

Impact of Cryptocurrencies and Their Technological Infrastructure on Global Financial Regulation: Challenges for Regulators and New Regulations

Juan Chavez-Perez, Raquel Melgarejo-Espinoza, Victor Sevillano-Vega, Orlando Iparraguirre-Villanueva
Facultad De Ingeniería, Universidad Tecnológica Del Perú, Chimbote, Perú

Abstract—The rise of cryptocurrencies is transforming the landscape of global finance, but their very decentralized nature is triggering unprecedented challenges for regulatory systems. This systematic literature review (SLR) aimed to gather and synthesize information to understand the functioning of cryptocurrencies in relation to their regulatory challenges. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology supports the rigor of the research, where 50 studies published between 2022 and 2025 were selected in databases such as Scopus, Web of Science, IEEE Xplore and Science Direct. Among the results, it was observed that the continents with the greatest contributions were Europe and Asia, representing 60% and 25% of the studies analyzed, respectively. Likewise, the period with the highest scientific production was the year 2024, with 50% of the manuscripts published. Regarding the analysis of keyword co-occurrence using VOSviewer, it was found that "blockchain" and "cryptocurrency" were the most predominant terms, with 18 and 16 mentions, highlighting their centrality in the academic discussion. Ultimately, the research highlights that cryptocurrencies bring with them major regulatory challenges, such as money laundering and lack of legal clarity, while blockchain emerges as an essential tool to improve the transparency and operability of financial regulation.

Keywords—Cryptocurrencies; financial regulation; blockchain; regulatory challenges; cryptocurrency laws

I. INTRODUCTION

For some years now, digital transformation has been playing a major role in the global economy. One of the emerging trends is cryptocurrencies, a new tradable asset capable of revolutionizing the way payments are made [1]. The innovation of its technology and its growing popularity are capturing the attention of the mainstream media and investors [2]. By 2023, more than 23,000 types of cryptocurrencies had been registered [3]. Their growth has exposed various regulatory challenges globally. According to the United Nations (UN), the decentralization of the network in which cryptocurrencies operate makes it difficult to regulate them within the existing legal framework and highlights the lack of legal clarity on procedural issues affecting transactions involving different countries [4]. Similarly, the World Health Organization (WHO) emphasizes the importance of establishing unambiguous measures as new technologies such as cryptocurrencies emerge, to develop functionalities that ensure security and accessibility [5]. The cryptocurrency market is positioning itself as a profitable activity for investors,

as they find it very beneficial to acquire this asset class at relatively low prices for subsequent sales at higher values [6]. This type of web-based digital exchange has now become a popular commodity and an attractive source of trading [7].

The cryptocurrency landscape is very broad, within it, "Bitcoin", one of the most popular cryptocurrencies for being the pioneer in the field, reached in less than a decade a capitalization value of one trillion dollars and boosted the creation of more than 10,000 additional cryptocurrencies [8]. The secret of the success of this technology lies in its cryptographic protection, derived mainly from the combination of cutting-edge technologies and decentralized systems, such as blockchain [9]. Blockchain technology also provides a secure and verifiable system of record [10] allowing individuals to interact with electronic wallets that make it possible to store and manage their cryptoassets independently [11]. This type of technology allows the creation of a peer-to-peer network, which acts in combination with a cryptographic algorithm, distributed data storage and a decentralized consensus mechanism. On the other hand, there are also technologies such as artificial intelligence (AI), which is playing a remarkable transformation in financial systems, since they allow optimizing critical processes, as well as handling incidents by 63%, decreasing resolution time and improving operational effectiveness to increase user satisfaction by more than 50% [12]. These technological advances, although promising, pose regulatory challenges like those of cryptocurrencies, such as the need to monitor algorithms and ensure transparency in automated decision making.

The rapid increase in the diversification of cryptocurrencies has represented a deficiency in studies on their economic and regulatory impact. Currently, financial regulation does not adequately address key aspects such as digital wallet software, which has generated risks in terms of security and financial crime [13]. A worrying example is the use of cryptocurrencies in dark web markets, which have become the main means of payment for illicit activities, because various features allow instant payments without major costs, their addresses can be easily obtained and modified, transactions are highly anonymous, a feature that complicates the identification of individuals [14]. This situation has generated new regulatory challenges in terms of personal data management standards, trust and traceability of financial events [15].

This study is justified by the need for research that addresses the global regulatory challenges associated with

cryptocurrencies and explores the impact of blockchain technology on evolving financial regulations. The objective is to compile and synthesize recent scientific evidence to understand the risks inherent in these digital assets, identify emerging regulations, and propose recommendations for a more effective regulatory framework tailored to the dynamics of the global financial system.

This paper is organized as follows: Section II presents a literature review, focusing on the challenges and financial regulations related to cryptocurrencies. Section III describes the methodology used for the review, based on the PRISMA method. Section IV presents the main findings obtained. Section V discusses the results, and finally, Section VI presents the conclusions of the study.

II. LITERATURE REVIEW

A. Regulatory Challenges for Cryptocurrencies

Several studies have analyzed the impact of cryptocurrencies on global financial regulation. In the study [16], we evaluated the dynamics and risks associated with cryptocurrencies to explore the stylized facts, volatility and risk measures in the performance of digital assets, by using daily data of bitcoin, ripple and Ethereum, and their comparisons with technology stocks, risk measures such as Value-at-Risk (VaR) and Expected Shortfall (ES) were applied. The results confirmed that cryptocurrencies present high volatility, dependencies between cryptocurrencies, volatility clusters and arbitrage opportunities, highlighting that cryptocurrencies are riskier than technology stocks.

Similarly, in [17], evaluated the presence of speculative bubbles in the cryptocurrency market during the COVID-19 pandemic, analyzing the gregarious behavior of investors and factors such as Google searches and transaction volume, using probit regressions in time series and panels, together with alternative measures of liquidity and volatility. It was determined that all the cryptocurrencies analyzed presented bubbles, and that explosive behavior in one cryptocurrency affects others, contradicting the efficient market hypothesis. Complementarily, in [18], hybrid models combining forward propagating neural networks (DFNN), and long term memory networks (LSTM) with generalized autoregressive conditional heteroskedasticity (GARCH) models were evaluated in three types (GARCH, EGARCH and APGARCH) with the objective of predicting the volatility associated with 27 cryptocurrencies, employing the outputs of the GARCH models as inputs to the neural networks, demonstrating that the hybrid models outperform the GARCH and deep learning (DL) models separately, significantly improving the accuracy in predicting volatility.

In [19], they analyzed tail risk in cryptocurrencies, non-fungible tokens (NFTs), stocks and gold, using conditional VaR-based models, showing that there is no superior model to

capture tail risk, but non-Gaussian distributions better modeled skewness and heavy tails, which is crucial for risk management and portfolio diversification. In the same vein, in [20], the ability of volatility models to predict downside risk in cryptocurrency trading was explored by applying models such as conditional autoregressive VaR (CAViaR), dynamic quantile rank (DQR), GARCH and generalized autoregressive score (GAS) to five cryptocurrencies (Bitcoin, Ethereum, Ripple, Litecoin and Stellar), evaluating forecasts using backtesting techniques and model confidence sets (MCS). The result showed that quantile-based models combined with a weighted aggregation method were the most effective in predicting downside risk.

B. Financial Regulations Through the Influence of Cryptocurrencies and Blockchain

In the study [21], they sought to promote a greater focus on the analysis of cryptocurrencies as money within international political economy (IPE), employing monetary theories, such as the "commodity theory of money" and the "state theory of money", concluding that cryptocurrencies represent a challenge to traditional monetary theories and suggesting that their development as money is influenced by political dynamics that deserve further investigation. Likewise, in research [22], examined the existence of seasonal patterns in cryptocurrency returns, through data analysis of 500 cryptocurrencies, focusing on the Monday effect and trading activity during weekends. As a result it was found that the positive Monday effect on Bitcoin did not persist after 2015, and that there is no robust evidence of anomalies in returns, although trading activity was lower on weekends.

Consequently, in [23], explored the transmission of extreme risks between NFTs, DeFi tokens and cryptocurrencies, using the quantile connectivity technique to analyze volatility conditions was able to identify that NFTs offer greater diversification opportunities, with lower risks compared to other blockchain markets, making them an attractive option to reduce extreme risks. Complementarily, in [24], they analyzed how climate shocks affect extreme risks in cryptocurrency markets, for which they built risk contagion networks using a TVP-VAR model to measure the sensitivity of cryptocurrencies to climate, political and financial factors, finding that extreme risks in cryptocurrencies are highly sensitive to climate shocks, and that global financial markets are the main transmitters of risks. Furthermore, in [25], addressed the comparison of herding behavior in "clean" low-energy and "dirty" high-energy cryptocurrency markets, using the method of collecting data on market returns and activity, and by using value-weighted and equally-weighted portfolios, it was found that herding behavior is more pronounced in "dirty" markets, especially in bearish market conditions, while "clean" cryptocurrencies only showed herding behavior when both markets were rising. Table I shows the main findings and limitations of the reviewed studies.

TABLE I. CONCLUSIONS AND GAPS FOUND IN THE REVIEWED PAPERS

Refs.	Main results	Limitations
[16]	Identify higher risk in cryptocurrencies using VaR and ES	It does not explore how financial regulations could mitigate these risks.
[17]	Detects speculative bubbles during COVID-19 using probit models and Google Trends	It does not analyze regulatory mechanisms to prevent bubbles.
[18]	Hybrid GARCH-LSTM models improve volatility prediction in 27 cryptos	It does not consider emerging regulations in the models.
[19]	Non-Gaussian distributions better model tail risk in cryptos vs. traditional assets	Does not discuss application to regulatory capital requirements.
[20]	CAViaR models outperform GARCH in predicting downside risk backtesting with MCS	Does not integrate with regulatory oversight systems.
[21]	Evidence of contradictions between cryptos and traditional monetary theories	It does not propose an adapted regulatory framework.
[22]	Refutes seasonal patterns in yields (500 cryptos analysis)	Does not evaluate the impact of market regulations.
[23]	NFTs show lower systemic risk than DeFi	It does not address specific regulation for NFTs.
[24]	Climate shocks increase systemic risk according to the TVP-VAR	It does not consider regulatory climate disclosure.
[25]	Increased gregarious behavior in "dirty" crypts (high energy consumption)	Does not analyze the impact of environmental policies.

III. METHODOLOGY

The study was guided by the PRISMA 2020 statement, widely recognized for its requirement in terms of rigor, transparency and relevance in conducting systematic reviews. The framework describes a concrete structure for identifying, selecting and synthesizing relevant studies, ensuring that the process is fully replicable and free of bias [26]. The application of PRISMA 2020 is essential to answer the research questions formulated, focusing on the regulatory challenges associated with cryptocurrencies and their influence on the evolution of international financial regulation. Complementarily, a graphical representation tool based on an R programming language and its Shiny package was used to build the flowchart. This allowed us to elaborate a clear visualization of the different phases of the process, covering from the initial collection of the studies to the final selection of the included documents, facilitating the comprehensive understanding of the procedure [27].

The research questions were developed based on a methodical and strictly structured process. The first step was to conduct a preliminary review of the existing literature regarding the subject matter of cryptocurrencies and financial regulatory standards, with the objective of identifying those trends, gaps and potential areas of interest. After this initial exploration it was detected that, although there are studies about the impact of cryptocurrencies on financial markets, there is a lack of publications addressing global regulatory challenges and the contribution of blockchain to the evolution of regulations in the field.

Based on this review, issues of current relevance were prioritized, and questions were formulated that not only reflect the most current problems in the field but also help to fill gaps in literature. The following are the research questions that were formulated to guide the study:

- What are the main regulatory challenges faced by the bodies in charge of supervising cryptocurrencies at a global level?
- How have cryptocurrencies and blockchain technology influenced the evolution of international financial regulations?

To ensure the suitability and quality of the selected studies, it was necessary to establish the relevant criteria to incorporate in-depth and specific research. These considerations are presented below:

A. Inclusion Criteria

Studies that explore the regulatory challenges associated with cryptocurrencies or analyze the impact of blockchain technology on global financial regulation.

Research published in academic databases related to the topic, peer-reviewed journals or presented at recognized international conferences, ensuring academic rigor.

Publications between the period 2022 and 2025, to capture the most recent developments and debates in the field.

Articles written entirely in English, due to their international scope and standardization in the academic community.

B. Exclusion Criteria

Studies published before 2022, as they may not reflect current developments and challenges in the cryptocurrency and blockchain ecosystem.

Research that does not directly address the main regulatory and technological aspects central to the study.

Articles that are not peer-reviewed or lack clear methodology and solid empirical evidence.

Papers that do not provide relevant information to answer the research questions posed.

The search for publications was carried out within academic databases relevant to the focus of the study, including Scopus, Web of Science, Science Direct and IEEE Xplore. Likewise, employing keywords such as cryptocurrencies, financial regulation, blockchain, regulatory challenges and cryptocurrency laws, together with Boolean operators and the period between 2022 and 2025, made it possible to ensure recent developments in the field and to gain insight into the various perspectives. The result of this process provided the compilation of an initial set of studies. Fig. 1 shows the distribution of these studies according to the source of origin, providing a complete overview of the number of publications identified.

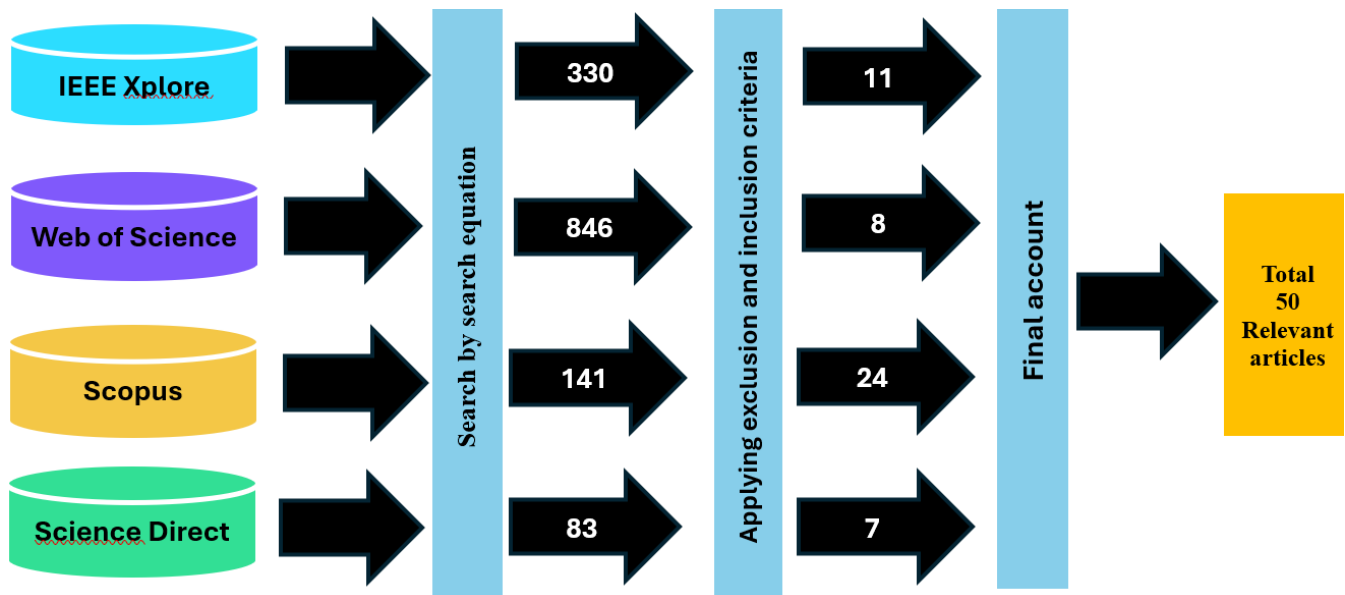


Fig. 1. Distribution of studies per database.

The PRISMA 2020 guidelines guided the process comprehensively, aligning under the framework is necessary to organize the SLR in four main phases, which are mentioned below:

- Identification: rigorous search of selected databases to identify potentially useful studies for addressing research questions.
- Selection: Filters were applied among the articles obtained, starting from the elimination of duplicate works and performing reviews based on title and abstract.
- Eligibility: To verify their relevance and materiality, the papers that passed the screening phase were subjected to an in-depth evaluation, in which it was verified that they adequately answered the research questions.
- Inclusion: The selection to be included for the review had to meet all the defined criteria, standing out for the finding in its literary information.

Fig. 2 illustrates in a synthesized way the selection process based on PRISMA 2020, mainly highlighting its organization in three key stages: identification, selection and inclusion. This visual representation expresses the sequential progression from the initial collection of studies to obtaining the final sample of those included, showing the gradual reduction of studies after the application of the established criteria.

Several computer tools were essential in the processing of the studies collected, since each of them played a strategic role throughout the different phases of the work. The Mendeley software made it possible to store and classify the documents according to their origin in the databases, contributing to the initial structuring of the set. The stored files were then exported in “.RIS” format and imported into Rayyan, a specialized resource platform for research work, whose incorporation made it possible to detect duplicities, create filters and apply

them in an evolutionary manner. Through this tool it was possible to identify and eliminate 87 duplicate articles and discard 125 documents that did not meet the eligibility criteria, including systematic reviews, meta-analyses and other types of secondary literature. Subsequently, the selected studies to be included in the SLR were classified in Microsoft Excel, organizing them in a data matrix, recording key information such as the database of origin, title, year of publication, type of document, country of origin, methodological approach classified as qualitative, quantitative or mixed, and the answers to the research questions. This structure enabled a more thorough analysis of the 50 studies chosen, allowing the identification of patterns and trends relevant to the development of the research.

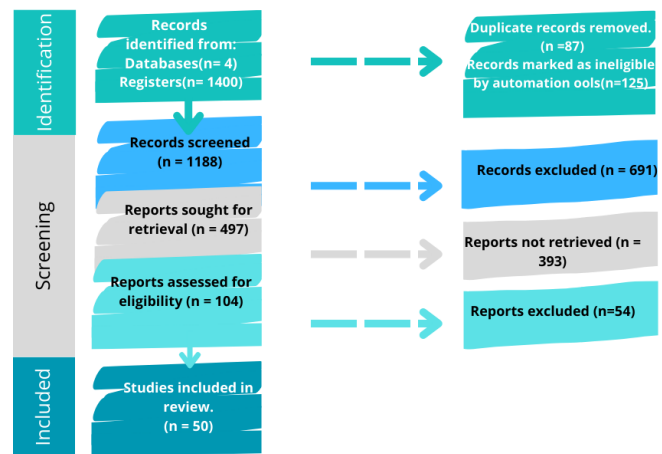


Fig. 2. PRISMA 2020 methodology.

IV. RESULTS

The results obtained provide a detailed overview, forming the basis for understanding how the latest scientific literature addresses the regulatory challenges of cryptocurrencies and their impact on the evolution of financial regulations. The

development of the stages of the screening process under PRISMA 2020 standards gradually contributed to improving the collected documents, so that it has been ensured that the final studies are the most relevant to represent the review. The initial compilation, presented in Table II, reflects the diversity of the sources consulted, laying a solid foundation for the subsequent analyses.

TABLE II. INITIAL DISTRIBUTION OF STUDIES BY DATABASE

Database	Quantity	Percentage
Scopus	141	10.07%
Web of Science	846	60.43%
Science Direct	83	5.93%
IEEE Xplore	330	23.57%
Total	1400	100%

After collecting the studies, they were classified within collections created according to their source of origin provided by the academic databases. From that process, the exhaustive analysis of the documents began, starting the filtering phases for inclusion and exclusion.

A. Phase 1: Elimination of Duplicates and Initial Filters

The first phase develops the debugging of duplicates and secondary documents that could have been included after compilation. Therefore, the full detection functionality provided by Rayyan is run, resulting in the consolidation of a refined set of 1,188 unique studies, excluding 212 non-representative ones. The reduction allowed optimizing the database, eliminating redundancies that could distort the analysis, in addition, it was possible to highlight Web of Science as the most representative source in the set, thanks to its high percentage value, followed by IEEE Xplore, Scopus and Science Direct, as detailed in Table III, which reflects the first significant transformation in the analyzed dataset.

TABLE III. DISTRIBUTION OF STUDIES AFTER ELIMINATION OF DUPLICATES AND INITIAL FILTERS

Database	Quantity	Percentage
Scopus	119	10.02%
Web of Science	732	61.62%
Science Direct	70	5.89%
IEEE Xplore	267	22.47%
Total	1,188	100%

B. Phase 2: Review of Titles and Keywords

The review of the 1,188 documents remaining up to this stage, using titles and key words, made it possible to identify those that maintained an evident and concrete link with the research questions posed. As a result of this analysis process, 691 documents were discarded because they did not address the central theme of the focus of the study, since they were outside the limits established in the framework. As a result of this filtering, the set of documents was reduced to 497 records. Table IV shows the updated distribution of the studies after this phase, showing the new proportional configuration between the databases.

TABLE IV. DISTRIBUTION OF STUDIES AFTER REVISION OF KEY TERMINOLOGY IN TITLES

Database	Quantity	Percentage
Scopus	70	14.08%
Web of Science	225	45.27%
Science Direct	29	5.84%
IEEE Xplore	173	34.81%
Total	497	100%

Subsequently, we proceeded to a more exhaustive review of the 497 documents, focusing objectively on the analysis of the summaries provided by the studies, but full texts were addressed in those that presented little information in their abstracts.

C. Phase 3: Review of Abstracts and Full Text

From this process, the analysis had to check those studies that accurately addressed the regulatory challenges of cryptocurrencies and how the impact of blockchain technology was affecting financial regulations. To do so, strategic keywords had to be used such as: cryptocurrencies, blockchain, digital currencies, regulatory challenges, DeFi and empirical study.

The result was the exclusion of 393 studies for not meeting the criteria, so that the set was reduced to 104, firmly refining the literature base for the final analysis. In this line, it was highlighted that the evolution of the studies belonging to Scopus for this stage showed that their content was relevant after their respective evaluation, thus emerging as the one that eliminated the least number of documents. Table V presents the updated distribution of the studies after this phase, reflecting this transformation in the composition of the final sample.

TABLE V. DISTRIBUTION OF STUDIES AFTER ABSTRACT AND FULL TEXT REVIEWS

Database	Quantity	Percentage
Scopus	26	25%
Web of Science	41	39.42%
Science Direct	14	13.46%
IEEE Xplore	23	22.12%
Total	104	100%

D. Phase 4: Final Inclusion

The last selective procedure, aimed at closing the studies for definitive inclusion, consisted of assessing the depth of the content, specifically the degree of complementarity with the methodological soundness and relevance of the contributions to the research approach and the questions formulated. Thus, 54 studies were excluded because they failed to provide substantial evidence and because they presented methodological limitations that compromised their validity in the context of the present study. Therefore, the final set was composed of 50 studies that rigorously met the established criteria, ensuring a robust and representative database for subsequent analyses.

TABLE VI. FINAL DISTRIBUTION INCLUDING STUDIES

Database	Quantity	Percentage
Scopus	24	48%
Web of Science	8	16%
Science Direct	7	14%
IEEE Xplore	11	22%
Total	50	100%

Regarding the final distribution of the chosen studies, the Scopus source predominated, followed by IEEE Xplore, Web of Science and Science Direct, reflecting a diverse and balanced composition of the specialized literature. Table VI illustrates this final distribution, consolidating the result of the systematic selection process.

To complement the collection of the 50 studies chosen in this review, a visual representation of the complete distribution is included through a bar graph, showing the numerical data for each academic database selected for the work. Fig. 3 not only

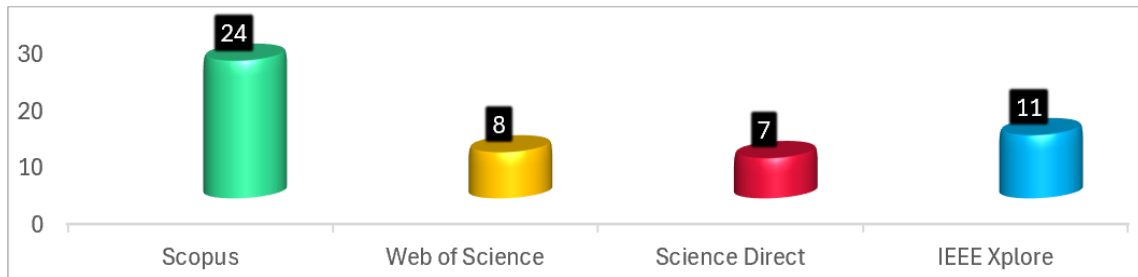


Fig. 3. Distribution of studies included by each database.

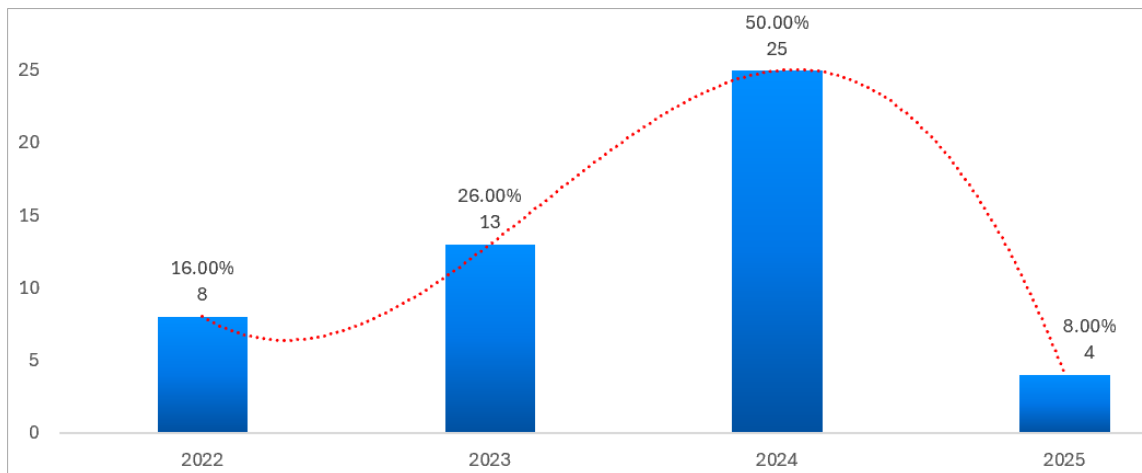


Fig. 4. Studies by year of publication.

In the same line, the time frame was relevant to determine the scientific production of studies associated with their respective databases. The most remarkable result was the contribution of Scopus in the year 2024, since it represented 12 studies, consolidating its relevance to the field as the main source in research. In the same line, IEEE Xplore showed its contribution with 7, Web of Science with 4 and Science Direct with 2. On the other hand, manifesting contributions in previous years, Scopus maintained its predominance in 2023 with 7 studies, while Science Direct and IEEE Xplore

facilitates the interpretation of the final set of data but also provides a clear and accessible perspective on the provenance of the selected literature.

Once the final studies were obtained, processes were carried out to determine certain aspects of relevance for the research. Starting with the temporal distribution, which covered the period from 2022 to 2025, where an increasing trend in academic production related to the subject of study was evidenced. Likewise, by 2022, 8 studies were identified, representing 16%. On the other hand, the number increased significantly in 2023, with a value of 13, representing 26%. The trend continued to increase in 2024, with the highest production of 25% of the set, equivalent to 50%. In contrast, in 2025, 4 studies were disclosed, representing 8% of the total. It is important to note that, as 2025 progresses, an increase in the number of published studies is expected. Fig. 4 illustrates this temporal distribution, highlighting the evolution of academic production and the importance of the studies published in the most recent period.

contributed with 3 and 2 respectively, and Web of Science with 1. As for the year 2022, the contributions were established with Scopus with 4, Web of Science with 3, IEEE Xplore with 1 and Science Direct with no records. On the other hand, for the most current year of 2025, the contributions with literary presence up to the present were constituted by Science Direct in 2 and IEEE Xplore in 1 study, while Scopus registered 1 and Web of Science did not present contributions. Fig. 5 illustrates the proportional trend, highlighting the contribution of each database over time.

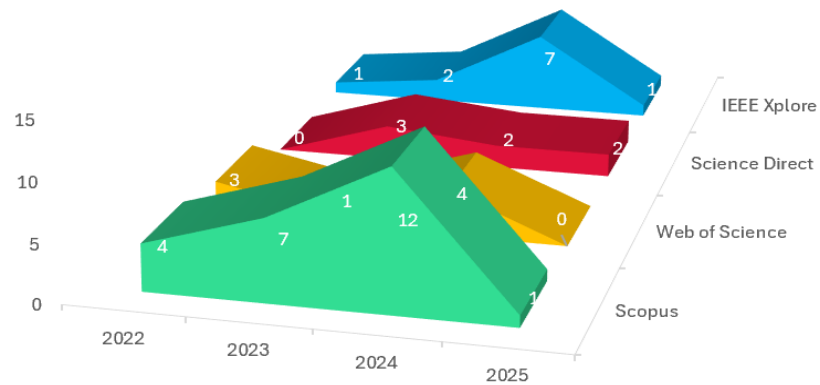


Fig. 5. Distribution of studies by year and databases.

As for the geographical origin of the SLR studies, the analysis showed that there was a strong prominence of countries with more developed financial systems, which have active regulatory frameworks for cryptocurrencies. The United Kingdom tops the list with 6 studies, representing 12% of the total, followed by China with 5 studies, corresponding to 10%, and Indonesia and Ukraine with 4 studies each, corresponding to 8%. Denmark, Estonia, Germany, Pakistan, Russia, Saudi Arabia and the United States are ranked with 2 studies each, representing 4%. In contrast, Australia, Bangladesh, Belgium, India, Italy, Hungary, Kazakhstan, Lithuania, Luxembourg,

Malaysia, Mauritius, Mexico, Morocco, Netherlands, Poland, Spain and Taiwan have 1 study each, equivalent to 2%. In view of the results, it can be stated that the academic production is higher in the regions of Europe with 60% and Asia at 25%, surely because of their concern for cryptocurrency regulation and financial development. Likewise, the low participation of Latin America and Africa suggests less attention to the treatment of the object of study in these regions. Fig. 6 provides a detailed geographical breakdown of the studies on the issue.

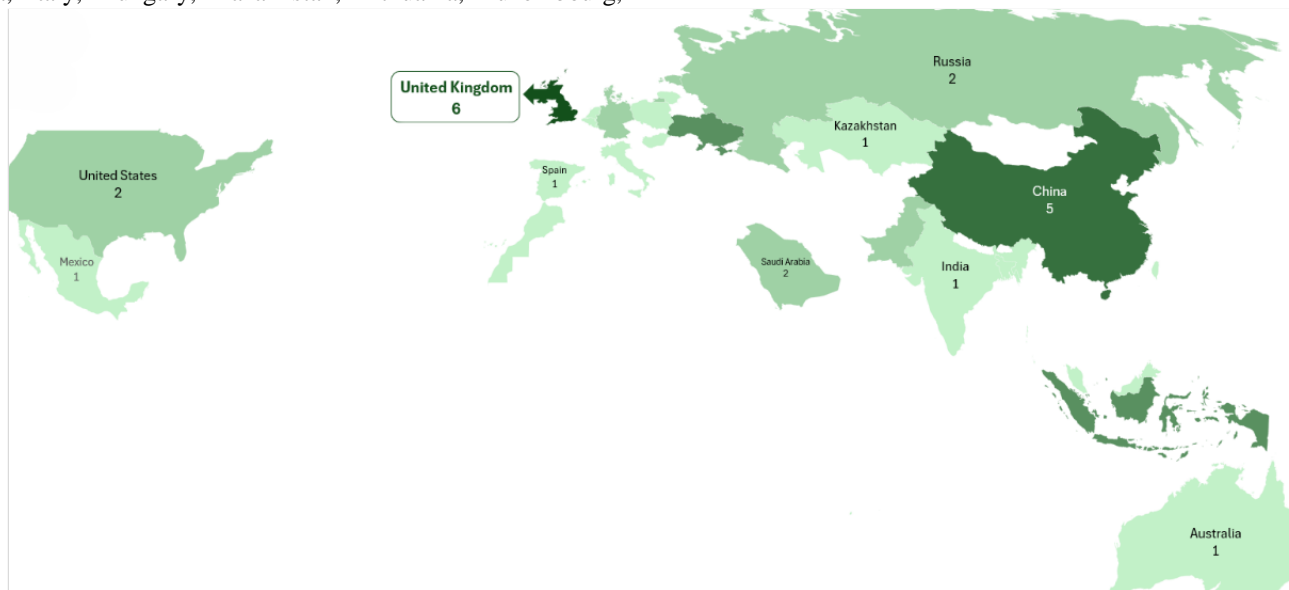


Fig. 6. Origin of studies by geographic region.

The review of each study included in this research revealed that 100% of the studies correspond exclusively to journal articles. This concentration reflects the prominence of scientific publications when studying the subject of interest regarding cryptocurrencies and their regulatory implications, reflecting the prominent role of this format in the generation and

dissemination of knowledge. However, it is imperative that the need to develop more applicable approaches in other fields to overcome the gap originated by the absence of other types of publications, such as conference proceedings and technical reports.

V. DISCUSSIONS

A. Q1: What are the Main Regulatory Challenges Facing the Bodies in Charge of Overseeing Cryptocurrencies Globally?

The growing adoption of cryptocurrencies brings with it governmental and institutional attention around the world. The purely speculative origin and their movements in conditions of anonymity contribute to challenges such as money laundering, lack of legal clarity and regulatory differences. In this sense, the study [16], addressed the risk associated with cryptocurrencies, evaluating their dynamics and volatility through daily data and metrics such as VaR and ES, showing that cryptocurrencies exhibit high volatility rates and high dependence, a fact that, in addition to suggesting arbitrage opportunities, highlights their potential to facilitate activities such as money laundering due to the difficulty of tracing anonymous transactions. On the other hand, research [17] examined the formation of speculative bubbles and herd behavior in the cryptocurrency market during the COVID-19 pandemic. Through probit regressions, alternative metrics of liquidity and volatility, they managed to identify that all the cryptocurrencies analyzed presented speculative bubbles. On the other hand, the paper [19] analyzed tail risk in cryptocurrencies, NFTs, stocks and gold, for which they used conditional models based on VaR, as a result it was revealed that there is no single superior model to capture extreme risk; however, it was observed that non-Gaussian distributions proved to be more effective when modeling asymmetry and heavy tails in returns. This reinforces the need to address the lack of legal clarity in the regulation of these assets, as the absence of clear standards increases risk exposure and hinders the implementation of effective regulatory frameworks.

Also, regarding volatility prediction, the study [18] combined neural networks such as DFFNN and LSTM with GARCH models in three types such as (GARCH, EGARCH and APGARCH) to analyze 27 cryptocurrencies, using the outputs of GARCH models as input data for the neural models, and showed that the hybrid models performed better than the individual models in terms of accuracy. Furthermore, [20] studied the ability of volatility models to predict downside risk in cryptocurrency trading, using models such as CAViaR, DQR, GARCH and GAS to five cryptocurrencies (Bitcoin, Ethereum, Ripple, Litecoin and Stellar), and using back testing and MCS techniques, it was concluded that quantile-based models, combined with a weighted aggregation method, are the most effective in anticipating the decline in the value of cryptocurrencies. Such a method allows highlighting regulatory discrepancies, as the lack of unified regulation hinders the implementation of effective risk management strategies. Below, in Table VII, the challenges in the regulatory arena found after the rigorous analysis are presented.

The results shows that cryptocurrency transactions have generated a wide range of regulatory challenges, many of which are interconnected. On the other hand, the decentralization and anonymity inherent in these technologies pose considerable hurdles for regulators, as they make it difficult to identify participants and track transactions. The problem arises especially in the case of stablecoins and DeFi

platforms, since their rapid growth and technical complexity exceed the capacity of regulators to establish effective controls. Added to this is the increase in fraud and scams within the ecosystem in which cryptocurrencies operate, a phenomenon that has exposed vulnerabilities in the protection of users and the security of blockchain platforms. In addition to affecting investor confidence, this phenomenon poses significant risks to the integrity of financial markets. In particular, the taxation of cryptocurrencies remains a critical area due to the lack of accurate transparent reporting mechanisms and monitoring in the verification of transactions. This situation is compounded by the absence of standardized international rules, creating an environment in which illicit activities can flourish.

TABLE VII. CHALLENGES FOR REGULATORY AGENCIES

#	Regulatory Challenge	Quantity	References
1	Money laundering	6	[28], [29], [30], [31], [32], [33]
2	Lack of legal clarity	5	[34], [35], [36], [37], [38]
3	Regulatory differences	5	[39], [40], [41], [42], [43]
4	Decentralization and anonymity	5	[44], [45], [46], [47], [48]
5	Stablecoins and DeFi	5	[49], [50], [51], [52], [53]
6	Fraud and protection	5	[54], [55], [56], [57], [58]
7	Blockchain security	5	[59], [60], [61], [62], [63]
8	Crypto taxation	4	[64], [65], [66], [67]
9	Transparency and monitoring	4	[68], [69], [70], [71]

These challenges underscore the urgent need to develop robust and cooperative regulatory frameworks that address both current and emerging risks. The implementation of innovative solutions, together with strengthened international cooperation, will be essential to promote the creation of a safe, efficient and more transparent financial ecosystem.

B. Q2: How have Cryptocurrencies and Blockchain Technology Influenced the Evolution of International Financial Regulations?

Cryptocurrencies have been greatly affected by the evolution of international financial regulation, as they pose regulatory challenges due to their decentralized and anonymous nature. Therefore, incorporating blockchain as a technological solution to support regulation is an essential strategy to balance innovation and regulatory control. In this way, this synergistic relationship enables regulators to develop more robust regulations tailored to the needs of the global financial system. These include those related to stability and governance, where blockchain enables real-time audits and decentralized governance systems (DAO), as well as supervision, where it improves transparency and ensures an immutable transaction history. Recent studies support this position, highlighting blockchain's ability to strengthen financial traceability and facilitate regulatory adaptation among dynamic digital environments.

In [23], the transmission of extreme risks between NFTs, DeFi tokens and cryptocurrencies was explored using the quant connectivity technique to analyze volatility conditions,

identifying that the NFTs offer greater opportunities to diversify and reduce risk levels compared to other blockchain markets, making them an alternative of interest to reduce extreme risks. The finding, together with the inherent traceability of blockchain, influences the creation of regulations that promote stability and governance in the cryptocurrency ecosystem, as well as the implementation of blockchain-based online auditing systems.

On the other hand, in [24], it was analyzed how climate shocks affect extreme risks in cryptocurrency markets, building risk contagion networks using a TVP-VAR model, whose results showed that cryptocurrencies are highly sensitive to climatic, political factors and that global financial markets are the main transmitters of risks. This has led regulators to strengthen oversight mechanisms and use blockchain technology to improve transparency and immutable transaction recording, thus mitigating associated risks. Also, Table VIII presents the impact of cryptocurrencies and blockchain on various financial regulations.

TABLE VIII. IMPACT OF CRYPTOCURRENCIES AND BLOCKCHAIN ON FINANCIAL REGULATION

#	Impact of Cryptocurrencies	Blockchain Impact	Quantity	References
1	Stability and governance	Audits	5	[50], [56], [72], [73], [74]
2	Supervision	Traceability	5	[43], [66], [67], [70]
3	DeFi and Anti-Money Laundering (AML) Regulation	Compliance	4	[28], [68], [75], [76]
5	Financial innovation	Regulations	4	[35], [49], [54], [77]

In terms with slight influence, DeFi and AML regulation stand out, where blockchain facilitates traceability, process automation and financial innovation, whose operation allows the implementation of regulations based on smart contracts. The study [25], compared gregarious behavior in "clean" and "dirty" cryptocurrency markets using profitability and market activity data. As a result, it was observed that herding behavior is more pronounced in "dirty" markets, especially in bearish market conditions. Similarly, in [22], seasonal patterns in cryptocurrency returns were examined by analyzing data from 500 cryptocurrencies and focusing on the effect of Monday and weekend trading activity, showing that a positive Monday effect on Bitcoin did not last after 2015, which has led regulators to consider financial innovation in designing smart contract-based regulations, enabling more efficient and transparent compliance in DeFi and AML regulations.

The influence of cryptocurrencies and blockchain technology on the evolution of international financial regulation is undeniable due to their nature in relation to their operations. Through traceability, real-time audits, automated compliance and DAO, blockchain not only mitigates the risks arising from cryptocurrencies, but also promotes transparency, efficiency and innovation for the global financial system. All of these developments underscore the importance of regulators harnessing the potential of existing technologies, such as blockchain and other emerging technologies, to support a

transformative new system that the masses are migrating towards; achieving this will ensure the stability and integrity of financial markets.

VI. CONCLUSION

In this SLR, the technological infrastructure within the cryptocurrency ecosystem was analyzed to identify its behavior in relation to the entities that regulate finance worldwide, taking as evidence the inclusion of 50 studies published between 2022 and 2025. The studies collected came from databases of recognized solvency for their prestige, such as Scopus with 24 articles, representing 48%, Web of Science with 8 equivalents to 16%, IEEE Xplore with 11 at 22%, and Science Direct with 7 representing 14%. The variety of these sources of information provides a complete and representative perspective of the current state of research in the field.

The results revealed that cryptocurrencies raise significant regulatory challenges, including money laundering, lack of legal clarity, decentralization and anonymity. It was also identified that blockchain technology is instrumental in improving transparency, traceability and regulatory efficiency. These findings underscore the need for innovative regulatory frameworks to balance technological innovation with user protection and financial stability. Moreover, it was reflected that the lack of unified international standards hinders the implementation of effective regulations, thus underlining the importance of global collaboration in this field.

This systematic study provides a solid foundation for future research to be undertaken by experts, as it synthesizes recent statistics and proposes priority areas for study, raising awareness. These areas include the development of flexible regulatory systems, comparative approaches across regions and the incorporation of new technologies into financial regulation. The findings also provide valuable input to regulators and policy makers, helping to create more effective regulations that are adaptable to current realities. However, the research faced limitations inherent to the study of emerging and disruptive issues. On the other hand, the rapid evolution of the cryptocurrency and blockchain ecosystem generated a gap between the literature findings and the current reality, suggesting the need for periodic updates in future reviews. Also, some studies presented methodological heterogeneity that hindered the comparability of results, so it is important to standardize approaches. Finally, the absolute lack of comprehensive papers addressing global regulatory challenges to financial regulation indicates a critical area for further research.

REFERENCES

- [1] D. Stosic, D. Stosic, T. B. Ludermir, and T. Stosic, "Multifractal behavior of price and volume changes in the cryptocurrency market," *Physica A: Statistical Mechanics and its Applications*, vol. 520, pp. 54–61, Apr. 2019, doi: 10.1016/J.PHYSA.2018.12.038.
- [2] Z. Li, Q. Lu, S. Chen, Y. Liu, and X. Xu, "A Landscape of Cryptocurrencies," *ICBC 2019 - IEEE International Conference on Blockchain and Cryptocurrency*, pp. 165–166, May 2019, doi: 10.1109/BLOC.2019.8751469.
- [3] M.-Y. Yang, Z.-K. Chen, J. Hu, Y. Chen, and X. Wu, "Multidimensional information spillover between cryptocurrencies and China's financial markets under shocks from stringent government regulations," *Journal*

- of International Financial Markets, Institutions and Money, vol. 100, p. 102134, Apr. 2025, doi: 10.1016/J.INTFIN.2025.102134.
- [4] N. Samuel Uzougbo, C. Gladys Ikegwu, A. Olachi Adewusi, and M. Scientia, "International enforcement of cryptocurrency laws: Jurisdictional challenges and collaborative solutions," 2024, doi: 10.30574/msarr.2024.11.1.0075.
- [5] S. Modi, "Bitcoin: A Blessing or A Curse?," Paripex Indian Journal of Research, pp. 2–6, Sep. 2022, doi: 10.36106/PARIPEX/5904618.
- [6] J. Geuder, H. Kinatader, and N. F. Wagner, "Cryptocurrencies as financial bubbles: The case of Bitcoin," *Financ Res Lett*, vol. 31, pp. 179–184, Dec. 2019, doi: 10.1016/J.FRL.2018.11.011.
- [7] H. Bhattacharya, D. Agrawal, D. Walia, and A. Kumar, "Cryptocurrency Trend Predictions through LSTM-Based Prediction," *Proceedings - IEEE 2023 5th International Conference on Advances in Computing, Communication Control and Networking, ICAC3N 2023*, pp. 1113–1116, 2023, doi: 10.1109/ICAC3N60023.2023.10541754.
- [8] Y. Huang et al., "Evaluating Cryptocurrency Market Risk on the Blockchain: An Empirical Study Using the ARMA-GARCH-VaR Model," *IEEE Open Journal of the Computer Society*, vol. 5, pp. 83–94, 2024, doi: 10.1109/OJCS.2024.3370603.
- [9] J. Cui, L. Gao, and Y. Wang, "The Impact of Cryptocurrency Exposure on Corporate Tax Avoidance Among US Listed Companies," *Journal of Risk and Financial Management*, vol. 17, no. 11, p. 488, Nov. 2024, doi: 10.3390/jrfm17110488.
- [10] Y. L. Gao, X. B. Chen, Y. L. Chen, Y. Sun, X. X. Niu, and Y. X. Yang, "A Secure Cryptocurrency Scheme Based on Post-Quantum Blockchain," *IEEE Access*, vol. 6, pp. 27205–27213, Apr. 2018, doi: 10.1109/ACCESS.2018.2827203.
- [11] T. Barbereau and B. Bodó, "Beyond financial regulation of crypto-asset wallet software: In search of secondary liability," *Computer Law & Security Review*, vol. 49, p. 105829, Jul. 2023, doi: 10.1016/J.CLSR.2023.105829.
- [12] O. Iparraquirre-Villanueva, L. Obregon-Palomino, W. Pujay-Iglesias, and M. Cabanillas-Carbonell, "Intelligent agent for incident management [Agente inteligente para la gestión de incidencias]," *RISTI - Revista Iberica de Sistemas e Tecnologias de Informacao*, vol. 2023, no. e51, pp. 99–115, Jan. 2023, doi: 10.17013/risti.51.99-115.
- [13] M. Tiwari, C. Lupton, A. Bernot, and K. Halteh, "The cryptocurrency conundrum: the emerging role of digital currencies in geopolitical conflicts," *J Financ Crime*, vol. 31, no. 6, pp. 1622–1634, Nov. 2024, doi: 10.1108/JFC-12-2023-0306.
- [14] V. Veselý and M. Žádník, "How to detect cryptocurrency miners? By traffic forensics!," *Digit Investig*, vol. 31, p. 100884, Dec. 2019, doi: 10.1016/J.DIIN.2019.08.002.
- [15] H. Chen, N. Wei, L. Wang, W. F. M. Mobarak, M. A. Albahar, and Z. A. Shaikh, "The Role of Blockchain in Finance Beyond Cryptocurrency: Trust, Data Management, and Automation," *IEEE Access*, vol. 12, pp. 64861–64885, 2024, doi: 10.1109/ACCESS.2024.3395918.
- [16] R. Bruzge, J. Černevičienė, A. Šapkauskienė, A. Mačerinskienė, S. Masteika, and K. Driaunys, "Stylized Facts, Volatility Dynamics and Risk Measures of Cryptocurrencies," *Journal of Business Economics and Management*, vol. 24, no. 3, pp. 527–550, Sep. 2023, doi: 10.3846/JBEM.2023.19118.
- [17] O. Haykir and I. Yagli, "Speculative bubbles and herding in cryptocurrencies," *Financial Innovation*, vol. 8, no. 1, Dec. 2022, doi: 10.1186/S40854-022-00383-0.
- [18] B. Amirshahi and S. Lahmiri, "Hybrid deep learning and GARCH-family models for forecasting volatility of cryptocurrencies," *Machine Learning with Applications*, vol. 12, p. 100465, Jun. 2023, doi: 10.1016/J.MLWA.2023.100465.
- [19] Z. Barson and P. Owusu Junior, "Tail risk modelling of cryptocurrencies, gold, non-fungible token, and stocks," *Research in Globalization*, vol. 8, Jun. 2024, doi: 10.1016/J.RESGLO.2024.100229.
- [20] F. Iqbal, M. Zahid, and D. Koutmos, "Cryptocurrency Trading and Downside Risk," *Risks*, vol. 11, no. 7, Jul. 2023, doi: 10.3390/RISKS11070122.
- [21] H. kyu Chey, "Cryptocurrencies and the IPE of money: an agenda for research," *Rev Int Polit Econ*, vol. 30, no. 4, pp. 1605–1620, 2023, doi: 10.1080/09692290.2022.2109188.
- [22] L. Mueller, "Revisiting seasonality in cryptocurrencies," *Financ Res Lett*, vol. 64, Jun. 2024, doi: 10.1016/J.FRL.2024.105429.
- [23] S. Karim, B. M. Lucey, M. A. Naeem, and G. S. Uddin, "Examining the interrelatedness of NFTs, DeFi tokens and cryptocurrencies," *Financ Res Lett*, vol. 47, Jun. 2022, doi: 10.1016/J.FRL.2022.102696.
- [24] K. Guo, Y. Kang, Q. Ji, and D. Zhang, "Cryptocurrencies under climate shocks: a dynamic network analysis of extreme risk spillovers," *Financial Innovation*, vol. 10, no. 1, Dec. 2024, doi: 10.1186/S40854-023-00579-Y.
- [25] B. Ren and B. Lucey, "Do clean and dirty cryptocurrency markets herd differently?," *Financ Res Lett*, vol. 47, Jun. 2022, doi: 10.1016/J.FRL.2022.102795.
- [26] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement," *International Journal of Surgery*, vol. 8, no. 5, pp. 336–341, Jan. 2010, doi: 10.1016/J.IJSU.2010.02.007.
- [27] N. R. Haddaway, M. J. Page, C. C. Pritchard, and L. A. McGuinness, "PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis," *Campbell Systematic Reviews*, vol. 18, no. 2, p. e1230, Jun. 2022, doi: 10.1002/CL2.1230.
- [28] V. Benson, U. Turksen, and B. Adamyk, "Dark side of decentralised finance: a call for enhanced AML regulation based on use cases of illicit activities," *Journal of Financial Regulation and Compliance*, vol. 32, no. 1, pp. 80–97, Jan. 2024, doi: 10.1108/JFRC-04-2023-0065.
- [29] J. Wiwoho, A. M. Pratama, U. K. Pati, and Pranoto, "Examining Cryptocurrency Use among Muslim Affiliated Terrorists: Case Typology and Regulatory Challenges in Southeast Asian Countries," *AL-IHKAM: Jurnal Hukum & Pranata Sosial*, vol. 18, no. 1, pp. 102–124, Jun. 2023, doi: 10.19105/al-ihkam.v18i1.7147.
- [30] S. Lyeonov, M. Tumpach, G. Loskorikh, H. Filatova, Y. Reshetniak, and R. Dinitis, "New AML Tools: Analyzing Ethereum Cryptocurrency Transactions Using A Bayesian Classifier," *Financial and credit activity problems of theory and practice*, vol. 4, no. 57, pp. 274–288, Aug. 2024, doi: 10.55643/fcaptop.4.57.2024.4500.
- [31] R. Anggriawan and Muh. E. Susila, "Cryptocurrency and its Nexus with Money Laundering and Terrorism Financing within the Framework of FATF Recommendations," *Novum Jus*, vol. 18, no. 2, pp. 249–277, Sep. 2024, doi: 10.14718/NovumJus.2024.18.2.10.
- [32] A. Venčauskas, Š. Grigaliūnas, L. Pocius, R. Brūzgienė, and A. Romanovs, "Machine Learning in Money Laundering Detection Over Blockchain Technology," *IEEE Access*, vol. 13, pp. 7555–7573, 2025, doi: 10.1109/ACCESS.2024.3452003.
- [33] C. Vinoth Kumar et al., "Ethereum Blockchain Framework Enabling Banks to Know Their Customers," *IEEE Access*, vol. 12, pp. 101356–101365, 2024, doi: 10.1109/ACCESS.2024.3427805.
- [34] K. Proskurina and Y. Porokhov, "Legal regime of cryptocurrencies," *Law, State and Telecommunications Review*, vol. 16, no. 1, pp. 239–277, May 2024, doi: 10.26512/LSTR.V16I1.45592.
- [35] N. Kshetri, "The nature and sources of international variation in formal institutions related to initial coin offerings: preliminary findings and a research agenda," *Financial Innovation*, vol. 9, no. 1, p. 9, Jan. 2023, doi: 10.1186/s40854-022-00405-x.
- [36] F. Sugianto and S. Tokuyama, "The Extended Nature of Trading Norms Between Cryptocurrency and Crypto-asset: Evidence from Indonesia and Japan," *Lex Scientia Law Review*, vol. 8, no. 1, pp. 193–222, Sep. 2024, doi: 10.15294/lsr.v8i1.14063.
- [37] P. Szwajdler, "Considerations on the Construction of Future Financial Regulations in the Field of Initial Coin Offering," *European Business Organization Law Review*, vol. 23, no. 3, pp. 671–709, Sep. 2022, doi: 10.1007/s40804-021-00225-z.
- [38] M. A. Egorova, V. V. Grib, L. G. Efimova, O. V. Kozhevina, and V. Yu. Slepak, "Research of the effectiveness of the system of legal regulation of tax relations for operations with cryptocurrency currently in force," *Vestnik of Saint Petersburg University. Law*, vol. 14, no. 3, pp. 564–579, 2023, doi: 10.21638/spbu14.2023.301.
- [39] C. Yu, Y. Zhan, P. Jing, and X. Song, "SPRA: Scalable policy - based regulatory architecture for blockchain transactions," *IET Blockchain*, vol. 3, no. 4, pp. 265–282, Dec. 2023, doi: 10.1049/blc2.12037.

- [40] B. Mahadew and S. Anben Mauree, "Cryptocurrencies and Virtual Assets in Mauritius: A Critical Assessment of the Legal Framework," *Afrika Focus*, vol. 37, no. 1, pp. 122–143, May 2024, doi: 10.1163/2031356x-20240107.
- [41] C. Wronka, "Digital currencies and economic sanctions: the increasing risk of sanction evasion," *J Financ Crime*, vol. 29, no. 4, pp. 1269–1282, Sep. 2022, doi: 10.1108/JFC-07-2021-0158.
- [42] A. P. Alekseenko, "Ban of Cryptocurrencies in China and Judicial Practice of Chinese Courts," *China and WTO Review*, vol. 8, no. 2, pp. 361–384, Jun. 2022, doi: 10.14330/cwr.2022.8.2.06.
- [43] T. Burgess, "A multi-jurisdictional perspective: To what extent can cryptocurrency be regulated? And if so, who should regulate cryptocurrency?," *Journal of Economic Criminology*, vol. 5, p. 100086, Sep. 2024, doi: 10.1016/j.jeconc.2024.100086.
- [44] R. Carletti, X. Luo, and I. Adelopo, "Understanding criminogenic features: case studies of cryptocurrencies-based financial crimes," *J Financ Crime*, Dec. 2024, doi: 10.1108/JFC-06-2024-0176.
- [45] A. Alhakim and T. Tantimin, "The Legal Status of Cryptocurrency and Its Implications for Money Laundering in Indonesia," *PADJADJARAN Jurnal Ilmu Hukum (Journal of Law)*, vol. 11, no. 2, pp. 231–253, Aug. 2024, doi: 10.22304/pjih.v11n2.a4.
- [46] M. Dhali, S. Hassan, and S. Zuhuda, "The regulatory puzzle of decentralized cryptocurrencies: Opportunities for innovation and hurdles to overcome," *Journal of Infrastructure, Policy and Development*, vol. 8, no. 6, p. 3377, Jul. 2024, doi: 10.24294/jipd.v8i6.3377.
- [47] M. Ylönen, R. Raudla, and M. Babic, "From tax havens to cryptocurrencies: secrecy-seeking capital in the global economy," *Rev Int Polit Econ*, vol. 31, no. 2, pp. 563–588, Mar. 2024, doi: 10.1080/09692290.2023.2232392.
- [48] V. Blikhar, H. Lukianova, I. Komarnytska, M. Vinichuk, and V. Gapchich, "Problems of Normative and Legal Regulation of The Process of Applying Blockchain Technology in the Financial System of Ukraine," *Financial and Credit Activity: Problems of Theory and Practice*, vol. 3, no. 50, pp. 410–418, Jan. 2023, doi: 10.55643/fcaptop.3.50.2023.4088.
- [49] N. Divissenko, "Regulation of Crypto-assets in the EU: Future-proofing the Regulation of Innovation in Digital Finance," *European Papers - A Journal on Law and Integration*, vol. 2023 8, no. 2, pp. 665–687, Nov. 2023, doi: 10.15166/2499-8249/681.
- [50] S. L. Schwarcz, "Regulating Global Stablecoins: A Model-Law Strategy," *SSRN Electronic Journal*, vol. 75, no. 6, pp. 1729–1785, Nov. 2021, doi: 10.2139/ssrn.3966569.
- [51] O. Kulyk, "Models of State Regulation of the Virtual Assets Market in Offshore Zones (On the Example of Bermuda Islands, Gibraltar, and Malta)," *Balkan Social Science Review*, vol. 20, pp. 43–61, Dec. 2022, doi: 10.46763/10.46763/BSSR2220043K.
- [52] R. Lener, "Cryptocurrencies and crypto-assets in the Italian and EU perspective," *Vestnik of Saint Petersburg University. Law*, vol. 13, no. 1, pp. 219–229, 2022, doi: 10.21638/spbu14.2022.112.
- [53] A. R. Meneses, "Cryptocurrencies: a phenomenon devoid of tax justice," *Dixi*, vol. 26, no. DIXI, pp. 1–19, Mar. 2024, doi: 10.16925/2357-5891.2024.03.03.
- [54] Z. Arif, Z., A. Supyadillah, A. Irfan, and A. Taufik, "The Revolution of Blockchain in Digital Payment Systems: Legal Implications and Regulatory Challenges," *Journal of Ecohumanism*, vol. 3, no. 8, pp. 12269–12284, Dec. 2024, doi: 10.62754/joe.v3i8.5833.
- [55] L. Damkjær Christensen, "Preventing fraud in crypto payments," *Journal of Economic Criminology*, vol. 7, p. 100124, Mar. 2025, doi: 10.1016/J.JECONC.2024.100124.
- [56] M. Tiwari, Y. Zhou, J. Ferrill, and M. Smith, "Crypto Crashes: An examination of the Binance and FTX scandals and associated accounting challenges," *The British Accounting Review*, p. 101584, Jan. 2025, doi: 10.1016/j.bar.2025.101584.
- [57] Y. Sun, H. Xiong, S. M. Yiu, and K. Y. Lam, "BitAnalysis: A Visualization System for Bitcoin Wallet Investigation," *IEEE Trans Big Data*, vol. 9, no. 2, pp. 621–636, Apr. 2023, doi: 10.1109/TBDATA.2022.3188660.
- [58] N. Nayyer, N. Javaid, M. Akbar, A. Aldegheshem, N. Alrajeh, and M. Jamil, "A New Framework for Fraud Detection in Bitcoin Transactions Through Ensemble Stacking Model in Smart Cities," *IEEE Access*, vol. 11, pp. 90916–90938, 2023, doi: 10.1109/ACCESS.2023.3308298.
- [59] N. Fikri, M. Rida, N. Abghour, K. Moussaid, A. El Omri, and M. Myara, "A Blockchain Architecture for Trusted Sub-Ledger Operations and Financial Audit Using Decentralized Microservices," *IEEE Access*, vol. 10, pp. 90873–90886, 2022, doi: 10.1109/ACCESS.2022.3201885.
- [60] S. Mahmood Babur, S. Ur Rehman Khan, J. Yang, Y.-L. Chen, C. Soon Ku, and L. Yee Por, "Preventing 51% Attack by Using Consecutive Block Limits in Bitcoin," *IEEE Access*, vol. 12, pp. 77852–77869, 2024, doi: 10.1109/ACCESS.2024.3407521.
- [61] N. M. Nasir, S. Hassan, and K. Mohd Zaini, "Securing Permissioned Blockchain-Based Systems: An Analysis on the Significance of Consensus Mechanisms," *IEEE Access*, vol. 12, pp. 138211–138238, 2024, doi: 10.1109/ACCESS.2024.3465869.
- [62] Y.-F. Wen and M.-F. Chen, "Mined Block Withholding and Imposed Fork by Using Mining Pool Alliance Strategic—A Case Study in Bitcoin System," *IEEE Access*, vol. 13, pp. 817–833, 2025, doi: 10.1109/ACCESS.2024.3522962.
- [63] J. Zhang, C. Zha, Q. Zhang, and S. Ma, "A Denial-of-Service Attack Based on Selfish Mining and Sybil Attack in Blockchain Systems," *IEEE Access*, vol. 12, pp. 170309–170320, 2024, doi: 10.1109/ACCESS.2024.3499350.
- [64] C. Wronka, "Crypto-asset activities and markets in the European Union: issues, challenges and considerations for regulation, supervision and oversight," *Journal of Banking Regulation*, vol. 25, no. 1, pp. 84–93, Mar. 2024, doi: 10.1057/s41261-023-00217-8.
- [65] G. Soana, "Regulating cryptocurrencies checkpoints: Fighting a trench war with cavalry?," *Economic Notes*, vol. 51, no. 1, Feb. 2022, doi: 10.1111/ecnno.12195.
- [66] I. H.-Y. Chiu, "An institutional account of responsiveness in financial regulation- Examining the fallacy and limits of 'same activity, same risks, same rules' as the answer to financial innovation and regulatory arbitrage," *Computer Law & Security Review*, vol. 51, p. 105868, Nov. 2023, doi: 10.1016/j.clsr.2023.105868.
- [67] N. Alsalmi, S. Ullah, and M. Rafique, "Accounting for digital currencies," *Res Int Bus Finance*, vol. 64, p. 101897, Jan. 2023, doi: 10.1016/j.ribaf.2023.101897.
- [68] A. Zhuk, "Beyond the blockchain hype: addressing legal and regulatory challenges," *SN Social Sciences*, vol. 5, no. 2, p. 11, Jan. 2025, doi: 10.1007/s43545-024-01044-y.
- [69] T. Barbereau, R. Smethurst, O. Papageorgiou, J. Sedlmeir, and G. Fridgen, "Decentralised Finance's timocratic governance: The distribution and exercise of tokenised voting rights," *Technol Soc*, vol. 73, p. 102251, May 2023, doi: 10.1016/j.techsoc.2023.102251.
- [70] T. Vinther Dagaard, J. Bisgaard Jensen, R. J. Kauffman, and K. Kim, "Blockchain solutions with consensus algorithms and immediate finality: Toward Panopticon-style monitoring to enhance anti-money laundering," *Electron Commer Res Appl*, vol. 65, p. 101386, May 2024, doi: 10.1016/j.elerap.2024.101386.
- [71] O. Kovalchuk, R. Shevchuk, and S. Banakh, "Cryptocurrency Crime Risks Modeling: Environment, E-Commerce, and Cybersecurity Issue," *IEEE Access*, vol. 12, pp. 50673–50688, 2024, doi: 10.1109/ACCESS.2024.3386428.
- [72] T. Tunzina et al., "Blockchain-Based Central Bank Digital Currency: Empowering Centralized Oversight With Decentralized Transactions," *IEEE Access*, vol. 12, pp. 192689–192709, 2024, doi: 10.1109/ACCESS.2024.3517147.
- [73] I. Mihus, V. Marchenko, A. Dombrovska, and O. Panchenko, "The Change of the Monetary Paradigm: Financial Security and Cryptocurrency," *Financial Internet Quarterly*, vol. 20, no. 2, pp. 89–101, Jun. 2024, doi: 10.2478/fiqf-2024-0014.
- [74] Y. Shi, "A Study of the Challenges of Digital Currencies to the Traditional Financial System and Their Implications for Economic Policy," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, p. 20241626, Jan. 2024, doi: 10.2478/amns-2024-1626.

- [75] M. Pan, D. Li, H. Wu, and P. Lei, "Technological revolution and regulatory innovation: How governmental artificial intelligence adoption matters for financial regulation intensity," *International Review of Financial Analysis*, vol. 96, p. 103535, Nov. 2024, doi: 10.1016/j.irfa.2024.103535.
- [76] D. McNulty, A. Miglionico, and A. Milne, "Data Access Technologies and the 'New Governance' Techniques of Financial Regulation," *Journal of Financial Regulation*, vol. 9, no. 2, pp. 225–248, Oct. 2023, doi: 10.1093/jfr/fjad008.
- [77] R. K. Lyons and G. Viswanath-Natraj, "What keeps stablecoins stable?," *J Int Money Finance*, vol. 131, p. 102777, Mar. 2023, doi: 10.1016/j.jimonfin.2022.102777.