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Network analysis in accounting research: an institutional and geographical perspective

Abstract

Purpose - The objective of this study is to explore the accounting research network among institutions and countries globally and to contribute to the knowledge development in accounting discipline across regions with a novel and original approach.

Design/methodology/approach - We have conducted this study by manually collecting data from 10,863 papers published in 22 accounting journals indexed in the Web of Science for the period 2000-2016. Analyses and visualizations of collaborative networks across institutions and regions were performed by using network analysis software packages, including Pajek, Ucinet 6, NetDraw, and VOSviewer.

Findings - The study finds that the most productive five universities are University of New South Wales, University of Sydney, University of Texas, University of California, and University of Manchester worldwide. In accordance with the institution ranking, the five most productive countries in all periods are the USA, the UK, Australia, Spain, and Canada. However, in addition to these countries, it is important to note that some European and Asian countries and New Zealand from Oceania are among the most productive countries which host prolific institutions. Furthermore, network indicators show that the UK is the most influential actor in centrality and brokerage within the research network. We should note that Australia is also among the most influential nations with its influential institutions. In all research metrics, the dominance of Anglophone countries (e.g., the USA, the UK, and Australia) is observable on which language advantage might play a role since most internationally-accredited journals publish scientific articles in English.

Research limitations/implications - The study is bounded with several main limitations. First, due to collecting the data manually, there might be some inherent limitations. Second, the study is constrained by the time frame between 2000-2016. The study does not answer *why* and *how* questions in investigating research productivity and effectiveness in the network. Our study might inspire new studies to complement ours by considering these constraints.

Practical implications - Our findings indicated the prominent institution-wide and country-wide actors; thus, the results provide a global perspective on the collaboration network. Secondly, our findings guide job seekers, who are particularly research-oriented, to potential recruiters around the world both at the institution level and country level. Third, the results

might play an important role in forming institution-based and country-based research policies. The USA, among others, is a particularly important actor in productivity, whereas the UK, among others, is a remarkable country in centrality and brokerage in the research network. By examining the policies of these two countries, other nations might shape their research strategies, promotion policies, and support and reward schemes. Fourth, cross-institution and in particular cross-country collaborations are imperative in the diversity of accounting research as they blend culturally diverse researchers. Fifth, prominent institutions highlighted in this study might be adopted as role models by other institutions in the same country, and benefit their expertise in productivity and cooperation by scrutinizing their approaches. Sixth, our findings and metrics might be adopted as benchmarks for institutions and nations for performance evaluation. Considering our 5-year period indicators, institutions can set targets for their improvement and for measuring the progress. We provide other important implications in the conclusion section of the study.

Originality/value - To the best knowledge of the authors, no study yet investigated the collaboration across academic institutions, regions, and countries in accounting discipline to this extent. Therefore, our research provides a significant contribution to the literature by seeking a comprehensive network analysis of authorship patterns from an institutional and geographical perspective. Doing so, we contribute to knowledge development in accounting discipline with institutional and geographical network analyses.

Keywords: Accounting; research; network; institutions; universities; geographies

1. Introduction

Academic institutions put particular emphasis on research productivity of the faculty members because research output is considered as one of the most important aspects indicating their reputation and quality (Hexter, 1969; Chan *et al.*, 2005; Chan *et al.*, 2006; Chan *et al.*, 2007; Englebrecht *et al.*, 2008a). Accordingly, within many universities, employment, promotion, and tenure decisions are made based upon research productivity of academics (Chan *et al.*, 2005; Bonner *et al.*, 2006; Raffournier and Schatt, 2010). As a response to the increased emphasis attached to research productivity (Schultz and Meade, 1989; Tucker *et al.*, 2016), academics are disposed to engage in national and international collaborations on scholarly works (Nathan *et al.*, 1998).

In recent years, improvement in communication technologies facilitated the trend in international research collaborations by creating an environment wherein researchers can communicate with other researchers flawlessly and inexpensively regardless of geographical proximity (Tucker *et al.*, 2016). International cooperation is not only a trend but also a

mandatory practice for individual researchers and their affiliated institutions that would enhance their visibility in the academic world and present many further benefits to them (Knobel *et al.*, 2013). Cross-border cooperation connects researchers with different sets of talents from different institutions or different countries to produce a research output (Kumar and Jan, 2013). To illustrate, when conducting international projects where researchers from a single country do not have full knowledge of business practices within other countries, international collaboration would make it easier for them to address country-specific issues (Hussain *et al.*, 2015). Further, since English is globally accepted language of scientific research, scholars from Anglophone countries (e.g., the USA, the UK, and Australia) have a considerable advantage to disseminate their research in leading journals compared to their counterparts who do not have English as their mother tongue (Carmona *et al.*, 1999). Therefore, scholars affiliated with institutions in non-English speaking countries might overcome language barriers and improve their publication chance in high-quality English language journals through involving in cooperation with researchers from Anglophone countries (Fleischman and Schuele, 2009).

Given the increasing importance of international cooperation in the academic community, it is relevant to analyze authorship patterns with an institutional and geographical perspective to understand the progress and diversity in collaboration across institutions and regions in accounting research. In this study, we apply network analysis using a set of accounting journals indexed in the Social Science Citation Index (SSCI) from 2000 to 2016. Network analysis is mostly used to examine authors who are central to the academic community (Kumar and Jan, 2013), to provide information on how authors control the communication and flow of resources in the community (Kumar and Jan, 2013), and to identify central participants in the entire network (Lohmann and Eulerich, 2017). This analysis can be also applied to identify prominent institutions and regions in the academic community and to present an overall picture of the collaborative networks across institutions and regions. Hence, first, we explore prominent institutions and countries with respect to research productivity (i.e., based on article counts), and how accounting discipline is compared to other management disciplines. Second, we identify which institutions and countries are the most active ones in the accounting research network in terms of centrality and mediation among network actors. By highlighting the most productive, central, and mediating institutions and countries based on research productivity as well as network analysis and visualization maps, we hope that the findings serve several purposes in academic settings. This study offers important insights into collaborative patterns across regions, regional research dynamics, and changes in regional and institutional

collaboration networks over time in accounting discipline. It may help students to decide on which universities to attend and assist job-seeking academics to determine which institutions to apply, and thus help them develop and improve their careers. Further, it may serve as a guideline in making recruitment, promotion and tenure decisions, support resource allocation and compensation determination, and form the basis for rewarding research activity (Spake and Harmon, 1998; Hasselback *et al.*, 2003; Chan *et al.*, 2005). Moreover, findings of such studies may impact research policies of institutions and nations and facilitate effective planning for future research performance (Ding *et al.*, 1999).

The extant literature exploring publishing patterns in accounting research mainly focused on the number of authors (Heck and Bremser, 1986; Chung *et al.*, 1992; Anderson, 2002; Englebrecht *et al.*, 2008a; Englebrecht *et al.*, 2008b; Vafeas, 2010; Gaunt, 2014; Kılıç *et al.*, 2018) and the antecedents, benefits, and pitfalls related with collaborative research (Nathan *et al.*, 1998; Fleischman and Schuele, 2009; Tucker *et al.*, 2016). In addition to authorship and co-authorship patterns, majority of prior studies also investigated prominent institutions (Henry and Burch, 1974; Williams, 1985; Chung *et al.*, 1992; Brown, 1996; Hasselback *et al.*, 2003; Chan *et al.*, 2005; Chan *et al.*, 2006; Chan *et al.*, 2007; Vafeas, 2010; Fülbier and Weller, 2011; Gaunt, 2014; Oler *et al.*, 2016; Andrikopoulos and Kostaris, 2017; Lohmann and Eulerich, 2017; Merigó and Yang, 2017) and regions and/or countries (Carmona *et al.*, 1999; Jones and Roberts, 2005; Chan *et al.*, 2006; Chan *et al.*, 2007; Vafeas, 2010; Gaunt, 2014; Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017; Merigó and Yang, 2017) in accounting discipline. This study uses bibliometric measures to examine collaborative networks at the institutional and regional levels, which have been rarely used in accounting research. In that sense, this study provides an institutional and regional ranking for the accounting field based on bibliometric indicators, namely betweenness and degree centrality. This study also provides further topological metrics of network attributes, such as average degree, density, average distance, nodes, and ties to identify the current structure of the accounting research network. Many prior studies examined published articles within a single journal (Williams, 1985; Anderson, 2002; Gaunt, 2014) or a limited number of top journals (Carmona *et al.*, 1999; Endenich and Trapp, 2016), whereas this study examined a larger set of accounting journals listed in Social Sciences Citation Index (SSCI) accessible online through Web of Science (WoS)[1]. Further, prior research mostly focused on a specific country (Tuttle and Dillard, 2007) or region (Carmona *et al.*, 1999; Chan *et al.*, 2005; Chan *et al.*, 2006), thus this study extends

[1] WoS is regarded as the most influential database in academic research since it covers journals that have the highest standards (Merigó and Yang, 2017).

the literature by providing evidence on a global scale. Moreover, preliminary studies implemented a simplistic approach using frequency analysis to rank institutions, countries, and regions, while this study utilized new tools and software packages, including Pajek, Ucinet 6, NetDraw, and VOSviewer to analyze and visualize collaborative networks across institutions and regions. To the best knowledge of the authors, no study yet investigated the collaboration across academic institutions, regions, and countries in accounting discipline to this extent. Therefore, our research provides a significant contribution to the literature by seeking a comprehensive network analysis of authorship patterns from an institutional and geographical perspective.

With a global perspective, this research reports several interesting findings such as the most productive institutions and countries, the most influential institutions and countries in research collaborations, the prominent research mediators between universities and nations. We outline a wide array of network indicators and visualization maps and draw conclusions accordingly. Finally, the study provides significant implications for researchers, institutions, and countries that might help shape their research and promotion policies.

The remainder of the manuscript is structured as follows. The following section presents a critical evaluation of the literature and explains how this study differs from prior studies. The third section outlines the research design and data collection methodology. The fourth section discusses the empirical findings. The last section presents the conclusions and outlines implications as well as the limitations of this study.

2. Literature review

Since bibliographic data comprises information about the institutional affiliation of authors and their geographical location, co-authorship or co-occurrence analysis can also examine the collaboration issues on the institutional and regional level (Zupic and Čater, 2015). The institutional affiliation and geographical origin of the authors who contributed to the academic journals in the field of accounting, as in other management disciplines, have attracted particular interest of researchers.

A significant number of studies investigated whether certain institutions and countries dominate the scholarly articles published by accounting journals. For instance, Prather-Kinsey and Rueschhoff (1999) detected that 78.1 per cent of international accounting articles published in the US journals and *Accounting Organizations and Society (AOS)* from 1980 to 1996 were authored by individuals affiliated to institutions in just three countries, namely the UK, the USA, and Australia. A further study by Carmona *et al.* (1999) investigated the contributions of European scholars to accounting research through examining their publications in thirteen

major accounting journals during the period 1992 to 1997. They found that the vast majority of European accounting research was dominated by British higher education organizations. In addition, Anderson (2002) documented that the UK was the most influential and leading country which contributed to the journal of *Accounting, Business and Finance History* between 1990 and 2000. Chan *et al.* (2006) presented similar evidence that the UK institutions represented the majority of top-25 among the 253 universities ranked with regard to accounting research output in leading 19 accounting journals over the period 1991 to 2002. Using a set of leading accounting journals, Chan *et al.* (2005) ranked the Asia-Pacific universities concerning research productivity between 1991 and 2002 and found that universities of Australia and Hong Kong dominated research output in that region. Further, Jones and Roberts (2005) detected that the USA, the UK, Australia, Canada, and Hong Kong dominate publications in top accounting and finance journals. Using a subset of top accounting journals, Chan *et al.* (2007) similarly reported the USA as the most productive and influential country followed by the UK, Australia, Canada, and Hong Kong. They also determined an *elite* degree effect in accounting research documenting that researchers affiliated with *elite* accounting programs dominated the publications in prominent accounting journals. Supporting the findings of Jones and Roberts (2005) and Chan *et al.* (2007), Fogarty and Jonas (2013) found that about only 10 percent of the authorship of three top journals (*The Accounting Review*, *Journal of Accounting Research*, and *Journal of Accounting and Economics*) was employed by non-US universities. Merigó and Yang (2017) also determined that the USA dominated research output within the top four accounting journals followed by the UK, Canada, and Australia in that order. In recent years, Andrikopoulos and Kostaris (2017) detected while the US institutions contributed to the majority of published articles within top accounting journals, Canadian, British and Australian institutions comprised the majority of the non-US affiliations.

Prior studies overwhelmingly concluded that the USA, the UK, Australia, Canada, and Hong Kong dominated academic publications in accounting discipline. In particular, the USA has a long tradition of accounting research (Merigó and Yang, 2017), has a larger size of accounting and finance academic community than other countries (Jones and Roberts, 2005), and scholars from this country hold editorial positions in the most prominent accounting journals (Merigó and Yang, 2017). The dominance of Anglophone countries in accounting research can be attributed to the use of English as the official publication language in leading academic periodicals (Carmona *et al.*, 1999; Raffournier and Schatt, 2010). Therefore, the language barrier is one of the reasons that explain the under-representation of academics from non-English speaking countries in major accounting journals (Raffournier and Schatt, 2010).

Moreover, a country's economic maturity (Chan *et al.*, 2006), the government's academic promotion criteria (Carmona *et al.*, 1999), and national research support policies (Chan *et al.*, 2006) may explain the dominance of certain countries in accounting research. For instance, in the UK, the institutions receive research funding based on the quality of academic publications of their faculty members which are assessed by the Research Assessment Exercise[2] (Prather-Kinsey and Rueschhoff, 1999). Further, Williams (1985) determined that while no certain group of institutions dominates the authorship structure in *The Accounting Review*, institutional forces mediate the acceptance of ideas into accounting research, and thus influence the publication process. At the institutional level, time allocated to teaching, pecuniary and non-pecuniary benefits, and being public versus private institution can impact research productivity in accounting discipline (Englebrecht *et al.*, 2008a). The presence of doctoral degree-granting programs at an institution (i.e., university) can also impact the quality and quantity of the institution's research output (Fleischman and Schuele, 2009; Chen *et al.*, 2010).

In the prior literature, there are some other studies investigated the collaborative networks between regions, countries, and institutions in accounting research. Concerning collaboration among countries, Anderson (2002) detected that academics from the UK and Australia are more likely to collaborate with their colleagues from different regions and/ or countries. On the contrary, US academics seem unwilling to work together with academics from overseas countries. Fleischman and Schuele (2009) examined authorship patterns in the accounting history discipline through analysis of publications in three accounting history journals (*Accounting, Business & Financial History*, *Accounting History*, and *Accounting Historians Journal*) and pointed out that co-authoring teams do not collaborate internationally, particularly US authors. They prefer to co-author with exclusively of researchers affiliated with schools in the USA. However, the UK, Canada, and Australia/ New Zealand are more likely to transcend national borders. What is noteworthy in their research is that the overall trend in cross-border collaboration is on the rise. Likewise, Endenich and Trapp (2016) found that while Asian countries and Canada are more likely to involve in international cooperation, many European countries and the USA involve in less international cooperation than expected. Accounting researchers who are interested in local issues tend to use domestic data, write only in their mother tongue, and publish only in their home country's journals, and are not much interested in international collaborations (Lukka and Kasanen, 1996). For example, while researchers of some countries from Western Europe (i.e., Portugal and Switzerland) have less willingness to

[2] In the UK, research in universities has been evaluated for funding purposes by the successive Research Assessment Exercise since 1986 (Elton, 2000).

involve in international collaborations, those of some other countries (i.e., Sweden and the Netherlands) have much more international collaboration tendency (Lukka and Kasanen, 1996). Further, there are a significant number of top-ranking US accounting journals, and in these journals, only academics studying on US data have a greater chance to publish their articles (Jones and Roberts, 2005). These US journals usually have a limited scope and are likely to publish academic papers dealing with issues that are popular in the USA, such as financial accounting (Raffournier and Schatt, 2010). Thus, US academics may be less likely to collaborate with their non-US counterparts who do not have access to US data (Jones and Roberts, 2005) and study the topics that are not prominent in the USA. Vafeas (2010) documented that academics affiliated with highly ranked universities are also less likely to participate in research collaborations. In that sense, institutions' criterion for promotion and tenure decisions may influence the willingness of researchers to collaborate or not with their colleagues (Vafeas, 2010), and hence may shape collaborative networks between institutions. Particularly concerning collaboration across institutions, Lohmann and Eulerich (2017) examined the network of publishing institutions in the accounting field through analysis of articles published within *The Accounting Review* between 1926 and 2014. They identified distinct networks in the accounting community and determined that the network of affiliated institutions which contributed to *The Accounting Review* became diverse and denser, which means collaboration was more extensive and involved more universities, over the analysis period.

This study differs from prior studies in several ways. First, although a substantial number of studies examined the prominent institutions, countries, and regions in accounting research, there is a dearth of research on collaborative networks across regions, countries, and institutions. Therefore, an obvious motivation of our study was to fill this gap in prior literature by performing a comprehensive network analysis of collaborations across countries and institutions in the field of accounting.

Second, many prior studies selected journals which are specified as *top*, *premier*, *major* or *leading* (Henry and Burch, 1974; Chung *et al.*, 1992; Carmona *et al.*, 1999; Chan *et al.*, 2005; Jones and Roberts, 2005; Chan *et al.*, 2006; Englebrecht *et al.*, 2008b; Fleischman and Schuele, 2009; Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017; Merigó and Yang, 2017), while some others concentrated on a single prominent journal (Williams, 1985; Heck and Bremser, 1986; Anderson, 2002; Gaunt, 2014; Lohmann and Eulerich, 2017). Further, a significant number of prior authorship studies focused on particular topics in accounting discipline, such as accounting history (Anderson, 2002; Fleischman and Schuele, 2009; Gomes

et al., 2015; Coronella *et al.*, 2019), accounting education (Urbancic, 2009), environmental management accounting (Schaltegger *et al.*, 2013), and accounting information systems (Worrell *et al.*, 2013). The findings of these studies certainly provide useful insights into the understanding of authorship patterns in accounting research. However, they offer a limited perspective as they are peculiar to a small number of certain journals and/or a specific topic. Unlike prior studies in the literature, our research aims to provide a wider perspective into regional and institutional-based publishing patterns in accounting by using a larger set of journals without restricting the sample to a specific topic or issue.

Third, prior studies on authorship collaborations are mostly confined to a single region, such as Asia-Pacific (Chan *et al.*, 2005) and Europe (Carmona *et al.*, 1999; Chan *et al.*, 2006; Raffournier and Schatt, 2010), while some other studies pertain to a single country, such as China (Hussain *et al.*, 2015), Germany (Fülbier and Weller, 2011), Italy (Coronella *et al.*, 2019), and the USA (Tuttle and Dillard, 2007). Although these regional and country-specific studies provide significant contextual implications, they do not provide a holistic and global picture of accounting discipline. Hence, further motivation for this study was to advance understanding of the trend of collaborations with a geographical perspective without relying on any specific region or country. The examination of collaborative networks in a global context offers an opportunity to present the worldwide picture of accounting research output.

We, therefore, suggested the following research questions:

Research question 1: Which institutions, regions or countries are prominent with respect to research productivity, and how accounting discipline is compared to other management disciplines?

Research question 2: Which institutions and countries are the most active ones in the accounting research network in terms of centrality and mediation among network actors?

Research Question 3: Which implications do the current situation of accounting research network provide?

3. Methodology

To address research questions mentioned in the previous section, we employed co-occurrence analysis as a part of bibliometric methods (Koseoglu 2016a). Bibliometric methods have been developed to assess progress in a given discipline. They are considered as quantitative research approach since they employ statistical methods and aim to increase objectivity in review studies (Dzikowski, 2018; Köseoglu *et al.*, 2018). Hence, this study utilized a quantitative research methodology by following prior studies (Zupic and Čater, 2015; Chen *et al.*, 2017; Dzikowski, 2018).

3.1. Database selection

The most common source of bibliographic data is the SSCI which is accessible through WoS (Zupic and Čater, 2015). Because WoS is regarded as the most influential database in for bibliometric studies (Kumar and Jan, 2013; Zupic and Čater, 2015; Koseoglu, 2016a; Merigó and Yang, 2017; Köseoglu *et al.*, 2018), the research sample of this study comprised 22 accounting journals which are indexed in the SSCI (WoS) (see Table I). The SSCI is one of the three flagship citation indices which covers top-tier scientific international and regional journals in social sciences (Clarivate, 2019). The acceptance of journals to this index is managed by WoS based on a set of criteria tracked over the years (Clarivate, 2019)[3]. The SSCI enables us to sort journals by a keyword (i.e., accounting) in every social discipline through which we determined the set of journals in our study. Hence, the selection of 22 accounting journals in the sample is due to being ranked in the SSCI. However, we should clarify that those journals have different impact factors which can be considered as the indicators of quality. Indeed, we did not want to limit our study to only high-impact factor journals since some previous studies have already studied those journals' co-authorship structure (Carmona *et al.*, 1999; Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017).

3.2. Data collection and preparation

We excluded publications other than research articles, such as book reviews, commentaries, and editorials by utilizing an approach which is adopted by many prior studies in this area (Prather-Kinsey and Rueschhoff, 1999; Anderson, 2002; Jones and Roberts, 2005; Chan *et al.*, 2006; Englebrecht *et al.*, 2008b; Fleischman and Schuele, 2009; Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017). Thus, our analysis is limited to regular research articles.

We considered the period after 1999 for the analysis because online content of a significant number of accounting journals (i.e., *Accounting Horizons*, *International Journal of Accounting Information Systems*, *Journal of Accounting Research*, *Spanish Journal of Finance and Accounting*, and *The Accounting Review*) has become accessible beyond this year. Thus, the analysis covering the years after 2000 provides updated evidence of collaborations among institutions and regions. Overall, our database comprised 10,863 papers written by 9,318 authors from 2,093 institutions for 17 years, from 2000 to 2016.

All data were manually collected from electronic copies of sample journals. We first downloaded the articles to obtain information with regard to the affiliation of each author contributed to the article. The country of origin of authors is considered as the country of

[3] Please see Clarivate (2019) for more detailed information about SSCI and journal selection process.

affiliation at the time of publication because current affiliation was considered as an appropriate measure to examine collaborative networks across institutions and regions. While some journals included information on the geographical location of the affiliated university, some others did not include such information. In that case, we further investigated the country where the institution is located. We carefully checked the collected data by inserting affiliated institutions and countries into an Excel spreadsheet to eliminate and/or minimize possible errors. For instance, some institutions can be presented in slightly different spellings (e.g., University of Seville could appear as Universidad de Sevilla and University of Sevilla) or can be abbreviated in different forms (e.g., Virginia Tech University could appear as Virginia Tech). We, therefore, aggregated institutional data under one spelling to avoid all others.

3.3. Data analysis and visualizations

Upfront before network analyses and visualizations, we rank the institutions and countries in terms of research productivity. In measuring research productivity, we adopted most prior studies' approaches and counted the number of articles published by the institutions and nations (Borokhovich *et al.*, 1995; Spake and Harmon, 1998; Chan *et al.*, 2005). Publication counting is presumed as an objective and verifiable methodology in assessing research productivity (Hasselback *et al.*, 2003). The absolute number of articles published by the institutions shows their commitment to research in accounting and is also helpful in predicting future publication potential which might be interesting and practical to research directors and other administrators (Chan *et al.*, 2004).

In this study, we conduct co-occurrence analysis (i.e., co-authorship, co-word, or co-citation) (Koseoglu, 2016a) via social network analysis since co-occurrence maps progress on the structure of the data set (Leydesdorff and Vaughan, 2006). Co-occurrence emerges when two actors co-publish a study (Lu and Wolfram, 2012). We used social network analysis (SNA) to map these co-occurrence structures since it helps the researcher to identify key actors and strengths of the structure of the communities (Serrat, 2017). To conduct this analysis, we followed the process used by previous studies (Zupic and Čater, 2015; Koseoglu, 2016b). Analyses and visualizations of collaborative networks across institutions and regions were performed by using network analysis software packages, including Pajek, Ucinet 6, NetDraw, and VOSviewer. To show significant changes and to explore trends in collaborative patterns that have occurred from 2000 through 2016, the research period was divided into three consecutive sub-periods as 2000–2005, 2006–2010, and 2011–2016.

[Insert Table I here]

4. Results

4.1. Productive universities (unweighted)

Table II presents the most productive 20 universities (unweighted) in accounting research between 2000-2016. Overall, the five most productive universities are University of New South Wales (Australia), University of Sydney (Australia), University of Texas (the USA), University of California (the USA), and University of Manchester (the UK). Notably, these universities are among the consistent publishers of a high number of accounting articles over the analysis sub-periods. Overwhelmingly, the prolific universities are located in the USA, Australia, and the UK. However, University of Valencia from Spain in the first sub-period, University of Toronto from Canada in the second and third sub-periods, Singapore Management University in the third sub-period, and the City University of Hong Kong in the third sub-period appear among the most productive universities. Compared to past studies that focused on leading accounting journals, our study provided a different list of prominent universities in accounting research (Andrikopoulos and Kostaris, 2017). While 19 US universities and one UK university were included in the list of 20 most productive universities in that prior study, our study ranks UK and Australian universities as well as US universities as the most productive ones. In this variance, major US universities' promotion and tenure criterion might be playing a role such that they accept high ranking journals as a proxy of quality publication (Swanson, 2004; Bonner *et al.*, 2006).

[Insert Table II here]

4.2. Productive countries (unweighted)

Table III presents the most productive 20 countries in accounting research globally. The USA's indisputable dominant position with 9,788 articles is observable, followed by the UK and Australia with 3,325 and 3,110 publications respectively. Spain and Canada are the fourth and fifth most productive countries with 1,286 and 1,041 publications in that order. Given ranking reveals the following four clusters of countries considering unweighted research productivity; cluster 1: the USA, cluster 2: the UK and Australia, cluster 3: Spain and Canada, and cluster 4: other countries. It is quite obvious that the first five countries are consistently the first five with a little change in ordering among themselves across the analysis sub-periods. In the recent two prior studies that were carried out on some selected leading accounting journals, the USA, the UK, Australia, Canada, and Hong Kong were the leading five countries in terms of research productivity (Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017). Thus, our results largely confirm these two previous studies' findings and confirm the dominance of highlighted countries in accounting research on a wider journal sample with the exception of the order of Hong Kong. However, the situation is different for Spain; while it falls behind Hong Kong and

the Netherlands in leading accounting journals in those prior studies (Endenich and Trapp, 2016; Andrikopoulos and Kostaris, 2017), it is ahead of these two countries in our sample. Other than the first five nations in the ranking, the Netherlands, Germany, France, Finland, Italy, Sweden, Belgium, and Denmark from Europe, Hong Kong, China, Taiwan, Singapore, South Korea, Japan from Asia, and New Zealand from Oceania are outstanding productive countries. Figure 1 depicts the research productivity map of countries for 2000-2016.

[Insert Table III here]

[Insert Figure I here]

To get a deeper insight into the productivity ranking of countries, we have compared this study with some others in social sciences (Table IV). This comparison mostly confirms the first and the second places of the USA and the UK, respectively. In the majority, the third country is either Canada or Australia. Thus, the USA, the UK, Australia, and Canada are among the first four most productive countries irrespective of the studied field in management or economics. In this study, Spain is among the most productive countries, even before Canada; this motivated us to find some evidence for the high productivity of this country. Another prior study based on *European Accounting Congresses* ranked Spain as the first in congress attendance (Raffournier and Schatt, 2010). This could be the reason that moved Spain up in the productivity ranking as conference attendance might enable Spanish researchers to exchange ideas and to find collaboration opportunities. Moreover, the outstanding productivity performance of the following countries is mostly confirmed with other studies as seen on the Table: Germany, France, Sweden, Italy, Belgium, Denmark, Hong Kong, Singapore, Taiwan, the Netherlands, and New Zealand.

[Insert Table IV here]

4.3. Network attributes-institutions

In addition to presenting unweighted productivity of institutions and countries, we investigated active actors (i.e., institutions and nations) within the accounting research network by calculating relevant metrics which will suggest additional insights and implications. In Table V, we reported the significant indicators of the collaboration network, which are commonly referred indicators in past studies in network analyses. While the nodes are collaborating institutions in a network, ties are connections among institutions (Lohmann and Eulerich, 2017). The unique number of institutions is 2,093 through which 2,015 nodes and 18,444 ties are formed during the whole period of analysis. Over the sub-periods, the increase in the quantity of both nodes and ties indicates that the number of actors (collaborating institutions) and the tendency of collaboration among actors have increased over the sub-periods. The

importance of a node within the network (connections established through that institution) is recognizable with the *degree* (Wang and Chen, 2003). While the average degree is 7.694 over the period between 2000 and 2016, it tends to rise over the years (i.e., 4.314 in 2000-2005, 4.968 in 2006-2010, and 6.384 in 2011-2016). Thus, collaboration among institutions is increasingly getting more cohesive. The clustering coefficient assesses the likelihood that two of an institution's collaborators have themselves collaborated on a research project (Erfanmanesh *et al.*, 2012). Considering the overall clustering coefficient (i.e., 0.473) and the trend over the periods (i.e., 0.384 in 2000-2005, 0.407 in 2006-2010, and 0.465 in 2011-2016), it is obvious that collaborators of an institution are becoming likely that they will collaborate among themselves as well.

Network density which ranges between 0 and 1 assesses the likelihood of tie formation (Andrikopoulos and Kostaris, 2017) and is the ratio of actual links present in a network to maximum possible links (Racherla and Hu, 2010; Gallardo-Gallardo *et al.*, 2017). The overall density rate (0.004) of the collaboration network in the whole period denotes that only 0.4% of all possible links are established among institutions. The seemingly low-density rate is not much surprising in a big network as in our case since density is inversely proportional to network size (Gallardo-Gallardo *et al.*, 2017). In this type of social network, the giant component which fills a major portion of the network structure and smaller components that fill the rest show whether the network is fragmented or tightly connected (Newman, 2001). The stable number of components in the first two sub-periods and the decrease in the last period, and the increase in the size of the giant component over the sub-periods are indicative of a more cohesive and tight network. Average distance is an indicator of the connectedness of institutions (Andrikopoulos and Kostaris, 2017) and collaboration maturity among institutions (Ye *et al.*, 2013). The average distance for the whole period indicates that any selected institution has to pass 3.788 steps to collaborate with another institution. Albeit slight, the decrease in this indicator over the sub-periods is an indication of the fastened cooperation process.

[Insert Table V here]

4.4. Network attributes-countries

According to Table VI, the rise in the number of nodes and ties denote that collaborating countries with at least one country and the connections among countries have increased. The growing trend in average degree signals tightening network among countries. For the whole period of 2000-2016, on average, a country collaborates with 6.53 countries and the trend in sub-periods shows an increasing number of collaboration among countries. Slightly fluctuating clustering coefficient up and down over the periods (i.e., 0.612 in 2000-2005, 0.647 in 2006-

2010, and 0.629 in 2011-2016) indicates that the tendency of collaboration between two countries if they have cooperated with a third nation seems instable. The network density rate shows that the actual number of links among countries comprise only 5.6% of all possible links. The up and down movement of this rate (0.053 in 2000-2005, 0.064 in 2006-2010, and 0.053 in 2011-2016) also shows instability. The decline in the number of components and the increase in the size of the largest component (i.e., 98.291%) confirms that the country network is getting more cohesive.

[Insert Table VI here]

In order to get deeper insight, we compared this study's metrics with those of a prior study conducted on five leading accounting journals (Andrikopoulos and Kostaris, 2017). While there is not much difference between two studies for some variables (i.e., average degree and clustering coefficient), some notable differences are observable for some others (i.e., density, average distance, size of the largest component, and percentage of the largest component) (Table VII). We presume that these differences are attributable to sample size differences between two studies (i.e., 22 versus 5 journals). For example, the density rate of this study is smaller than that of Andrikopoulos and Kostaris (2017) since as the network size gets larger the probability of tie formation tends to decline. Likewise, the gap in the average distance between two studies implies that institutions and countries need to pass through longer steps to reach out to a collaborator. Furthermore, the larger network has understandably more actors in the largest component and appears to be more connected as the largest component percentages denote.

[Insert Table VII here]

4.5. Degree centrality-institutions & countries

Degree centrality assesses the number of institutions/countries an actor (i.e., institution and country in this study) collaborates with (Acedo *et al.*, 2006). Table VIII presents the ranking of the first 20 institutions in terms of degree centrality over the sub-periods and the whole period between 2000 and 2016. The noteworthy point is that US universities (i.e., 13 universities between 2000 and 2016) are the most active collaborators in this league. Furthermore, the Table denotes that other than US universities, some UK, Australian, Hong Kong, and Singaporean universities are also active collaborators. In consideration of the whole period, the first five institutions comprise three US (i.e., University of Texas, University of California, and University of Illinois), one UK (University of Manchester), and one Australian (University of New South Wales) universities. The remarkable issue is that these institutions are consistently among high collaborators in all sub-periods.

In addition to ranking institutions in terms of degree centrality, we ranked countries as well (Table X). It is quite plausible that the degree centrality of institutions influences those of countries to some extent. Thus, the UK, the USA, and Australia are the first three countries in order in all examination periods which is a little bit surprising. While the US universities are the prominent ones in institution ranking, why the USA is not at the top of this list? The answer hinges on the type of collaborations of the UK and the USA engage with; the UK tends to have more cross-country collaborations than the USA. Other than these three countries, Canada from the North America, Spain, the Netherlands, Germany, France, Italy, Finland, Sweden, Belgium, Denmark, and Austria, from Europe, New Zealand from Oceania, Hong Kong, China, Singapore, South Korea, and Taiwan from Asia are outstanding countries in that league.

4.6. Betweenness centrality-institutions & countries

Betweenness centrality measures the capacity of an institution/country to connect other actors (i.e., institution and country in this study) inside the network by undertaking a brokerage role (Koseoglu, 2016a). Table IX presents the first 20 institutions with respect to betweenness centrality which has a few surprises again compared to degree centrality. While US universities are the majority (i.e., 13 universities) institutions in the degree centrality, they are the minority (i.e., six universities, namely University of Texas, University of California, State University of New York, University of Wisconsin, New York University, and California State University) in betweenness centrality. Instead of US universities, more UK (i.e., University of Manchester, Lancaster University, The London School of Economics, Cardiff University, and University of Edinburgh), Australian (University of New South Wales, University of Sydney, University of Melbourne, Monash University, and The University of Queensland), and Asian (i.e., The Hong Kong Polytechnic University, Nanyang Technological University, and National Taiwan University), Spanish (i.e., University of Valencia) universities take their places in the ranking.

Moreover, country ranking with respect to betweenness centrality has some surprises as well (Table XI). The first three countries are in line with degree centrality (i.e., the UK, the USA, and Australia). In bridging nations, the UK plays a more effective role than the USA. Other important points are that Spain is moving to fourth place in the ranking, and Turkey, South Africa, and Greece appear as new entrants to the ranking which were absent in degree centrality.

[Insert Table VIII here]

[Insert Table IX here]

[Insert Table X here]

[Insert Table XI here]

4.7. Visualization maps-institutions

In addition to degree and betweenness centrality metrics in the preceding sections, we visualized the collaboration structure of the research network of accounting discipline among institutions and countries. These graphs are complementary to the metrics presented in the preceding sections, and helpful showing the central actors in the network. Figures II and III visualize density and network maps respectively. In the density map, red fill denotes peaks in density in terms of bibliographic coupling; yellow, green, and blue fills signify decreasing densities in the network (Nelhans and Lorentzen, 2016). As in Figure II, the largest red nuclei are located around University of Texas, University of California, and University of Pennsylvania between 2000–2005. In this period, some UK, Australian, and Canadian universities appear to be influential, such as University of New South Wales, University of Alberta, University of Queensland, University of Melbourne, University of Sydney, University of Manchester, and Cardiff University. Two Spanish universities form two separate green nuclei (i.e., University of Sevilla and University of Zaragoza) detached from the main component. In the second period between 2006-2010, two USA universities (i.e., University of California and University of Texas) form red nuclei along with a Canadian university (i.e., University of Toronto). University of New South Wales, University of Sydney, and University of Manchester appear as important actors although their influence fades as seen in color change around them. In the third sub-period between 2011-2016, University of Wisconsin joins to University of California and University of Texas around red nuclei along with a Canadian university (i.e., University of Toronto). University of New South Wales and University of Manchester keep their position on the map as influential actors. In the overall period between 2000-2016, University of Texas, University of California, and University of New South Wales appear as the most influential universities. In all sub-periods and the whole period, what we observe is that the density maps are integrated and cohesive as the main component occupies the map largely. Other small green and blue fills appear as ignorable components in the map.

In Figure III, while the links between the institutions demonstrate a collaboration network, the relative size of circles (i.e., nodes) assigned to each institution denotes the number of links. In addition to showing influential institutions in the collaboration network, this map shows cooperation among institutions specifically. As this figure largely confirms the previous one in showing the main actors, we prefer not to comment on universities particularly. In summary, both density and network maps mostly overlap and show an integrated and cohesive network. Other than a few nodes in the network, the majority of components are closely connected to each other forming a giant component.

4.8. Visualization maps-countries

In all periods, both density (left side) and network (right side) maps show two nodes for the USA as the most influential countries in the network (Figure IV). Interestingly, one of these two nodes is attached to other USA node which is connected to the global network. Thus, one USA node seems to be collaborating only with the USA, and the other one is with the rest of the world. Second important point is that one USA node and UK node appear to act as hubs through which other nodes are connected. Indeed, the UK's central role in the network was confirmed in the preceding sections with the betweenness centrality indicator. Furthermore, Australia, Canada, and Spain take their positions as influential countries in the network. It seems that Spain needs better integration with the rest of the world and intensify its collaboration.

[Insert Figure II here]

[Insert Figure III here]

[Insert Figure IV here]

5. Conclusion

This study is solely dedicated to accounting research network among institutions and countries which is unprecedented to this extent before; thus, it's approach is truly novel and original. We have conducted this study by manually collecting data from 10,863 papers published in 22 accounting journals indexed in the Web of Science for the period 2000–2016. The aim is to indicate prominent institutions and countries worldwide in research productivity and centrality which offers important implications as highlighted below. This study is thoroughly international as it is based on a broad set of journals and provides a broad perspective of accounting research network encompassing worldwide institutions and countries.

The main findings of the study are as follows. The most productive five universities around the world are University of New South Wales, University of Sydney, University of Texas, University of California, and University of Manchester. The decomposition of the most prolific universities indicated that a broader set of journals (i.e., 22-journal) serves better research diversity compared to a limited number of leading journals (Andrikopoulos and Kostaris, 2017). In accordance with the institution ranking, the five most productive countries in all periods are the USA, the UK, Australia, Spain, and Canada. However, in addition to these countries, it is important to note that some European and Asian countries and New Zealand from Oceania are among the most productive countries which host prolific institutions. Moreover, institutional network attributes indicated that the number of actors (collaborating institutions) and the tendency of collaboration among actors have increased in accounting discipline over the periods. Considering the whole analysis period, University of Texas, University of California,

University of Manchester, University of Illinois, and University of New South Wales are the most active collaborators (i.e., degree centrality) in the accounting research network. However, University of Manchester, University of New South Wales, University of Texas, Lancaster University, and University of Sydney are the most active universities in undertaking a brokerage role (i.e., betweenness centrality) between other institutions in the network. Furthermore, country-level network indicators show that the UK is the most influential actor in centrality and brokerage within the research network. We should note that Australia is also among the most influential nations with its influential institutions. Other than the UK, Spain appears to outperform other European countries in research productivity and effectiveness in the network. In all research metrics, the dominance of Anglophone countries (e.g., the USA, the UK, and Australia) is observable. As scholarly journals publish papers written in English, language advantage might be playing a significant role in the productivity and centrality within the network of these countries.

The study provides significant implications for researchers, institutions, and countries. As the accounting research network manifests a tightly connected network, it provides actors with opportunities to seek national and international collaborations. First, our findings indicated the prominent institution-wide and country-wide actors in accounting discipline; thus, the results provide a global perspective on the collaboration network. Second, our findings guide job seekers, who are particularly research-oriented, to potential recruiters around the world both at the institution and country levels. Third, the results might play an important role in forming institution-based and country-based research policies. The USA, among others, is a particularly important actor in productivity, whereas the UK, among others, is a remarkable country in centrality and brokerage in the network. By examining the policies of these two countries, other nations might shape their research strategies, promotion policies, and support and reward schemes. Fourth, cross-institution and in particular cross-country collaborations are imperative in the diversity of accounting research as they blend culturally diverse researchers. Fifth, prominent institutions highlighted in this study might be adopted as role models by other institutions in the same country, and benefit their expertise in productivity and cooperation by scrutinizing their approaches. Sixth, our findings and metrics might be adopted as benchmarks for institutions and nations for performance evaluation. Considering our 5-year period indicators, institutions can set targets for their improvement and for measuring the progress. Seventh, if high performing institutions' research policies are publicly available or reachable although private, lower-performing ones may adopt them in developing their own indigenous strategies. Eighth, although we did not investigate, research performance of institutions might

be significantly affected by some other policies such as recruitment or graduate education policies which might also be scrutinized in connection with research policies. Ninth, to enhance cross-institutional or cross-country collaborations, the policies, and support for greater researcher mobility need to be enabled. Tenth, although our analyses highlight prominent institutions and countries, they suggest some implications and set concrete benchmarks for those who are out of the rankings in terms of research productivity and mediation. Finally, we believe that our study is an indication of recognition and appreciation of hard work dedicated to research which is a kind of intangible return. We hope that this equivalently encourages and motivates both high and low performing institutions and countries.

Nevertheless, the study is bounded with several main limitations. First, due to collecting the data manually, there might be some inherent limitations. Second, the study is constrained by the time frame between 2000-2016. Third, the study does not answer *why* and *how* questions in investigating research productivity and effectiveness in the network. Fourth, our sample of journals consists of accounting journals ranked in SSCI. Thus, this study does not consider the articles published in other accounting journals not ranked in this index. Moreover, there might be some other articles published in non-accounting journals such as finance, economics, management, etc. Future studies may replicate this study's methodology to overcome this limitation and broaden journal and/or article selection criteria. Overall, our study might inspire new studies to complement ours by considering these constraints. Finally, we did not focus on a specific topic or theme in accounting; future studies might drill down into more specific concepts in the field.

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Table I. The journals within sample and affiliated countries

Journal Title
Abacus-A Journal of Accounting Finance and Business Studies
Accounting and Business Research
Accounting and Finance
Accounting Auditing & Accountability Journal
Accounting Horizons
Accounting Organizations and Society
Asia-Pacific Journal of Accounting & Economics
Australian Accounting Review
British Accounting Review
Contemporary Accounting Research
Critical Perspectives on Accounting
European Accounting Review
International Journal of Accounting Information Systems
Journal of Accounting & Economics
Journal of Accounting and Public Policy
Journal of Accounting Research
Journal of Business Finance & Accounting
Journal of International Financial Management & Accounting
Management Accounting Research
Review of Accounting Studies
Spanish Journal of Finance and Accounting
The Accounting Review

Table II. Productive universities (unweighted)

2000-2005		2006-2010		2011-2016		2000-2016	
University of New South Wales	106	University of Sydney	114	University of Texas	160	University of New South Wales	355
University of Manchester	84	University of New South Wales	106	University of New South Wales	143	University of Sydney	309
Cardiff University	83	The University of Queensland	86	University of California	120	University of Texas	308
University of Sydney	80	University of California	82	University of Sydney	115	University of California	276
University of California	74	Monash University	81	University of Illinois	109	University of Manchester	264
University of Pennsylvania	68	University of Texas	80	University of Manchester	103	The University of Queensland	229
University of Texas	68	University of Manchester	77	University of Melbourne	92	Monash University	222
University of Valencia	64	Cardiff University	76	University of Toronto	90	University of Melbourne	208
Stanford University	61	University of Pennsylvania	71	The University of Queensland	88	University of Pennsylvania	204
Monash University	57	Stanford University	66	University of Technology Sydney	87	Cardiff University	203
University of Southern California	57	University of Chicago	63	Monash University	84	Stanford University	203
University of Melbourne	56	University of Melbourne	60	Macquarie University	82	University of Illinois	195
Macquarie University	55	New York University	52	Stanford University	76	Macquarie University	180
The University of Queensland	55	University of Michigan	49	Singapore Management University	69	University of Technology Sydney	174
University of Michigan	54	University of St. Andrews	48	Indiana University	68	University of Chicago	172
Lancaster University	52	Lancaster University	45	The Ohio State University	67	New York University	164
New York University	50	University of Technology Sydney	45	University of Pennsylvania	65	University of Toronto	161
University of Edinburgh	49	University of Toronto	45	City University of Hong Kong	64	University of Michigan	156
Indiana University	48	Florida International University	43	New York University	62	University of Southern California	155
University of Chicago	48	Macquarie University	43	RMIT University	62	Indiana University	154

Table III. Productive countries (unweighted)

2000-2005		2006-2010		2011-2016		2000-2016	
USA	2740	USA	2731	USA	4317	USA	9788
UK	1040	UK	1090	Australia	1311	UK	3325
Australia	846	Australia	953	UK	1195	Australia	3110
Spain	416	Spain	448	Canada	481	Spain	1286
Canada	230	Canada	330	Spain	422	Canada	1041
Hong Kong	160	New Zealand	169	Hong Kong	290	Hong Kong	588
New Zealand	138	The Netherlands	140	Germany	269	New Zealand	533
The Netherlands	83	Hong Kong	138	China	247	The Netherlands	444
Singapore	68	France	89	New Zealand	226	Germany	397
Finland	51	Germany	84	The Netherlands	221	China	329
Denmark	47	Finland	74	Taiwan	216	Taiwan	319
France	47	Italy	74	Singapore	155	France	287
Sweden	47	Taiwan	74	France	151	Singapore	281
Germany	44	Sweden	72	South Korea	142	Finland	231
Belgium	36	Denmark	69	Italy	133	Italy	225
Ireland	33	Belgium	61	Finland	106	South Korea	224
Taiwan	29	China	59	Sweden	93	Sweden	212
South Korea	28	Singapore	58	Belgium	73	Belgium	170
China	23	South Korea	54	Austria	56	Denmark	159
Japan	22	Japan	49	Portugal	56	Japan	122

Table IV. Comparison of this study's finding with the findings of other studies in social sciences

Accounting (this study)	Accounting (Andrikopoulos and Kostaris, 2017)	Knowledge Management (Serenko *et al.*, 2010)	Strategic Management (Koseoglu *et al.*, 2015)	Economics (Kocher *et al.*, 2006)	Tourism (Park *et al.*, 2011)
USA	USA	USA	USA	USA	USA
UK	Canada	UK	UK	UK	UK
Australia	UK	Australia	Canada	Canada	Australia
Spain	Australia	Spain	Italy	Israel	Spain
Canada	Hong Kong	Canada	Australia	France	Hong Kong
Hong Kong	The Netherlands	Germany	Spain	Australia	Canada
New Zealand	Singapore	Finland	The Netherlands	Belgium	Taiwan
The Netherlands	France	Sweden	Ireland	Japan	New Zealand
Germany	China	The Netherlands	Norway	Sweden	South Korea
China	Germany	Italy	Alberta	Germany	Israel
Taiwan	South	Greece	Austria	Italy	Turkey
France	Taiwan	Denmark	Belgium	The Netherlands	The Netherlands
Singapore	Denmark	Taiwan	Berlin	Switzerland	Singapore
Finland	Israel	India	Cuba	Spain	Norway
Italy	Spain	France	New Zealand	New Zealand	China
South Korea	Sweden	New Zealand	Switzerland	India	Austria
Sweden	New Zealand	Malaysia	Cyprus	Hong Kong	Greece
Belgium	Finland	Singapore	India	Norway	Denmark
Denmark	Belgium	Norway	Scotland	South Korea	Germany
Japan	Ireland	Japan	Singapore	Taiwan	Sweden

Table V. Network attributes-institutions

	2000-2005	2006-2010	2011-2016	2000-2016
Average Degree	4.314	4.968	6.384	7.694
Density	0.005	0.005	0.004	0.004
Components	63	63	53	66
Average Distance	4.24	4.152	4.023	3.788
Overall Clustering coefficient	0.384	0.407	0.465	0.473
Size of the largest component	806	924	1320	1871
% of the size of the largest component	85.381	87.335	91.73	92.854
Nodes	944	1058	1439	2015
Ties	4710	6194	10794	18444

Table VI. Network attributes-countries

	2000-2005	2006-2010	2011-2016	2000-2016
Average Degree	4.103	5.146	5.745	6.53
Density	0.053	0.064	0.053	0.056
Components	4	2	3	2
Average Distance	2.599	2.569	2.577	2.594
Overall Clustering coefficient	0.612	0.647	0.629	0.669
Size of the largest component	75	80	106	115
% of the size of the largest component	92.308	97.561	96.364	98.291
Nodes	78	82	110	117
Ties	454	616	950	1168

Table VII. Comparative assessment of network attributes with those of (Andrikopoulos and Kostaris, 2017)

	Institution (our study)	Country (our study)	Institution (Andrikopoulos and Kostaris, 2017)	Country (Andrikopoulos and Kostaris, 2017)
Average Degree	7.694	6.53	7.978	5.909
Density	0.004	0.056	0.0108	0.134
Components	66	2	–	–
Average Distance	3.788	2.594	3.361	1.969
Overall Clustering coefficient	0.473	0.669	0.476	0.723
Size of the largest component	1871	115	650	42
% of the size of the largest component	92.854	98.291	88.076	95.455
Nodes	2015	117	–	–
Ties	18444	1168	–	–

Table VIII. Degree Centrality-Institutions

2000-2005		2006-2010		2011-2016		2000-2016	
University of Texas	55	University of Texas	63	University of Texas	97	University of Texas	140
Indiana University	38	University of California	45	University of California	73	University of California	114
New York University	37	University of Manchester	43	University of Illinois	68	University of Manchester	106
University of Manchester	36	University of Sydney	41	University of Manchester	63	University of Illinois	101
Texas A&M University	34	University of Toronto	41	The Hong Kong Polytechnic University	63	University of New South Wales	97
University of Illinois	34	University of New South Wales	39	University of Wisconsin	61	University of Melbourne	91
University of North Carolina	33	Cardiff University	37	University of Melbourne	60	University of Wisconsin	90
University of California	32	University of Chicago	33	University of New South Wales	59	The Hong Kong Polytechnic University	88
University of New South Wales	29	Indiana University	32	State University of New York	56	Nanyang Technological University	86
University of Melbourne	29	New York University	32	Singapore Management University	54	Texas A&M University	83
University of Wisconsin	28	University of Pennsylvania	31	University of Toronto	53	State University of New York	83
The City University of New York	28	University of Washington	31	Nanyang Technological University	53	University of Sydney	81
University of Southern California	27	Michigan State University	31	University of Arizona	52	Indiana University	81
University of Arizona	27	University of Michigan	31	Indiana University	51	University of Toronto	80
The University of Queensland	25	Monash University	30	University of Arkansas	50	University of Missouri	80
University of Michigan	25	University of Illinois	30	Arizona State University	50	New York University	80
Nanyang Technological University	25	The London School of Economics	30	Temple University	50	California State University	80
University of Missouri	24	Texas A&M University	29	University of Missouri	50	Michigan State University	76
Georgia State University	24	University of Arkansas	29	University of Sydney	49	University of Arizona	76
California State University	24	University of Missouri	29	Michigan State University	48	Arizona State University	75

Table IX. Betweenness Centrality-Institutions

2000-2005		2006-2010		2011-2016		2000-2016	
University of Manchester	29787.96	University of Sydney	43608.973	University of Manchester	70899.18	University of Manchester	121174.633
University of Texas	27096.72	University of Manchester	39725.488	University of Melbourne	49362.35	University of New South Wales	76032.555
New York University	22883.35	University of Texas	39297.613	University of New South Wales	47838.06	University of Texas	73639.758
University of New South Wales	22472.04	University of Toronto	25163.811	University of Texas	43660.46	Lancaster University	70314.719
The University of Queensland	19524.70	Cardiff University	22332.305	University of Sydney	33225.87	University of Sydney	67244.406
University of Melbourne	18476.61	The London School of Economics	20793.693	National Taiwan University	29193.79	University of Melbourne	59680.559
Indiana University	17135.69	University of New South Wales	20275.535	University of California	29043.48	University of Valencia	54239.316
Nanyang Technological University	16298.16	Lancaster University	16226.341	The University of Queensland	28360.99	The London School of Economics	52222.926
Macquarie University	15697.80	University of Valencia	14816.058	The Hong Kong Polytechnic University	28277.95	Monash University	51320.543
University of Valencia	15689.70	Monash University	14704.346	State University of New York	25816.07	The Hong Kong Polytechnic University	51040.051
Texas A&M University	15529.27	University of California	14352.459	Monash University	25534.53	The University of Queensland	50438.863
University of Wales	14082.12	University of Melbourne	14241.527	Lancaster University	25246.93	University of California	48825.133
University of Wisconsin	13882.65	University of London	13270.008	Nanyang Technological University	24847.90	Nanyang Technological University	46667.055
Lancaster University	11699.23	Concordia University	12932.715	Deakin University	23764.66	Cardiff University	44064.961
University of California	11571.25	University of St. Andrews	11660.424	ESSEC Business School	23631.96	State University of New York	41510.02
Glasgow University	11170.34	City University of London	11652.165	Glasgow University	23402.17	University of Wisconsin	40505.371
The City University of New York	11004.26	University of Exeter	11643.816	The London School of Economics	21304.35	University of Edinburgh	38117.801
University of Illinois	10834.87	University of Edinburgh	11238.695	University of Wisconsin	21098.25	New York University	35252.594
Cardiff University	10637.31	The University of Queensland	11211.677	University of Essex	20831.60	California State University	34855.457
University of Waikato	9922.48	University of Wisconsin	11128.62	City University of Hong Kong	19837.58	National Taiwan University	34757.551

Table X. Degree Centrality-Countries

2000-2005		2006-2010		2011-2016		2000-2016	
UK	36	UK	40	UK	54	UK	58
USA	30	USA	34	USA	45	USA	49
Australia	22	Australia	28	Australia	38	Australia	43
Hong Kong	15	Canada	22	Canada	24	Canada	28
Canada	14	France	18	Germany	22	Spain	27
Germany	13	The Netherlands	16	The Netherlands	22	The Netherlands	27
Singapore	11	Italy	15	France	22	Germany	25
The Netherlands	10	Spain	14	Spain	21	New Zealand	24
Spain	9	Singapore	14	China	20	France	24
New Zealand	9	Hong Kong	13	New Zealand	19	Hong Kong	23
Belgium	8	Denmark	12	Hong Kong	16	China	22
Denmark	7	New Zealand	11	Italy	15	Italy	20
Finland	7	Sweden	10	Finland	13	Singapore	20
Taiwan	7	Germany	10	Austria	13	Finland	16
Sweden	7	China	10	Sweden	12	Sweden	16
France	7	Switzerland	9	Denmark	12	Belgium	15
South Korea	6	Taiwan	8	Singapore	11	Denmark	15
Ireland	6	Belgium	8	Belgium	11	South Korea	13
Italy	6	Austria	8	Malaysia	11	Austria	13
Norway	5	Finland	7	Switzerland	10	Taiwan	12

Table XI. Betweenness Centrality-Countries

2000-2005		2006-2010		2011-2016		2000-2016	
UK	1035.12	UK	1072.28	UK	1979.52	UK	2144.73
USA	756.43	USA	686.57	USA	1207.41	USA	1226.56
Australia	349.09	Australia	532.62	Australia	910.45	Australia	942.34
Hong Kong	195.41	Canada	288.94	Spain	462.17	Spain	708.27
Singapore	165.04	Spain	261.53	France	392.92	Hong Kong	415.73
Canada	154.43	Sweden	239.24	Germany	338.31	France	400.77
Spain	153.42	Singapore	173.29	New Zealand	269.98	New Zealand	356.54
New Zealand	152.41	The Netherlands	162.51	Canada	264.30	Canada	252.81
Belgium	142.98	France	131.96	Italy	223.30	Italy	251.10
Germany	135.84	Italy	123.00	The Netherlands	213.60	Germany	249.80
The Netherlands	96.91	Hong Kong	112.57	China	197.33	The Netherlands	240.32
France	84.29	Denmark	92.96	Hong Kong	140.64	Belgium	238.36
Sweden	82.85	New Zealand	91.27	Austria	121.47	China	220.36
Finland	78.95	Switzerland	84.86	Sweden	120.26	Turkey	203.20
Denmark	74.65	Taiwan	84.38	Finland	117.63	Singapore	195.82
Ireland	72.70	China	84.23	Denmark	114.84	Sweden	146.30
Austria	71.53	Germany	82.92	Switzerland	110.71	South Africa	134.78
Taiwan	70.00	Belgium	81.63	Belgium	109.56	South Korea	128.59
Cyprus	70.00	Norway	81.05	South Korea	107.33	Greece	127.84
Turkey	70.00	Japan	81.03	Ireland	107.33	Finland	123.86

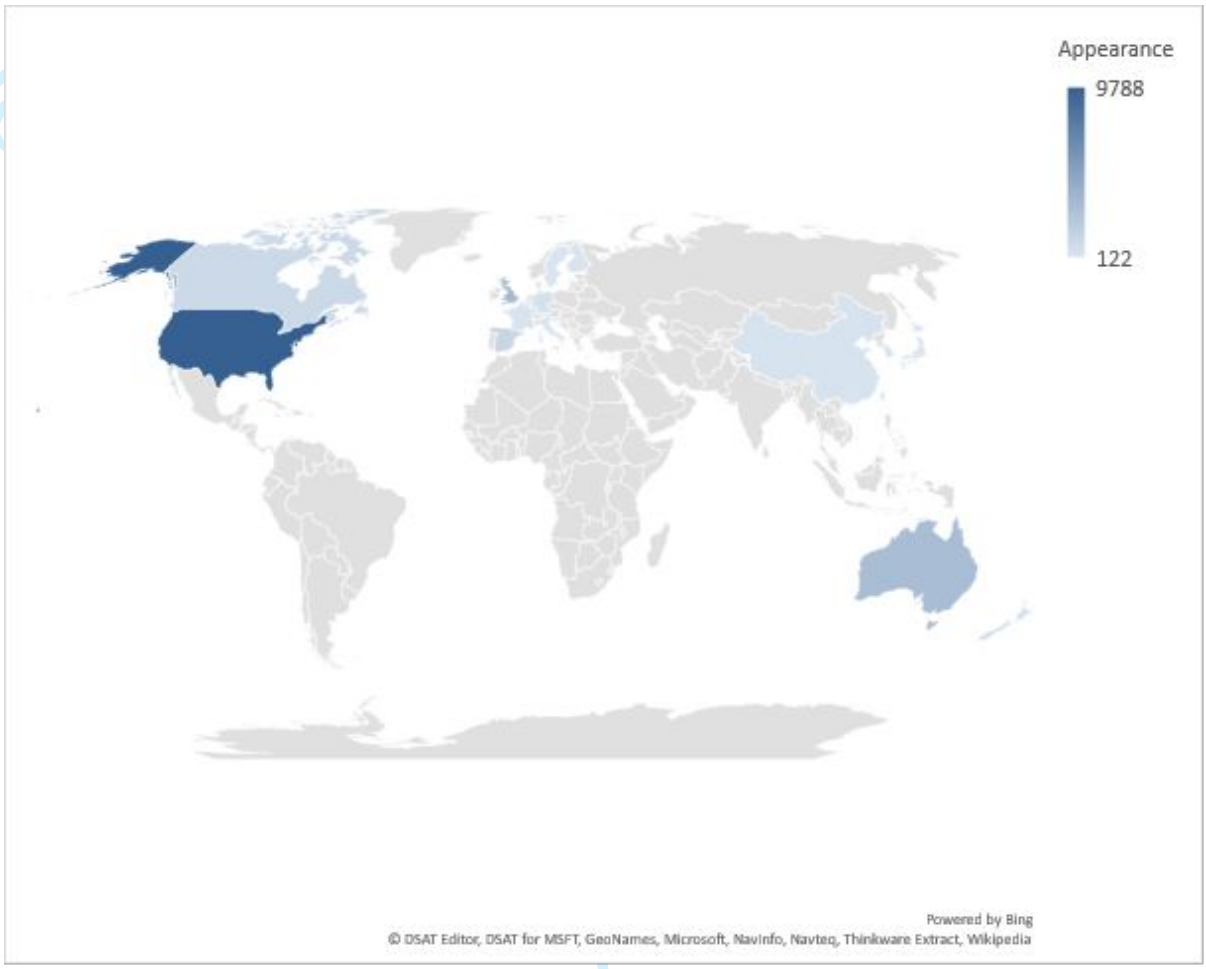


Figure I. Research productive (unweighted) map for 2000-2016

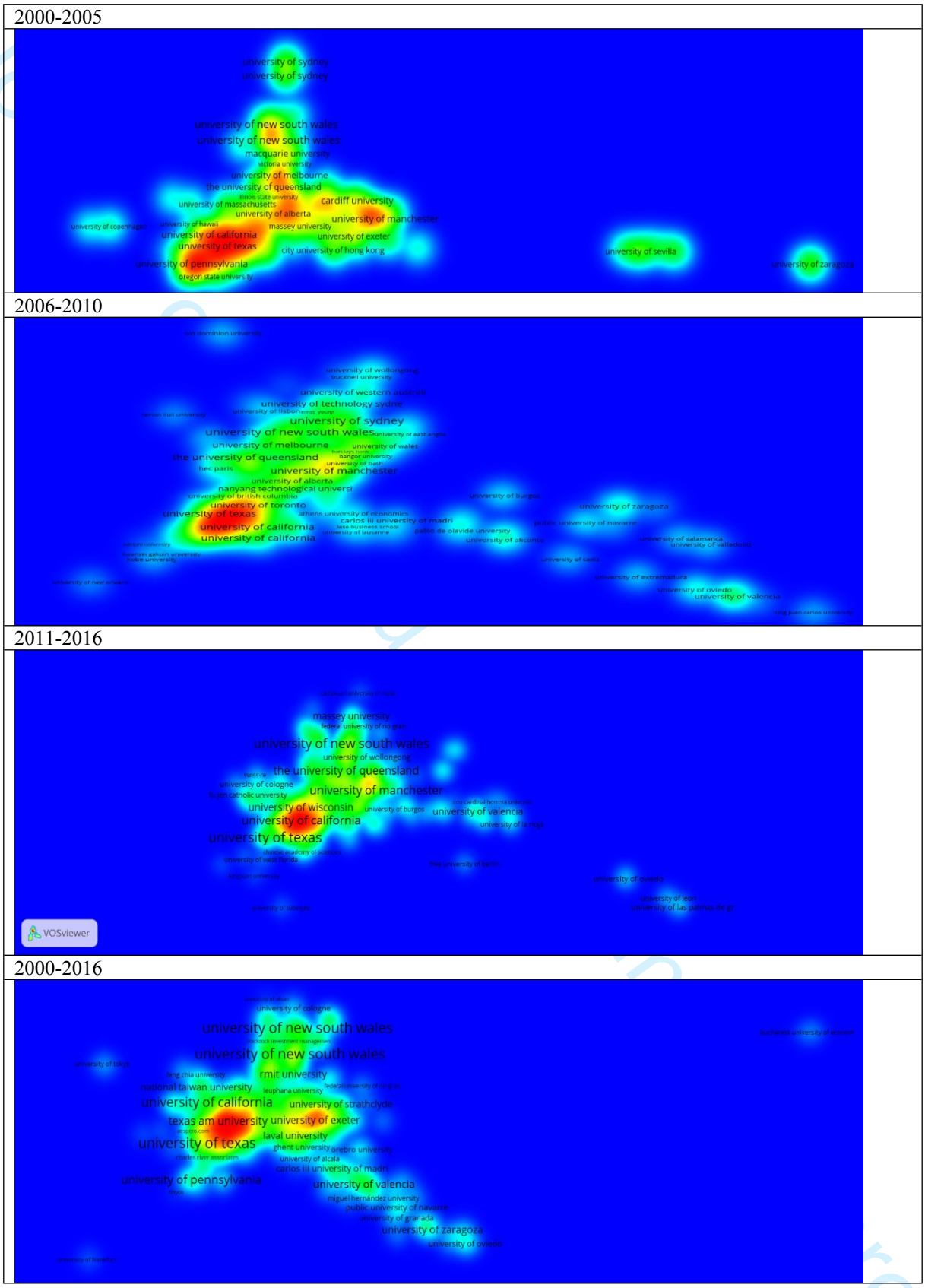


Figure II. Density map for institutions

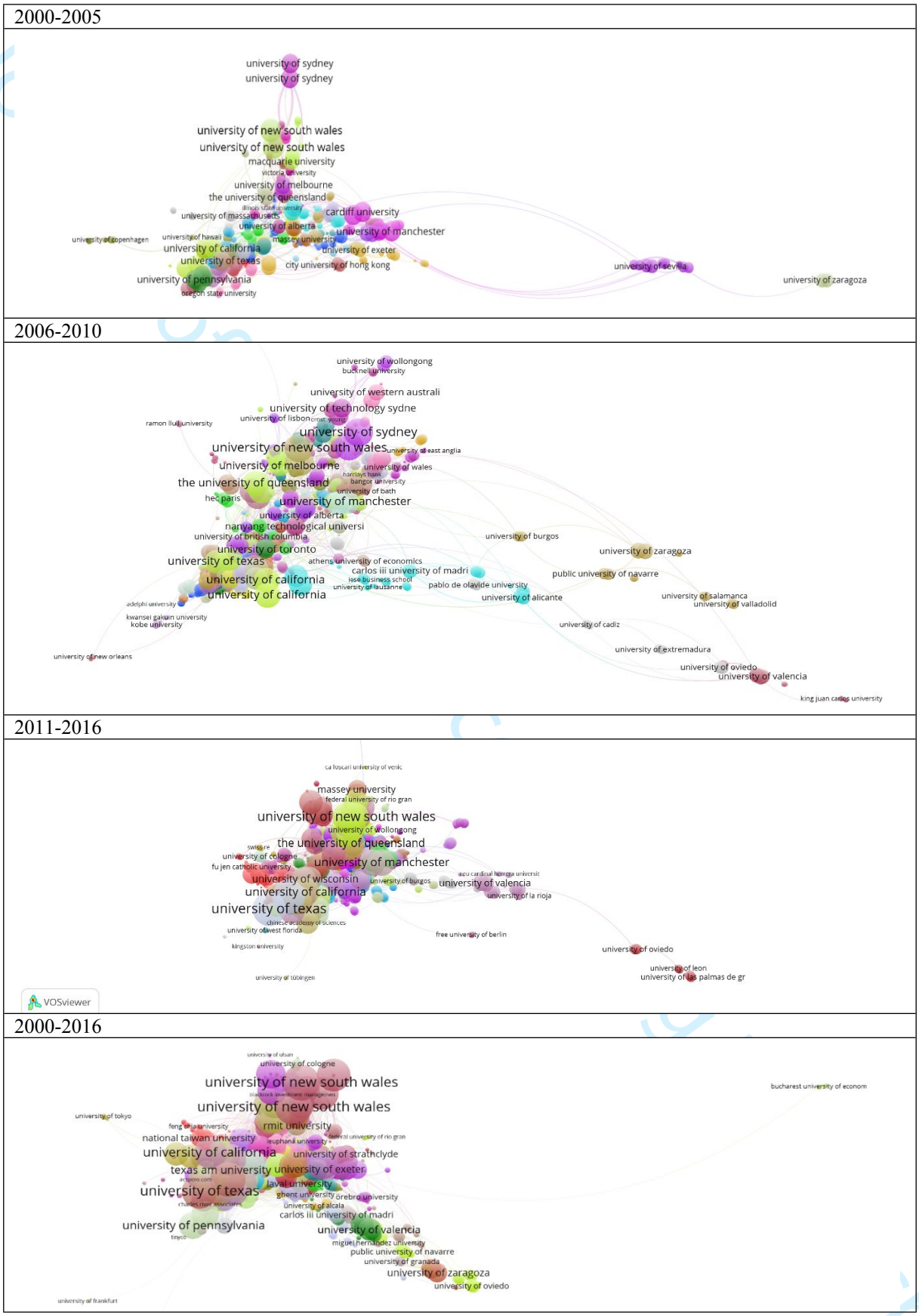


Figure III. Network map for institutions

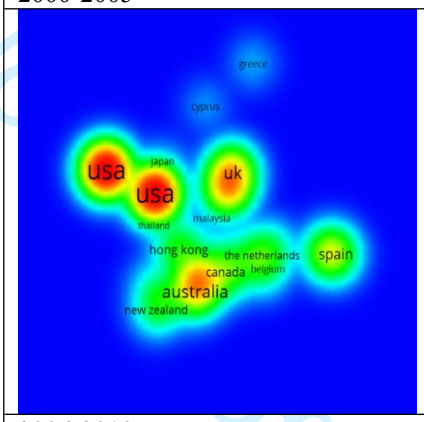
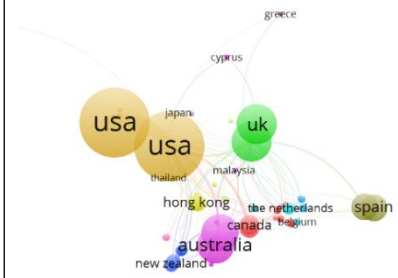
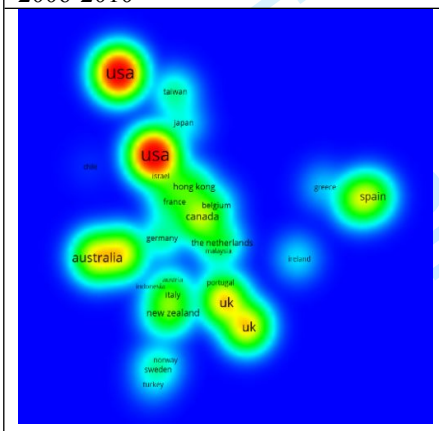
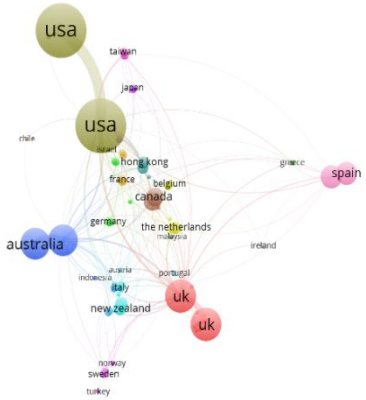
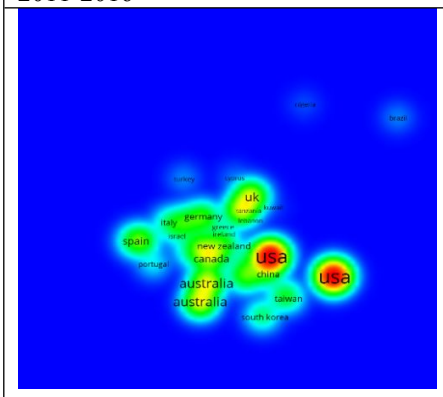
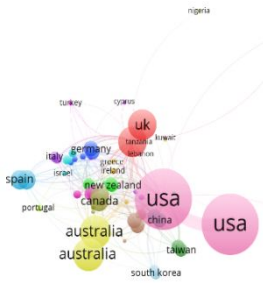
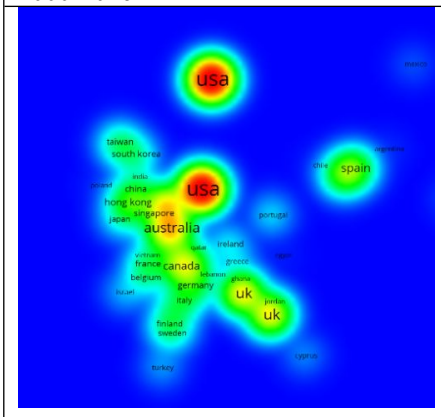
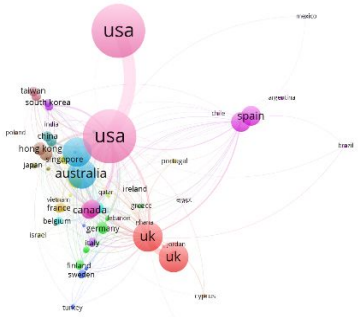
2000-2005	2000-2005
	
2006-2010	2006-2010
	
2011-2016	2011-2016
	
2000-2016	2000-2016
	

Figure IV. Density (left side) and network (right side) maps for countries