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BIBLIOMETRIC ANALYSIS ON CRYPTOCURRENCIES' RELATED TAXONOMY

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Abstract. *Researching the taxonomy of cryptocurrencies, this study examines the relationships between researchers, their affiliated institutions, and the countries they are associated with. Data from Scopus (Elsevier) and the Web of Science Core Collection were employed, mainly publications from 2005 to 2023. By leveraging tools like VOSviewer, Biblioshiny, and Microsoft Excel, we pinpointed influential research on cryptocurrency taxonomy, collaboration networks among researchers, thematic groupings, and research trends. Our findings indicate that although research collaboration is still evolving, the insights extracted in the thematic analysis outline the structure, components, and implications of taxonomy in the context of blockchain and cryptocurrencies, providing a foundational understanding. The limitation arises from the restricted timeframe, as the data was collected in August 2024. Given the dynamic nature of cryptocurrencies, the bibliometric analysis might benefit from updates to capture the latest developments.*

Keywords: *cryptocurrency, taxonomy, blockchain, bibliometric analysis, VOSviewer, Biblioshiny*

JEL: M41, G23, K42, L14, O30

1. Introduction

Blockchain technology is considered foundational, as it facilitates decentralized and transactional data sharing across networks lacking trust (Bachmann et al., 2022). This capability stems from its core features, such as distributed ledgers, cryptographic security, and consensus mechanisms, which ensure the integrity and immutability of transactions. By eliminating the need for a central authority, blockchain enhances efficiency, reduces the risk of fraud, and enables new business models and applications across various industries, including finance. Different authors have explored a taxonomy of blockchain-based innovations to understand better and manage technology developments, as cryptocurrencies have emerged as a revolutionary form of digital currency that operates autonomously from traditional financial institutions (Alashaikh, 2021; Bachmann et al., 2022; Derun & Mysaka, 2022; Yatsyk & Shvets, 2020).

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A taxonomy is a tool created through design science research which categorizes features of objects or elements to support further research, particularly in technology-driven domains like blockchain (Bachmann et al., 2022). Cryptocurrency taxonomy can be a valuable tool for researchers and industry professionals to understand the diverse landscape of this emerging asset class.

This study delves into the significant research in this field, identifying prominent authors, reputable institutions, and key countries that have shown interest in exploring the taxonomy related to cryptocurrencies. Bibliometry evaluates the influence and efficiency of various research components, such as authors, institutions, and countries.

The authors sourced their data for this research from Scopus (Elsevier) and the Web of Science Core Collection (WoS) databases. We used various software tools to analyse and visualize the data: VOSviewer for network analysis and visual images, Biblioshiny (from R Studio) for data processing and analysis, as well as Microsoft Excel for generating standard graphs (Lazea et al., 2024).

2. Research method

The process of bibliometric analysis starts with a systematic method aimed at identifying important literature from the WoS and Scopus. Researchers used the search string ("crypto*" OR "cryptocurrenc*" OR "virtual currenc*" OR "digital currenc*" OR "initial coin offering" OR "bitcoin" OR "blockchain*") AND ("taxonom*") to conduct their study based on article title, abstract, and keywords in Scopus, and on topic in WoS. We limited the research to the time frame between 2005 and 2023 as a final year to have a fixed database. The sources considered for analysis encompassed articles, review articles, proceeding papers, early access materials, book chapters, and editorial material published in English.

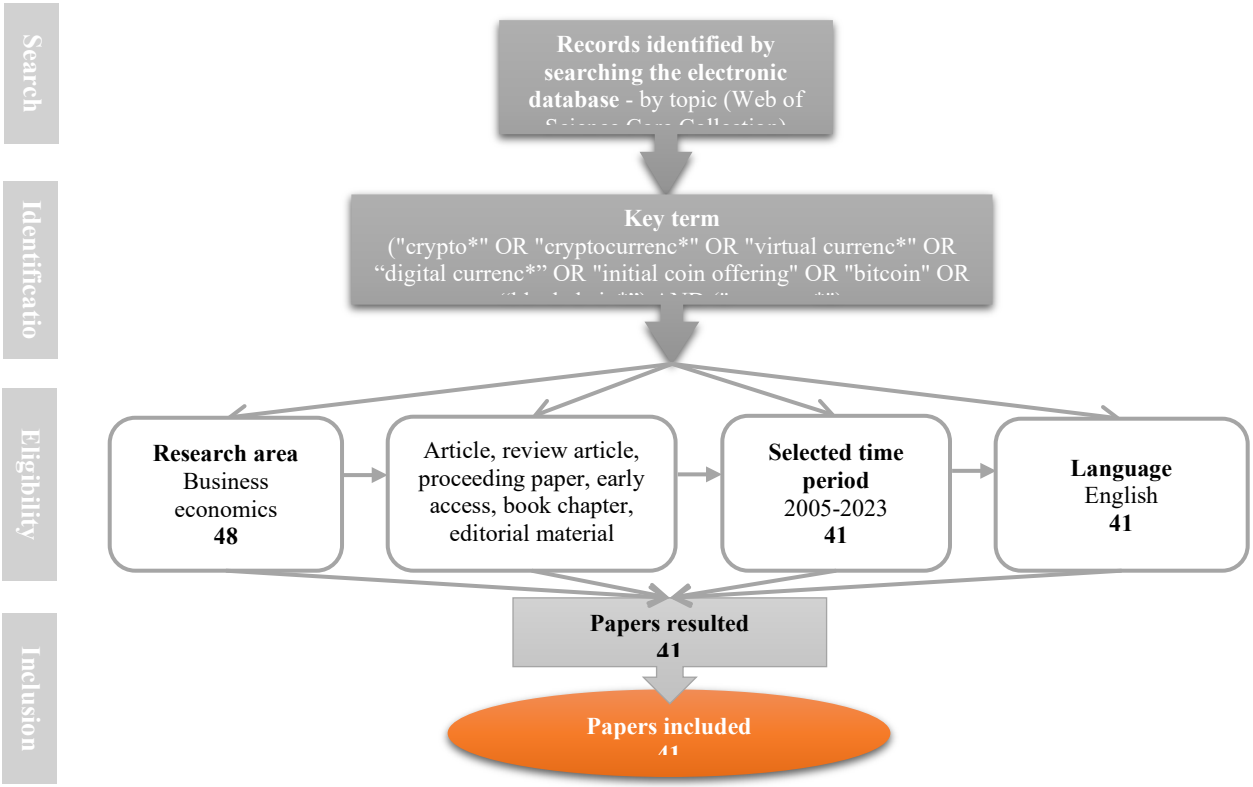

Figure 1. Diagram of the screening process on cryptocurrency-related taxonomy literature (WoS)

Source: Data processed by authors

The purpose of the bibliometric analysis is to evaluate the current trend concerning cryptocurrency-related taxonomy in the context of business economics. Hence, WoS resulted in 41 scientific papers that met the inclusion criteria revealed in Figure 1.

In our Scopus search, we focused on the business, management, and accounting domains, resulting in an initial pool of 4229 papers. After applying the filters shown in Figure 2, we identified 88 relevant papers to our research.

41 + 88 = 129 papers → **129 – 16 duplicates = 113 relevant papers**

After merging the two databases using RStudio, a total of 129 papers were identified, which comprised duplicate entries from Scopus and WoS. Subsequently, 16 duplicate files were eliminated, leaving behind 113 pertinent files.

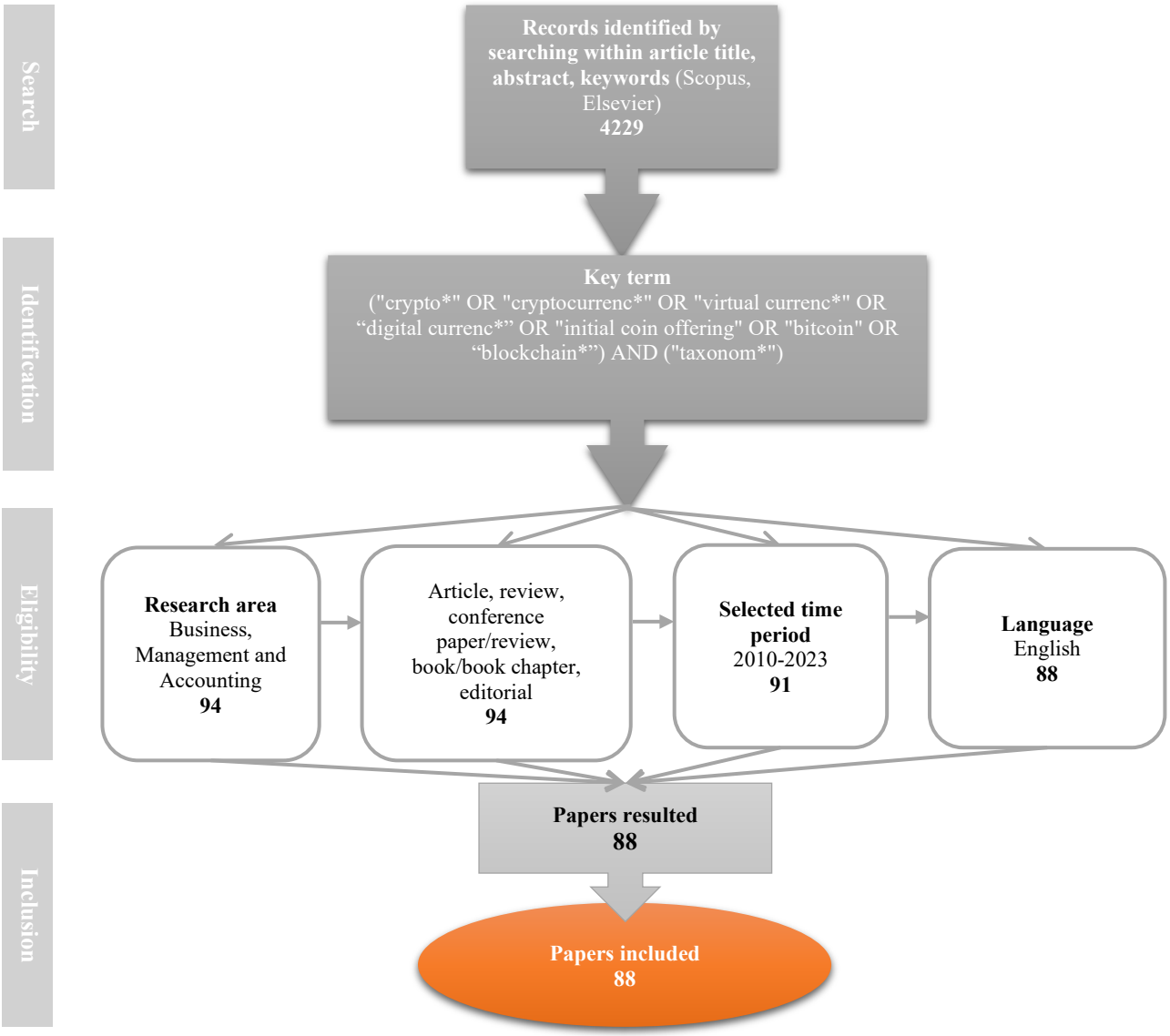

Figure 2. Diagram of the screening process on cryptocurrency-related taxonomy literature (Scopus)

Source: Data processed by authors

3. Bibliometric analysis

3.1. Annual and regional scientific activity

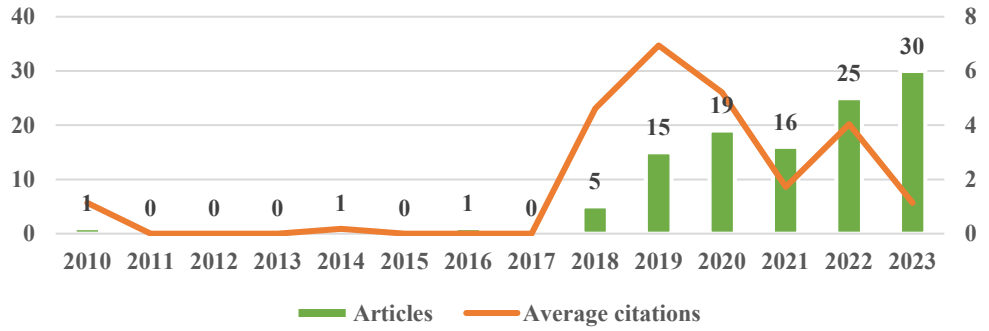

Figure 3. Annual publication and average citations of manuscripts

Source: Data processed by authors

Figure 3 illustrates the annual publication and citation of manuscripts on cryptocurrency-related taxonomy. In general, up until 2019, there was a noticeable positive correlation. This suggests that publications with a higher number of citations tended to be associated with a higher number of publications. However, as the number of publications increased over the years, there was a corresponding decrease in the number of citations. In terms of specific observations, there has been a notable rise in the number of publications from 2019, with 15 articles, to 2020, with 19 manuscripts. This was then succeeded by a further increase from 2021, with 16 articles, to 2023, with 30 articles. This pattern could indicate a significant surge in research activity in recent years.

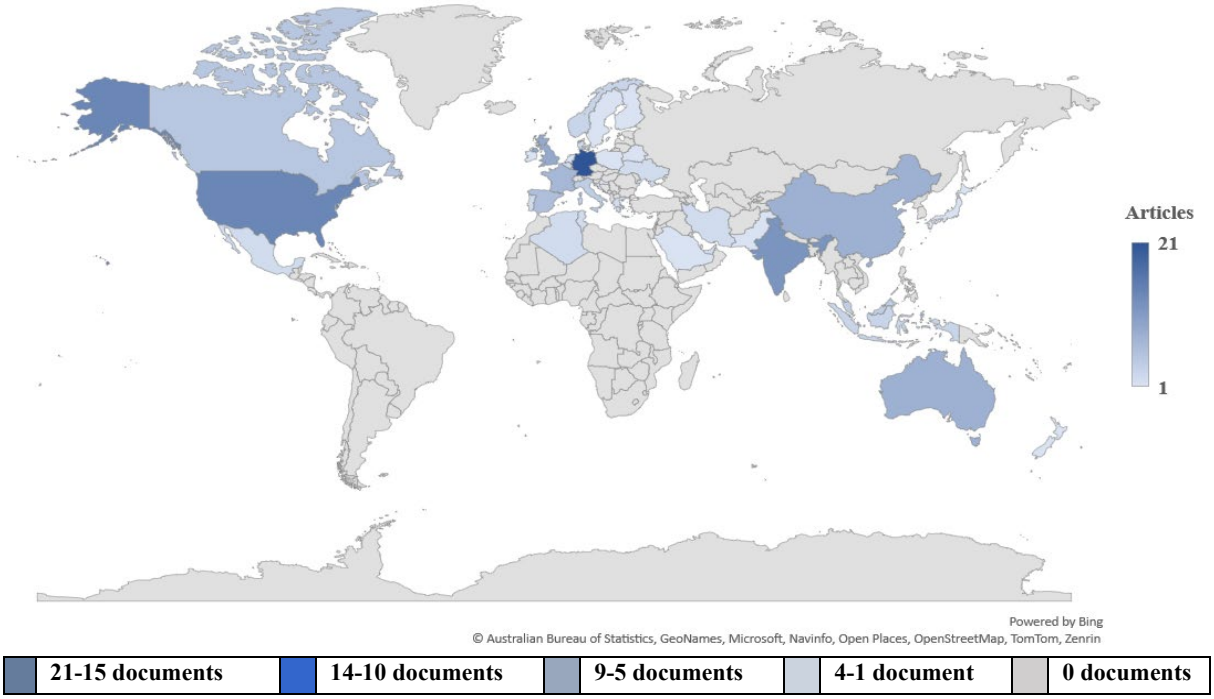

Figure 4. Country scientific publication on cryptocurrency-related taxonomy

Source: Authors' projection with MS Excel

The authors created a map using Biblioshiny to visually represent the distribution of articles related to cryptocurrency taxonomy across different countries for further analysis. Germany is the only country marked with dark blue, which signifies the highest number of publications (21 articles) based on this study. The USA and India seem to have published between 10 and 14 manuscripts. Australia, Canada, China, France, Spain, and the United Kingdom have shown fewer released articles.

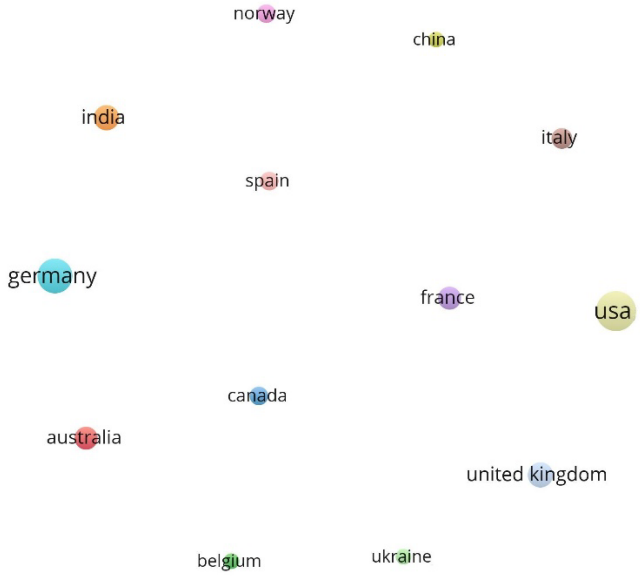

Figure 5. Co-authorship of countries on cryptocurrency-related taxonomy
Source: Authors' projection with VOSviewer

By analysing the co-authorship network of countries in VOSviewer, valuable insights can be gained into international research on crypto-related taxonomy. In this case, a low threshold of a minimum of three documents with at least one citation at the country level was chosen. Hence, 13 countries meet the threshold, but none of them are connected.

3.2. Co-authorship of authors

Through the analysis of co-authorship, one can investigate the collaborative patterns among researchers. Authors belonging to a cluster exhibit similar research interests and engage in frequent collaboration, often co-publishing articles together. In this case, the threshold was set at a minimum of one document with five citations from an author. As a result, out of the total of 291 authors, 166 met the criteria, and they were organized into groups of up to ten authors.

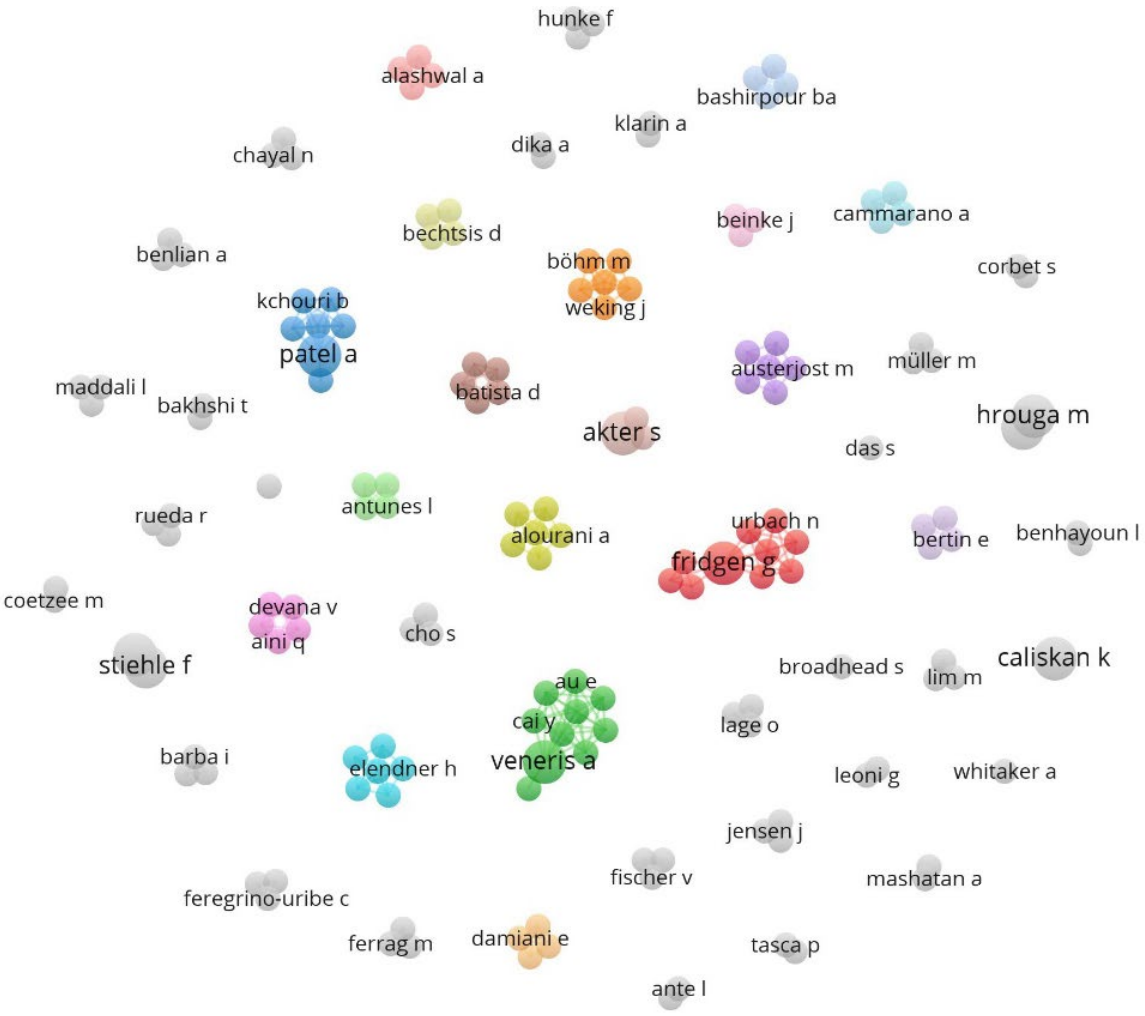

Figure 6. Co-authorship of authors' clusters on cryptocurrency-related taxonomy

Source: Authors' projection with VOSviewer

Hence, within the red cluster, the authors collaborating include Bachmann, Drasch, Fridgen, Hartwich, Miksch, Ollig, Regner, Rieger, Schweizer, and Urbach (two documents, 12 citations, nine link strength). Contained within the green cluster are the following esteemed researchers: Au, Cai, Jacobsen, Meijers, Motepalli, Pocher, Sun, Veneris, Zhang G., and Zhang S. This cluster encompasses two documents, 15 citations, and nine link strength. Notably, the blue cluster features Kchouri, Khan, Kräussl, Patel, Qi, State, and Yatoo, presenting two articles, 32 citations, and six link strength.

3.3. Co-authorship of institutions

The analysis of co-authorship at the institutional level highlights leading research institutions and elucidates collaborative patterns among institutions across diverse regions. In examining the institutional network, the criterion set for publication at the organizational level required a minimum of one document with five citations. This led to the inclusion of 99 out of 175 institutions within the parameters, with only seven demonstrating interconnectedness.

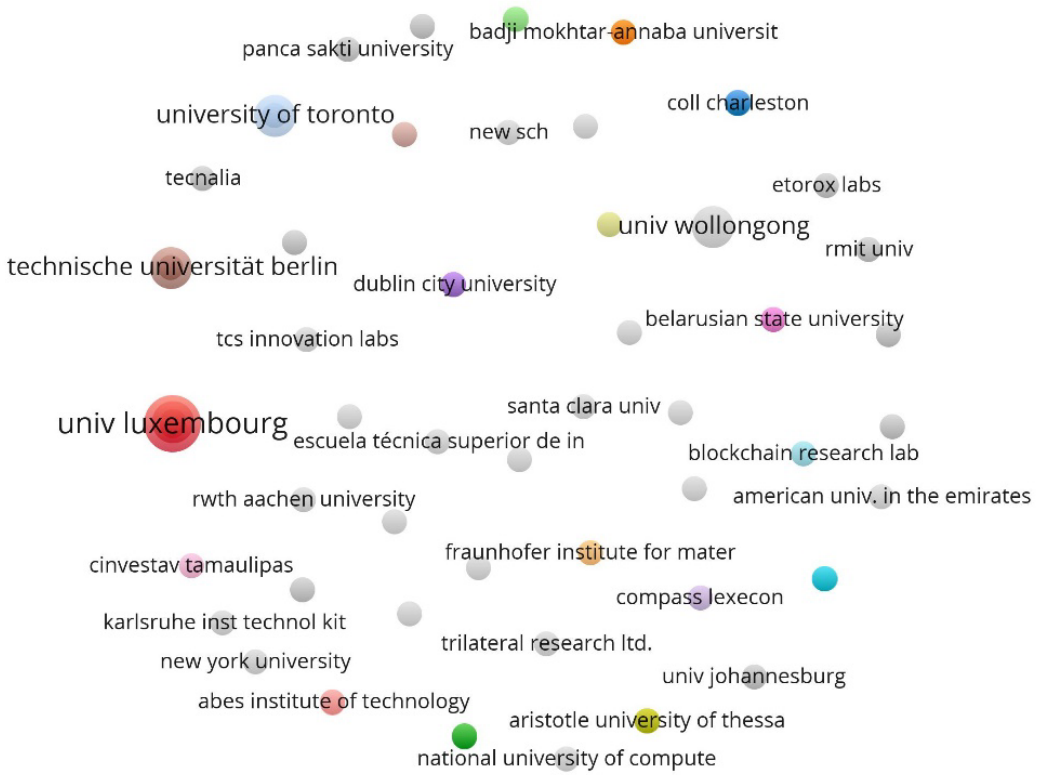

Figure 7. Co-authorship of institutions network

Source: Authors' projection with VOSviewer

The related institutions from the largest group are the University of Luxembourg, the Universities of Bayreuth, Augsburg, and Frankfurt in Germany, International Open University in Gambia, 570easi in France, and Fraunhofer FIT in Germany.

4. Keyword analysis

The process of keyword analysis encompasses the identification and highlighting of the most pertinent keywords and key terms, serving to apprise researchers of their significance. In the context of this analysis, the authors have established a criterion of three keywords. Consequently, after processing the database in VOSviewer, 19 out of the 333 keywords satisfied the specified criterion. All 19 keywords were used to calculate the total strength of the connections between keywords that occur together. In Figure 8 and Table 1, the keyword clusters can be grouped into three themes: "types of cryptocurrencies", "technologies and frameworks", and "security".

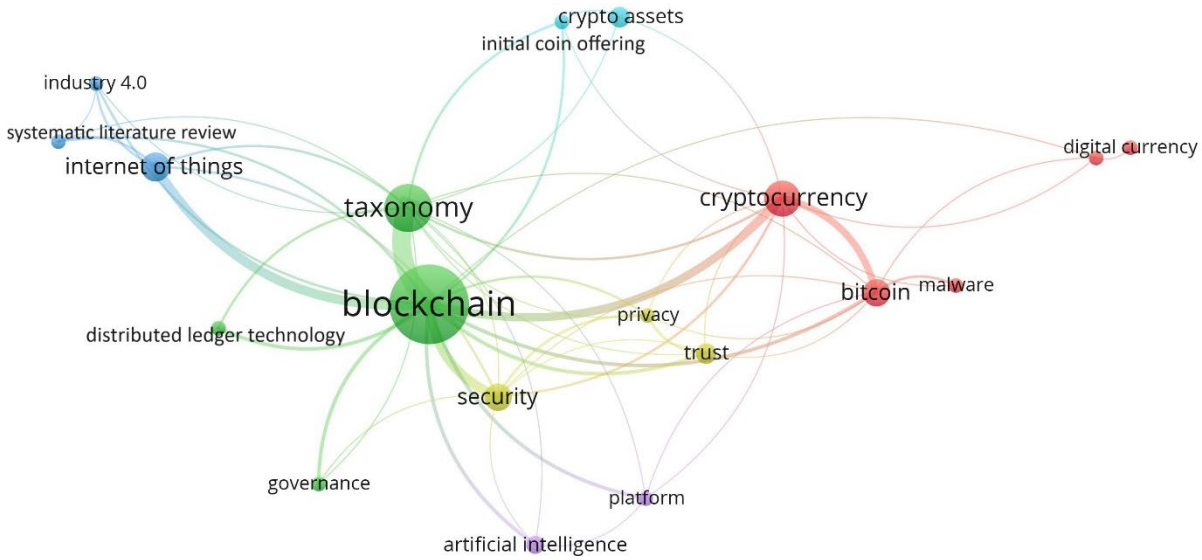

Figure 8. Co-occurrence cluster of author keywords on cryptocurrency-related taxonomy

Source: Authors' projection with VOSviewer

Table 1. Keyword clusters for cryptocurrency-related taxonomy in VOSviewer

Cluster 1 – red (5 items)	**Occurrence**	**Cluster 2 – green (4 items)**	**Occurrence**	**Cluster 3 – blue (3 items)**	**Occurrence**
bitcoin	8	blockchain	49	industry 4.0	3
cryptocurrency	13	distributed ledger technology	3	Internet of things	9
digital currency	3	governance	3	systematic literature review	3
malware	3	taxonomy	21		
stablecoin	3				
Types of cryptocurrencies		**Technologies and frameworks**		**Technologies and frameworks**	
Cluster 4 – yellow (3 items)	**Occurrence**	**Cluster 5 – purple (2 items)**	**Occurrence**	**Cluster 6 – light blue (2 items)**	**Occurrence**
privacy	3	artificial intelligence	4	crypto assets	5
security	8	platform	3	initial coin offering	3
trust	5				
Security		**Technologies and frameworks**		**Types of cryptocurrencies**	

Source: Authors' projection from VOSviewer

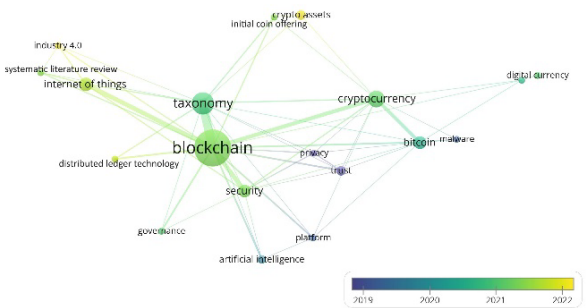

Figure 9. Co-occurrence overlay of author keywords

Source: Authors' projection with VOSviewer

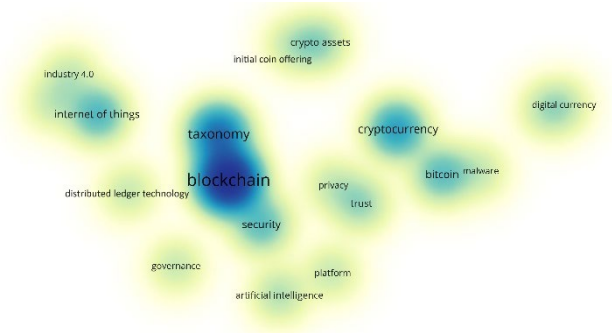

Figure 10. Co-occurrence density of author keywords

Source: Authors' projection with VOSviewer

Over the years, Figure 9 illustrates the gradual addition of new terms to crypto-related taxonomy research. Between 2020 and 2022, terms such as "blockchain" and "cryptocurrency" were added, indicating a growing interest in understanding the taxonomy of blockchain and cryptocurrency. The most recent terms, added in 2023 and coloured in yellow, include "crypto assets", "Internet of things", and "industry 4.0".

Furthermore, Figure 10 provides a visual representation of the co-occurrence density of author keywords. The circular shapes in the visualization represent the keywords, and the size of each node reflects its prominence. The presence of multiple central clusters indicates the existence of distinct topical areas within the taxonomy related to cryptocurrency. The prominent blue clusters appear to centre around "blockchain" and "taxonomy", while other clusters in softer colours highlight "cryptocurrency", "bitcoin", and "Internet of things". Overall, the visualization of the clusters serves as a valuable starting point for exploring the main topics.

5. Thematic analysis

In order to address the knowledge disparity pertaining to contemporary cryptocurrency-related taxonomy deliberations and the array of viewpoints on the subject, we conducted a thematic analysis of relevant literature on blockchain technology and crypto assets. The uniqueness of this study lies in its methodology, which categorizes the assessed articles based on the research themes derived from VOSviewer's co-occurrence keyword clusters. These thematic categories regarding the taxonomy encompass types of cryptocurrencies, technologies and frameworks, and security.

The crypto-economy comprises diverse components (Wieninger et al., 2019), primarily focusing on the correlation between blockchain technology and digital assets (van der Merwe, 2021). There are various types of crypto assets, which can be categorized based on their use cases or purpose (Parrondo, 2023), underlying technology, and design principles (Tasca & Tessone, 2019). Despite these categorisations, van der Merwe (2021) highlights the common characteristics of digital assets, including high volatility, reliance on decentralised technology, and variances in risk.

Cryptocurrency taxonomy based on use cases or purpose

Derun & Mysaka (2022) emphasized the importance of a structured classification (taxonomy) for digital assets due to their intangible nature for accurately determining ownership rights and economic perspective. They suggested categorising digital assets into crypto assets and non-crypto assets based on their functionality and methods of obtaining financial benefits (van der Merwe, 2021). Crypto assets are characterized by secrecy, verification, data accuracy, and encryption, with distributed ledger technology ensuring that transaction data is accessible and transparent, making them suitable for business use. According to Derun & Mysaka (2022), crypto assets include cryptocurrencies, smart contracts, domain names, and crypto tokens.

Similarly, van der Merwe (2021) proposed a taxonomy that categorizes different types of digital assets, including cryptocurrencies, stablecoins, bitcoin futures, and decentralized finance (DeFi) products.

In their research, Fry & Ibiloye (2023) performed a taxonomic analysis and developed innovative approaches for classifying crypto assets according to their distribution patterns or historical trends. They found that, distributionally, cryptocurrencies (excluding those pegged to the US Dollar) share similarities with tech stocks, while time series analysis categorizes them primarily as speculative assets, with Bitcoin and potentially Solana being exceptions.

Yatsyk and Shvets (2020) address the absence of a standardized taxonomy for crypto assets by proposing a classification system that distinguishes between cryptocurrencies (payment tokens) and digital tokens (excluding cryptocurrencies). They outline four primary types of digital tokens: security tokens, utility tokens, asset-backed tokens, and hybrid tokens (Parrondo, 2023).

Cryptocurrency taxonomy based on technology and frameworks

Decentralized and distributed digital ledgers, known as blockchain technology, consist of blocks where transactions and information are recorded using a peer-to-peer network, ensuring data immutability and security, which is pivotal for emerging business practices (Cammarano et al., 2023). In terms of blockchain taxonomy, Caliskan (2020) proposes an actor-based taxonomy of cryptocurrency blockchains, focusing on the participants involved in maintaining blockchain infrastructure. Specifically, the taxonomy identifies two main actors: transactioners (users engaging in transactions) and accountants (those responsible for validating transactions).

One of the most widely recognized taxonomies in the cryptocurrency domain is the distinction between "coins" and "tokens". Coins, such as Bitcoin and Ethereum, are native digital assets that operate on their own blockchains, while tokens are built on top of existing blockchain platforms like Ethereum (Caliskan, 2020; Derun & Mysaka, 2022; Lage et al., 2022; Parrondo, 2023; Soares et al., 2023). These tokens can represent a variety of assets or utilities, such as digital currencies, access rights, or even project ownership.

Standard setters face difficulties in creating a framework due to the lack of clear definitions for crypto assets and structured criteria for determining their taxonomy (Parrondo, 2023; Whitaker, 2019).

Cryptocurrency taxonomy based on security

Another important taxonomy in the cryptocurrency domain is the classification based on the consensus mechanism. The most common consensus protocols are Proof-of-Work (miners solve puzzles), Proof-of-Stake (validators are chosen based on staked coins), and Delegated Proof-of-Stake (delegates are elected to validate transactions) (Tasca & Tessone, 2019). Proof-of-Work, used by Bitcoin, relies on energy-intensive mining, while Proof-of-Stake and Delegated Proof-of-Stake are more energy-efficient alternatives that use different mechanisms to validate transactions (Ghosh et al., 2020).

Custody is crucial for organizations and individuals accessing crypto assets. Custodians hold private keys, verify, and authorize transactions, ensuring efficient and secure transactions to prevent losses or theft. According to Jaroucheh & Ghaleb (2023) crypto asset custody solutions can be categorized into multiple classes based on five key dimensions: responsibility, distribution, connectivity, key storage, and technology.

6. Conclusions

Firstly, the keyword analysis identifies three major clusters related to the crypto-related taxonomy: 1) types of cryptocurrencies, 2) technologies and frameworks, and 3) security.

Secondly, the co-authorship network among the authors indicates that collaborative efforts are relatively underdeveloped. Similarly, the co-authorship networks among countries and organizations exhibit a comparable trend. These networks are in their nascent stages, with Germany, the USA, and India emerging as the most prominent contributors.

Thirdly, the thematic analysis reveals that understanding the different types of crypto assets is crucial for grasping their functionalities, use cases, and economic roles. Distinguishing between coins and

tokens is essential for understanding their underlying technology and how they function within their respective blockchain ecosystems.

The study's limitations include a timeframe of 2005-2023. Another time frame might reveal more about historical growth.

Finally, it is essential to acknowledge that the crypto asset industry is rapidly evolving, and new types of digital tokens may emerge that exhibit characteristics of multiple subclasses. This may require further analysis and professional judgment to determine the appropriate classification and accounting treatment.

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