Accounting, Auditing, Accountability: Key Insights from a Multidisciplinary Review of AI and Big Data Literature

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Abstract. Big Data and Artificial Intelligence (AI) projects have been rapidly applied by the diversity of applications, as well as effectively uncover the secret behind the data. In recent years, Big Data and AI have also had a huge impact on accounting and auditing, such as the launch of intelligent robots. This research puts forward a review of literature on Big Data, AI, and Machine Learning with Accounting, Auditing, and Accountability, based on 259 articles retrieved from Web of Science Database since 1989 to 2019. With the database, the author analyzed occurrences and produced the data contact network with the United States as the largest data resource subject and associated in three directions. Through the comparison of the three figures, it is not difficult to find that the countries with advantages in data resources have more influence in an organizational and sources cluster, and the United States is the most obvious example.

1. Introduction
The social, economic, and political implications of the advancement and adoption of Big Data and AI applications have been at the forefront of high-level dialogues in recent years, discussing its promises and potential dangers[1]. The Association of Chartered Certified Accountants(2013) published the report “Big data: it’s power and perils”, which proposed that big data could provide Accountants and accounting professionals with opportunities for radical innovation, as well as opportunities for more strategic and "future-oriented" positions in enterprises[2]. Deloitte (2019) released the Global AI industry white paper, which pointed out that today's AI is being commercialized in an all-round way, accelerating enterprise digitization, improving industrial chain structure and improving information utilization efficiency[3].

Previous research on the application of big data and AI, accounting, auditing and accountability do not provide a full picture. For example, Krahel & Titera (2015) proposed changing the accounting standard to focus on the process and analysis of data generation, which will add value and relevance to the accounting industry and improve the efficiency of the capital market[4]. Brown-Liburd et al.,(2015) discussed challenges encountered by auditors in integrating big data into audit analysis, as well as various analytical tools currently used by companies in big data analysis[5]. Griffin & Wright(2015) outlined the agenda of the relationship between social media, big data, and accounting functions. It is expected that accounting, accountant, social media, and big data will become part of future dialogue.
[6]. Katyal(2019) discussed the conflict between civil rights protection and AI and helped solve the opacity and accountability of AI by using various tools[7].

To sum up, the application of AI and big data in accounting, auditing, and accountability system has become a hot topic discussed by all circles in recent years. In this context, we provide a general picture of the field, placing the latest research concerns and developments related to big data and AI in the context of accounting, auditing, and accountability. Such maps will help track and explore cross-disciplinary collaboration over the years, thus providing a foundation for the application of AI and big data in accounting-related fields.

2. Data and methods

The paper first describes the query design that defines literacy about big data, AI and machine learning, and then explains the mapping protocols and strategies as follows:

From the WoS database, we executed queries below to gather literature data on the various terms of literacy in relation to Big Data and AI on Nov 2019:

- \( \text{TS} = ("\text{Artificial Intelligence" OR "machine learning" OR "Big Data") AND TS= ("accounting" OR "auditing" OR "accountability " OR "accountants") AND SU= ("Business & Economics "OR" Government & Law" OR "Social Sciences Other Topics")}.\)

Various terms of literacy were chosen from the Oxford bibliography [8]. As a result, 259 articles are retrieved on Nov 2019. VOSviewer and Python visualization packages were used for mapping. It reveals heightened interests and perhaps paper quality on the topic.

3. Research mapping results

3.1. Annual trends

The statistics show a small number of articles and references published between 1989 and 2010. However, the number began to spike in 2010 and peaked in 2018. This suggests that more and more people are likely to study the topic and improve the quality of the papers.

3.2. Top WoS categories and research areas

The classification of WoS is shown in table 1. According to the proportion of WoS, the categories of business and finance rank first, followed by management, social sciences and interdisciplinary, etc. The number of articles published in adjacent categories is similar, but the number of publications in the top three categories accounts for about 1/2 of the total publications. It indicates that these categories are clustered, that is, people are more inclined to study this field. Other top categories include law, economics, and education.

| WoS categories                        | No. of Articles | 415 in total |
|---------------------------------------|-----------------|--------------|
| Business, Finance                     | 96              | 23.13%       |
| Management                            | 66              | 15.90%       |
| Social Sciences, Interdisciplinary    | 46              | 11.08%       |
| Business                              | 40              | 9.64%        |
| Law                                   | 36              | 8.67%        |
| Economics                             | 28              | 6.75%        |
| Education & Educational Research      | 10              | 2.41%        |
| Political Science                     | 9               | 2.17%        |

Table 2 lists the top research fields with more than 7 articles in 9 fields. It can be found that business and economics[9] still hold the top position, accounting for about half of the total articles published, far ahead of social sciences [10], politics and law [11]. The first three fields are roughly the same as the WoS category, but the rankings vary, such as education and education research, which ranks fourth in the research field and seventh in the WoS category.
Table 2. Top research areas

| Research areas                          | No. of Articles | %  |
|----------------------------------------|-----------------|----|
| Business & Economics                   | 168             | 48%|
| Social Sciences - Other Topics          | 52              | 15%|
| Government & Law                       | 42              | 12%|
| Education & Educational Research       | 10              | 3% |
| Arts & Humanities - Other Topics        | 8               | 2% |
| Operations Research & Management Science| 8               | 2% |
| Computer Science                       | 7               | 2% |
| Public Administration                   | 7               | 2% |
| Information Science & Library Science   | 7               | 2% |
| Others                                 | 41              | 12%|

Table 3. Top Countries

| Countries       | No. of Articles | %  |
|-----------------|-----------------|----|
| USA             | 105             | 33%|
| PEOPLES R CHINA | 55              | 17%|
| ENGLAND         | 28              | 9% |
| AUSTRALIA       | 27              | 8% |
| ITALY           | 11              | 3% |
| GERMANY         | 9               | 3% |
| ROMANIA         | 9               | 3% |
| CANADA          | 7               | 3% |
| FRANCE          | 6               | 2% |
| DENMARK         | 5               | 2% |
| NETHERLANDS     | 5               | 1% |
| NEW ZEALAND     | 5               | 1% |
| SCOTLAND        | 5               | 1% |
| Others          | 45              | 14%|

3.3. Top organizations

From the institutional distribution can be seen in table 3, research institutions, led by the United States, published several accounts for one-third of the total, followed by China and the UK, the top three countries in a paper published several proportions is as high as 72.59%, indicates that these countries dominated in the field in this paper, and China is the only developing country.

3.4. Top publications

In the most frequently cited article, Cao et al. (2015) argued that big data analysis can improve the efficiency and effectiveness of financial statement auditing[12]. Other top 10 most cited articles also focus on the impact of big data or AI on corporate accounting or audit analysis and judgment (such as Vasarhelyi, MA; Kogan, A and Tuttle, BM[13]; Warren, JD; Moffitt, KC and burns, P[14]; Brown - Liburd, H; Issa, H and Lombardy, D[15]). It indicates that the influence of big data and AI on accounting and auditing is far-reaching and worth discussing.

3.5. Clusters

As shown in (a), (b) and (c) of Figure 1, three keywords related to technology are striking on the map. Among them, compared with "organization" and "source", the "country" has the widest contact area. As shown in Figure 1 (a), the relationship description of this figure covers 13 countries. At the same time, Figure 1 (a) shows us the data contact network with the United States as the largest data resource subjected and associated in three directions. The data branch headed by the United States is related to five major countries including the China, the Netherlands, Canada, France, and Romania. The data branch headed by China is related to three major countries including the United States, England and Germany. This branch of data, with the Australia, Italy and New Zealand as the main body, not only integrates with the data of the United States, but also connects the data systems of England and Scotland. Denmark and Germany, as the other kind of correlated data subjects shown in the figure, although the data proportion is small, they also have correlated communication with each country through the main branches of the first two types. In the group of "organizations", Figure 1 (b) clearly shows that the three major organizational plates, namely "Rutgers state univ", "Nyu" and "Stevens inst
techno”, are closely related to each other. Obviously, among the 9 publishing channels in Figure 1 (c), "Journal of Information Systems", "Journal of Emerging Technologies in Accounting" and "International Journal of Accounting Information Systems" occupy the most important positions and are closely related to each other.

Through the comparison of the three clusters, it is not difficult to find that the countries with advantages in data resources have more influence in an organizational and sources cluster, and the United States is the most obvious example.

![Country cluster](image1.png) ![Organization cluster](image2.png) ![Sources cluster](image3.png)

Figure 1. A keyword map based on co-occurrence data

4. Conclusion
The paper intends to contribute to the body of knowledge towards the relationship between domains of accounting and technological keywords. To understand the links and gaps of literature related to accounting, auditing, accountability, big data and AI, this paper visualizes the keyword analysis networks of key publications from the WoS database. The data branch headed by United States is related to six major countries, including China, England, Netherlands, Canada, France and Romania. The data branch headed by China is related to three major countries including the United States, England and Germany.

The analytical results of this paper provide some gaps and potential to better understand the relationship between domains of accounting and technological keywords. Through the comparison of the three clusters, it can find that the United States with advantages in data resources have more influence in organizational cluster and sources cluster.

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