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IMPLICATIONS OF THE APPLICATION OF BLOCKCHAIN TECHNOLOGY IN ACCOUNTING AND PUBLIC FINANCE

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Abstract: *This paper aims to analyze the implications of blockchain technology in the accounting profession and the government sector. Blockchain technology, unknown until just a decade ago, emerged from the shadow of bitcoin and is now at the center of the debate about the future of the digital economy. Blockchain is a decentralized database secured by cryptographic protection, which is estimated to store about 10% of global gross domestic product (GDP) on its platform by 2027. Double-entry bookkeeping, which has been used for more than 500 years, in today's era of technological change and applied blockchain technology, could develop a new system, the triple-entry bookkeeping. Dominant market leaders in this field PwC, Deloitte, EY and KPMG have already begun research to introduce this technology into their business practices. The application of blockchain technology, in addition to the private sector, could also be used in the government sector, especially in the field of taxes. Blockchain would eliminate retroactive tax recording and provide an automated and impenetrable platform for many types of tax fraud. However, the adoption of blockchain technology, like any new technology, depends on its ability to overcome regulatory, technical and societal challenges.*

Key words: *blockchain technology, distributed general ledger, triple-entry bookkeeping, taxes*

JEL classification: M41, M48

1. INTRODUCTION

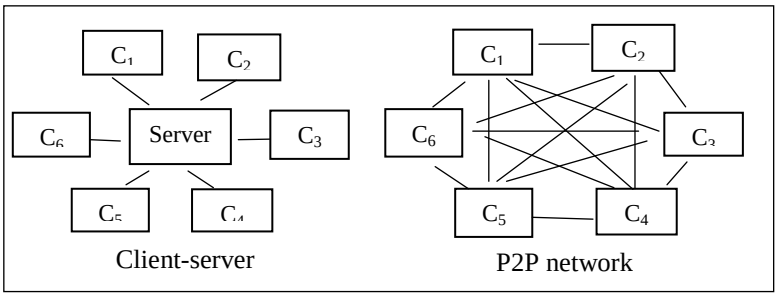
Blockchain technology has brought about changes to many sectors around the world, and a study by Moody's Investors Service in 2016 identified 25 use cases, of which 24 in just four sectors: finance, business, government activities and sustainable society (Rocamora and Amellina, 2018 page 6). Accounting is one of the oldest professions, with some of the earliest known records of trade dating back to around 3500 BC in Mesopotamia. The double-entry bookkeeping system represented a revolution compared to the single-entry bookkeeping system, while modern financial bookkeeping has been based on this system for more than 500 years. Since blockchain technology is basically an accounting technology, it can also improve the accounting profession. Triple-entry accounting is an advancement of the traditional double-entry bookkeeping system in which all bookkeeping records, which include external parties, are cryptographically sealed with a third entry. If companies "shifted" their business ledgers to a distributed ledger based on blockchain technology, they could access transactions and balance aggregates in real time. Global accounting firms have already taken the lead in adopting this technology. Deloitte announced the early start of blockchain technology back in 2014 with the development of the Rubix platform, which provides clients with an enterprise-level solution.

In 2017, KPMG and Microsoft announced the launch of joint blockchain nodes designed for use cases that apply this technology to business processes (KPMG, 2017). PwC announced the launch of an audit service with its Blockchain Validation Solution in 2018 (PwC, 2018), followed by the EY Blockchain Analyzer which facilitated EU auditors' transaction review and analysis (EY, 2018b). The digital age has many implications for taxation and is not only changing the relationship between taxpayers and the tax authorities, but also the way taxes are calculated and paid. In the era of the forth industrial revolution, a special attention should be paid on VAT as one of the most significant contributions to state revenues. The application of blockchain technology in the VAT system can have implications for the optimization of the electronic VAT system, improve the user experience of taxpayers who use the electronic VAT system, help in the analysis of the national economy by clarifying the data related to VAT, as well as improve the transparency of VAT transactions. Despite the enormous potential of blockchain technology, there are also significant obstacles to its expansion and adoption, such as regulatory uncertainty, technical complexities of blockchain applications, lack of employee knowledge and skills, etc.

2. BLOCKCHAIN TECHNOLOGY

Blockchain technology is a relatively new technology, that gained the public attention by following the popularity of Bitcoin. It represents a combination of the Internet, private key cryptography and consensus. The functioning of this technology requires a peer-to-peer (P2P) network that uses a dispersed and distributed architecture. All computers and devices are peers in this network and there is no central network administrator (Frankowski et al., 2017, p. 3). The traditional payment mechanism is routed through a trusted third party, e.g. a bank, which certifies the transaction. The transaction is then recorded and stored on a centralized server, and the user receives a copy of the transaction (Pradhan, 2018, p. 31). On the other hand, blockchain is a data ledger that is replicated on all computers connected to a P2P network and uses cryptography for communication (Frankowski et al., 2017, p. 7). All users use the services equally through consensus rules. A member of the blockchain system can add a transaction when there is consensus that the block meets predetermined criteria and is verified by other members. Each block contains a unique hash, which acts like a person's digital fingerprint, connecting the previous block and creating a chain of blocks. A hash is a 64-character alphanumeric unique code assigned to a transaction that allows a third party to see the original information (Rao and Pandurangiah, 2018, p. 42). A computer software is used to calculate hashes and reach consensus. This model differs from the client-server model where data is stored on a central server and the client needs to log in to the server to access the information (Figure 1). Distributed ledger technology eliminates the need for centralization, provides a secure way of information exchange, direct transactions, protects against unauthorized use and can be shared across the network, regardless of geographic origin or other restrictions.

Figure 1. Client-server *vs.* P2P network



Source: Adapted from Frankowski et al., 2017

2.1. TYPES OF BLOCKCHAINS AND ACCESS PERMISSIONS

What is characteristic of blockchain technology is anonymity, which is achieved by creating a private and public key (Pradhan, 2018, p. 32). The public key is used to create a user's address that is broadcast on the network to undertake transactions, while the private key is used to authorize transactions by the user. In the Bitcoin blockchain system, the private key is a whole number between one and 1,077 and is used to derive the public key, which is an identifier of 26-35 alphanumeric characters, and then the public key is hashed in order to be delivered to the user's address. Some examples of a permissioned

blockchain system are a shared ledger between multiple banks (for business), an internal ledger of a group of companies (e.g. holding companies and subsidiaries) and individual companies and business networks that require confidentiality or regulatory compliance. For accounting record keeping, business entities will use private blockchain to protect confidential data. The most popular permissionless product in the blockchain technology system is Bitcoin. A permissionless blockchain could be called a "public blockchain" and can potentially be compared to the Internet as we know it today (Deloitte, 2017).

2.2. REACHING CONSENSUS

The consensus mechanism ensures that the added block contains true information, and the most popular consensus mechanism in blockchain is the Proof of W – PoW used by Bitcoin. In PoW, miners compete to add the next block of information (a list of transactions) by solving a cryptographic puzzle. The first miner to reach the solution "wins" 12.5 new bitcoins plus the transaction fee (Frankowski et al., 2017, p. 9). However, PoW has disadvantages that prevent its use in business blockchain, as it requires large amounts of energy and computing power, and transaction confirmation is a long process that lasts up to 60 minutes. For these reasons, PoW is not considered an effective solution in a business environment. Another consensus solution is Proof of Stake - PoS and in contrast to PoW, PoS does not require a lot of computing power and energy, and is more efficient for a blockchain that is not connected to a cryptocurrency. However, it should be noted that these are not the only consensus algorithms available, and the creation of new algorithms is a constant process suitable for many types of blockchains.

2.3. SMART CONTRACTS

The validation and recording of transactions is facilitated when you can program the contract terms to partially or fully execute the contract clauses in real time. As smart contracts reduce settlement and payment time for all parties involved, this minimizes the need for a conventional third party and manual verification (Rocamora and Amellina, 2018, p. 14).

3. DEVELOPMENT OF THE ACCOUNTING SYSTEM

3.1. Single and double-entry bookkeeping

The historical development of accounting can be observed through different development periods. The Babylonian Empire is considered to be the first legally organized state that was a center of craftsmanship and trade from about 3500 to 500 BC. From Mesopotamia to ancient Egypt, Greece and Rome, state affairs were performed by "scribes" (bookkeepers) who were record keepers, legal representatives and accountants (Petrović and Tanasić, 2020, p. 13). It is believed that the temples in Greece were the first organizations where bookkeeping records were maintained, and the use of coins as a monetary unit in 600 BC is still considered the basic principle of bookkeeping. According to Cicero (143-106 BC), the main document, the "Cash Receipts and Expenditures Journal", was the predecessor of what is now called the general ledger (Radović and Bosiočić, 2014, p. 22).

The double-entry bookkeeping system represented a revolution in comparison to the single-entry bookkeeping system, and modern financial accounting has been based on this system for more than 500 years. Recent research indicates that the double-entry bookkeeping system was first used by bankers rather than the merchants, considering the terminology used. The terminology originated from the banking guild of Florence (including terms such as: cassa, banco, bancarotta, giornale, debito, debitore, credito and creditore), rather than the merchants (Staley, 1906, pp. 178-179). Claims that Pacioli and Kotruljević are the fathers of modern accounting are challenged by evidence such as a diary, a ledger, Florentine bank bookkeeping and books from the early 13th century. However, 1494 remains the year that Pacioli's accountants celebrate as the day of double-entry bookkeeping. It is when the "Summary of Arithmetic, Geometry, Proportions and Ratios" was published. Pacioli's bookkeeping tractate "Particularis de Computis Et Scripturis" is only one part of the "Summary" and Pacioli himself claimed that he did not invent double-entry bookkeeping, but only explained the "Venetian method" as the best one for traders (Petrović and Tanasić, 2020, p. 12).

3.2. Triple-entry accounting

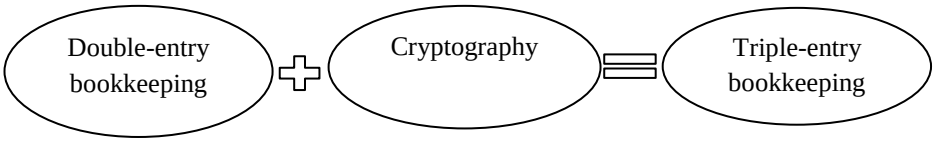
Unlike the double-entry bookkeeping system, in which two points have to be specified for one period, the triple-entry bookkeeping system shows the state of income being earned at any single point in time, which makes it a dynamic assessment, and momentum being defined as the rate at which income is being earned. Therefore, accountants acquire a different perspective considering the financial forecast of the enterprise, the accounting systems will be more dynamic and would not focus on the current state but on the future forecast (Ijiri, 1986).

Today's connotation of the term triple-entry bookkeeping has almost nothing in common with the original semantic use of the same word, whose purpose was to direct the manager's attention towards the future development of the company, instead the current state (Gröblacher, Mizdraković, 2019, pp. 60-61). Ian Grigg, a financial cryptographer, presented a paper called "Triple-entry Accounting" giving this term a completely different meaning from Ijiri's. Grigg introduced a new concept of "transaction confirmation in which a digital signature protected by financial cryptography between two parties can be viewed as a shared third entry" (Cai, 2019, p. 2).

Initaially, it was unclear who, as a trusted and neutral third party, would control the third shared ledger. The advent of Bitcoin and the blockchain protocol three years later showed that a trusted and neutral third party is not necessarily needed, as a third public ledger, according to Grigg, can be decentralized, immutable, secure and automated using blockchain (Cai, 2019, p. 7). A third party, secured by financial cryptography, can simultaneously record transactions between enteprises with a third entry, debiting one and crediting another account based on a signed confirmation. A digital signature creates a record with a higher level of reliability and all participants have the same copy, which eliminates asymmetric information (Grigg, 2005).

The triple-entry bookkeeping system (Figure 2) can also be seen as an extension of the double-entry bookkeeping system, where all transactions are cryptographically verified, sealed and recorded in a distributed ledger, creating an interconnected chain system of accounting records (Nalini, 2018, p. 57). The intuition of blockchain technology is that each participant in the database receives the same copy of the "whole" ledger without a central authority (e.g. a bank). The distributed ledger is updated, shared, synchronized and integrated into the triple-entry mechanism suggested by Grigg where all users (accountants, auditors, clients, regulators) can "see" an identical copy of the ledger.

Figure 2. Triple-entry bookkeeping system



Source: Adapted from Grigg, 2005.

In 2016, Deloitte published an article suggesting that the implementation od triple-entry bookkeeping with blockchain will be a game-changer in accounting (Deloitte, 2016). Blockchain accounting has significant advantages: (1) recording transactions in real time saves time and cost (faster processes), (2) the technology is protected from unauthorized use and changes to transactions (security), (3) quicker access for books with automated audit trial (simplification), (4) an encrypted signature is required for income and expenses (reduction of internal fraud) (5) trusting relationships with financial and commercial partners (automation), etc. (Vijai, Elayaraja, Suriyalakshmi, and Joyce, 2019, p. 554).

4. TAX IMPLICATIONS OF BLOCKCHAIN TECHNOLOGY

According to the World Economic Forum (WEF), the blockchain is the basic platform of the fourth industrial revolution and the WEF expects that 10% of the world's GDP will be stored on the blockchain by 2027. The use of blockchain attracted nearly $1.8 billion from investors in the first half of 2018 alone (Houben, Van Ginneke, & Dingenouts, 2020, p. 59). According to WEF research, governments will collect taxes using blockchain technology for the first time in 2023, and the leading countries are expected to be Finland and Estonia, where tax agencies are currently using blockchain technology in their business. A tax invoicing system based on blockchain technology to combat fraud and corruption was implemented in China as early as 2018 (Houben, Van Ginneke, & Dingenouts, 2020, p. 61). So the question is not whether blockchain technology will change the tax system, but how quickly and how deeply this will happen. Blockchain is about *80 per cent business process change and 20 per cent implementation of technology and blockchain tax system.* The time and costs of implementing blockchain technology are significant, as changes in the legal system and tax policy are necessary. From a technological perspective, challenges related to security and scalability will have to be overcome, because although encryption creates superior security, absolute protection of data from cyber attacks, hacking and corruption is not guaranteed.

Tax administrations today face major challenges caused by globalization and digitization and a lack of connection between value-creating activities and their relevant taxes has been created, disrupting tax collection systems that were designed in previous periods (OECD, 2015).

Blockchain technology application for VAT theoretically enables the automatic calculation and transfer of taxes using smart contracts. If transactions were recorded in a distributed ledger, through smart contracts, VAT could be paid directly to the state budget, which would reduce transaction costs and the risk of fraud (Houben, Van Ginneke and Dingenouts, 2020, p. 61). In VAT transactions, invoices play the most important role and their role would not change in the blockchain system. In this way, each VAT invoice would have a digital footprint, derived through a consensus process, and the system would make the entire transaction history visible (Frankowski et al., 2017, p. 16). In order to implement this, experts suggest the creation of "VATCoin", i.e. cryptocurrencies fixed to the home currency that companies would use to pay indirect taxes (Ainsworth et al., 2017). This may seem extreme, but some countries, such as Great Britain, Russia, Canada and China, are considering it, and taxation, based on cryptocurrencies, may be closer than expected (Rocamora and Amellina, 2018, p. 51). In most developed countries, payroll issues are mostly digitized, but the systems for calculating payroll tax (income tax) also have shortcomings. Many institutions are involved and each has its own registry that duplicates data that other institutions have. With the application of blockchain technology and built-in smart contracts, employers wouldn't have to be responsible for calculating and paying taxes and contributions on employees' wages, manual errors would be avoided, there would be permanent proof of tax payment, and it would also be useful for employees who often change employers, especially when working in different countries (Rocamora and Amellina, 2018, p. 50). This could be done in the following steps: (Frankowski et al., 2017, p. 11): (1) the employer inserts the gross amount of salary into the system, (2) within the Blockchain system (limited only to the tax administration, banks and the other necessary parties), tax data is matched with the payment by smart contract technology and calculates the correct tax and social security amounts, (3) the net salary is automatically transferred to the employee’s account and the calculated tax to the government, (4) as a result, the payroll tax process is faster and less costly and cash-flow is more efficient.

Transfer pricing refers to the rules and methods for determining prices within and between enterprises with common ownership or control. As intra-company trade accounts for 30% of world trade, transfer pricing rules play a major role in preventing tax evasion. However, transfer prices are highly dependent on paper documents within the company, so there is a high risk of falsification of documents due to tax avoidance. On the other hand, a distributed ledger of transactions based on blockchain technology would provide transaction transparency, enable self-executing corporate contracts through smart contracts and automation of transfer prices (Rocamora and Amellina, 2018, p. 50). The Digital Invoice Customs Exchange (DICE) was originally designed for the EU wih the aim to modernize the VAT Information Exchange System (VIES) by creating a solution that would automate the exchange of invoice data. DICE is based on the idea of using a digital signature on an account, sending encrypted data to a database and performing risk assessments on the EU single market (Ainsworth and Shact, 2016, p. 1.167). The main challenge for tax administrations are the disruptions caused by global trade, while taxes for cross-border goods depend on customs information, such as the origin and destination of the goods, classification, information about the buyer, seller, carriers, etc. (Rocamora and Amellina, 2018, p. 49). Blockchain technology could be used for customized declarations via digital invoices based on encrypted real-time trade data, allowing regulators to track the product from its origin and in the value chain. In this way, smart contract technology could be fully automated for the collection of prescribed duties (Rocamora and Amellina, 2018, p. 49).

5. BLOCKCHAIN TECHNOLOGY IMPLEMENTATION CHALLENGES

According to a survey conducted in the EU (EY, 2018a), 61% of respondents see regulatory complexity as the biggest obstacle to the widespread implementation of blockchain technology, followed by integration with old technology (51%) and a lack of general understanding of the new technology's capabilities (49%). Governments in many countries are trying to regulate blockchain technology and are facing obstacles similar to the ones they face when regulating the Internet. Experts envisage two methods: legal system or technical code. The legal system, as the most suitable regulator, lacks a centralized concept, so the technical code could be the most realistic option in the short term. Cryptography can make the database more difficult to hack, however cyber attacks can still threaten this technology, which means decentralized ledgers need to be protected like other technology

systems. The confidentiality function is an adjustable parameter of the blockchain system, such as data encryption, pseudonymous addresses, etc. A technical challenge for the implementation of blockchain technology is its interoperability between different blockchain platforms, as well as between blockchain and legacy systems. There are big social challeneges of blockchain technology implementation, because the public needs to get used to this technology and its common application in everyday life. Public institutions and companies must include business and public services using this technology in experimental tests. Despite its many potential applications and benefits, the concept of a cryptographically secured decentralized ledger, supplemented by smart contracts, is probably not easily understood by most people. Ensuring the truthfulness of data in the blockchain remains the responsibility of the participants themselves and, in adition to independent verifiers and auditors, the service providers specializing in this area will likely emerge in the future to respond to this need.

CONCLUSION

An increasing need for modernization in everyday life is making people open to new technologies. Blockchain is considered a new technology and is built by the orchestration of three technologies known so far (internet, private key cryptography and consensus), which results in a system that enables the interaction of digital relationships without a third party. This is a type of distributed ledger technology where all nodes are equal and transactions contain a strict verification process and there is no central administrator. When a node in the network makes a transaction, the entire network is notified and when the transaction is confirmed, a new block is added. This new block, like all blocks, is encrypted with transaction details and can be traced back to the original block. Because of this encryption, changing information is theoretically impossible and the verification process increases the transparency, sequence and security of the transaction. Blockchain tools offer great opportunities for changes in accounting mechanisms and the creation of a new platform for reshaping the business world and transforming the accounting and auditing profession. Barriers to the implementation of triple-entry accounting represent an area for future research and could include regulatory issues, potential security threats, and uncertain return on investment. Blockchain technology's ability to provide an immutable ledger and transactions offers opportunities to transform the way governments collect taxes, as well as the way individual and corporate taxpayers pay taxes. Blockchain can provide data that can be shared anonymously and in real time, which can be valuable for tax authorities. Although blockchain technology alone cannot provide complete solutions and replace the adoption of quality tax regulations, it can bring more coordination between departments of tax administrations. The lack of a regulatory framework, accompanied by mistrust and reluctance of institutions, poses a challenge for blockchain technology implementation. In other words, without a clear idea of what will be allowed and restricted in the future, the use of blockchain technology represents a risk that many legal entities will not be willing to accept.

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SUMMARY

The modern business environment, with the continuous and accelerated development of technique and technology, has opened the door to the emergence of various modern, advanced digital systems in various fields of business. Blockchain technology based on a combination of the Internet, private key cryptography and consensus, relies on the application of P2P networks and smart contracts without a central administrator. As a broad and flexible data structure, it operates on the principle of distributed general ledger technology, which provides a secure way of exchanging information, direct transactions, protects against unauthorized use and can be shared over a network, regardless of geographical origin or other limitation. Blockchain technology introduces a new set of opportunities for changes in accounting mechanisms and the creation of a new platform for reshaping the business world and transforming the accounting and auditing profession. New technology revives the concept of accounting with three entries, the so-called triple accounting, where the distributed general ledger is updated, shared and synchronized and where all users (accountants, auditors, clients, regulators) can "see" an identical copy of the general ledger. The application of blockchain technology in accounting is considered to be (r)evolutionary and many believe that it could end the reign of double-entry bookkeeping that has lasted for more than 500 years. The digital age shapes the taxes and not only changes the relationship between taxpayers and the tax authorities, but also changes the way it is calculated and paid. The ability of blockchain technology to provide immutable general ledger and transactions, provides opportunities to eliminate retroactive tax recording and provide an automated and impenetrable platform for many types of tax fraud. Blockchain technology can provide data that can be shared anonymously and in real time, which can be valuable for tax administrations. The World Economic Forum (WEF) predicts that governments will collect taxes through blockchain technology as early as 2023, which means that the question is not whether blockchain technology will change the tax system, but how quickly and how deeply it will happen. At the same time, changes in the legal system and tax policy are necessary, because blockchain technology alone cannot provide complete solutions and replace the adoption of quality tax regulations, but it can provide a greater degree of coordination between tax administrations. However, the lack of an adequate regulatory framework, including technological immaturity, difficulties in building a business network, as well as potential conflict with data protection law, etc., is a significant obstacle to the adoption of this new technology. This means that without a clear idea of what will be allowed and limited in the future, blockchain technology will not be able to overcome regulatory, technical and social barriers, so the risk of its application for most users will be too high.