An Empirical Assessment of the Impact of Blockchain Technologies on the Effectiveness of the Supply Chain Development

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***Abstract*—The purpose of this paper is to review the existing literature on blockchain technology, present some trends and consider its potential value in supply chain management (SCM) of market. In modern economic conditions, the financial market integrated into the global economy is of fundamental importance for the development of the national economic system. In order to maintain and develop economy, the financial sector is constantly looking for ways to optimize its business processes and operations. Today, blockchain technology is considered by many participants in the financial market as a tool that forms the innovative potential of the industry providing a number of additional effects. It should be noted that despite the very high interest on the part of international and national financial institutions, enterprises of the real sector of the economy in the distributed data storage technology, studies on the problems of assessing the use of the potential of blockchain platforms in the socioeconomic environment, their theoretical understanding is not often demonstrated. Existing works, as a rule, reveal either the technical side of the object under study, or the regulatory or legal aspects of the applicability of blockchain technologies in the national economy. In this regard, this work attempts to overcome this conditional vacuum of understanding in order to make up for conditions with questions revealing other aspects of the subject of research, for example, such as the economic and social effects of introducing blockchain technologies into the activities of business entities. A formalized assessment of the development prospects of the banking sector in the new institutional economic environment is carried out on the basis of the assessment of the emerging effects caused by the integration of distributed data storage technologies into the system of operational processes in credit institutions**

Keywords*— *blockchain technology, supply chain, operational process management, credit risks, operational risks, capital reserves, finance, scenario modelling, forecasting.

1. Introduction

Better visibility into procurement, more accurate and reliable data for analytics, and increased trust among all participants in your supply chain network are some of the benefits of adding blockchain to your infrastructure [1-3]. Blockchain is an integrative meta-technology characterized by a decentralized and distributed way of storing a data register (containing timestamps of the performed actions and transaction parameters with the possibility of identifying personalized data about the participants of the transaction and its object), which cannot be changed due to their security with cryptographic codes and an integrated consensus mechanism. In solidarity with foreign and Russian researchers and experts in the field of studying distributed data storage technologies [4, 5], the following main properties of blockchain technology can be formulated: reliable data verification and processing, accounting and protection of information resources in a decentralized way with fewer intermediaries serving the transaction, and reduced control by regulators.

Similar to how the digitalization of the socioeconomic environment destroys traditional areas of business (for example, digital channels replaced analogue ones), blockchain technologies can significantly transform existing supply chain processes, including in the financial sector, thereby continuing to develop the FinTech paradigm. It should be noted that the financial and real sectors of the Russian economy have already begun to go through the stages of transformation of business processes due to the transition to blockchain technology. In this regard, the search for solutions aimed at moving from general ideas about the impact of blockchain on the supply chain and its individual sectors to formalized assessments with a high level of data and calculation detail to understand the efficiency and feasibility of transferring the infrastructure of financial operations and business processes in financial institutions on the “rails” of blockchain technology becomes an extremely important task.

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

2. METHODS

What are the Blockchain Use Cases in Supply Chain Management?
Enterprise blockchain technology can transform the supply chain with these three use cases:
Traceability; Transparency; Tradeability.
Traceability improves operational efficiency by mapping and visualizing enterprise supply chains. A growing number of consumers demand sourcing information about the products they buy. Blockchain helps organizations understand their supply chain and engage consumers with real, verifiable, and immutable data.
Transparency builds trust by capturing key data points, such as certifications and claims, and then provides open access to this data publicly. Once registered on the Ethereum blockchain, its authenticity can be verified by third-party attesters. The information can be updated and validated in real-time.

Tradeability is a unique blockchain offering that redefines the conventional marketplace concept. Using blockchain, one may "tokenize" an asset by splitting an object into shares that digitally represent ownership. Similar to how a stock exchange allows trading of a company's shares, this fractional ownership allows tokens to represent the value of a shareholder's stake of a given object. These tokens are tradeable, and users can transfer ownership without the physical asset changing hands.
It should be noted that the following technological procedures are the most important components in the issue that reveal the features of the functioning efficiency of organizations in the supply chain process [6]:
1) Verification of assets.
2) Accounting and maintaining a transaction database.
3) Data confidentiality.
4) Transaction costs.
In this regard, it is advisable to study in this work the process of necessity and validity of the transition of the financial industry to blockchain technology as part of the analysis and evaluation of the transformation of these functional components. It is important to emphasize that our study is methodologically based on the analysis of the efficiency growth of the banking sector in the economy under the influence of the penetration of blockchain technologies through the prism of accounting and evaluating the improvement and optimization of its supply chain processes. This aspect is highlighted in view of the fact that a study of the influence of blockchain technologies on the supply chain and the national economic system as a whole can be built on the basis of two main hypotheses. One of them is based on the hypothesis that distributed data storage technologies create effects that are generated as a result of lower transaction costs for supply chain. This effect is caused by the potential to reduce intermediary links in on-going transactions that are being formed as part of the use of peer-to-peer blockchain systems (PPBS).
The second hypothesis predetermines an increase in the functioning efficiency of the banking sector of the economy due to the optimization of operational processes in credit organizations, which forms the basis for reducing (minimizing) credit and operational risks. This aspect of the research problem will be the subject of the present work. In this regard, such an important and significant functional of blockchain systems as "Transaction costs" will be excluded from the research field, since it is disclosed mainly within the framework of the first hypothesis outlined above, which implies the evaluation of effects through the prism of transaction cost reduction analysis.
So, returning to the previously identified technological procedures that determine the possible effects of improving the operational activities of banking institutions, they should be disclosed in more detail, taking into account the designated research context. In general, it should be noted that blockchain technologies have a very high level of potential for optimizing the supply chain system by reducing transaction costs associated with:
- Accounting and data storage;
- Search for information about counterparties;
- Synchronization of heterogeneous information resources;
- Transition to business models with a minimum level of mediation;
- Reduction of risks of financial losses resulting from the use of false information;
- Automation of business processes based on the use of smart contracts;
- Transition to a decentralized procedure for storing and processing data;
- A decrease in the level of financial crime as a result of the invariance of data on completed transactions;
- Reduction of time for processing databases containing dynamically changing information about assets (their owners, value, time of transactions, etc.);
And so on.
In a concentrated form, the algorithm for determining macroeconomic effects due to the penetration of blockchain technologies into the banking sector is shown in the figure 1.

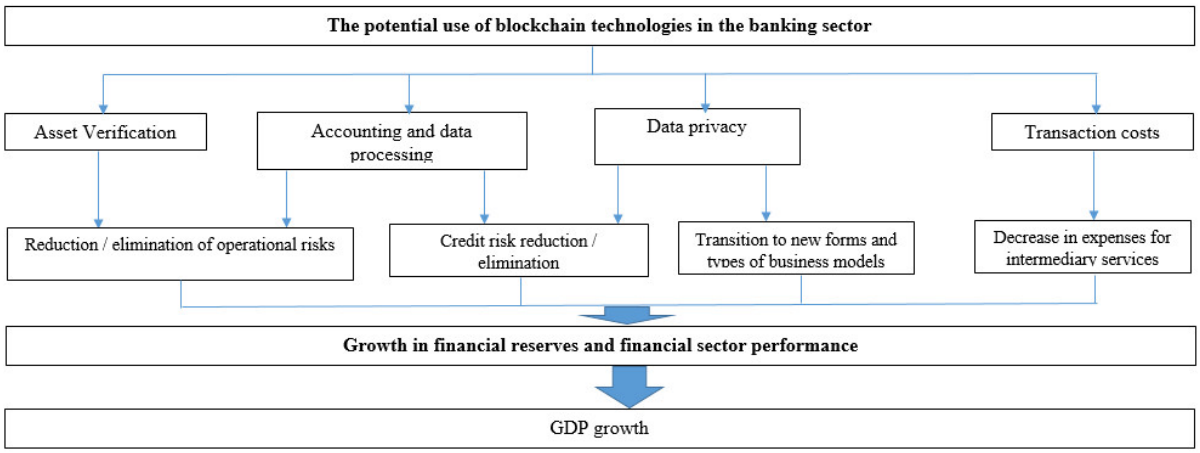

Figure 1 - Algorithm for determining macroeconomic effects due to the penetration of blockchain technologies in the banking sector (developed by the authors)

Further, a formalized assessment has been carried out relying on the above effects, which form the basis for eliminating / minimizing operational and credit risks in banking activities based on the application and integration of blockchain technologies into the system of operational processes.

3. RESULTS

It is accepted as the main hypothesis of this stage of the study, that the introduction of blockchain technologies in the operational activities of the banking sector of the economy will minimize / eliminate the risks under study. When determining the possible effects generated by the hypothesis under consideration, the amount of reserved capital for operational and credit risk in the banking sector is assumed in accordance with the above defined effects. Guided by the hypotheses presented, as well as the emerging effects in the operating activities of credit institutions within the framework of using blockchain technologies, tables 1 and 2 present scenario calculations that determine the possible effects generated as a result of reducing risks in the banking sector of the Russian economy and, accordingly, reducing the size of claims to bank capital in relation to operational and credit risk (Table 1, 2). It should be noted that scenario-based risk reduction models are largely consistent with the estimates of the Accenture Consulting [7-10] consultancy.

Table 1 - Scenario parameters for the operating risk capital coefficient, in % of the average bank (financial institution) gross income for the last three years.

	The coefficient value reflecting the average level of unforeseen losses due to operational risk in relation to the amount of income received					
	Scenario Parameters				Actual Parameters	
	1% Scenario 1	3% Scenario 2	5% Scenario 3	10% Scenario 4	The value of operational risk (RR) with a coefficient of 12.5 in accordance with the instruction of the Central Bank of the Russian Federation. As of 01.01.2020.	15.0% (in accordance with the operational risk assessment methodology set out in the Basel Committee capital adequacy agreement "Basel II").
Amount of capital requirements in relation to operational risk, billion roubles	651,0	1953,0	3255,0	6509,9	8137,4	9764,9

Table 2 - Scenario parameters for the credit risks capital (calculated on the basis of Bank of Russia Regulation dated June 28, 2017 No. 590-P "On the Procedure for Formation by Credit Institutions of Reserves for Possible Losses on Loans, Loan and Equivalent Debts" and Programmable Scenario loan terms by categories), in %

	01.01.2017	01.01.2018	01.01.2019
Scenario 1	173,3	187,9	214,7
Scenario 2	3118,5	3654,5	4134,7
Scenario 3	3869,1	4438,9	4923,6
Scenario 4	4244,4	4831,0	5318,1

In relation to scenario modelling of credit risks, scenarios include:

1. Scenario 1 is an idealized model, according to which loans of such categories as doubtful, non-performing and uncollectible are eliminated as part of the concept of the penetration of blockchain systems into the supply chain system.
2. Scenario 2 provides for the "calibration" of decisions of a credit institution on the feasibility of including counterparty in the bank's circle of customers based on its reputation in an open blockchain system. In addition to the fact that the use of relations between the bank and the borrower, which are participants in the blockchain systems, helps minimize opportunistic models (in view of the previously stated arguments), the use of distributed data storage technologies will more effectively form KYC procedures, operationalize the interaction processes between participants in a credit transaction (for example, based on the use of "smart" contracts), formulate conditions for the automation of management decisions, etc.
3. Scenario 3 is based on Scenario 2, taking into account the fact that the use of blockchain technologies in the supply chain system will reduce doubtful and non-performing loans by 50%.
4. Scenario 4 is based on Scenario 2, taking into account the fact that the use of blockchain technologies in the supply chain system will reduce doubtful and non-performing loans by 25%.

Given that bank reserves, in fact, "mothball" the liquidity of financial credit institutions, their creation generates the prerequisites for reducing the financial results of the banking sector of the economy. Undoubtedly, the formation of reserves is one of the mechanisms of the central regulator that contributes to the sustainable development of the supply chain of the economy in the context of its possible turbulence caused, for example, by the growth of overdue debts in the loan portfolio. Without going into details about the reservation rates established by the Central Bank of the Russian Federation for one or another risk of the banking sector, it is unambiguously necessary to state that financial institutions suffer losses as a result of reduced liquidity as part of the "freezing" of assets in reserved funds.

In order to detect such dependencies, models have been built that assess the impact of operational and credit risks on key parameters of the financial results of the banking sector (Formula 1 and Formula 2 - Models of the impact, of operational and credit risks on the financial results of credit organizations, respectively) [11, 12].

$$Y = 12{,}24 + 0{,}19X\_1 - 0{,}18X\_2 \quad \text{(Formula 1)}$$

$$Y = -437{,}28 + 0{,}23X\_1 - 0{,}3X\_3 \quad \text{(Formula 2)}$$

Where:

Y - Financial performance of credit institutions, billion roubles

X1 - The volume of loans issued, billion roubles.

X2 - The value of operational risk (OR) with a coefficient of 12.5%, billion roubles.

X3 – The reserve created for possible losses on loans.

The reliability of the obtained models is determined by the correspondence of the significance parameters to their normative values.

4. DISCUSSION

The results obtained predictably demonstrate a very significant impact of the growth of operational and credit risk reserves on the volume and dynamics of profit of credit organizations.

In the future, the scenario that generates the minimum possible effects will be used as the basic one that determines the prognostic estimates of changes in the profit of the banking sector of the economy as part of the penetration of blockchain technologies. Thus, it would practically guarantee the possible results generated in the banking sector in the areas of "Credit activity" and "Operational activity". At the same time, it would undoubtedly rely on the maximum scenario thresholds of the potential for growth in financial results; hence, we can admit about the possible prospects of using blockchain technologies in the banking sector of the Russian economy.

Returning to the previously constructed regression models that assess the relationship between the supply chain and blockchain technologies the level of reserved capital for credit and operational risks, Table 3 shows the calculations of the change in the indicator characterizing the financial results of the banking sector in accordance with the developed baseline scenario based on minimalistic estimates of the decrease in reserves.

Table 3 - Assessment of the impact of adjusting credit and operational risks on changes in the profits of the banking sector of the economy (basic scenario 4 providing for the minimum possible effects generated by the penetration of blockchain technologies into the supply chain of credit institutions), billion roubles

The value of operational risk (Fact / baseline)	Credit Risk Value (Fact / Baseline)	The increase in financial results of the banking sector as a result of the decline: operational risk / credit risk / total
8137,4/ 6509,9	5 712,6 / 5318,1	+58,6 / +29,9 / +88,5

The implemented calculations built within the framework of using the concept of scenario modelling, demonstrate very impressive parameters for the growth of banking sector's financial results in the process of using blockchain technologies in supply chain. In accordance with the estimates obtained, the introduction of distributed data storage technologies in the operational activities of credit institutions is able to provide an increase in financial results up to 88.5 billion roubles (which is about 4.5% of the actual value of the indicator as of 01.01. 2020) within the framework of the baseline scenario.

5. Conclusion

The blockchain technology is rapidly making inroads in many industries and there is tremendous potential to eliminate intermediaries and to make SCM more efficient. Given that the financial market determines the trends and development parameters of the real sector of the economy in the most direct way, the importance and expediency of the transition of the banking sector to the distributed data storage technology is becoming an important area of government policy.

An assessment of the possible consequences of the blockchain technology penetration into the banking environment creates the potential for a formalized assessment of changes that may occur in the national economic system as a whole. This, in turn, allows us to move on to developing new models of economic growth under the influence of the digitalization elements of the economy (in particular, as a result of the use of blockchain technologies in the financial sector). This will be the subject of our future work.

Leaders of the financial industry expect that distributed storage technology will have a significant impact on its development [11]. According to IBM [12], 66 per cents of banks should deploy large-scale supply chain networks by 2021. Such forecasts and estimates demonstrate that changes are inevitable; the deployment of blockchain technologies in the supply chain financial sector of the economy will entail significant changes in operating activities. Willingness to them means not only the synchronization of national economic systems with the developing global trends of digitalization. Understanding the possible risks and consequences can ensure the growth of competitiveness of the economy for many decades to come.

ACKNOWLEDGEMENTS

The study was carried out with a grant from the Russian Science Foundation (project No. 19-18-00202)

We would like to thank for the help in the preparation of the paper to the participants of the scientific project supported by the RFBR No. 18-010-00536.

References

[1] Statistics of the national payment system [Electronic source]. - Access mode: https://cbr.ru/statistics/nps/psrf/, free access (22.04.2020)

[2] Oblad, Timothy. "Cyberbullying among emerging adults: exploring prevalence, impact, and coping methods." International journal of criminology and sociology 8 (2019): 45-54.

[3] Tapscott, D., & Tapscott, A. (2017). How Blockchain Will Change Organizations. MIT Sloan Management Review, 58(2), 10-13.

[4] Pazaitis, A., De Filippi, P., & Kostakis, V. Blockchain and value systems in the sharing economy: The illustrative case of Backfeed. Technological Forecasting and Social Change. doi:https://doi.org/10.1016/j.techfore.2017.05.025

[5] Safiullin M.R., Abdukaeva A.A., Yelshin L.A. Integrated multi-component assessment of the

development of the blockchain technology market in the national economy of Russia. Innovation 2019.No 7 (249). P. 41-49.

[6] Tilooby, Al, "The Impact of Blockchain Technology on Financial Transactions." Dissertation, Georgia State University, 2018. https://scholarworks.gsu.edu/bus_admin_diss/103

[7] Safiullin M., Savelichev M., Yelshin L. Scenarios for the development of blockchain technologies based on economic sociodynamics. Society and economics. 2019.No 9. P. 32-42.

[8] Workie, H., & Jain, K. (2017). Distributed ledger technology: Implications of blockchain for the securities industry. Journal of Securities Operations & Custody, 9(4), 347-355.

[9] Kiviat, T. I. (2015). BEYOND BITCOIN: ISSUES IN REGULATING BLOCKCHAIN TRANSACTIONS. Duke Law Journal, 65(3), 569-608.

[10] Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. Financial Innovation, 2(1), 24.

[11] Moyano, J. P., & Ross, O. (2017). KYC optimization using distributed ledger technology. Business & Information Systems Engineering, 59(6), 411-423.

[12] Rechtman, Y. (2017). Blockchain: The Making of a Simple, Secure Recording Concept. CPA Journal, 87(6), 15-17.