Assessment Technique of the Impact of Blockchain Technology Diffusion on the Sustainable Development of the National Economic System (on the Example of the Russian Federation Economy)

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Abstract: Blockchain technologies arouse intense interest in both business entities and government regulators with a certain level of uncertainty about generated effects both for themselves and for the national economy as a whole. The distributed data storage technologies are becoming an integral part of the modern economy and have an increasing impact on the prospects and competitiveness of its development. To understand the "depth" of their impact, possible changes in socioeconomic dynamics under the action of blockchain technology diffusion, it is very important to develop methodological approaches to a formalized assessment of risks and opportunities for the national economic system in the context of the issue. The purpose of this study is to strengthen the positions of formalized approaches to the stated scientific and practical problem. The paper proposes an impact algorithm of the blockchain technology on GDP dynamics through the transformation of key parameters of economy financial and real sectors. The implemented analysis and argumentation, it was substantiated that the integration of blockchain technology into economic processes of the national economic system will most significantly affect the change in the financial results of credit institutions, increase the capital availability of economic agents, as well as accelerate the processes of socialization of access channels of business entities to financial markets (greater access of economic agents to stock trading platforms) Based on proposed and tenable hypotheses, a cointegration model has been developed, making it possible to determine the main effects and potential impact of possible transformations of economic activity (most susceptible to changes as a result of blockchain technology diffusion) on GDP dynamics. The resulting estimates of the sensitivity of economic dynamics to considered adjustments made it possible to identify the potential for economic growth as a result of possible integration of blockchain technology into the economic environment.

1 INTRODUCTION

The socioeconomic medium digitalization is fundamentally transforming traditional spheres of economic activity. Analogue television has been replaced by digital television; fiat payments are being replaced by electronic ones; data exchange and their management models were transferred to the electronic document management system, etc. Blockchain technology can also significantly change the established processes and models of business entities, as well as the financial sphere, expanding the FinTech paradigm.

Blockchain technology was developed by S. Nakamoto in 2008 (Nakamoto, 2008) in order to get round centralized systems transaction regulation and operational processes based on distributed (decentralized) data storage mechanisms. Thus, “an

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algorithm was developed for the buyer and the seller to make transactions directly over the network using encryption and conciliation mechanisms by blockchain network nodes" (Guo and Liang, 2016).

2 METHODS

But despite the growing interest on the part of the expert and scientific community in distributed data storage technology and the problems of studying their impact on the national economy and its individual sectors development, there is no a unanimous view on the problem solution and the lack of common approaches to a formalized assessment of possible generated opportunities and risks. Normally, as the review of foreign and Russian scientific literature shows, studies aimed at methodological analytic approaches to the impact of blockchain technology on economic dynamics are limited either by qualitative characteristics, or are implemented through expert assessments, as well as reasoning of a general logical order. At the same time, in the vast majority of cases, the authors believe that these studies are relevant, practically an scientifically significant, requiring proper methodological mechanisms. For example, this view is described in the works of E. A. Pekhtereva (Pekhtereva, 2018), R.K. Nurmukhametova, P.D. Stepanova, T.R. Novikova (Nurmukhametov et al, 2018), Yu.A. Konopleva, V.N. Kiseleva, S.E. Cheremnykh (Konopleva et al., 2018), E.D. Butenko, N.R. Isakhaev (Butenko et al, 2018), V.A. Popov (Popov, 2018), M.A. Markov, M.D. Slyusar, O.R. Trofimenko (Markov et al, 2018), N.Yu. Sopilko, K.L. Malimon, I.A. Kanyukov (Sopilko, 2018).

Foreign scientists also study the set problems. Most works of foreign researchers note the need for the closest attention to the study of blockchain technology, both from the standpoint of qualitative and quantitative analysis (Vranken and Hong, 2016; Bariviera et al., 2017; Cocco et al., 2017; Pieters and Vivanco, 2017).

Supporting the arguments on the role of blockchain technology in the modern developing world, their possible impact on macroeconomic generations, it should be stated that some countries have been actively following the path of development and integration of the considered technology under into the economic environment in recent years. The People's Republic of China, where "since May 2020, the national cryptocurrency of the Central Bank of China (DCEP) has been put into circulation" (The date of the launch, 2020). A number of Chinese banks already in 2020 began to apply distributed data storage technology in their operational activities for making payments, digital accounts, a big data register and other purposes.

As additional examples, it should be noted that back in 2015, an international consortium (R3) was organized, bringing together more than 80 financial institutions in the field of blockchain technology. The non-financial sector companies are also actively involved in the study and testing of blockchain technology as part of their business operations. IT companies actively generate proposals and developments in this area.

The distributed data storage technology is integrated into the turnover of the Russian Federation national economy. So, according to the draft road map for the blockchain technology development in the RF, presented by the Russian state corporation Rostech, "the volume of the distributed ledger technology market in Russia in 2018 amounted to 2 billion rubles, by 2024 it will increase to 80 billion - 454 billion rubles. In the world, the volume of the distributed ledger technology market in 2018 amounted to $ 2 billion, by 2024 it will increase to $ 23 billion - $ 54 billion" (Figure 1).

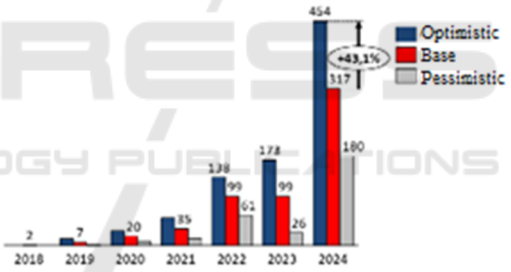

Figure 1: Forecast of the market size of distributed registry technologies in Russia until 2024, billion rubles.

Abstracting in this study from the risks and threats posed by the blockchain technology integration (for example, such as money laundering due to the planetary, cross-border structure of distributed ledgers, the risks of 51% attacks, Sibyl, etc.), the authors are developing a model to assess the effect of their diffusion (as a result of the "penetration" of distributed data storage technology into operational processes) on the gross domestic product dynamics.

Then a model was developed with corresponding assessments implemented, making it possible to determine the impact on GDP of blockchain technology integration into the economic environment. The solution to this problem will make it possible to understand the sensitivity of the country's economic dynamics to adjustments in certain functional segments of the national economy.

The quarterly data from official sources were used. The calculations were performed using the Eviews statistical package. Table 2 shows the developed model variables, their symbols, and data sources.

Table 1: Description of the variables of the developed model.

Variable	Symbol	Data source
Dependent		
Gross domestic product, bln. rubles	GDP	Federal State Statistics Service
Independent		
Stock market trading volume, bln. rubles	$V_{\text{торгов}}$	Moscow Exchange
Money transfers made through the payment system of the Bank of Russia using transfer services/settlement systems, bln. rubles	$V_{\text{транзакций}}$	Central Bank of the Russian Federation
Total profit/loss received by operating credit institutions, mln. rubles	$V_{\text{финрез}}$	Central Bank of the Russian Federation

An important methodological aspect that predetermined the model development procedure is that in the case of financial time series, use of traditional methods of correlation-regression analysis can cause biased, inconsistent and inefficient estimates. This model may be unsuitable for further analysis and forecasting.

The study of dependencies between financial (stochastic) time series can be perorme using cointegration analysis. The initial analysis stage is to determine the cointegration rank. At the same time, cointegration rank between GDP and exogenous factors is determined using a preliminary analysis of the selected series. First of all, it is necessary to make sure that the analyzed series are represented by integrated series of the first order. The stationarity of the first-order difference was carried out using the Dickey-Fuller test, with the following condition (relative to the analyzed time series): y_t~ I (1) if the series of first-order differences $\Delta y = y_t - y_{t-1}$ is stationary $\Delta\, y_t$~ I (0).

According to, the hypothesis of the absence of a causal relationship is refuted for all studied pairs of time series at a 5% significance level, except for the following pair: The volume of money transfers made through the payment system of the Bank of Russia and the profit (loss) of credit institutions according to Granger.

If the set of time series is an integrated first-order process, then the use of the regression model can result in biased, inconsistent, and ineffective estimates. Such series are called cointegrated and use the cointegration equation. To test the cointegration, the assessment method used in this study includes the Johansen Juselius cointegration test (Watson M.W., 1994):

$$Y_t = A_1 Y_{t-1} \ldots + A_n Y_{t-n} + BX_t + \varepsilon_t \qquad (1)$$

Based on the implemented iterations, the following equation of the required dependence was derived:

$$\text{ВВП} = 48{,}67 + 0{,}01 * V_{\text{торгов}} + 0{,}05 * V_{\text{транзакций}} + 6{,}35 * V_{\text{финрез}} \qquad (3)$$

Comparison of actual GDP values with those predicted based of the resulting model is shown in Figure 2.

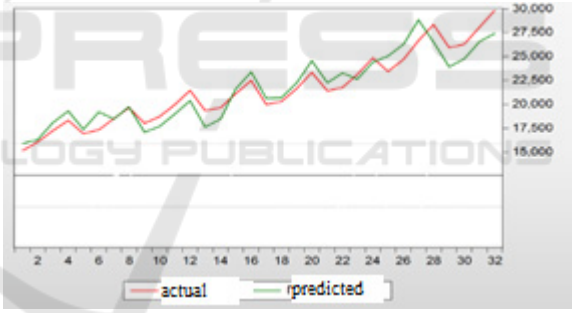

Figure 2: Comparison of the actual and predicted time series

Source: developed by the authors

The developed cointegration equation indicates the presence of a positive impact on GDP of the considered exogenous factors, making it possible to quantify the degree and possible potential of their impact in terms o "blockchaining" economic processes.

Based on the results obtained as the final iteration of the study, a scenario analysis of the value adjusting effect of the considered set of factors due to the diffusion of distributed data storage technology on the economic growth dynamics in the RF is implemented.

2.1 Effect 1

To provide predictive estimates of the impact of cryptotransactions on the stability and parameters of GDP development, 4 scenarios of economic "blockchaining" and transition of the financial transactions market to the crypto environment were proposed (Table 5).

The transition scale is specified by the need for a comparative analysis of our estimates, in terms of the impact on GDP dynamics, with similar estimates published in other studies (Tilooby, Al. 2018.).

As a baseline scenario, within the framework of the analysis of GDP sensitivity to an increase in the capital liquidity of economic agents as a result of the payment system transfer to crypto transactions, the most conservative of the considered scenario No. 1 was adopted, providing an increase in the liquidity of economic entities up to 128 billion rubles. (Table 3).

2.2 Effect 2

Clearly, we should consider both positive and negative factors. The risks posed by the transition of the financial transaction system to a decentralized blockchain environment should be thoroughly studied. However, in terms of a formalized assessment of economic effects, it should be stated that the transition of transactions to the crypto environment will not affect the volume of money transfers made through the payment system of the Bank of Russia. Moreover, when we mean the formation of the so-called digital ruble, based on blockchain principles and technology, but, at the same time, retaining control by the regulator. In other words, the effect of "interconnected vessels" arises - the transfer of payments from the fiat environment will result in a proportional growth of the payment system based on the digital money.

The only negative effect here may be the loss of part of the income by credit institutions as commission fees for transfers. However, given that the share of this item of profit is less than 1% of the total profit of banking institutions, the generated negative externalities will be insensitive both for the financial sector and the national economic system as a whole.

2.3 Scenario Analysis of the Trading Volume Adjustment in the Stock Market as a Result of the Blockchain Technology Penetration

According to the MICEX, in 2019 the trading volume in the stock, money, foreign exchange and commodity markets amounted to 778,155 bln. rubles. (https://www.moex.com/ru/ir/interactive-analysis.aspx). The average brokerage fee for leading brokers in 2019 corresponds to 0.3% of the transaction amount. Thus, we can conclude that commission fees corresponded to the value of 2334.465 bln. rubles, which corresponds to about 1325 rubles per 1 resident of the RF. Many brokers, insufficient transparency of commission calculations, and data search complex procedures are barriers for new investors. Moreover, brokerage fee, depository service fees can account for more than half of an investor's potential income. In 2019, several of the largest US brokers at once - Interactive Brokers, Charles Schwab, TD Ameritrade and E*Trade - announced that they would not be taking commissions for online stock trading. The companies expect zero commissions to attract more customers.

To test the hypothesis that there is a connection between the trading volumes on the stock exchange and the increase in the income of the population, due to the abolition of commission fees, a regression model was proposed. "Trading volume on the Moscow Interbank Currency Exchange" was taken as a dependent indicator, and "Average per capita monetary income of the population" was taken as an independent indicator. The following equation is obtained with the coefficient of determination equal to R^2=0.97:

$$Y = -6243{,}9 + 6{,}16_x \quad (10)$$

The resulting equation makes it possible to evaluate the effect of canceling brokerage commissions. Thus, an increase in household income by 1,325 rubles contributes to a quarterly increase in trading volumes on the MICEX by 9,246 bln. rubles.

Table 2: Significance parameters of the regression equation.

	Factors	*t-statistics*	*P-Value*
Y-crossing	-6,243.90	-0.16	0.87
Average per capita monetary income of the population	6.16	4.97	3,6191 2E-05
$R^2 = 0{,}88$			

Source: developed by the authors

3 RESULTS AND DISCUSSION

According to the presented research algorithm on the gross domestic product of the national economy, as part of the integration of blockchain technology into the economic environment, 3 key factors will have an effect:

1. $V_{\text{финрез}}$
2. $V_{\text{торгов}}$
3. Increase in the liquidity of economic agents due to the working capital growth. This effect is determined base on the dependences obtained between the level of change in current assets and GDP dynamics (Formula 3).

$$Y = 20513 + 0{,}79x \quad (3)$$

It is important to note that this indicator value of the constructed cointegration model will not change due to the generated effect of "interconnected vessels".$V_{\text{транзакций}}$ This means that the diffusion of blockchain technologies and the crypto transactions built on their basis will not affect the volume and value characteristics of payments made in the economy. There will be a flow of transactions, accompanied by traditional electronic/fiat-based regulatory mechanisms, into the blockchain environment.

Table 3 presents the main resulting effects characterizing the possible increase in the studied exogenous factors due to the penetration of blockchain technology into the national economic system.

Table 3: Possible effects caused by the correction of the investigated factors of the cointegration model as a result of the blockchain technology diffusion.

No.	Exogenous factor of the cointegration model	Expected, in accordance with the scenario analysis, increase in the factor value, in bln. rubles.
1	$V_{\text{финрез}}$ - total amount of profit/loss received by operating credit institutions	+ 88.5 per year; + 22.125 average quarter
2	$V_{\text{торгов}}$ - trading volume on the stock market	+ 9246.63 average quarter
3	Increase in working capital, revitalization of business activity (1 factor effect $V_{\text{транзакций}}$)	+128.0 per year (baseline scenario 1, Table 9)

Based on the results, identifying the characteristics of the possible growth of exogenous factors of the developed model, Table 12 presents an analysis of the sensitivity of GDP to their projected adjustments.

Table 4: Analysis of the gross domestic product sensitivity to changes in model exogenous factors.

No.	Factor	Average quarterly GDP growth, bln. rubles	GDP growth per year, bln. rubles
1	$V_{\text{финрез}}$ - total amount of profit/loss received by operating credit institutions	22.125*6.35 = +139.7	558.8
2	$V_{\text{торгов}}$ - trading volume on the stock market	9246*0.01 = +92	368.0
3	Increase in working capital, revitalization of business activity	25.3*	101.2
	TOTAL:	332.7	1,028.0

* The calculation was performed according to formula 3. Explanation of calculations: 20,513 + 0.79* ((34,351/4) +128/4) = 27,322.6 - taking into account the growth of working capital by 128.0 bln. rubles per year. 20,513 + 0.79 * (34,351/4) = 27,297.3 - excluding the growth of liquidity by 128.0 bln. rubles. Quarterly growth = 27,398-27,297 = 25.3 bln. rubles.

Table 5: Scenario analysis of changes in commission income of credit institutions in the Russian Federation and an increase in the liquidity of economic entities as a result of the transition of the payment system of the Russian Federation to the crypto environment.

Total money transfers, as of 01/01/2019		Estimated commission rate,%*	Fee and commission income, bln. rubles	Sensitivity analysis of the reduction in fee and commission income of credit institutions as a result of "Transfer of funds" indicator reduction by:											
				Scenario No. 1: 10%			Scenario No. 2: 20%			Scenario No. 3: 30%			Scenario No. 4: 50%		
				Total money transfers, bln. rubles	Fee and commission income, bln. rubles	Growth of capital liquidity of economic entities, bln. rubles**	Total money transfers, bln. rubles	Fee and commission income, bln. rubles	Growth of capital liquidity of economic entities, bln. rubles**	Total money transfers, bln. rubles	Fee and commission income, bln. rubles	Growth of capital liquidity of economic entities, bln. rubles**	Total money transfers, bln. rubles	Fee and commission income, bln. rubles	Growth of capital liquidity of economic entities, bln. rubles**
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
q-ty, mln. pcs.	volume, bln. rubles	0.09	1,396.8	1,409,815.3	1,268.8	128.0	1,253,169.2	1,127.9	268.9	1,096,523.0	986.9	409.9	783,230.7	704.9	691.9
1,715.7	1,566,461.4														

* The rate value is determined by calculation based on the ratio of commission income of credit institutions and the volume of remittances for the year

** The value of the capital liquidity growth of economic entities corresponds to the reduction of commission income of credit institutions (For scenario 1, column 4 - column 6)

Source: compiled according to the Central Bank of the Russian Federation

4 CONCLUSIONS

Thus, based on the results, we can state that within the framework of the considered effects caused by the blockchain technology diffusion into the economic environment, an increase in gross domestic product is possible by 1,028.0 bln. rubles, which is about 1.0% according to data for 2019. Thus, it can be argued about a very significant role of the use of distributed data storage technologies in the implementation of state policy aimed at digital transformation. At the same time, it is important to note that this possible increase shall be classified as conservative, since the basis, when carrying out scenario calculations, are made adjustments that characterize the very moderate possible transformations of the factors used in the cointegration model.

It is worth noting that the purpose of this study was to strengthen formalized approaches to the study of the scientific and practical problem against the background of the overwhelming predominance of qualitative approaches to blockchain technology and their possible impact on key macroeconomic parameters.

Clearly, the proposed model and solutions cannot claim to be a reference algorithm for the implementation of this kind of research. Realizing the depth of the problem, it is necessary to state in a completely unambiguous way about a wider set of factors and processes in the economy, transforming under the impact of the distributed data storage technology penetration into the economic environment.

Meanwhile, the built-in potential of the developed model, including, among other things, a scenario

analysis of possible adjustments of exogenous factors in the context of an extremely limited information base that reveals the characteristics and prospects for the blockchain technology penetration into real and financial sectors of the national economy, makes it possible to outline not only probable consequences, but also to obtain formalized estimates of the probabilistic change in the gross national product. It, in turn, opens up new horizons for interpreting the prospects and feasibility of legalizing blockchain technology and creates new opportunities for holding discussion platforms on this topic.

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