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### Co-authorship networks of Brazilian postgraduate programs in Accounting

*Redes de coautoria dos programas brasileiros de pós-graduação em Contabilidade*

*Redes de coautoria de los programas de posgrado en Contabilidad brasileños*

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#### ABSTRACT

This study aims to analyze the configuration of the social network of co-authorship of Brazilian stricto sensu Postgraduate Programs in Accounting, in the 2013-2016 quadrennium, based on the production of papers published in journals of their permanent teachers. A documentary study was performed using sociometric tools to analyze 21 programs and 291 curricula, with master's and doctorate. The main results of the research show a low density of social networks of document co-authorships. However, there is an increase in this density, when compared with previous similar studies, indicating a historical increase in co-authorship. It was found that individual characteristics of teachers influence their potential to contribute to fostering partnerships, between authors and between postgraduate programs.

**Keywords:** social networks analysis; co-authorship networks; postgraduate programs in Accounting; scientific production of teachers; fostering partnerships.

#### RESUMO

Este estudo objetivou analisar a configuração da rede social de coautoria dos programas de pós-graduação stricto sensu em Contabilidade existentes no Brasil, no quadriênio 2013-2016, a partir da produção docente de artigos publicados em periódicos científicos. Realizou-se um estudo documental, analisando-se, a partir de ferramentas de caráter sociométrico, 291 currículos lattes de todos os docentes permanentes de 21 programas de pós-graduação em Contabilidade, com mestrado e doutorado. Os principais achados da pesquisa indicam baixa densidade das redes sociais de coautorias dos docentes. Porém, observa-se uma elevação dessa densidade, se comparada com estudos similares anteriores, indicando um aumento histórico das coautorias. Verificou-se que características individuais dos docentes influenciam seus potenciais de contribuição para fomento das parcerias, tanto entre autores quanto entre programas de pós-graduação.

**Palavras-chave:** análise de redes sociais; redes de coautoria; programas de pós-graduação em Contabilidade; produção científica de docentes; fomento de parcerias.

#### RESUMEN

Este estudio tuvo como objetivo analizar la configuración de la red social de coautoria de los programas de posgrado stricto sensu en Contabilidad en Brasil, en el cuatrienio 2013-2016, a partir de la producción docente de artículos publicados en revistas científicas. Se realizó un estudio documental, analizando con herramientas sociométricas, 291 lattes curriculares de todos los profesores permanentes de 21 posgrados en contabilidad, con maestría y doctorado. Los principales hallazgos indican una baja densidad de redes sociales en coautoria de profesores. Sin embargo, hay un aumento en esta densidad cuando se compara con estudios similares anteriores, indicando un aumento histórico en la coautoria. Las características individuales de los docentes influyen en su potencial contributivo a fomentar las asociaciones, tanto entre autores como entre programas.

**Palabras clave:** análisis de redes sociales; redes de coautoria; programas de posgrado en Contabilidad; producción científica de profesores; fomentando asociaciones.

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## 1 INTRODUCTION

The evolution of Accounting Science in the Brazilian context is mainly due to the increase in the number of graduate programs (GPs) in Accounting, with new masters and doctorate courses contributing to studies in the area (Silva, Reina, Ensslin & Reina, 2012). For Costa and Martins (2016), the fact that GPs have grown in number has generated an increase in the number of congresses, journals and scientific publications related to the accounting theme. The evaluation of the Brazilian GPs and the publications from their professors, students and alumni is a responsibility of the Coordination for the Improvement of Higher Education Personnel (CAPES).

Based on the guidelines of the Quadrennial Evaluation carried out on the GPs by CAPES in the 2013-2016 quadrennium, it was emphasized the evaluation of the publications of the professors belonging to the GPs (Vogel, 2015). Therefore, considering the pressure and growing difficulty to publish, the partnership between researchers in the form of co-authorship appears as an alternative to increase the number, and even quality, of publications (Ferreira & Serra, 2015). It should be noted that publishing in co-authorship is not a CAPES evaluation criterion but only a strategy to enhance the publications of professors.

For Oliveira, Matheus, Parreiras and Parreiras (2006), the co-authorship networks, studied from the perspective of the Social Networks Analysis (SNA), in which there is a sharing of scientific article authorship, are the ones that stand out most among the professors and/or researchers. Joint production appears as an alternative to increase the production of articles and their quality (in view of the increasing demand for standards and impact factors), aiming to take advantage of a publication that contemplates more than one author (Welsh & Bremser, 2005).

According to SNA, the network has a higher quality according to the greater number of lines or connections. To the extent that connections are more relevant than the actors that form them in the study of social networks, the SNA theme presents relevancy, a statement corroborated by the dissemination of the SNA methodology in publications in different areas, including educational institutions and research (Silva, Câmara & Barros, 2017).

Thus, given the relevance of verifying how the networks of co-authorships work in different areas and the timeliness of studying this topic in the accounting context in view of the growth of GPs in Accounting, the present research question arises: how are the co-authorship networks formed from the scientific production of professors in graduate programs in Accounting in Brazil? As a way to answer it, this study aims to analyze the configuration of the social network of co-authorship of the *stricto sensu* GPs in Accounting in the 2013-2016 quadrennium, based on the professors' production of articles published in scientific journals.

The relevance of the SNA is highlighted since it makes it possible to assess the contribution of individual attributes of the actors that compose the network, in addition to their network cooperation as a whole. Batista, Rodriguez, Cardoso, Costa and Dias (2018) verified this collaboration, especially concerning social co-authorship networks in the context of a GP, offering a comparison of its evolution in two explored periods that correspond to the years 2015 and 2016. The authors argue that the absence of systematic support for the management of scientific production in GPs generated the need to develop and apply an SNA system to support this management in graduate courses. It allows identifying relevant characteristics of the actors, which can encourage a greater connection between members of the academy, pointing out the valuable contribution of SNA in scientific production.

Thus, although CAPES evaluates the GPs in Brazil, the application of an SNA, especially to Accounting programs, contributes to a possible self-management tool for programs (Cela, Sicilia & Sanchez, 2015; Otte & Rosseau, 2002) and the visualization of a Brazilian accounting scientific production panorama. It consents to the research furtherance agencies to observe its evolution and comparing it with previous studies that presented similar analyzes. Understanding how scientists interact to produce science contributes to identifying the dynamics originated through the relationships between institutions, graduate programs and researchers, as well as between these units. Also, it enables the identification of which of them contribute in a more relevant way to the academic and scientific developments of Accounting Sciences in Brazil. In this sense, it is possible to improve a critical look to understand how accounting science has reached its current stage and how structuring its development occurs.

This study also collaborates with the literature of studies focused on Accounting research by discovering central authors of the networks, which can clarify aspects of the structure of the accounting academy in the context of Brazilian GPs, and provide insights into the interaction between academics (Andrikopoulos & Kostaris, 2017). It should be noted that this research also differs from the others due to the period of analysis comprised by the 2013-2016 quadrennium. In addition to this introduction, the article also includes, in the sequence, a theoretical framework that addresses the explanation of how the Social Networks Analysis is configured, as well as related studies. It is followed by the methodology session, where the data collection and treatment procedures are detailed. The results are presented in the fourth session, and, finally, the final considerations conclude the article.

## 2 THEORETICAL FRAMEWORK

The theoretical framework to support the study is arranged in terms of: i) Social Networks Analysis (SNA),

where the SNA perspective is explained; ii) Social Networks Analysis in related studies, where are presented previous studies of accounting and administration that SNA was used.

## 2.1 Social Network Analysis

Considered an interdisciplinary technique, SNA was developed under various influences. Within an SNA perspective in the field of sociology, it can be described as originating from sociometry, with its first investigations being carried out by Harvard researchers in the 1930s and 1940s. They were inspired by the work of French sociologist Durkheim and British anthropologist Radcliffe-Brown, which were interested in relationships and group formation (Scott, 2000).

The SNA makes it possible to outline and study the structure of social groups and the relationships and positions of the actors who are part of the community applying matrices and/or graphic images. It is noteworthy that relational data are the focus of the investigation, but individual characteristics and relational links are fundamental to fully comprehend the social phenomena under study (Wetherell, Plakans & Wellman, 1994). For Wasserman and Faust (1994), understanding these relationships may indicate a pattern of cooperation and exchange between individuals and organizations. Networks are present in different situations and have an excellent potential for explanatory power in organizational contexts (Batista et al., 2018).

The actors who are part of social networks are called "nodes." The "node" is the basic element of a network (Newman, 2016), which can be a person, an organization, a group or a concept. Social ties are established with other nodes in the social context, representing a relationship bond (Wasserman and Faust, 1994). A fundamental task of SNA has been to assign theoretical properties of graphs that characterize structures, positions and dyadic properties, such as cohesion and connectivity of structure, in addition to the distribution of relational ties (Zheng, Le, Chan, Hu & Li, 2016).

The relational ties of connections between the actors can be strong, which indicates a dense network, or weak, representing low density. Dyads are characterized by connections between only two actors, while ties between three or more actors characterize triads; groups are characterized by being a finite set of actors, and the centrality represents the main actors in a network (Wassermann & Faust, 1994). Also, the structural gaps represent the absence of connections and links, which means the absence of information sharing (Wassermann & Faust, 1994).

In the SNA, the density indicator stands out, which indicates the general level of connection of the graph. The density calculation is performed from the number of lines in a graph divided by the maximum number of lines - the case

in which each actor is connected to all the others, so it is a relative measure with values between 0 and 1, where 1 indicates that all possible relationships (100%) have been established (Cela, Sicilia & Sánchez, 2015; Costa-Ferreira, 2011).

Regarding the modes of analysis, the most studied concept is the centrality one (Borgatti, Mehra, Brass & Labianca, 2009; Das, Samanta & Pal, 2018). It captures the interdependence of the network, interpreting the potential power that an actor can exercise over others. The centrality measures most important are: degree and intermediation (Otte & Rousseau, 2002).

The degree centrality (degree) of a node is defined as the number of links that the node has with other "nodes" (in the theoretical terminology of the graph, it is the number of edges adjacent to that node) (Otte & Rousseau, 2002). The degree is usually expressed as a percentage - 0 to 100% - and can represent the power of the actor in the network or even the degree centrality of the network as a whole, showing whether there is a high or low connection between the actors (Costa-Ferreira, 2011).

The betweenness centrality (betweenness) can be freely defined as the number of times a node needs a certain node to reach another. In other words, it is the number of shortest paths that pass through a given node (Otte & Rousseau, 2002). For this reason, this centrality considers an actor as the intermediation of information or flow that streams through the network, characterizing the power to control information and the path it takes (Costa-Ferreira, 2011). Equally to the degree, the betweenness centrality is represented in percentage for the actors individually and the general network.

In conclusion, based on the evaluation of empirical data, the SNA can provide an appropriate approach to determine knowledge, scientists, institutions and groups. Besides, it offers interesting information to understand the nature and structure of relationships and interactions within a scientific community, pointing out relationship patterns (Batista et al., 2018).

## 2.2 Social Networks Analysis in related studies

Several studies have used SNA in the context of co-authorship networks. Mello, Crubellate and Rossoni (2010) investigated the network of co-authorships formed by professors of the GPs in Administration to verify the changes in the network from the Institutional Theory. The authors found that programs that interact with each other through co-authorship tend to develop similar cognitive patterns, which leads to similar behavior in the face of a change in norms.

Nascimento and Beuren (2011) sought to identify social networks in the definitive scientific production of Brazilian GPs in accounting sciences in the 2007-2009 triennium. The results showed an evolution of scientific production, and the network was dispersed among the

strata of the Qualis System, which classifies the quality of journals. Additionally, the network centrality was occupied by the GP of the University of São Paulo (USP) and, in general, the programs presented weak, sparse and little dense connections.

Ullrich, Oliveira and Scheffer (2012) explored the formation and structure of co-authored social networks in the people management area in Brazil between 2007 and 2009. They concluded that there was a low density of co-authorship both between authors and institutions. Also, they realized that there is a greater number of partnerships between institutions, which may mean that there is no structuring of internal co-authorship relationships in the analyzed GPs.

In a like manner, Silva et al. (2012) aimed to map the scientific collaboration networks in journals of Accounting GPs in the 2007-2009 triennium. The authors indicated that the USP and Regional University of Blumenau (FURB) programs had the highest mean number of actors in addition to an evolutionary trend of the programs Foundation Institute Capixaba of Research in Accounting, Economics and Finance (FUCAPE), FURB, Pontifical Catholic University of São Paulo (PUC SP), Federal University of Bahia (UFBA), Federal University of Pernambuco (UFPE), Federal University of Rio de Janeiro (UFRJ), Federal University of Santa Catarina (UFSC) and University of Vale do Rio dos Sinos (UNISINOS) concerning the number of links in the collaboration networks. In addition, they found that most programs contributed to the evolution of research in Accounting.

Similarly, Behr and Pavão (2012) evaluated the co-author relations of articles published in the Electronic Journal of Administration (REAd) between 1995 and 2010, through measures of degree and betweenness centralities. The authors verified that the co-authorship network of the journal is poorly connected, with many articles by a single author or two and no connection to larger groups or actors more centrally in the network. Using centrality measures, they observed that the preferential calls are related to the most productive actors in the network.

Ferreira and Serra (2015) investigated the benefits and difficulties in co-authoring by asking questions for international researchers in the administration area with a high number of impact studies. They concluded that the pressure and the growing difficulty in publishing foster co-authorship and that these emerge from the relationships between orientations and personal affinities.

Santos and Santos (2016) examined the evolution and structure of co-authorship networks present in articles published by the Tourism & Management Studies journal between 2011 and 2015. The authors demonstrated that

geographical proximity and linguistic affinities are important factors in the structure of scientific collaboration among the institutions, noting that most of the articles result from collaborative research involving two or more authors from the same institution.

Andrikopoulos and Kostaris (2017) examined social networks exploring the co-authoring relationships in Accounting journals and discovered properties called "small world." They pointed out that, within a small world of academics, disseminating ideas can be rapid. However, a closely connected network may be less open to heterodox conceptions.

Favaretto and Francisco (2017) investigated 2,381 documents published over 50 years in the Journal of Business Management (RAE) through social network, geoanalysis, bibliometrics and text mining. These authors mapped the formation of the co-authorship networks of researchers in the area and demonstrated that 88.4% of the articles published in the journal between 2013 and 2016 were written by two, three or four authors, noting that collaboration is an item valued by the journal. The authors revealed the high density of collaboration in scientific Administration journals.

Batista, Rodriguez, Cardoso, Costa and Dias (2018) analyzed the contribution that SNA can offer to the scientific production of graduate programs in Brazilian federal institutions. The areas of knowledge studied, trends and evolution of publications were analyzed from 2015 to 2016. The authors concluded that the application in the SNA in the studied context demonstrated the feasibility of evaluating individual attributes and the network as a whole, allowing a comparison of the evolution of the publications in the period.

In view of these studies related to the Accounting and Management area, the relevance of the SNA and the timeliness of more current analysis are highlighted, as proposed in this study and comprising the 2013-2016 quadrennium.

### 3 METHODOLOGY

This descriptive research was carried out considering the 2013-2016 quadrennium to analyze the formation of social networks co-authored by stricto sensu GP in Accounting in Brazil. The study population is equivalent to the 21 stricto sensu master's and doctoral courses in Accounting recommended by CAPES in 2017. Programs that started activities during the evaluated period (2013-2016) were not included in the sample. Table 1 shows the 21 Accounting GPs analyzed in this study, according to the list made available in the CAPES four-year report.

**Table 1**

List of programs with master's and doctoral degrees in Accounting (2013-2016 quadrennium)

HEI Principal	HEI Acronym	Name of GP	Modality
Foundation Institute Capixaba of Research in Accounting, Economics and Finance	FUCAPE	Administration and Accounting Sciences	Master's/ Doctorate
Foundation Institute Capixaba of Research in Accounting, Economics and Finance	FUCAPE	Accounting Sciences	Master's*
Regional University of Blumenau	FURB	Accounting Sciences	Master's/ Doctorate
Pontifical Catholic University of São Paulo	PUC/SP	Accounting and Actuarial Sciences	Master's
State University of Rio de Janeiro	UERJ	Accounting Sciences	Master's
Federal University of Bahia	UFBA	Accounting	Master's
Federal University of Ceará	UFC	Administration and Controllershship	Master's/ Doctorate
Federal University of Ceará	UFC	Administration and Controllershship	Master's*
Federal University of Espírito Santo	UFES	Accounting Sciences	Master's
Federal University of Minas Gerais	UFMG	Controllershship and Accounting	Master's/ Doctorate
Federal University of Pernambuco	UFPE	Accounting Sciences	Master's/ Doctorate
Federal University of Paraná	UFPR	Accounting	Master's/ Doctorate
Federal University of Rio de Janeiro	UFRJ	Accounting Sciences	Master's/ Doctorate
Federal University of Santa Catarina	UFSC	Accounting	Master's/ Doctorate
Federal University of Uberlândia	UFU	Accounting Sciences	Master's/ Doctorate
University of Brasília	UNB	Accounting UNB - UFPB - UFRN	Master's/ Doctorate
Fecap University Center	UNIFECAP	Accounting Sciences	Master's
University of Vale do Rio dos Sinos	UNISINOS	Accounting Sciences	Master's/ Doctorate
Mackenzie Presbyterian University	UPM	Accounting Sciences	Master's*
University of São Paulo	USP	Controllershship and Accounting	Master's/ Doctorate
University of São Paulo/Ribeirão Preto	USP/RP	Controllershship and Accounting	Master's/ Doctorate

Source: Elaborated based on the CAPES quadrennial evaluation (2017).

Note: \*Professional Master's degree. Data consulted on March 18, 2018.

The GPs in Accounting Sciences were selected and, then, the list of permanent professors who are part of these programs was identified using the information provided by CAPES. It considers as permanent professors who: develop teaching activities at undergraduate and/or graduate levels; participate in research projects; guide master's and/or doctoral students; and have a functional-administrative link with the institution (CAPES, 2016).

In total, 375 professors compose the permanent staff of GPs. However, as some professors participate in more than one program, excluding the duplication of names, 291 permanent professors were distributed in the 21 programs under analysis. For cases in which the same professor works in more than one of the 21 programs, his publication is considered the same for all. Therefore, we sought to study

the population defined as a whole and not a sample cut. Data collection related to articles by permanent professors published in journals was carried out on the Lattes Platform (<http://lattes.cnpq.br/>) from May to October 2018.

In the co-authorship SNA established between professors and GPs, the UNICET® software was used, in which the metrics of degree centrality (degree) and betweenness centrality (betweenness) were calculated for SNA of co-authorship, following the characteristics of other related researches, such as Batista et al. (2018), and Ulrich, Oliveira and Scheffer (2012).

It is noteworthy that the information referring to articles published in journals by professors, collected from the consultation in their curricula lattes, were filled in by the research professors themselves. Therefore, the occurrence

of typing errors, duplicate or deficient information, and a lack of updating in the collection period is possible. In case of conflicting information found, such as articles published in more than one journal or the duplication of records, it was decided to exclude them from the data set to be analyzed. In total, 1.18% of articles were excluded, a limitation that must be considered for the interpretation of results. In the end, there were 3,778 titles of articles published by the permanent professors of the programs. It is important to mention that it was not accessed the full versions of the articles since the intention was not to analyze their content but rather the co-authorship relationship between the professors of the GPs.

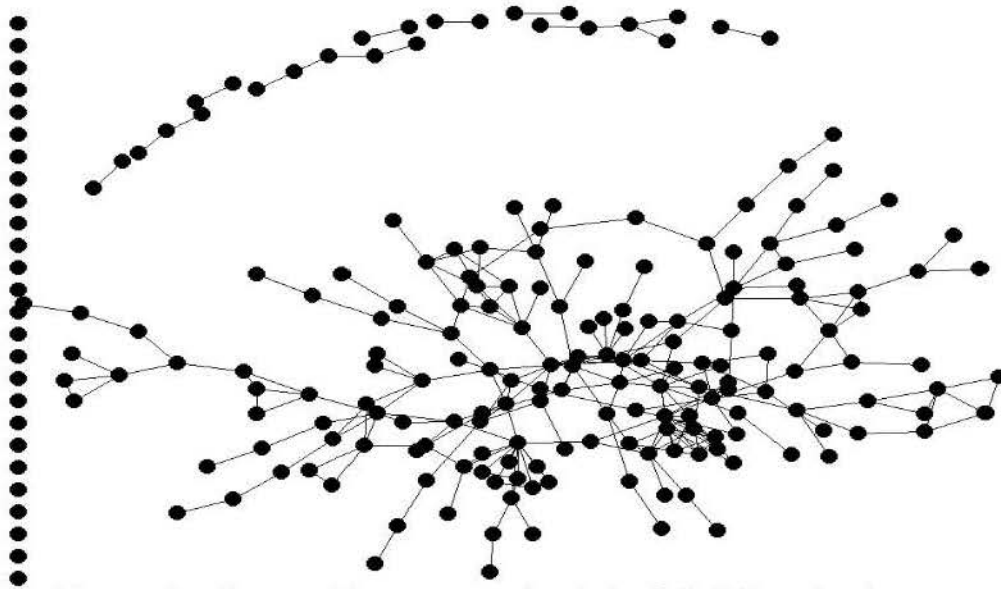
The results are arranged in terms of: i) professors and GPs co-authorship networks; ii) degree centrality of professors and GPs; and iii) intermediation between the actors, being them professors or GPs.

## 4 ANALYSIS AND DISCUSSION OF RESULTS

The results are arranged in terms of: i) professors and GPs co-authorship networks; ii) degree centrality of professors and GPs; and iii) intermediation between the actors, being them professors or GPs.

### 4.1 Co-authorship Networks

Figure 1 illustrates the formation of the co-authorship network among the permanent professors of the GPs in Accounting. The points in Figure 1 represent the authors, while the lines represent the ties formed between them. The points that are isolated, without any connection, represent researchers who did not publish in cooperation in the analyzed period.



**Figure 1.** Visualization of the co-authorship network between researchers in the 2013-2016 quadrennium  
Source: Elaborated by the authors.

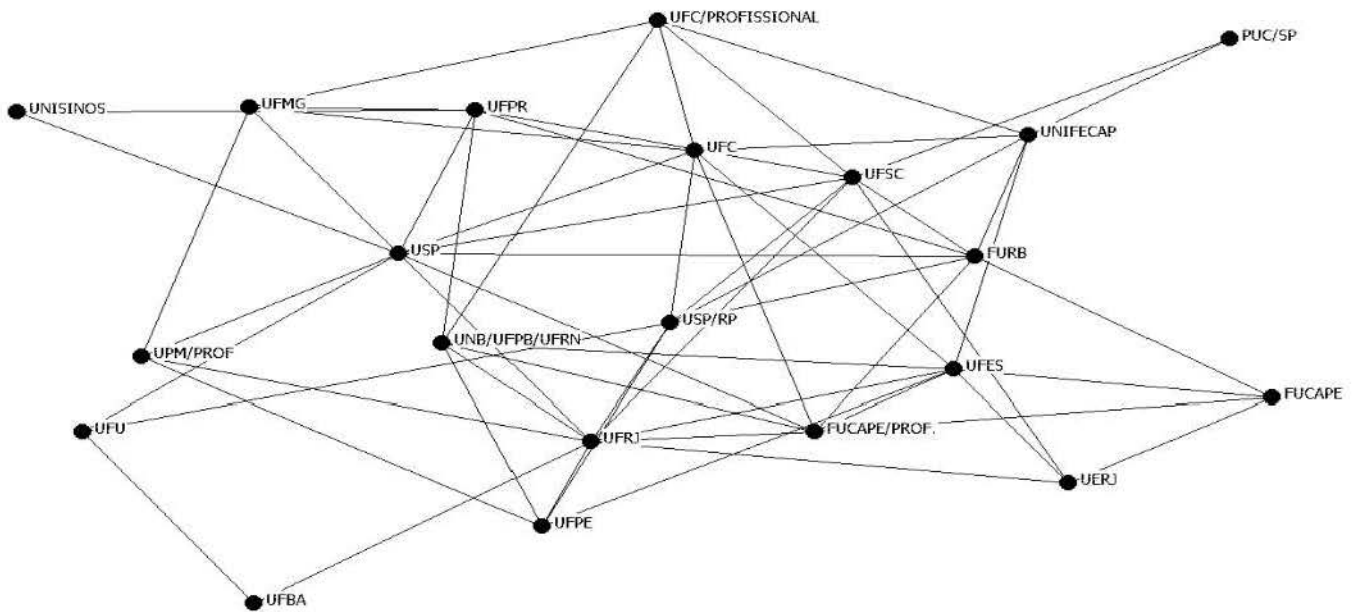
The network density is 0.6351%, which indicates a low degree of cooperation between professors in the publication of articles. As the density is calculated from the mean of relations, we highlight the large number of nodes that do not have relational ties, located at the left end and also at the top of Figure 1, which ends up lowering the mean and decreasing the density of the graph (Cela, Sicilia & Sánchez, 2015). It is noteworthy that the densest parts of the graph are mainly occupied by professors from the UFRJ, UFSC, UNISINOS and UFPR programs, as they have a greater number of relationships, indicating internal affinity in publications and concentrated density.

Previous studies have shown different density realities. Studies on networks formed in journals, such as the RAE (Favaretto & Francisco, 2017) and the Tourism & Management Studies journal (Santos & Santos, 2016), showed high cooperation between authors, while studies such as by Behr and Pavão (2012) presented networks slightly dense and disconnected. This counterpoint allows us to infer that the density of the co-authorship networks is

closely linked to the studied context, as an audience, area or periodical under analysis.

Concerning the analysis of publications by the institution of the connection of professors (Figure 2), the density is 28.09%. It reveals that GPs made 28.09% of the publications in co-authorship out of the 100% that would be possible. It is worth noting that this percentage refers to co-authorship among permanent professors of Accounting GPs, not taking into account whether there were co-authorships with programs in other areas. In comparison with the results of Ulrich, Oliveira and Scheffer (2012), this density was interpreted as average, referring to the considerable connectivity of GPs.

It should be noted that density refers to the possibilities of relationships between the actors and not the frequency of relationships. In Figure 2, it is observed that the actors of the network are the institutions that belong to the studied programs. At the same time, the lines symbolize the ties formed between these institutions with the publications of the professors.



**Figure 2.** Visualization of the co-authorship network between institutions in the 2013-2016 quadrennium  
Source: Elaborated by the authors.

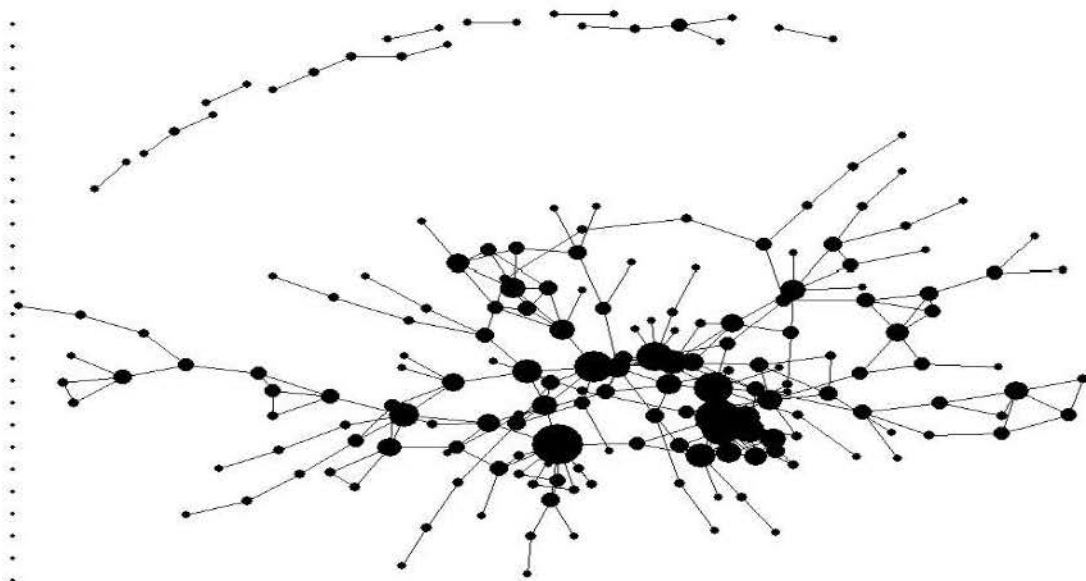
In Figure 2, it is observed that none of the GPs in Accounting is isolated on the network. This means that at least one professor from each GP published in co-authorship with another from a different GP in the population. It is perceived, illustratively, an increase in density compared to the co-authorship network formed by the GPs in Accounting in relation to the 2007-2009 triennium, presented by Nascimento and Beuren (2011).

The study by Nascimento and Beuren (2011) analyzed 17 programs, while the network shown in Figure 2 has 21 GPs. However, in the 2007-2009 triennium study, four institutions did not have relational ties, while the network in this study does not show any program without relationships. This fact indicates an increase in cooperation between institutions in the context of Accounting programs.

In other words, more articles are being produced together, in the form of co-authorships, aiming a publication that contemplates more than one author is used (Welsh & Bremser, 2005).

#### 4.2 Degree centrality (*Degree*)

Figure 3 refers to the centrality of the degree of formation of co-authorship networks between the authors. It is analyzed, verifying that the bigger the actor's node size, the higher the index of relations presented by him. The network centralization index is 3.87% and the degree of heterogeneity is 0.83%, which indicates a low variability of the network as a whole, as can be seen in Figure 3, due to the presence of several dyads (formed by just two actors).



**Figure 3.** Degree centrality of the co-authorship network among researchers in the 2013-2016 quadrennium  
Source: Elaborated by the authors.

The author with the highest degree centrality is Marcelo Álvaro da Silva Macedo, who during the 2013-2016 evaluation was part of the permanent faculty of the UFES and UFRJ programs, a fact that may have contributed to the establishment of co-authorships with a greater amount of

professors. Table 2 presents the five professors with the highest degree and the descriptive statistics of the degree centrality of the professors' co-authorship network. The normalized degree represents the percentage of the respective degrees.

**Table 2**

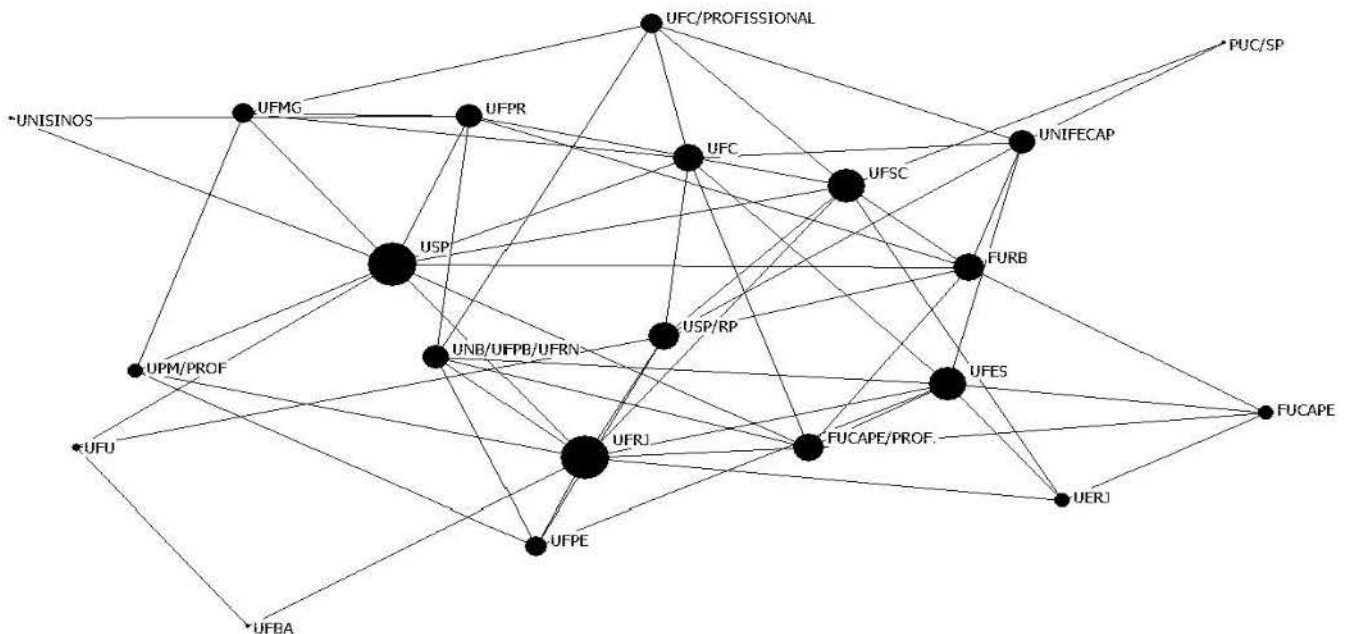
Descriptive statistics of the degree centrality of the co-authorship network of professors and professors with a higher degree

Descriptive Statistics of the Network	Degree	Normalized Degree
Mean	1,842	0,635
Standard Deviation	2,186	0,754
Sum	536	184,828
Variance	4,779	0,568
Minimum	0	0
Maximum	13	4,483
Professors with higher Degree	Degree	Normalized Degree
Marcelo Álvaro da Silva Macedo	13	4,483
Elisete Dahmer Pfitscher	12	4,138
Nelson Hein	10	3,448
Gerlando Augusto Sampaio Franco de Lima	10	3,448
Ilse Maria Beuren	9	3,103

Source: Elaborated by the authors.

Among the five professors with the highest degree, only Professor Marcelo and Professor Ilse Maria Beuren were part of more than one GP during the quadrennium analyzed. Even participating in only one program, the remaining stood out in the number of partnerships in their publications, indicating their ability to connect. It is confirmed that the high degree, represented by the largest quantity of ties number, considers the number of ties between authors, regardless of the frequency in which there was a collaboration (Otte & Rousseau, 2002).

Concerning the institutions, the network centralization index is 24.21%. In comparison, the heterogeneity is 5.57%, which still indicates a higher variability than the network of the professor, however, with low variability of the network as a whole yet. In other words, there are few homogeneous groups of actors that play a central role in the network. Figure 4 represents the graph formed from the degree of the institutions.



**Figure 4.** Degree centrality of the co-authorship network between institutions in the 2013-2016 quadrennium

Source: Elaborated by the authors.

The institutions with the highest degree are USP and UFRJ. It is noteworthy that the GP of USP is the only one with concept 6, the highest of the GPs in Accounting in Brazil. The UFRJ program has Professor Marcelo on its

faculty, who has the highest degree among professors. Therefore, his individuality can contribute to the program degree. The degrees of the other GPs are demonstrated in Table 3.



**Table 3**

Descriptive statistics of the degree centrality of the co-authorship network between GPs and individual degree of GPs

Descriptive Statistics of the Network		
	Degree	Normalized Degree
Mean	5.619	28.095
Standard Deviation	2.319	11.596
Sum	118	590
Variance	5.379	134.467
Minimum	2	10
Maximum	10	50
GPs with higher Degree		
	Degree	Normalized Degree
UFRJ	10	50
USP	10	50
UFSC	8	40
UFES	8	40
FUCAPE*	7	35
FURB	7	35
USP/RP	7	35
UFC	7	35
UNB/UFPB/UFRN	6	30
UFPR	6	30
UNIFECAP	6	30
UFMG	5	25
UFPE	5	25
UFC*	5	25
UPM*	4	20
FUCAPE	4	20
UERJ	4	20
UFU	3	15
PUC/SP	2	10
UNISINOS	2	10
UFBA	2	10

Source: Elaborated by the authors.

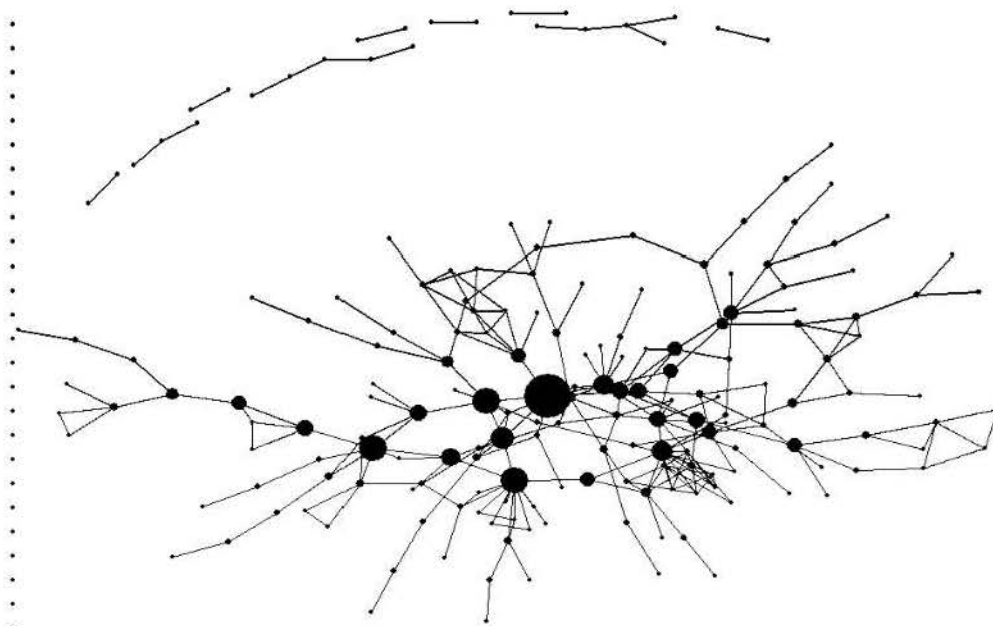
Note: \*Professional Master's degree.

Since the normalized degree is the percentage of the degree represented, it is possible to note that the USP and UFRJ programs, for example, established 50% of the possible relationships with other GPs (10 relationships out of the 20 possible). While the programs of PUC/SP, Unisinos and UFBA presented the lowest degree centralities. In comparison with the study by Silva et al. (2012), there was a continuity of prominence in relation to the USP program, in the same way as the confirmation of evolutionary forecast regarding the GP of UFRJ and the

non-confirmation related to the UNISINOS, UFBA and PUC/SP programs. Even though these programs have low degrees, they have at least two connections with other GPs.

#### 4.3 Intermediation between the actors (*betweenness*)

The value of the measure of betweenness corresponds to the channels established by the author with different groups or actors in the context of the network it is inserted. The graph shown in Figure 5 represents the betweenness centrality of the professors' co-authorship.

**Figure 5.** Betweenness centrality of co-authorship among researchers in the 2013-2016 quadrennium

Source: Elaborated by the authors.

The centralization index of the represented network is 12.40%, indicating low variability in the composition of the actors that constitute it, as outlined by Ullrich, Oliveira and Scheffer (2012). According to Behr & Pavão (2012), the betweenness centrality is considered a position of

advantage since the central actor allows information to circulate through the network, becoming a fundamental figure in disseminating information in a network. Table 4 shows the values of the descriptive statistics of the network and the actors with the highest betweenness.

**Table 4**

Descriptive statistics of the betweenness degree of the co-authorship network of professors and professors with higher betweenness

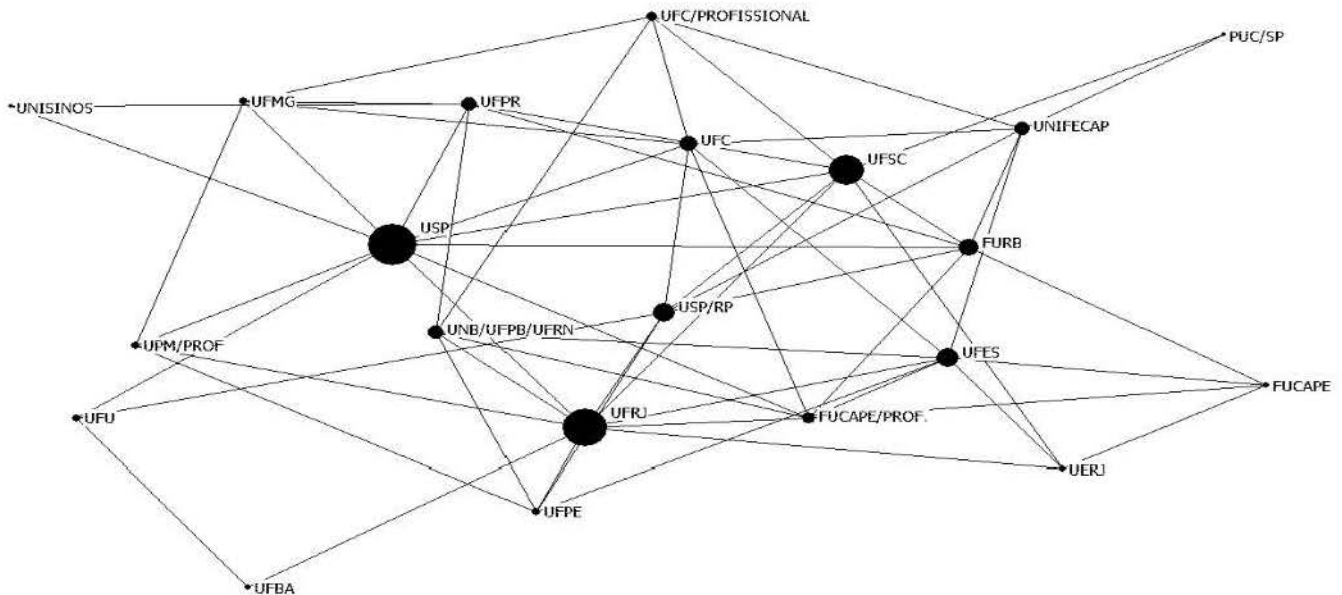
Descriptive Statistics of the Network	Betweenness	Normalized Betweenness
Mean	238.447	0.569
Standard Deviation	592.353	1.414
Sum	69,388	165.584
Variance	350881.781	1.998
Minimum	0	0
Maximum	5,417.387	12.928
Professor with higher Betweenness	Betweenness	Normalized Betweenness
Gerlando Augusto Sampaio Franco de Lima	5,417.387	12.928
Fernando Caio Galdi	3,014.864	7.195
Edilson Paulo	2,973.937	7.097
Marcelo Álvaro da Silva Macedo	2,937.816	7.011
José Elias Feres de Almeida	2,390.18	5.704

Source: Elaborated by the authors.

The professor with the highest betweenness degree is Gerlando Augusto Sampaio Franco de Lima from the GP of USP. The first number in the column, 5417,387, represents the total number of node pairs that the actor is able to connect. The second value, in percentage (12.92%), corresponds to the normalized betweenness degree. From betweenness, it is possible to affirm that Professor Gerlando exercises the highest relative betweenness degree between the network actors, which indicates his capacity for

distribution of knowledge in the scientific field and his power of control over the network (Costa-Ferreira, 2011).

The betweenness degree of the network of the institutions is 13.19%, which characterizes a low variability in the composition of those that make the intermediation of the relationships of the network. Considering that the network is composed of 21 actors (institutions), the GP from USP is the one with the greatest relative betweenness degree, as shown in Figure 6.



**Figure 6.** Betweenness centrality of co-authorship between institutions in the 2013-2016 quadrennium

Source: Elaborated by the authors.

The GP of USP boasts the highest betweenness degree, in addition to having a high centrality degree, which determines that it has the greatest amount of relational ties and that its intermediary position in the network may

determine a better capacity for the distribution of scientific knowledge. In addition to the descriptive statistics of the network, the betweenness of the GPs are presented in Table 5.

**Table 5**

Descriptive statistics of the betweenness degree of the co-authorship network between the GPs and individual betweenness of the GPs

<b>Descriptive Statistics of the Network</b>	<b>Betweenness</b>	<b>Normalized Betweenness</b>
Mean	8.810	4.637
Standard Deviation	9.001	4.737
Sum	185	97.368
Variance	81.014	22.441
Minimum	0	0
Maximum	32.673	17.196
<b>GPs</b>	<b>Betweenness</b>	<b>Normalized Betweenness</b>
USP	32.673	17.196
UFRJ	29.935	15.755
UFSC	22.336	11.756
USP/RP	12.983	6.833
UFES	12.442	6.548
FURB	11.344	5.971
UFC	9.360	4.926
UFPR	8.802	4.633
UNIFECAP	8.675	4.566
UNB/UFPB/UFRN	7.417	3.904
FUCAPE*	7.275	3.829
UFC*	4.175	2.197
UFMG	3.917	2.061
UFU	3.426	1.803
UFPE	2.958	1.557
UPM*	2.833	1.491
UERJ	2.208	1.162
FUCAPE	1.167	0.614
UFBA	0.825	0.434
PUC/SP	0.250	0.132
UNISINOS	0.000	0.000

Source: Elaborated by the authors.

Note: \*Professional Master's degree.

It should be noted that the USP program was the first postgraduate course in Accounting in Brazil, having been the only doctoral course for 30 years. The prominence of the USP program as central to the accounting networks was also observed in the studies by Nascimento and Beuren (2011) and Silva et al. (2012). For the UFRJ program, it is worth noting that, in addition to sharing the highest degree with USP, it also has a prominent betweenness, being the second largest among the GPs studied. The UFBA, PUC/SP and UNISINOS programs, as well as the degree, show the lowest betweenness degrees.

In general, the results show a low density concerning the co-authorship of the professors. However, compared to previous studies, this density has increased. Thus, it appears that the co-authored collaboration strategy in scientific publication, even if it is not a CAPES evaluation criterion, has been increasingly used by professors of Accounting GPs.

## 5 FINAL CONSIDERATIONS

The research aimed to analyze, from the faculty production of articles published in journals, the configuration of the social network of co-authorship of the stricto sensu GPs in Accounting in the 2013-2016 quadrennium. The results were elaborated according to the co-authorship networks of the professors of the GPs in Accounting. Thus, for both, the measures of density, degree centrality (degree) and betweenness degree (betweenness) were determined.

Regarding the density of the network of the programs, an increase was noticed in relation to previous studies, such as the one of Nascimento and Beuren (2011). The co-authorship network among professors has low density, which indicates little cooperation between them. Also, it was possible to verify that dense parts of the density graph of the professors indicate a concentration of the same GP. It means that professors of the same program are publishing together more than entering into partnerships with other programs. An example is UNISINOS, which has a high concentration in the density graph but has low centrality and betweenness degrees. In other words, a large production of knowledge in a "small world" of academics in a correlated way to the verified by Andrikopoulos and Kostaris (2017).

It was noticed that the individual characteristics of some professors are consistent with the criteria of the programs to which they are linked, as is the case of professors and GPs with a higher degree (professor Marcelo Álvaro da Silva Macedo and UFRJ) and greater betweenness (professor Gerlando Augusto Sampaio Franco de Lima USP). This result allows signaling the potential contribution of some professors to the formation of co-authorships, benefiting the programs (Batista et al., 2018; Oliveira et al., 2006).

The USP program stands out for the centrality and betweenness degrees, corroborating Silva et al. (2012), who analyzed the triennium prior to this study. The UFRJ and UFSC programs also stand out due to the number of co-authorships and the intermediation capacity. The

UNISINOS, UFBA and PUC/SP programs did not confirm the evolutionary trend of the co-authorship networks foreseen by Silva et al. (2012). Thus, with the interest of these programs in increasing the number of publications, an alternative would be to seek partnerships with other professors from other GPs for joint production, even if co-authorship is not a CAPES evaluation criterion.

From the findings, it was possible to characterize the networks of co-authorships between professors and Brazilian Accounting GPs. This disclosure contributes to the provision of information of individual attributes and a panorama of the area. It may serve as a subsidy to the management of postgraduate courses and CAPES evaluation policies. The programs may identify the leading professors responsible for their scientific production and disseminating knowledge through the analysis carried out. This way, they may seek measures to increase the production of professors who are less active in scientific research and provide scientific development within the scope of Accounting Sciences in the country.

From this research, it was possible to highlight the form of interaction between accounting researchers and contribute to the debate agenda regarding the dynamics of relations between institutions, graduate programs and researchers that contribute to the academic and scientific development of Accounting Sciences in Brazil. Thus, it corroborates the understanding of the development of Accounting Science up to its current stage and how this development is structured. These findings contribute by providing aspects of the structure of scientific production in Accounting in the context of Brazilian GPs, bringing insights into academic partnerships from prominent actors in the networks, both between GPs and professors, according to what is pointed out in the literature (Andrikopoulos & Kostaris, 2017).

We should consider the limitation of articles excluded from the sample due to their inconsistency in the titles or publications that appeared as published in more than one journal. For future research, it is suggested to replicate this study, considering the research groups linked to the GPs, once it is believed that these may bring interesting contributions from trends in publications and concentrations of density, centrality and betweenness. These researches may provide a greater understanding of the affinity and possibilities of partnerships between researchers and research groups and enable interaction of these groups of GPs from outside the country.

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