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A Review of Researches on Blockchain

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Abstract: Analyzing 242 articles related to the study of blockchain which were published in China and abroad from 2014 to 2016, and from the aspects of literature sources, research subjects, research methods and western countries, the basic frame of blockchain research classification is put forward. Summarize the current blockchain technology progress, research limitations and future development trends. The research shows that the domestic research on the blockchain is more decentralized, non-systematic, and has not reached a certain research depth. What's more, it is lack of quantitative analysis. Digital currency, Internet finance, and the risk of blockchain technology research will be the focus of future research.

Keywords: blockchain, financial applications, digital currency, Internet finance, future and risk

1. INTRODUCTION

The blockchain first appeared in the 2008 article "Bitcoin: A Peer-to-Peer Electronic Cash System" by Satoshi Nakamoto. He proposed an electronic currency: Bitcoin, based on the de-centralized P2P system design structure to solve the problem of trust between both parties, which is one of the application of the blockchain.

With the further study of the blockchain, its application is further diversified. In January 2015, at the Bitcoin Conference in Miami, USA, 'The Bretton Woods System 2015 White Paper' was released and the three phases of blockchain development were proposed: Blockchain 1.0 stage, the encrypted digital currency. It mainly reflected in the Bitcoin application. Blockchain 2.0 stage, intelligent contract. Blockchain is used in financial or economic markets and extends to stocks, bonds, futures, loans, mortgages, property rights, intellectual property and other contracts. Blockchain 3.0 stage, widely innovative application stage. It is widely used in some global public services. All walks of life are highly interested in the development of blockchain and think its prospects are very good. The academic community thinks that blockchain not only involves the financial industry, but also subvert the operation of the whole society, so blockchain technology will be a new Internet revolution. Regulators are more concerned about that blockchain will bring changes and impact. The blockchain will redefine human life and have great research value. In January 2016, the British government issued an important report on the blockchain technology. The report, titled "Distributed Book Technology: Beyond the blockchain", mentions that the UK federal government is exploring distributed account technology which is similar to blockchain technology and analyzes the potential of the blockchain if it is applied to the traditional financial industry. The People's Bank of China established a digital money technical team as early as 2014, and in January 2016, it carried out a special seminar on digital currency. In the seminar, they explored the feasibility of using the blockchain technology to issue virtual currency in order to improve the efficiency, convenience and transparency of financial activities. And as of the beginning of 2016, the capital market has been invested one

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billion US dollars to accelerate the development of the chain area.

According to this trend, the paper synthesizes the classification of blockchain in domestic and foreign academic papers, and then proposes a classification framework for blockchain and describes the characteristics of blockchain. The significance of this paper is that by summarizing the classification of the blockchain, we have a better understanding of the current research situation, and clarify the work which needs to be improved further, therefore we can promote China's blockchain research.

2. THE BLOCKCHAIN CONCEPTS AND FEATURES

Reading the literatures, the papers extract blockchain concept is: a kind of decentralized collective manner and to trust the distributed database maintenance technology. Using of cryptographic method, the technology records a certain period of time between the nodes of all the exchange of information to a data block and links to the blockchain. All the nodes of the system jointly authenticate the information recorded on block.

The blockchain technology has the following characteristics: 1. Eliminating the center. The system does not rely on centralized management organizations or hardware; 2. Eliminating trust. There is no need to trust each other exchanging of data between the nodes of the system. Therefore, one node cannot cheat other nodes; 3. Collective maintenance. Each node in the system safeguard security and integrity of the database system altogether. 4. Tamper resistance. Unless it can control more than 51% of the nodes, editing a single node does not affect other nodes of the database, and cannot achieve the purpose of tampering with information; 5. Traceability. Each data block contains information that can be traced back to the front of the block content; 6. Anonymity. Node sides can be traded anonymously, and do not need to trust each other; 7. Openness, node transaction information is disclosed, and the transaction between the nodes becomes transparent.

3. RESEARCH AND ANALYSIS OF CHINESE LITERATURES

To analyze the current situation of domestic blockchain research better, we took 'blockchain' as keyword to search relative literatures in CNKI, WANFANG DATABASES, Google Academic and so on. Finally we selected 216 Chinese literatures from a large number of literatures. The principles of selection are as follows:

1. Literatures published from January 2014 to December 2016 are selected.
2. Literatures which are obvious irrelevant with blockchain is excluded.
3. Literature must be published by popular domestic journals (such as: Modern Bankers, China Economic Weekly) or important articles (such as: Financial Times, First Financial Daily, etc.).

In the collection of literature, there are 188 journals and 28 newspapers (0 in 2014, 3 in 2015, 25 in 2016). As the newspaper is basically a summary of the introduction or report, this study only uses journals to research.

3.1 Analysis of Literature Sources

Our journal classification principles are derived from the China Social Sciences Research and Evaluation Center of Nanjing University and the website of the Center of Literature and Information of the Chinese Academy of Sciences. Among them, the humanities and social sciences is in accordance with the Chinese Social Science Citation Index source journals' catalog to sort, a total of 25 categories and 534 kinds of publications. Natural science is in accordance with the Chinese Science Citation Database source journals' catalog to sort, selected 2 categories and 34 journals. Therefore, all the journals are divided into five categories: economics, management, technology, comprehensive social science journals, and comprehensive university journals, which does not rule out the possibility that some articles will cross multiple categories. Table 1 Classification statistics show that the blockchain research involves many fields, especially in the field of technology and economics.

Table 1. Classification of Chinese Literature Periodicals

Journal Classification	Classification Subtotal	proportion	Cumulative proportion
Economics	139	73.94%	73.94%
Management	3	1.60%	75.54%
Technology	33	17.55%	93.09%
Comprehensive social science journals	7	3.72%	96.81%
comprehensive university journals	6	3.19%	100%
Total	188	100%	100%

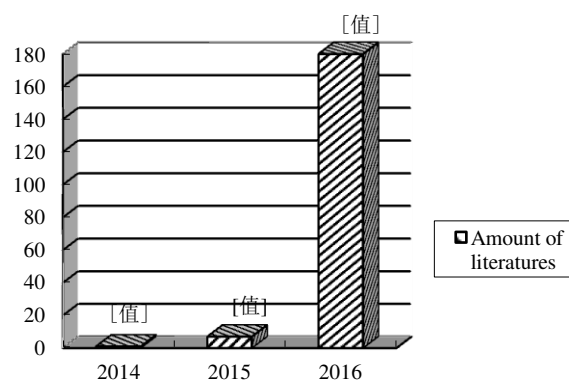
**Figure1. Amount of literatures from 2014 to 2016**

Figure 1 shows that the development of blockchain technology promotes the academic research of other related fields, and there is a breakthrough in 2016.

3.2 Analysis of Literature Research Subjects

After full text reading, the 188 Chinese literatures selected will be divided into seven categories according to the subject. They are: finance, accounting, credit, big data, energy Internet, the status quo, future and risks and others. The subject of finance had been further divided into seven categories: digital currency, payment, bill, bank, Internet finance, supply chain finance and comprehensive financial sector. The number of papers on different subjects and statistics, results shown in Table 2.

Table 2. Subject Classification statistics table

No.	Research Subjects		Amount	Percentage
1	finance	Digital currency	29	15.43%
		Payment	7	3.72%
		Bill	4	2.13%
		Bank	15	7.98%
		Internet finance	20	10.64%
		supply chain finance	2	1.06%
		Comprehensive financial sector	48	25.53%

No.	Research Subjects	Amount	Percentage
2	Accounting	3	1.60%
3	Credit	5	2.66%
4	Big Data	5	2.66%
5	Energy Internet	6	3.19%
6	The status quo, future and risks	25	13.30%
7	Others	19	10.11%
	Total	188	100.00%

1. The most often studied subject is the application of blockchain in the financial field, a total of 148, 66.49% of the total literatures. The subject could be further specified into seven sub-subjects:

① Digital currency. There are 29 papers about Bitcoin and digital currencies which regard blockchain as the underlying protocol, accounting for 15.43%. Wu^[1] (2016) proposed three model assumptions of digital currency in the future, namely: the central bank accounts model, retaining the existing currency mechanism which is that the central bank and commercial banks cooperate to issue currency commonly, banks issue their own bank notes. Wang^[2] (2016) conducted a study of Legal Tender System based blockchain, analyzed the technical characteristics of legal tender and designed technical form and payment system of legal tender. Finally he mentioned monetary policies of the legal tender and financial regulatory recommendations.

② Payment. Subverting the centralized transaction processing and solving the problem of the trust between strangers, the blockchain technology change the payment system and facilitate cross-border transactions, but there are long-time, low-frequency and supervision problems. As the practice result of blockchain technology in the field of payment, Ripple system can simplify the payment process and reduce the cost of doing business (Tao Zhendong Etc.^[3] 2016).

③ Financial bill. Blockchain technology is mainly used in digital bill and in the decentralized stock trading. Nie Shu Etc.^[4] (2016) analyze the strengths and weaknesses of blockchain technology which is applied to the smart digital bill system.

④ Bank. The block-chain distributed book brings challenges and opportunities to the bank, which is researched mainly from the influence, the application pattern and countermeasure suggestion several aspects. Jin Hong^[5] (2016) pointed that it influence commercial banks from these aspects: hybrid digital currency system, credit mechanism, the scene of the value chain, payment settlement. It influence the financial system, monetary policy, currency and payment settlement of the central bank's financial system, monetary policy, currency and payment settlement. The application models are peer to peer transaction, registration, property clear and intelligent management.

⑤ Internet finance. Blockchain provides technical support for the Internet financial sector, impacting and promoting online trading network platform, network information management system. It also develops the credit risk control. Li and Ren^[6] (2016) has pointed out that the chain block has totally changed the modern financial credit system and reduced the financial risk and the risk of fraud. Zhao Dawei^[7] (2016) has analyzed the influence of the chain to block P2P net loan brings with respect to smart contract and credit.

⑥ Supply chain finance. Supply chain finance is mainly targeted at small and medium-sized enterprises or small businesses. It uses the characteristics that small and medium enterprises can cluster credit stack to enhance the ability of small and medium enterprises credit, financing and so on. Due to the lack of core enterprise credit protection, banks face a bottleneck in the promotion of supply chain financial services. The blockchain technology makes the data input to the database have the characteristics of time stamp and non-tampering, which effectively solves the problem of credit risk in supply chain financing, and greatly reduces the cost that

the bank invests in verifying the authenticity of the data. (Gao Fanya etc. ^[8] 2016)

⑦ Comprehensive financial sector. 25.53% of the literature about chainblock have studied the influence on the whole financial domain, including the problems of the development of recommendations, investment research and other aspects. Blockchain applied firstly to the financial infrastructure systems, securities settlement systems, central securities depository, and then extended to the credit system, accounting, money laundering and other ancillary financial facilities.

2. Accounting. There are 1.60% of the Chinese literatures related to the accounting profession. Li Yishuo ^[9] (2016) pointed out that the blockchain would enhance the audit efficiency, and would reduce audit costs. At the same time, some companies had begun to develop self-auditing applications, which would greatly liberate the manual audit and the business model of accounting firms would change greatly.

3. Credit. There are 5 papers related to credit, accounting for 2.66%. Zheng Yao etc. ^[10] (2016) pointed out that credit was an important factor affecting the efficiency of economic and social resources allocation. In Large data era, massive data are difficult to distinguish whether they are true or false. Blockchain can reduce the global "credit" cost and build a global "credit" system. Liang Xia ^[11] (2016) proposed the concept of currency days of destruction which made the transaction irreversible, so digital credit made brush and other cheating behaviors become invalid.

4. Big data. Literatures related to big data account for 2.66%. Hanfeng ^[12] (2016) thought that the blockchain technology can be applied to big data so that everyone can control their own data ownership, meanwhile achieving information sharing and reducing the cost of obtaining credit resources.

5. Energy Internet. The literatures about blockchain technology applied to energy Internet accounts for 3.19%. Energy Internet mainly involves four aspects which are power generation, transmission, consumption and storage. Zhou and Lv ^[13] (2016) mentioned that the "Distributed books + intelligence contract system" of blockchain technology can guarantee energy flow, capital flow and information flow of power companies match more effectively, but there are still some problems, such as efficiency, the storage redundancy of blockchain.

6. The status quo, future and risks. Literatures about the blockchain development Status, future trends and risks account for 13.30%. Zhangbo ^[14] (2016) described the application status of the blockchain among finance, communications, domain names, healthcare, voting, Internet of things and other areas, and noted that the blockchain technology has great influence on reducing the risk of trust, optimizing business processes of financial institutions, driving new Business model to generate and so on.

7. Other. In this paper, there are 19 literatures (10.11%) which cannot be classified into the above categories. Lian Lin etc. ^[15] (2016) discussed the prospects of the blockchain technology in the military application from three aspects: intelligence work performance incentive, weapon equipment life-cycle management and military logistics. Finally, they summed up the problems that the blockchain technology really faced in the military field. Zhang Hong ^[16] (2016) put forward the application of the blockchain in education, through the cat claw coins to raise money to build a personalized learning community - JiKeDou Institute.

3.3 Analysis of Literature Research Methods

There are many types of research methods, this paper mainly from the quantitative and qualitative aspects to classify and analyze literatures. Quantitative analysis is a method to analyze the quantitative characteristics of social phenomena, quantitative relationships and Quantity change. It is specifically through statistical investigation or experimental method to establish the hypothesis, to collect accurate data and to make statistical analysis and testing. Qualitative analysis is a method that mainly rely on the rich practical experience of forecasters and the subjective judgment and analysis ability to deduce the nature and development trend of things. The method is mainly applicable to these do not have complete historical data and data matters.

Table 3. Statistical Methods of Chinese Literature Research Methods

Classification		Qualitative	Quantitative	Total	Percentage
Finance	Currency	29		29	15.43%
	Payment	7		7	3.72%
	Bill	4		4	2.13%
	Bank	15		15	7.98%
	Internet Finance	20		20	10.64%
	Supply Chain Finance	2		2	1.06%
	Financial Synthesis	47	1	48	25.53%
Accounting		3		3	1.60%
Credit		5		5	2.66%
Big Data		5		5	2.66%
Energy Internet		6		6	3.19%
Current Situation, Future and Risk		25		25	13.30%
Other		19		19	10.11%
Total		187	1	188	100%
Percentage		99.47%	0.53%	100%	100%

From the statistical results in Table 3, in the method of blockchain research, qualitative research method is the mainstream, which is 99.47%, far more than quantitative research methods. The main reason is that qualitative analysis is the basic premise of quantitative analysis, and the development of blockchain in China is still in its initial stage, most scholars are still focusing on the nature, characteristics of the blockchain, and the future development trend of the industry, so the quantitative research is very scarce. In response to this situation, we propose to use the blockchain technology as quickly as possible to go to the actual, and through the actual data analysis to make the qualitative analysis results more scientific and accurate, which can make the qualitative analysis draw broad and deep conclusions.

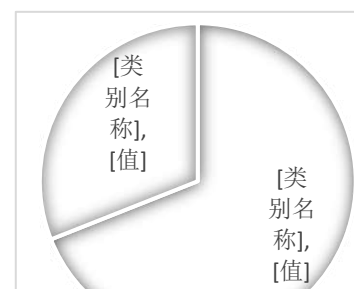
4. RESEARCH AND ANALYSIS OF ENGLISH LITERATURES

In order to better analyze the current situation of blockchain research abroad, we have blockchain as a keyword to search for relevant literatures in Springer, PRL and Google Scholar, selecting 54 papers from a large number of documents. The principles of selecting literature are as follows:

1. Literatures published from January 2014 to December 2016;
2. Literatures which are obvious irrelevant with blockchain are excluded.

4.1 Analysis of Literature Sources

Since 2008 Nakamoto put forward the concept of blockchain, indeed there have been many cases applying blockchain. But only since 2015 blockchain began to get into researchers' visio, so it's said that practice lead theory in terms of blockchain technology. Although we don't find articles in SSCI and ESI, but we refer to 17 articles which were referenced by international conference about the blockchain, such as CCS, CHI, SP, MICRO, accounting for 31% of English literatures. In addition to 69% non-conference papers, they are from Springer, PRL and Google Scholar. English literature sources as shown in Figure 2.

**Figure2. English literature sources**

4.2 Analysis of Research Subjects

Research topics involved in English literatures focus on financial, credit, accounting and others. Research topics as shown in Figure 3.

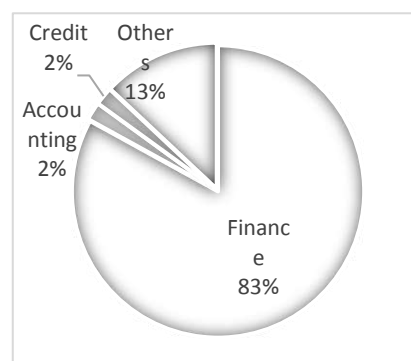


Figure3. English literature subjects

1. Financial. Any technology that can be applied to the financial sector tends to be preferred by scholars of all ages, which may be related to the properties of finance itself. Under the theme of finance, what foreign scholars studied most is the currency application of blockchain. Ranjit Kumaresan etc.^[17] (2014) proposed how to use Bitcoin calculate correctly in encryption tasks, mentioned four modes: verification computation, secure computation with restricted leakage, fair secure computation and non-interactive bounties. Allen and Darcy^[18] (2015) proposed how Bitcoin and other digital currencies challenge the global economic order in encryption currency age. In terms of payment, Kelly etc.^[19] (2015) proposed cross-border payment systems based blockchain technology need fewer steps to pay, have less risk, compared to the traditional banking system. But only a limited number of transactions processed in 1 second, so they need to be used in conjunction with other applications to improve transaction efficiency. Hughes and Middlebrook^[20] (2015) proposed the establishment of a framework to regulate the payment of encrypted money. Irni Eliana Khairuddin etc.^[21] (2016) proposed that Bitcoin technology has three driving factors, namely: bitcoin's predicted role in a monetary revolution, users' increased empowerment and perceived real value of Bitcoin currency. Roman Matzutt^[22] (2016) studied the evolution of storage content in Bitcoin's blockchain, classified the stored content, and highlighted implications of allowing the storage of arbitrary data in globally replicated blockchains. **Blockchain is not a panacea, it also has its own flaws.** Ghassan Karame^[23] (2016) thought Bitcoin's blockchain still has many limitations, such as security attack, scalability and limits of decentralization. Western scholars are not only interested in the Bitcoin, but they also look to encrypted currency with more general sense. Claus Dierksmeier etc.^[24] (2016) explained the impact of blockchain technology on financial transaction nature from the perspective of business ethics. Lewis Cohen etc.^[25] (2016) studied how to apply the blockchain model to commercial paper, derivatives, and asset-backed securities. Stanley and Buckley^[26] (2016) argued that the principles of blockchain can be applied to anti-money laundering and terrorist financing.

2. In terms of credit, only found an English literature. Aniket Kate^[27] (2016) proposed concrete principle and the role of blockchain technology to build credit networks.

3. In accounting terms, only to found an English literature. Cecily Raiborn^[28] (2014) proposed the blockchain technology can be applied to auditing.

4. In other areas, for example, Ahmed E. Kosba etc.^[29] (2015) proposed the implementation of blockchain model in distributed intelligent contract system. COLLINS etc.^[30] (2016) mentioned blockchain will play an significant role in protecting data security. Steve Huckle^[31] (2016) proposed the use of Internet of things and blockchain as a technology to build distributed applications, in order to benefit applications of sharing economy such as Airbnb and Uber, so that people create more wealth. Yue etc.^[32] (2016) presents a block-based chain of applications (called the Healthcare Data Gateway (HGD)) architecture so that patients can control and share their own data without compromising privacy.

In summary, the main research object of foreign scholars is the application of blockchain technology in Bitcoin and other encrypted currency, including not only the advantages of blockchain technology, but also the defects of blockchain technology and the solution. At the same time cross-border payment is also a focus of attention of foreign scholars, because the blockchain technology can help reduce transaction risk and cost.

4.3 Analysis of Literatures Research Methods

At present, the blockchain research is still in the exploratory stage of qualitative analysis in China, while foreign scholars prefer to take quantitative analysis method. Figure 4 shows that English literatures using quantitative methods has reached 41%, far higher than China. They mainly use mathematical modeling and simulation methods as quantitative analysis. We believe that quantitative analysis is more convincing, so domestic scholars need to work harder in the blockchain's further research to dig the essence behind the phenomenon.

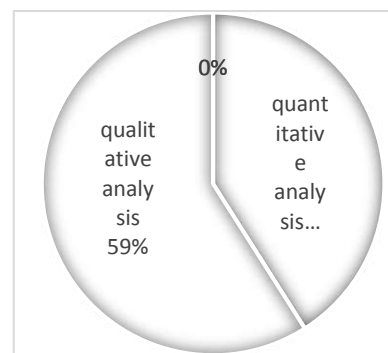


Figure4. English literature research methods

5. RESEARCH LIMITATION

Since the current domestic research on blockchain hasn't been systemized and deepened and it is difficult to find articles about blockchain on CSSCI, so our Chinese literatures aren't from the top journals. It is necessary to further improve the quality of quoted journals in the future research. Moreover, this paper fails to cover all the research subjects due to the shortage of English literatures and therefore we don't do the comparative analysis between Chinese research and Western research.

6. FUTURE RESEARCH DIRECTIONS

Through the analysis of relevant literatures on blockchain, the future research direction of Chinese and foreign scholars about blockchain will focus on the following aspects:

1. Digital currency, especially about accounts model that central bank issues the digital currency. Zhou Xiaochuan, the president of China's central bank, said definitely that we should launch the digital currency early issued by central bank. According to a Sohu report in February, the blockchain-based digital ticket trading platform which is promoted by central bank has been successfully tested and a legal digital currency has been in the platform for a test run. The central bank's digital money research institute will also be formally Listed.
2. Internet finance, especially about the application of blockchain technology in P2P network lending platform. This will have a significant impact on reducing information asymmetry and credit default rates.
3. Discussion about the risks of blockchain technology, such as the operational risk and moral risk raised with the DAO attack event. The discussion on risk provides a reference for the safe application of blockchain in various fields.
4. Energy Internet applications. This will not only enable the power companies to achieve digital control, to ensure that energy flow, capital flow, information flow convergence, and its distributed accounting principles are also significant for private power transactions.

7. CONCLUSION

After investigating blockchain's industry application status, prospects and risks, we reach the following conclusions: From the literature sources, the number of research findings on blockchain has an explosive growth in 2016. This shows that the blockchain has recently received a high degree of attention from domestic scholars, which is largely due to the development of digital money. Bitcoin and Lehman coins are the two currencies with relatively large trading volume. China's HUOBI.com occupies more than 60% of the world's share market share. The journals mainly source from economics and technology class. Technical articles mainly focus on the theory of blockchain technology and economic articles mainly focus on the use of blockchain technology in the economic field. From the research subjects, the number of literatures from financial field has an absolute advantage (a total number of 169 papers, accounting for 70.25%), among which digital currency, bank, internet finance and financial synthesis account higher. The focus of the research topic also highlights the focus of the

previous journal category, the digital currency is the focus of attention, while the development of banking and Internet finance is also actively seeking blockchain technology solutions to help them reduce financial risks and financial costs. From research methods, only 1% Chinese literatures take quantitative analysis method while English literatures posse a higher percentage of 41%. This shows that the domestic scholars take more monotonous research methods, and the theoretical contribution is insufficient, still need to further enrich the research methods to improve persuasion. Future research of Chinese and foreign scholars should be more focused on the blockchain theory system deeply because the current study is decentralized, not systematic, does not reach a certain degree of research.

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