

Evolution of Think Tanks Studies in View of a Scientometrics Perspective†

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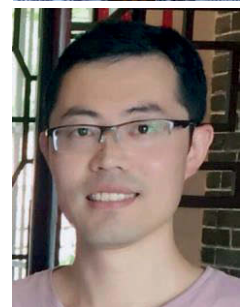
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Abstract: The paper presents a scientometrics analysis of research work done on the emerging area of think tanks, which are regarded as a domain of information science. Research on think tanks started during the last century and in recent years has gained tremendous momentum. It is considered one of the most important emerging domains of research in information science. We have analyzed the research output data on think tanks during 2006-2016 indexed in the Web of Knowledge™ and Scopus®. Our study objectively explores the document co-citation clusters of 1,450 bibliographic records to identify the origin of think tanks and hot research specialties of the domain. CiteSpace was used to visualize the perspective of the think tanks domain. Pivotal articles, prominent authors, active disciplines and institutions have been identified by network analysis. This article describes the latest development of a generic approach to detect and visualize emerging trends and transient patterns in think tanks.

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1.0 Introduction

Knowledge organization (KO) is the order of the elements of ontology, which has been regarded as a subfield of science of science (Dahlberg 2006). Think tanks are public-policy research analysis and engagement organizations that generate policy-oriented research, analysis, and advice on domestic and international issues, thereby enabling policy-makers and the public to make informed decisions about public policy (McGann 2016). It can be seen that the think tanks are a typical kind of knowledge management, whose main function is to produce and provide knowledge for

decision-makers (Rodríguez-Bárcenas and López-Huertas 2013; Hjørland 2008). A think tank is an organization that performs research and advocacy concerning topics such as social policy, political strategy, economics, military, technology and culture. Most policy institutes are non-profit organizations, which some countries such as the United States and Canada provide with tax exempt status. Other think tanks are founded by governments, advocacy groups, or businesses, or derive revenue from consulting or research work related to their projects (Stone 1996). Think tanks vary by ideological perspectives, sources of funding, topical emphasis and prospective consumer. A new trend is

collaboration between policy institutes in different countries (Weidenbaum 2011). The Think Tanks and Civil Societies Program at the University of Pennsylvania annually rates policy institutes worldwide in a number of categories and presents its findings in the “Global Go to Think Tanks” (2013) rating index. In recent years, more and more think tanks are gradually breaking through the position of some country, the development of the target positioning in the global service. Think tanks study and try to solve the fundamental problems that affect the survival of the earth and the human, such as environment, population, climate, energy, etc., even in politics, diplomacy, military, security and other traditional research areas of think tanks, to pay more attention to global peace, stability and development effects in the interests of the state and national scruples. It can create new and innovative platforms to deliver their products and services to an ever-expanding audience of citizens, policymakers, and businesses around the world. Think tanks are a global phenomenon in education as in other sectors, reflecting coordinated efforts to shape public policy. Some 6618 think tanks operated around the globe in 2014, and each one reflects funders’ significant efforts to project particular ideas into the public and policy arena (Lubienski et al. 2016).

From 2008 to 2015, millions of people lost their jobs in Europe due to the economic and financial turmoil sweeping their countries. Public debt became huge and investors grew frightened that entire countries were at risk of default in the so-called sovereign debt crisis. The most influential group of think tanks in Spain deals with the great recession by inputs and constituencies (funding, founders, trustees and experts) (Ricard Parrilla et al. 2016). In the USA, think tanks played a central role in the development of the Common Core State Standards (CCSS), which is purportedly a state-led initiative, but has been driven to a large extent by non-government policy actors and organizations (Savage 2015). The increased influence of these organizations is wielding increasing influence over policy development and enactment processes. The rise of think tanks and edu-businesses is symbolic of new policy networks and communities of expertise, new transnational policy discourses and new knowledge flows (Slee and Stambach 2010; Aubert 2012). As the governments increasingly outsource police work previously done by education departments and academics to these new policy actors, more think-tanks have emerged that represent a wide range of political views and ideological positions (Loughland and Thompson 2016). Think tanks are playing an important role in Australia as policy actors. The increasing influence of think tanks is symptomatic of shifts in government and governance “towards informal policy networks and the concomitant marginalization of traditional partners—local authorities, teaching unions and the civil service, and aca-

demia” (Ball and Exley 2010). Medvetz (2012) notes that there was no think tank category per se, either in public or specialized political discourses, until roughly the 1960s. McDonald (2014) found in the USA that conservative think tanks produced the largest number of education media citations when compared with centrist and liberal think tanks. The think tanks and civil societies program plays an important role in governments and civil societies around the world. The think tanks and civil societies program has developed and led a series of global initiatives that have helped bridge the gap between knowledge and policy in critical policy areas such as international peace and security, globalization and governance, international economics, environmental issues, informational peace and society, poverty alleviation, and healthcare and global health (McGann 2016). The think tanks are achieved with the help of over 1,900 peer institutions and experts from the print and electronic media, academia, public and private donor institutions, and governments around the world. Thus, people have a strong relationship with knowledge management throughout the world. Knowledge organization is closely related to people’s lives with more and more influence (Wolfram 2016; Meireles et al. 2014; Sienkiewicz and Ki-jeńska-Dąbrowska 2013).

2.0 Method

2.1 The general procedure of analysis and visualization with CiteSpace

The steps in our methodology were as follows:

- Identify the think tank domain, which is defined by relative papers and their citations;
- Data collection: we conducted a search on the Web of Science™ Core Citation Database and Scopus®. The retrieval strategy was “Topics= ‘think tank’ OR ‘think tanks’ AND Type=article AND Language=English” with time span from 2006.01.01 to 2016.12.31. 893 bibliometric records were obtained from WOST™, and 786 bibliometric records were obtained from Scopus®. We removed duplicates by native CiteSpace function. Finally we got 1,450 bibliographic records for subsequent text analysis.
- Time slicing: we specify 1 year as the length of a single time slice.
- Threshold selection: we selected the top 50 most-cited references per time slice to map the document co-citation network in both a standard graph view and a time-zone view.
- Pruning and merging. Minimize spinning tree is chosen for network pruning.

3.0 Methods of data analysis

Citation analysis has been used to evaluate the performance of science research and to analyze the hot topic of one field. Mapping knowledge is a useful method in evaluative bibliometrics, mostly aimed at displaying structural and dynamic aspects of scientific research (Noyons et al. 1999). Mapping knowledge has been used to explore the trend of fields, such as information science (White and McCain 1998), management science (Gundolf and Filser 2013), library science (Zhao and Wang 2011), medical science (Chaomei et al. 2012), and so on. The complete set of bibliographic records generated from the search term “think tank” was visualized and analyzed by CiteSpace. CiteSpace divides the entire decade (2006-2016) into a series of time slices and extracts the top-cited references during each time slice for subsequent analysis. In the analysis, each time slice equals one year and each slice is represented by the top 100 references for citation analysis. A density area with some large circles and a few purple round nodes in the center part of the map reveals that this is a developed area of the think tank domain with pivotal nodes and high citation burst.

We can get persistent and transient information from the scientific literature with the help of visualization tools. People can learn about the complex knowledge network of think tanks and forecast the new trends in the development of think tanks by drawing a visualization map. The analysis of thematic trends is based on the concept of burst detection (Chen 2006). Citation bursts of papers mean that highly cited papers provide concrete indicators of emerging themes as well as authors once highly active (Fang 2015). Salient conceptual structures can be identified through clustering analysis. A lot of literature about the trend analysis using CiteSpace has been published. However, little research has been done about the hot topics of the think tanks by using bibliometric methods. With the help of CiteSpace, we analyze literature about the think tanks retrieved from Web of ScienceTM and Scopus[®] to discover the main trends and hot topics of the think tanks, then provide more information for think tanks research. We traced the high burst cited references among document co-citation networks to highlight the salient themes and contributors of the think tanks research field and how the focus of the domain changes over time. We also identified the perspective of think tanks along the clustering analysis.

4.0 Results

4.1 Landscapes of the think tanks domain

The think tanks domain is a collection of various disciplines of experts and scholars, with their wisdom and abil-

ity to provide satisfactory solutions or the optimization scheme for decision-makers, which is a domain of information science. The domain of think tanks can be represented by a network of cited references, collaborating authors and co-occurring keywords. Our study focuses on co-cited reference networks. The nature of a cluster can be identified by algorithmically generated labels of the cluster and representative concepts in the cluster. A link in a document co-citation network represents how frequently two articles are cited together by other articles in a dataset. In this merged network, the size of a node is proportional to the different colors and thickness. Nodes with citation bursts are visualized with rings in red. Lines between nodes represent co-citation links. The colors of links denote when a particular connection was made for the first time. Blue colors indicate the earliest connections, whereas orange colors indicate the most recently made connections. The more dissimilar links in the network can be aggregated into clusters based on their interconnectivity. Clusters are labeled in red color initially by the number followed with one or two terms extracted from keywords and abstracts of articles. Each cluster is a group of tightly coupled references known as the intellectual base of a research specialty. Articles that are responsible for the citation patterns are known as the research front of the research specialty.

In CiteSpace, we selected top 100 cited references per year, imported the dataset of think tanks retrieved from Web of ScienceTM, performed minimum spanning tree algorithm and finally made a co-citation cluster network which contains 14,913 references and 354 links. The overview of a document co-citation network of a think tanks domain is presented in Figure 1.

In the panorama of think tanks, the most recent co-citation relationships are visualized as larger nodes in size. In Figure 1, individual links always follow the color of the time slice for the initial co-citation relationship if the references were co-cited more than once. Larger node sizes suggest that the reference is cited more frequently and implies that the paper is an important one within the knowledge domain. Third, red rings around a node represent a citation burst. In sum, references with large nodal size and links are worth further discussion because they reflect primacy or dominance in this knowledge domain. Each node in the figure represents a document, the more important literature is represented by larger nodes, such as Medvetz T. (2012), Jacques P.J. (2008), Abelson D. (2002), Stone D. (2004), etc.

Table 1 shows the top 15 largest clusters ranked in ascending cluster number but descending size order of the whole network. They are all with high modularity that represents a considerable amount of inter-cluster links. From an interpretive perspective, the size of a cluster label is determined by the total number of publications

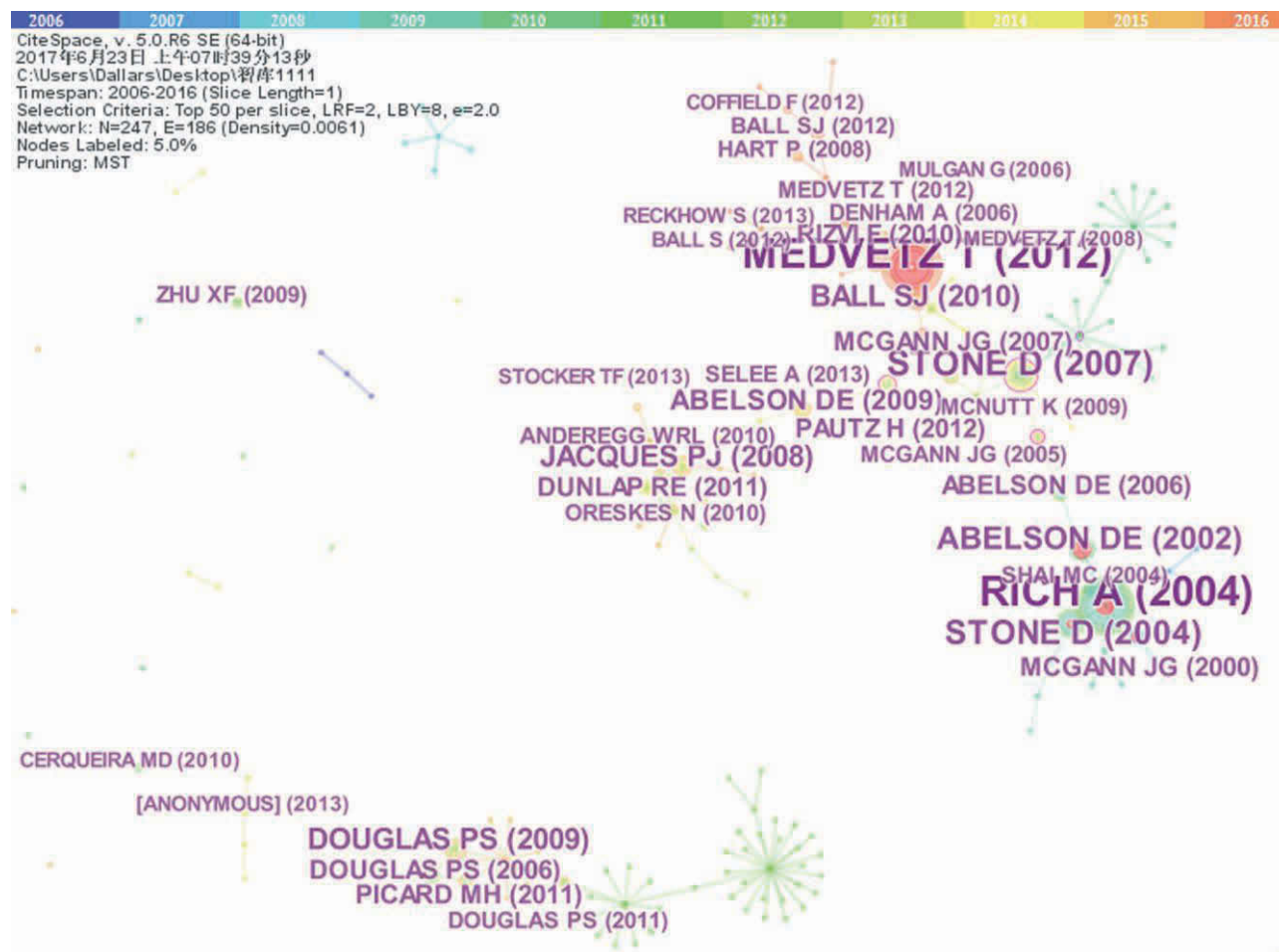


Figure 1. Panorama of think tanks

that a cluster contains. In this instance, there are 55 clusters in the network. Table 1 generated by CiteSpace details the fifteen largest clusters in rank order. Figure 1 illustrates that strategies and education policy are the two largest clusters. Ideological evolution and developing countries are the two newest clusters, and research utilization is the oldest cluster. The values of the silhouettes for each cluster are greater than 0.7, suggesting robust and meaningful results.

From the perspective of the clusters, we analyzed the aspects of each cluster from prominent members of a cluster as the intellectual basis and subjects identified in the citers of the cluster as research fronts. Research fronts of the document co-citation cluster were characterized by terms extracted from the citers of the cluster. We implement extraction by a log-likelihood ratio tests algorithm and top-cited terms labeled clusters automatically. The clusters for ideological evaluation and developing countries are the two relatively bigger networks and connected by many nodes. This suggests that ideological evaluations written by authors in these clusters were cited

by many of the same articles and significant overlap exists within this knowledge domain. That means not all nodes will contain a specific clustering term. Within the ideological evaluation cluster, which contains 40 references, there are citations to Michael George's 2009 book and the articles of Rich A (2004), Smith J (1991) and Stone D et al. (1996) based on the titles of the citing articles in the cluster, studies related to ideological evaluation from a major foundation of the knowledge domain, covering facets of strategy, environmental management, developing countries, business field, governmental agency, etc. In fact, strategy is the key term for this cluster if the LLR clustering algorithm is used for additional context. These connections within the information domain make good intuitive sense. Researchers interested in a strategy of developing countries and ideological evaluation, along with evolving theory, are particularly connected with how to change the ideological evaluation into strategy to solve problems.

Cluster 0 ideological evaluation reveals that strategy and its application is the main subfield of think tanks by

| ID | Size | Silhouette | Label (TFIDF) | Label (LLR) | Label (MI) | Mean(year) |
|----|------|------------|--|--|--|------------|
| 0 | 40 | 1 | ideological evolution | ideological evolution; | ideological evolution | 1996 |
| 1 | 30 | 0.939 | developing countries; policy making | developing countries | developing countries | 2001 |
| 2 | 28 | 1 | evolving theory | evolving theory | evolving theory | 1997 |
| 3 | 28 | 0.924 | policy expert | policy expert | state | 2001 |
| 4 | 27 | 1 | emerging typologies | emerging typologies | emerging typologies | 2005 |
| 5 | 25 | 0.956 | social policy | social policy | American politic | 1997 |
| 6 | 24 | 0.953 | knowledge management | knowledge management | think tank | 2002 |
| 7 | 23 | 0.937 | American politic | American politic | American politic | 2001 |
| 8 | 23 | 0.975 | policy setting | policy setting | policy setting | 2009 |
| 9 | 22 | 0.947 | increasing | increasing | increasing | 1989 |
| 10 | 19 | 0.93 | publics approach | advocacy | interest | 2000 |
| 11 | 19 | 1 | British Columbia capital as- set management | British Columbia capital as- set management | British Columbia capital as- set management | 2002 |
| 12 | 18 | 0.938 | policy actor | policy actor | public domain | 2002 |
| 13 | 18 | 1 | non-government | non-government | non-government | 2009 |
| 14 | 17 | 0.944 | discursive strategies | discursive strategies | discursive strategies | 2001 |

Table 1. Top-ranked clusters in think tank (TFIDF=term frequency-inverse document frequency; LLR=long-likelihood tests; MI=mutual information test)

the mean year of 1996. Ideological evaluation is one of the most important components in the field of think tanks that study and try to solve the fundamental problems affecting the survival of the earth and human life, such as the environment, population, climate and energy, even in the political, diplomatic, military and security of traditional intelligence research field. The mean year 2001 contains four clusters (1 developing countries; 3 policy experts; 7 policy settings; 14 discursive strategies). Cluster 1 developing countries is the second largest cluster, of which the size is 30. It should be mentioned that developing countries is the hot research topic of think tanks, as well as China and Japan. In developing countries, the think tank is an important part of national soft power that should attach great importance to exploring organization and management methods. The think tanks of developing countries are dedicated to public policy and public service, which is an important part of a national government system. In January 2015, China issued the “opinions on the strengthening the construction of new think tanks,” which points out the direction and the idea of development and construction of China’s new think tanks from the strategic level. The developing countries conduct research on the relationship between think tanks, politics and public policy to bridge the gap between knowledge and policy. In the past two decades, no other region has boasted unprecedented growth more than developing countries in the world. The results suggest that developing countries have converged increasing recognition of the importance of think tanks, or policy research

institutions, as an integral source of policy ideas and innovation. Think tanks haven’t exerted their effect in developing countries, as the government’s hand is often an inevitable presence in the structuring, as well as operation of policy actors and epistemic communities. For instance, Chinese think tanks have often been noted as having traces of government’s hand in almost every research institute—a fact may be deemed as lacking “independence.” Think tanks as Rumble (2013) argues, exemplify new policy networks that “bring into play in the policy process new sources of authorities and indeed a new market of authorities”.

Cluster 3 policy expert and cluster 7 policy setting are the two similar fields, which can provide the service or plan for the decision maker. Policy expert is the main field in the big data era. Medvetz notes that there was no think tank category per se, either in public or specialized political discourses, until roughly the 1960s. Think tanks have become even more influential policy actors since that time (Lubienski et al. 2011). The number of think tanks in the USA has grown since the 1970s and particularly since the 1990s (McDonald 2014b). McDonald writes that the think tanks interested in education policy and advocacy are either neoliberal or neoconservative in orientation. Jennifer Buckingham is a research fellow in the Education Program at the Centre for Independent Studies and an Australian exemplification of a new professional category of policy worker associated with think tanks—the “policy expert” (Medvetz 2008). The new professional policy expert is one who is able to traverse the logic of these fields, while sit-

ting within the logic of the think tanks field (Lingard 2015). The think tank policy expert might then be seen as an interdisciplinary field's professional workers. In view of this, think tanks and their policy experts seek to maximize political access, ensure their work has immediate policy relevance (Medvetz 2008). Cluster 7 policy setting reflects that think tanks can carve a niche in today's environment, as developing countries adopt technological practices, think tanks can provide the necessary consulting and policy advice to recommend adequate privacy laws and regulations to accompany these advancements, simultaneously providing information to the public about the changing technological and policy environment. In the environment of big data, the scientific and democratic decision-making comes from the discussion group because of the increasingly complicated social environment, the information explosion, information security, information pollution, etc.

Cluster 14 discursive strategies display that the wisdom of the civil foundation has continued to strengthen, such as the People's Forum and the Young Leaders Forum, which is the collection of wisdom. Independence is the most striking feature of it if were compared to the official think tanks. The main feature of the think tanks is discursive strategies. Cluster 2 evolving theory and 5 social policy by mean year 1997 reveal that they have relatively close relationship between each other. The evolving theory is abstract and has a guiding role for social policy, while social policy is the embodiment of the social policy. The social policy can promote the development of the evolving theory and decide the theoretical research of "the environment." Think tanks act as a bridge between the academic and policymaking. Cluster 4 emerging typologies is the characteristic of think tanks by mean year 2005. More and more emerging typologies of think tanks come out with the development of think tanks, such as the World Resources Institute, the Stanford Research Institute, the American Enterprise Institute for Public Policy Research, the Georgia Tech Research Institute's Office of Policy Analysis and Research, the Center for Development Research, the Joint Research Center, the National Institute of Science and Technology Policy, Science and Technology Policy Institute, etc. There are two main types of think tanks including government types and non-government types (independent think tank).

Mean year 2002 contains three clusters (6 knowledge management; 11 British Columbia capital asset management; 12 policy actor). Cluster 6 knowledge management is one of the most important aspects of think tanks. Think tanks mainly refers to the research and advice for the decisions and actions of government, business or social groups to solve specific problems, and a form of social organization for the cultivation, storage and delivery of talent. It is special that think tanks do not produce any material prod-

uct, but gather a large number of experts and scholars, and use collective wisdom for society, economy, military, science and technology to provide a scientific basis for organization and management, or provide optimization theories, strategies and plans, in order to make decisions for the leadership of the government, business or social group. Thus, think tanks is a typical knowledge producing organization, which mainly provides and produces decision-making for policy makers. In fact, it is carrying on knowledge management activities all the time. Cluster 11 reveals that the scope of the think tank has been expanding, with more and more extensive field involved in it. From Global Go to Think Tank Index Report, we get the statistic of think tanks around the world during 2014-2015. The number of think tanks in the world in 2014 is 6,618, and the number in 2015 is 6,846. There are more and more categories of think tanks around the world, such as national security think tanks, economic policy think tanks, education policy think tanks, good governance think tanks, energy and resource policy think tanks, environment think tanks, foreign policy and international affairs think tanks, health policy think tanks, science and technology think tanks, social policy think tanks, etc.

The mean year 2000 contains cluster 10 advocacy, which is included in special achievement. The advocacy campaigns are groups of activities or actions that convey ideas and beliefs of the organizations to the public. That being said, advocacy types of think tanks tend to take strong positions on particular policy issues, which may potentially derail the institute's objectivity and consistent value (McGann 2014). Another two clusters were shown in mean year 2009, namely 8 philanthropies and 13 non-government, which became hot discussing themes. Philanthropies are the main non-profit organizations in US. Many social problems were solved by the philanthropies and non-government. There are many non-government think tanks donated by the philanthropies that include scientific philanthropy and venture philanthropy. According to the National Philanthropic Trust, in 2014 alone, private citizens gave US\$356.38 billion, corporate donations amounted to US\$17.77 billion and foundation giving was US\$53.7 billion (Andreoni et al.2016). The Bill and Melinda Gates, Walton Family, Michael and Susan Dell, Robertson, Eli and Edythe Broad Foundations and Doris and Donald Fisher Fund are known as the "big six" philanthropies due to their dominance in US education policy funding (Researcher and P-May 2014). These kinds of organizations take an active role in promoting the development of think tanks. Some philanthropies offer critical support for non-government and education.

Cluster 9 increasing reveals that the number of think tanks is growing with the development of information technology, education, health care etc., from the 2015

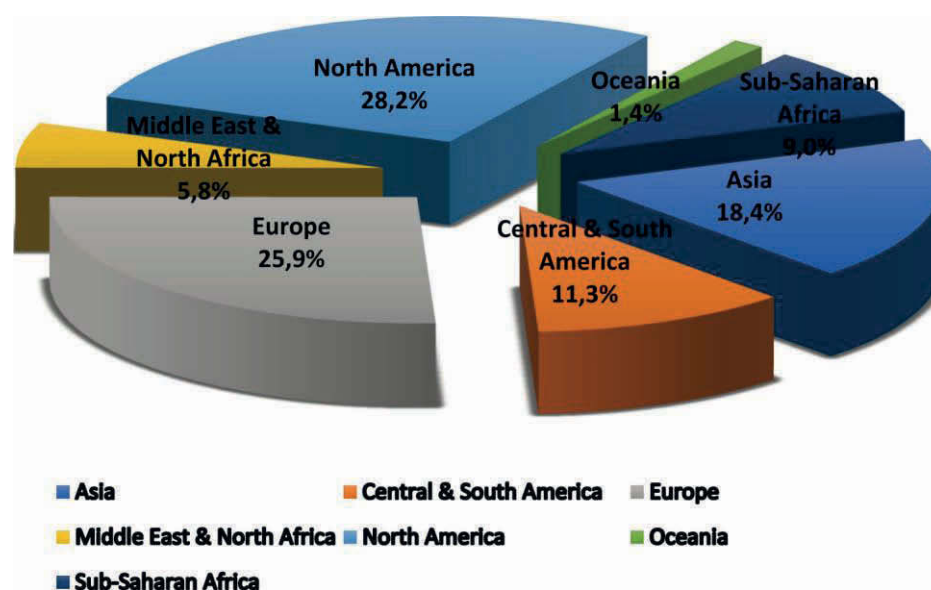


Figure 2. Number of think tanks in the world in 2015

| Rank | Country | Number of Think Tanks(2015) | Number of Think Tanks(2011) | Growth Rate |
|------|----------------|-----------------------------|-----------------------------|-------------|
| 1 | United States | 1835 | 1815 | 1.1% |
| 2 | China | 435 | 425 | 2.4% |
| 3 | United Kingdom | 288 | 286 | 0.7% |
| 4 | India | 280 | 192 | 45.8% |
| 5 | Germany | 195 | 194 | 0.5% |
| 6 | France | 180 | 176 | 2.3% |
| 7 | Argentina | 138 | 137 | 0.7% |
| 8 | Russia | 122 | 112 | 8.9% |
| 9 | Japan | 109 | 103 | 5.8% |
| 10 | Canada | 99 | 97 | 2.1% |

Table 2. Countries with the top ten largest numbers of think tanks

Global Go to Think Tanks Index Report, we get new data about the quantities of think tanks around the world. Percentage of think tanks were presented in Figure 2; North America ranks first in the chart. From the perspective of country, the largest number of think tanks in the world is United States with 1835, the second largest is China with 435, the top 10 countries are ranked in Table 2. The number of think tanks is growing through comparative analysis of different time periods. The world's fastest growing is India, about 45.8%. Think tanks are more and more important for any country because they are the information resource that is the most important information source of knowledge innovation.

There are many think tanks around the world, especially in North America, which takes up 28.2%, and second large

est is Europe with about 25.9%. Think tanks have increased in number, but also the scope and impact of their work has expanded dramatically. The substantial growth was due to the information and technological revolution, the increased complexity of policy issues, the growth of global philanthropy, the rise of civil society, the forces of globalization, and the demands for timely and concise policy analysis. Think tanks can be affiliated or independent institutions that are structured as permanent bodies, not ad hoc commissions, which is now widely accepted around the globe to describe public-policy research analysis and engagement organizations that generate policy-oriented research, analysis, and advice on domestic and international issues. These institutions often act as a bridge between the academic and policymaking communities, which enable

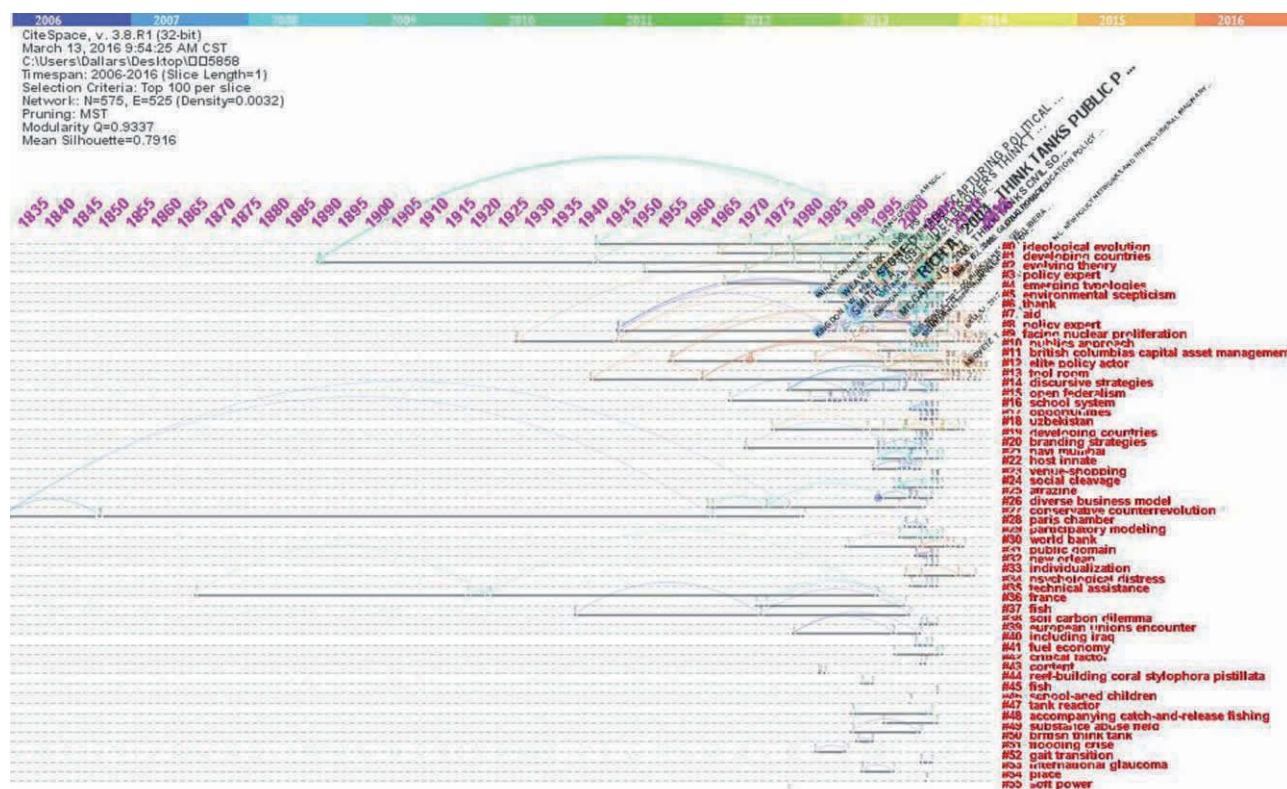


Figure 3. Timeline view of document co-citation analysis of think tank: 2006-2016

policymakers and the public to make informed decisions about public policy issues. The challenge for the think tanks is to harness the vast reservoir of knowledge, information, and associational energy that exist in public policy research organizations so that it supports self-sustaining economic, social, and political progress in every region of the world for public good (McGann 2014).

4.2 Emerging trends and the research front of think tanks

An alternative approach for viewing these clusters and their relationships is with timeline visualization (Figure 3). This kind of method provides a temporal overview of nodes, links and clusters. It is a two-dimensional network that graphs the publication years of cited papers with the derived clusters. According to Price (1965), the research front is about 50 articles published prior to the citing article. Small and Griffith (1974) represented currently activated scientific specialties as clusters of co-cited articles. Chen defines a research front differently to emphasize emerging trends and abrupt changes as the defining features of a research front. The most obvious trend in Figure 3 is that most of the documents cited were published after 2000 and are found in the cluster for conservative think tank. In sum, the main take-away from Figure 3 is that most of the

larger nodes, or those with citation bursts, high betweenness centrality, or both, belong to the fifteen largest clusters. Again, ideology evaluation and developing countries have most close connectivity, but there are other clusters worth mentioning. CiteSpace identifies emerging topics by algorithm; a citation burst of articles which have received the steepest citations and a strong frequency surge of keywords (Fang 2015).

There are a total of 55 clusters of co-cited references. Each cluster corresponds to an underlying theme. The signature of the network is shown on the upper left corner of the display. In particular, the modularity Q and the mean silhouette scores are two important metrics that tell us about the overall structural properties of the network. The homogeneity of each cluster is measured by a silhouette score from -1 to 1. The modularity Q of 0.9337 is relatively high, which means that the network is reasonably divided into loosely coupled clusters. The mean silhouette score of 0.7916 suggests that the homogeneity of these clusters on average is not very high. A low modularity suggests a network that cannot be reduced to cluster with clear boundaries, whereas a high modularity may imply a well-structured network (Chen 2004). The highest citation burst reference starting from 2012 is associated with a 2006 paper by Maton titled "Psychological Research, Practice, and Social Policy: Potential Pathways of Influence." It is the

| Cluster | Citation | Burst | Author | Year | Reference |
|---------|----------|-------|---------------------|------|---|
| 5 | 34 | 5.13 | Medvetz T | 2012 | US think tanks in the field of state power |
| 9 | 25 | 2.92 | Ingram Alan | 2007 | Security and the geopolitics of US-Nigerian relations |
| 17 | 12 | 2.80 | Madersbacher Helmut | 2012 | What are the causes and consequences of bladder over distension |
| 2 | 39 | 2.62 | Ryan Thomas | 2015 | Training in echocardiograph |
| 0 | 58 | 2.61 | Zhu Xufeng | 2007 | Think tanks in transitional China |
| 1 | 39 | 2.57 | Lingard Bob | 2016 | Think tanks, policy experts and ideas for education policy making in Australia. |

Table 3. The top ranked item by bursts

most active cluster with high citation burst. The second highest citation burst in 2007 is attributed to the faster technologies, such as internet, social network, the cloud, and handheld computers, which are the constitution of a networked society, a new social structure that utilizes Information-Age technologies to expand, reconfigure and overcome the limitation of think tanks. Thus, there appear more and more think tanks around the world every year.

For example, ideological evolution and knowledge management are two highly connected clusters. Knowledge management is divided into explicit knowledge management and tacit knowledge management. Ideological evolution is close to tacit knowledge management. Think tanks produce and supply high quality decision knowledge for the decision-maker. Clusters representing new development since our 2015 review are shown in Table 3 as the co-citation activities appeared to the left of the column of the clusters' labels. A more detailed visualization was generated to further investigate new developments in think tanks, which is including cluster 5 social policy, cluster 9 increasing, cluster 17 alternative knowledge, cluster 2 evolving theory, cluster 0 ideological evolution, cluster 1 developing countries. The visualized network reveals the overall structure of think tanks in a broader context, because the citing articles were drawn from the expanded and integrated dataset. The overall structure consists of two major areas of activity. From 2006 to 2010, the node of network is sparse, after 2010 a lot of big nodes have come out with dense network.

We get the new development direction of think tanks by CiteSpace network mapping. The large node was defined as a highly-cited article that can be identified by size, height or volume and pivotal node joining several different-colored links. The betweenness centrality is a direct measure of message traffic, and the high betweenness centrality scores indicates that the vertex lies on considerable fractions of shortest paths connecting others, for which it plays an important role in the network. A pivotal node which is identified by high betweenness centrality is potentially a transformative discovery and intellectual turning

point because betweenness centrality is found to correlate with long-term citations predicted into the future (Kas et al. 2014). A node with high betweenness centrality would be more valuable than that with a higher citation count (Chen et al. 2009). According to visual network, nodes with betweenness centrality over 0.1 are considered high betweenness centrality and easy to be found in paths connecting different clusters. Pivotal nodes with high betweenness centrality are highlighted in the CiteSpace displayed with a purple ring and connect more different color links.

From the timeline visualization of think tanks (Figure 3), which shows the interrelationship of clusters and provides a distinct view to identify the characteristics of a cluster by its history length, citation bursts, especially the pivotal nodes that were marked horizontally with the label shown at the end of the timeline. In Figure 3, the typical nodes contain the developing countries. Developing countries have gradually strengthened the construction of think tanks in face of fierce international battle to improve scientific decision-making and enhance the international influence such as the Indian Council of World Affairs, the Institute for Defense Analyses, the Centre for Policy Studies, the Center for Strategic Studies of Egypt and other influential development countries. For example, there have been more and more think tanks in China since the reform and opening up. Chinese people improve the scientific and democratic decision level by organizing different kinds of think tanks, especially folk think tanks. Internationally, the formation and implementation of the policy are affected by think tanks in varying degrees. The most remarkable feature is their specialization and integration in function. Think tanks are mainly to provide new insight, and decision-making for the government and decision maker, according to various complex domestic and foreign affairs, to put forward specific and available solutions for the government when the new contradictions and problems come out.

The emerging trends in sciences can be captivated by documents receiving the surging frequency of citations.

| References | Year | Strength | Begin | End | 2006 - 2016 |
|--|------|----------|-------|------|-------------|
| MCGANN J G, 2000, THINK TANKS CIVIL SO, V, P | 2000 | 2.7801 | 2007 | 2008 | |
| ABELSON D E, 2002, DO THINK TANKS MATTE, V, P | 2002 | 3.5825 | 2008 | 2010 | |
| STONE DIANE, 2004, THINK TANK TRADITION, V, P | 2004 | 2.8275 | 2006 | 2009 | |
| RICH A, 2004, THINK TANKS PUBLIC P, V, P | 2004 | 4.3163 | 2007 | 2010 | |
| STONE D, 2007, PUBLIC ADMIN, V85, P259, DOI | 2007 | 2.542 | 2013 | 2014 | |
| JACQUES PJ, 2008, ENVIRON POLIT, V17, P349, DOI | 2008 | 2.599 | 2013 | 2016 | |
| DOUGLAS PS, 2009, JACC-CARDIOVASC IMAG, V2, P231, DOI | 2009 | 2.599 | 2013 | 2016 | |
| ABELSON DE, 2009, DO THINK TANKS MATTER?: ASSES- SING THE IMPACT OF PUBLIC POLICY INSTITUTES, V, P1 | 2009 | 2.6079 | 2014 | 2016 | |
| MEDVETZ T, 2012, THINK TANKS AM, V, P | 2012 | 4.9211 | 2013 | 2016 | |

Table 4. The top 9 references with strongest citation bursts

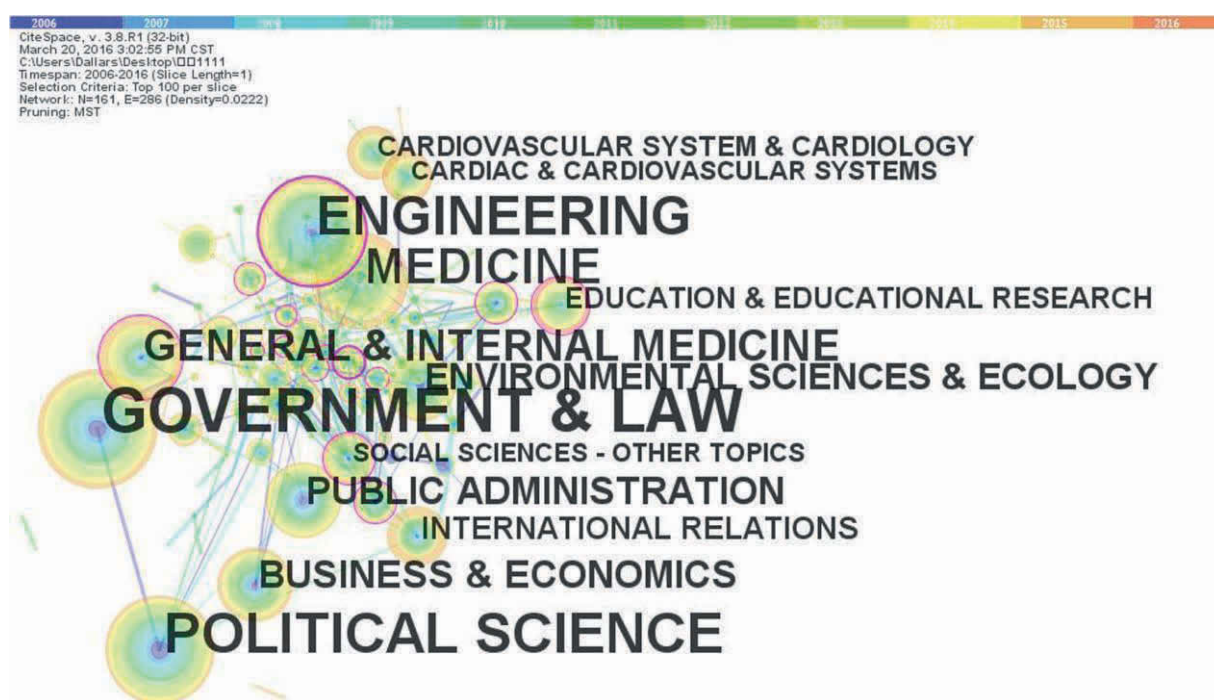


Figure 4. Category of think tanks from 2006 to 2016

Table 4 lists the top 9 references with the strongest citation bursts in the core dataset. A citation burst indicates the likelihood that the scientific community has paid towards the underlying contribution. As shown in Table 4 the root of think tanks can be traced back to the extensive work by Weaver and McGann (2000). As discussed above, it is assumed that the domain of think tanks is relatively new, still emerging and developing.

4.3 Hot research category and institution

Figure 4 shows top categories think tanks research focuses on, whose publishing numbers are greater than 45. In

order to facilitate the analysis, we list the category which publish ≥ 45 as shown in Table 5. The publishing number of “government & law” is the first in the ranked list. “Political science” ranked in the second, the publishing number is 87. The third category is engineering, and then the field of medicine. The publishing number between each other is very small. “Government & law” is obviously the core subject of think tanks. Most categories are related to government, such as policy, public administration, international relations, etc. Typically today the government is the main service object of the think tanks. Hart and Vromen (2008), proffer a categorization of think tanks, consideration of the ways they work, their purpose, and

| Frequency | Category |
|-----------|----------------------------------|
| 94 | Government & Law |
| 87 | Political Science |
| 84 | Engineering |
| 76 | Medicine |
| 66 | General & Internal Medicine |
| 60 | Public Administration |
| 59 | Business & Economics |
| 55 | Environmental Sciences & Ecology |
| 48 | International Relations |
| 45 | Education & Educational Research |

Table 5. Top 10 publishing numbers

their relevance and influence, and named the government think tanks as one of the categories.

Figure 5 shows the high specialty from the top cited journal as depicted in Table 6, where cited frequency is over 30. The centrality of a node is a graph-theoretical property that quantifies the importance of the node's position in a network. There are two journals' centrality over two, which reveals government and political science are the main themes of the think tanks.

The top published institutions are shown in Figure 6. The color of a citation ring denotes the time of corresponding citations, the thickness of a ring is proportional to the number of citation in a given time slice, Duke University is the largest circle and thickest orange rim. It reveals that the Duke University's research on think tanks began much earlier and its publishing works come out in a great amount in recent years.

4.4 Limitation

The scientific databases we employed in the review, namely the Web of Science™ and Scopus®, selectively index publications. The relevant records could be missing if the query phrases for topic research do not appear in article. We explored documents of think tanks and co-citation clusters by CiteSpace to map the structure and evolution trend of think tanks over time. This review has an obvious limitation. In order to get uniform references for CiteSpace analysis, we retried Web of Science™ core database only. Though CNKI (China National Knowledge Infrastructure) has the most extensive coverage of papers published on think tanks, references may not be available in the CNKI database.

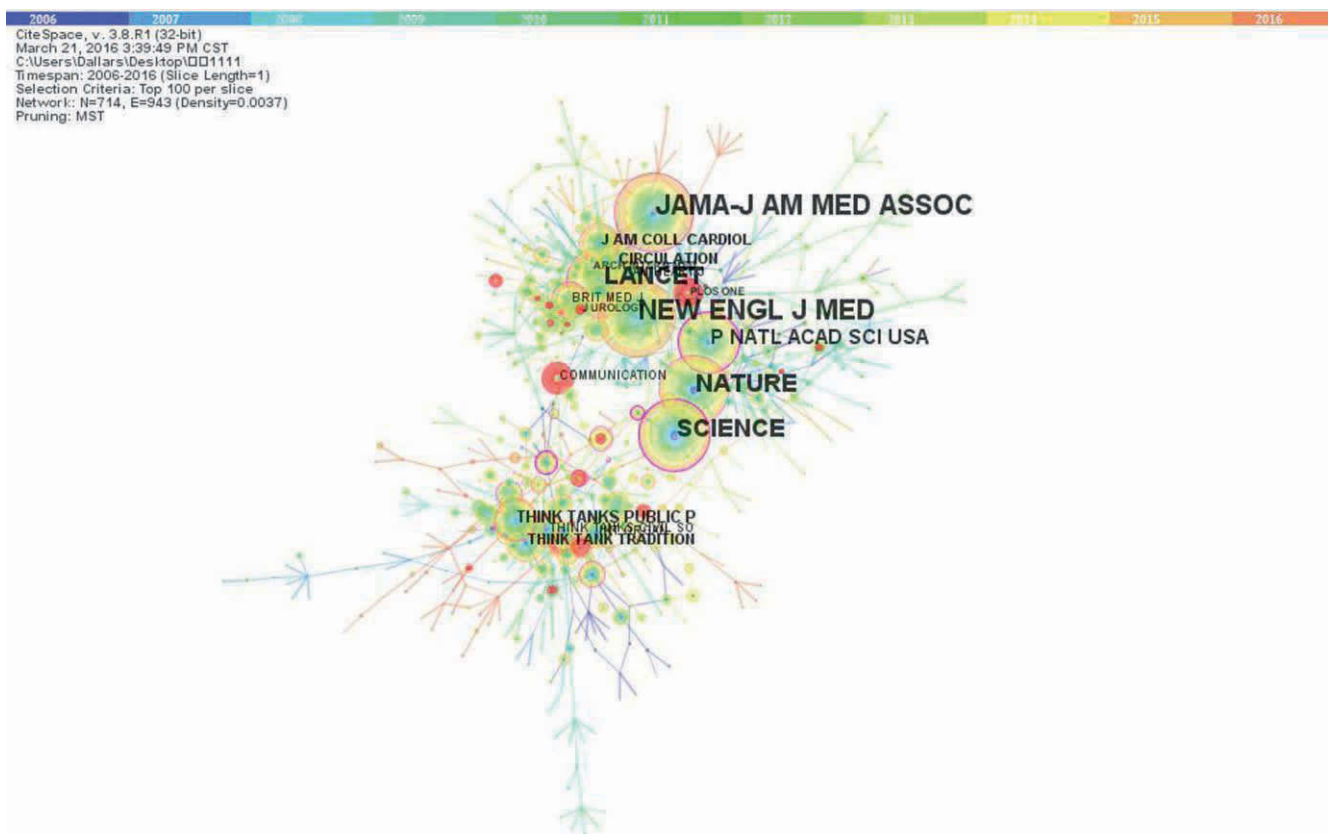


Figure 5. Top cited journals

| Cited frequency | Centrality | Year | Cited reference |
|-----------------|------------|------|----------------------|
| 69 | 0.06 | 1998 | New ENGL J MED |
| 67 | 0.17 | 2003 | Jama-j AM MED ASSOC |
| 62 | 0.11 | 1999 | LANCET |
| 62 | 0.32 | 1997 | SCIENCE |
| 60 | 0.2 | 1981 | NATURE |
| 52 | 0.28 | 2004 | P NATL ACAD SCI USA |
| 41 | 0.07 | 2004 | Think TANKS PUBLIC P |
| 39 | 0.03 | 2002 | CIRCULATION |
| 38 | 0.03 | 2006 | J AM COLL CARDIOL |
| 36 | 0.08 | 2004 | Think TANK TRADITION |
| 32 | 0.19 | 1997 | Brit MED J |
| 31 | 0.02 | 2002 | Think TANKS CIVIL SO |
| 30 | 0.05 | 2001 | COMMUNICATION |

Table 6. Top cited journals with cited frequency over 30

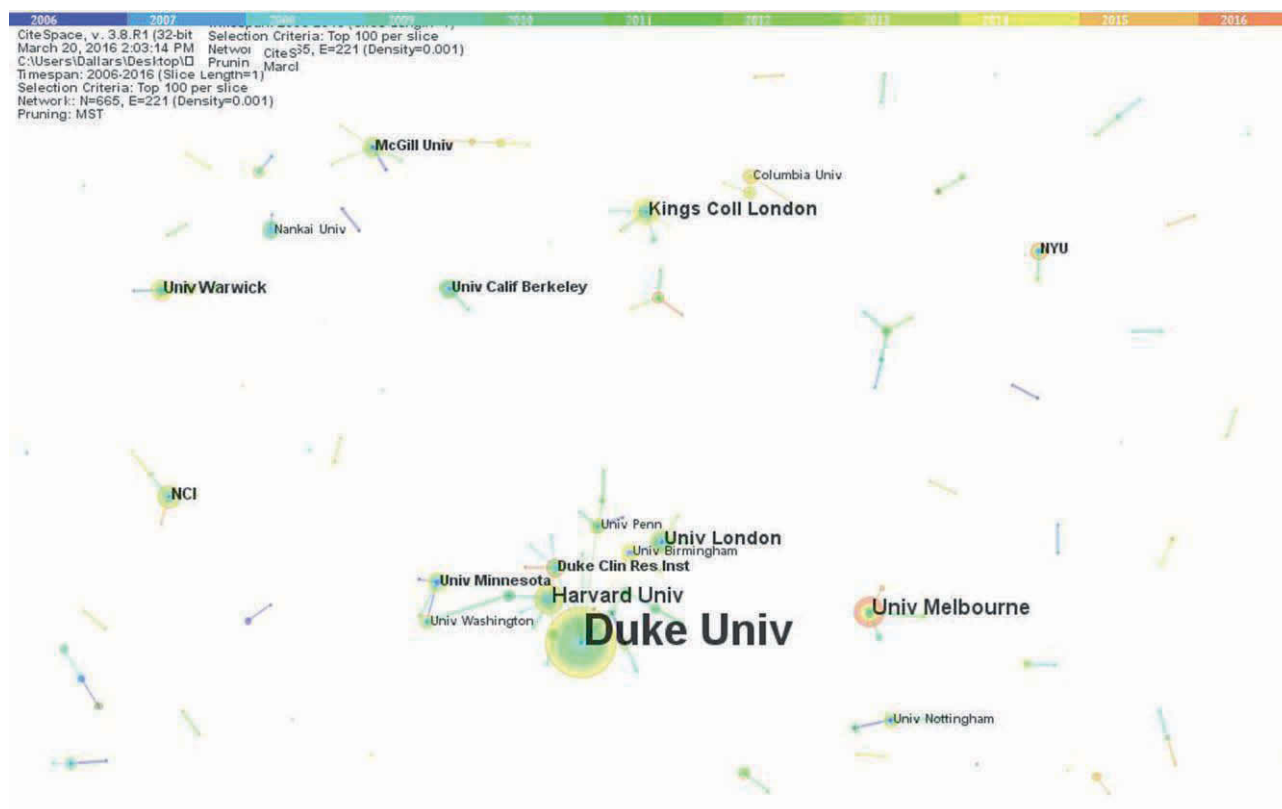


Figure 6. Top published institutions

5.0 Discussion and conclusion

Domain analysis of publication and citation data from numerous articles can help identify important features of active aspects of scientific research. This paper presented a study on the evolution of think tanks from the intellectual landscapes, citation article, and bursting citation. The analysis indicates that think tanks plays an important role in

domain of information science, which becomes one of the patterns in knowledge organization. The investigation of bursting citation and intellectual landscapes justifies the trend of think tanks. From the analysis of evolution of think tanks, we identified that academic, contract, and lobbying think tanks are the dominant forms in the domain of think tanks. Our scientometric study has also revealed novel domain-dependent trends and hotspots.

Based on analysis of 1450 bibliographic records, we got consistency that think tanks mainly are concerned about government, policy, and ideological evolution, and developing countries. As an important part of knowledge management, ideological evolution, developing countries, policy export, etc., have been active and flourished. With the development of information science, think tank tends to become involved in information management, knowledge management, and knowledge organization. In the early stage, it is concentrated on knowledge management from experimentalism. The studies on think tanks go throughout knowledge organization research at all stages.

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