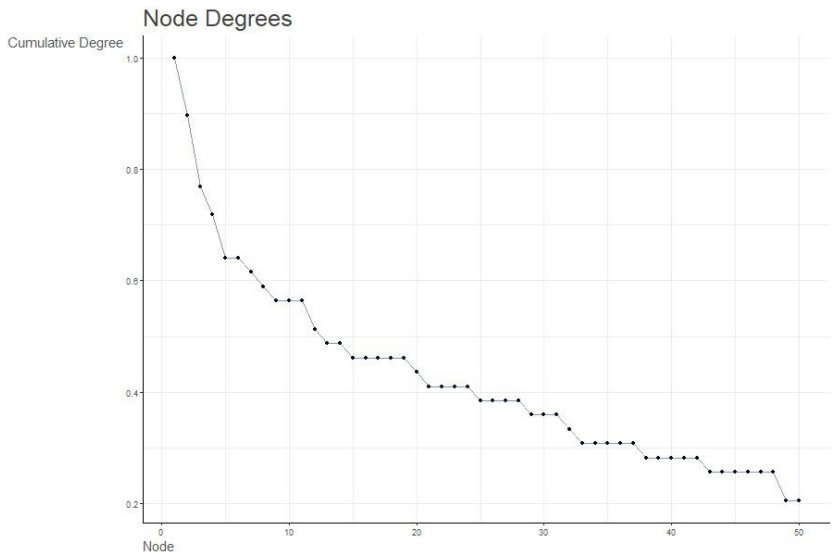

Figure 2. Cumulative distribution graph of author's collaboration network.

Collaboration of institutions

The largest cluster of collaborations is comprised of 34 participating institutions. The top five collaborating institutes are the University of São Paulo (Brazil), the University of California, the University of Los Andes, the University of Concepción, and the University of Chile. Other institutions demonstrating a notable capacity for collaboration include the North Federal University of Paraíba, Fluminense Federal University, North Carolina State University, and the University of Minnesota. The University of North Carolina at Chapel Hill demonstrates the most robust collaborative relationship with the Universidad Austral de Chile and the Federal University of Paraná. The following most frequent collaborative partners are two Colombian universities: Francisco José de Caldas District University and the National University of Colombia. These institutions demonstrate a robust collaborative relationship, as illustrated in Figure 3.

The University of São Paulo, with a betweenness centrality of 285, is positioned as a pivotal node in the interconnectivity of diverse clusters. It establishes itself as a hub for academic collaborations within the Latin American region and with institutions across other continents. Chilean universities, such as Pontificia Universidad Católica de Chile and the University of Chile, also emerge as vital nodes, exhibiting a betweenness centrality of 69 and 74, respectively, and a closeness centrality of 0.01. This illustrates the existence of robust collaborative relationships within Chile and with other Latin American countries. Similarly, universities such as the National Autonomous University of Mexico, with a betweenness centrality of 27, are more frequent collaborators within their national context but have fewer direct links to other Latin American institutions.

Notably, the network also underscores the collaborative endeavors between Latin American and North American academic institutions, particularly with the University of California (betweenness centrality 165). This intercontinental collaboration highlights the necessity of integrating Latin American research into the global scientific academic community. Among Latin American educational institutions, Brazilian and Chilean universities, notably the University of São Paulo and the University of Chile, are at the vanguard of collaborative endeavors, establishing connections with institutions worldwide. Conversely, some Latin American institutions, including the Universidad Nacional de Loja (Ecuador), the International Center for Tropical Agriculture (Colombia), the Universidad EAFIT (Colombia), and the Universidad Torcuato Di Tella (Argentina), exhibit relatively lower betweenness centrality. This indicates that these institutions are engaged in more specialized research collaborations within their respective networks, with no recorded betweenness centrality or lacking international partnerships with other institutions.

The cumulative distribution graph of the institutional collaboration network demonstrates that over 75% of the institutions within the top 50 have robust collaborative networks with one another. In comparison, 25% of them have maintained a relatively lower level of collaboration (Fig. 4).

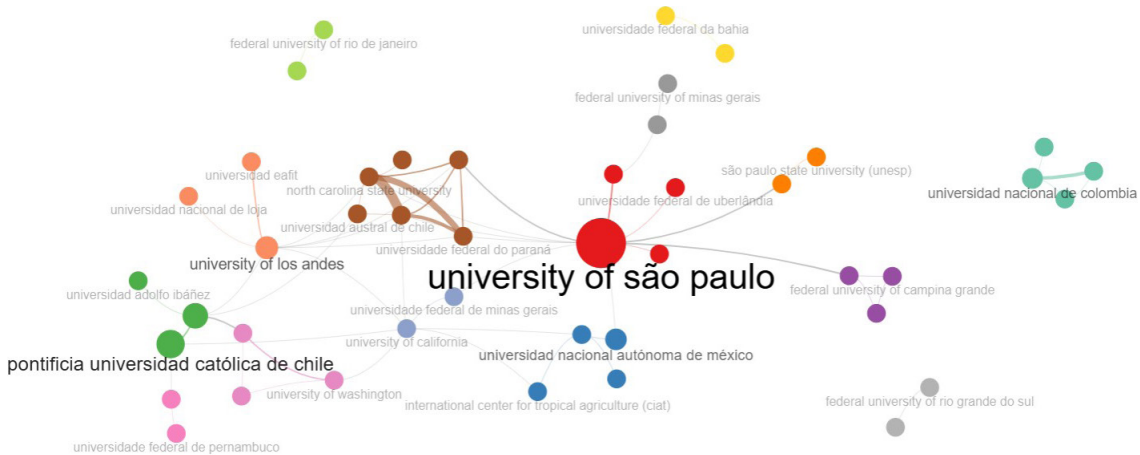

Figure 3. Collaboration network of institutions.

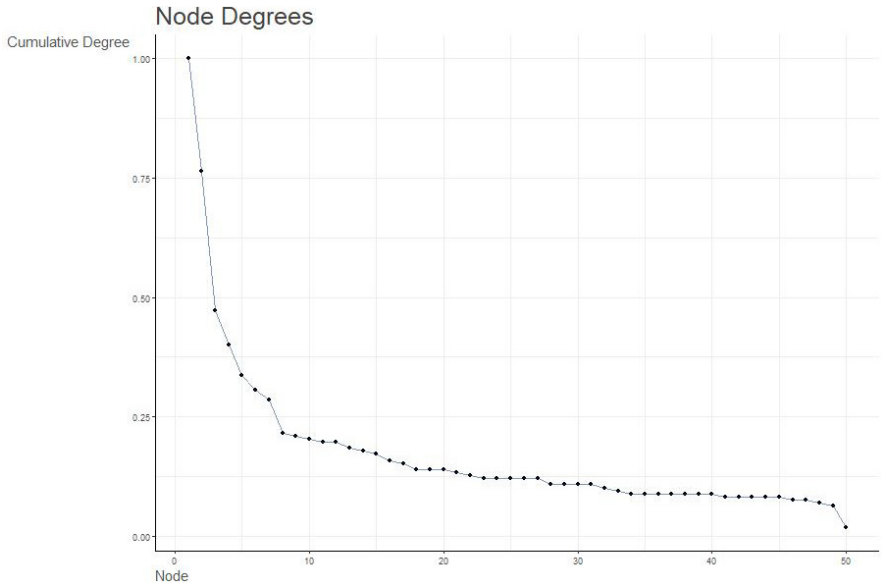

Figure 4. Cumulative distribution graph of Institution's collaboration network.

Collaboration of countries

The analysis of country collaboration networks revealed the existence of two prominent clusters, with Brazil emerging as the most prominent collaborative partner in Latin America. The United States occupies the second position, followed by Colombia, Mexico, the United Kingdom, and the United States (Figure 5). Brazil emerges as the most central Latin American country in the collaboration network, with a betweenness centrality 52. The robust interconnectivity of Brazil with other Latin American countries, including Colombia, Argentina, and Chile, as well as with the USA, the United Kingdom, and Germany, underscores its notable contributions to regional and global research collaborations at the country level. Additionally, Colombia and Mexico are notable collaborators within the academic network of Latin America and other countries such as the USA, the UK, and other European nations. Similarly, Mexico, with a betweenness centrality of 18 and a closeness centrality of 0.017, also demonstrates a propensity for forming collaborative relationships that facilitate connections between Latin America and North America, particularly the USA.

While Argentina and Peru are less central than Brazil, Colombia, and Mexico, they play an essential role in the regional academic network. Argentina's betweenness centrality of 6 and closeness centrality of 0.014 and Peru's (betweenness centrality 8 and closeness centrality of 0.017) indicate that these countries are becoming increasingly involved in regional and global collaborations. The countries of Venezuela, Bolivia, Costa Rica, Cuba, Panama, Paraguay, and the Dominican Republic, with betweenness centrality values less than 1, are situated at the network's periphery. However, these countries are actively engaged in regional collaborative endeavors. Additionally, Latin American countries such as Argentina, Peru, Ecuador, Uruguay, Venezuela, Cuba, Jamaica, Paraguay, Costa Rica, and Barbados exhibit noteworthy collaboration with countries in Asia, including Panama, India, Pakistan, Japan, and South Korea. Trinidad and Tobago serves as a pivotal nexus, facilitating interconnections between Asian, European, and other Latin American countries in collaborative networking.

The cumulative distribution graph of the countries' collaboration networks demonstrates that over 50% of the countries within the top 50 have robust collaborative networks with one another. In comparison, 50% of them have maintained a lower level of collaboration (Fig. 6).

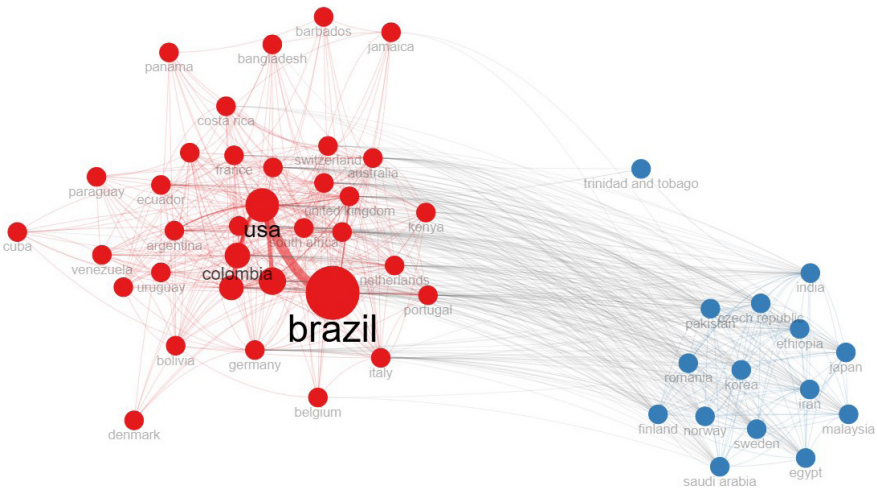

Figure 5. Collaboration network of countries.

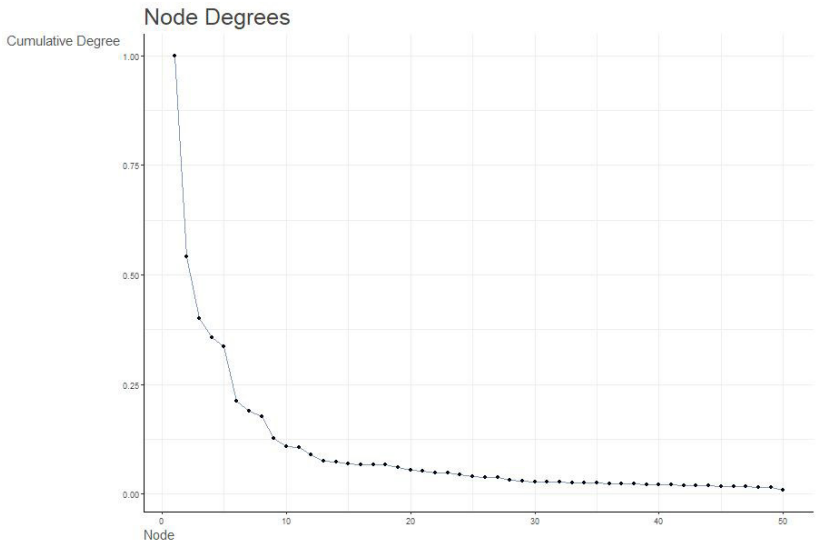

Figure 6. Cumulative distribution graph of countries' collaboration network.

DISCUSSION AND CONCLUDING REMARKS

One of the most significant findings of this study is the relatively low level of international collaboration among Latin American authors, with a rate of 33.01%. This indicates that investment-related research is predominantly regional, as evidenced by the observed co-authorship patterns. While investment studies are applied and context-responsive, this pattern of limited international collaboration limits the exchange of ideas and the overall impact of research in the region. Greater international collaboration with institutions outside the area could enhance the visibility and influence of the topic at the global level.

Concerning co-authorship networks, collaboration is primarily confined to specific groups of researchers, with minimal interaction. Authors such as Olsina F. and Moreno R. were identified as central figures within their respective groups, yet their influence remains primarily confined to localized networks. This indicates that, although robust collaboration exists, these efforts need more integration into a unified regional or global network.

The University of São Paulo and the University of California stand out as the most prominent institutions in the collaborative network of academic entities. Both institutions are integral to research collaborations within and beyond the Latin American region. The University of São Paulo

is distinguished by a high degree of centralized structure. This indicates its function as a connector within the regional academic network. However, the dominance of some institutions suggests that opportunities for collaboration are concentrated within certain academic elites, which institutions with greater or lesser research resources may marginalize. This highlights the necessity for the formulation of strategies that facilitate the expansion of opportunities for collaboration.

Regarding country-level analysis, Brazil, followed by Colombia and Mexico, emerges as a prominent contributor to research collaboration within and beyond the region. This indicates the robust infrastructure Brazil has developed for investment research. It is also noteworthy that countries such as Trinidad and Tobago are important connecting nodes, facilitating collaborative networks with institutions in Asian and European countries. The results also revealed notable discrepancies in the extent of collaboration between countries and academic institutions. While some universities and countries demonstrate a high level of connectivity, others exhibit a comparatively low level of cooperation. The case of countries and institutions from Ecuador and Argentina exemplifies this. This indicates unequal research capabilities, such as institutional interest, research funding, or collaborative programs.

These findings have significant implications for academic institutions and funding agencies. International collaboration would facilitate the dissemination of global knowledge on the subject. Further research could investigate the potential geographical constraints on international cooperation in investment and related areas.

Conflict of interest

The authors declare that they have no conflict of interest.

Contribution statement

Both authors contributed equally during the research process derived from this article.

Data availability statement

The data generated during the research process have been included in the article. ●

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