

Development of a Model for Assessing the Potential Impact of Blockchain Technologies on Economic Growth Dynamics in Financial Markets

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Abstract

Over the past years, blockchain technologies have become one of the outstanding innovations in the financial sector of the economy, enhancing and facilitating transaction procedures in many spheres. Moreover, these technologies are of great significance concerning the financial market, including regulators. However, it may well involve a certain level of uncertainty of the generated effects both for themselves and for the national economy. It is worth mentioning that quite many works devoted to the problems posed focus on qualitative assessments and conclusions, focusing either on the study of the technological component of the technologies or on the regulatory and legal ones. This study aims to reinforce the positions of formalized approaches to the study of the scientific and practical problems posed. The paper proposes an algorithm for studying the influence of blockchain technologies on the GDP dynamics through the prism of the transformation of key functioning parameters describing the financial and real sectors of the economy. A cointegration model has been built that allows one to determine the main effects and the potential impact of possible transformations (as a result of the penetration of blockchain technologies into the system of economic relations) of individual functional areas in the financial sector of the economy on GDP dynamics. The obtained estimates of the sensitivity of economic dynamics to the considered adjustments of the financial market demonstrated the potential for economic expansion, provided the possible integration of blockchain technologies in the business environment.

Keywords: blockchain technology, dynamics of economic growth, GDP, the financial sector of the economy, blockchain systems, modeling, the sustainability of economic growth

1. Introduction

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 business processes, including in the financial sector, thereby continuing to develop the FinTech paradigm.

The fundamental basis that determines the development of the financial market is the trust between its participants. As a rule, financial transactions are carried out through the mediation of third parties (clearing organizations, brokers, international payment systems). The parties undertake to verify the parameters of the transaction, which commence with assessing the reliability of data on the assets and end with the certificate and registration of the transaction (Michellini, & Fiorentino, 2012). Moreover, most often these types of services include insurance, which is a guarantee of the cleanliness of transactions, even if one of the parties violated its obligations. For example, in case of default of a party to the transaction, financial intermediaries assume all risks. It is clear that a third party, as part of the implementation of the financial transaction procedure, charges a fee to the participants in the transaction. For example, the Visa international payment system charges a commission of 3% of the transaction value for a transaction within the framework of servicing the world's largest wholesale and retail chain Walmart. Given that the vast majority of transactions are based on the use of credit cards, Walmart takes into account the size of this commission and includes it into the prices (Tilooby, 2018).

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 (Figure 1). In this regard, the search for solutions aimed at moving from general ideas about the impact of blockchain on the economy to its formalized assessments with a high level of detail of data and calculations to understand the effectiveness and feasibility of transferring the infrastructure of financial transactions to the path of blockchain technologies becomes a vital task.

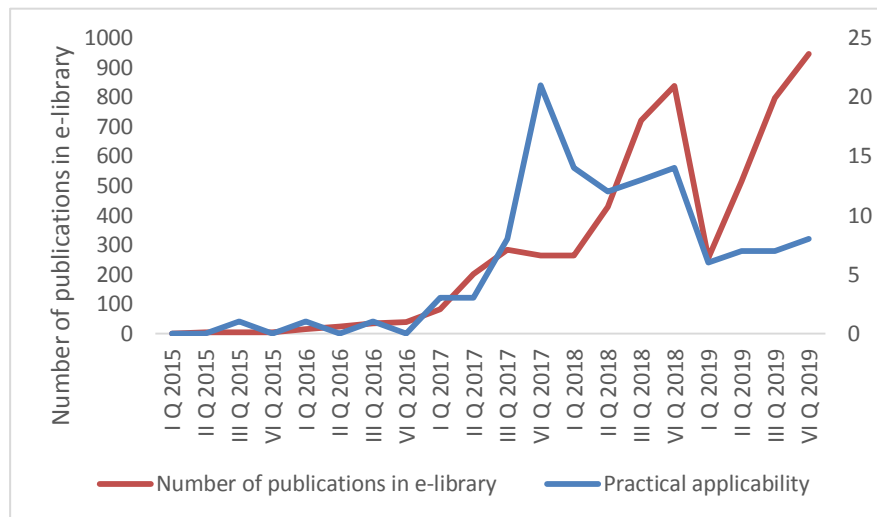


Figure 1. A fixed number of facts on the use of blockchain technologies in the operational activities of Russian companies (Guo & Liang)

Actualizing the importance and role of blockchain technologies, it should be noted that despite the conflicting approaches and positions of experts on the feasibility and possibility of using blockchain technologies in the economic turnover, individual states are already actively moving and developing along the path of “blockchain”. As a vivid example, we can cite the PRC, where since May 2020 the circulation of national cryptocurrency of the Central Bank of China (DCEP) was launched (The launch date of the national cryptocurrency in China has become known, 2020). Since 2020, Chinese banks will use distributed ledger technology to record digital accounts, make payments, and for other purposes (Alibaba, Baidu and four state-owned banks of China are developing blockchain applications, 2020).

As already noted, despite the very high interest in the distributed data storage technologies from international and national financial institutions, and from enterprises of the real sector, studies on the problems of assessing the use of the potential of blockchain platforms in the socioeconomic environment, and their theoretical understanding can be met rarely vary at the same time (Karimi, 2020). Existing works, as a rule, reveal either the technical side of the object under study, or the regulatory and legal aspects of the applicability of blockchain technologies in the national economy. (Iansiti, & Lakhani, 2017)

In this regard, this scientific work attempts to overcome this conditional vacuum in order to increase the number of questions on revealing other aspects of the subject of research, for example, such as the economic and social effects of introducing blockchain technologies into the national economic system.

The aim is abstracting in the present study from the risks and threats posed by the integration of blockchain technologies in financial markets and the real sector of the economy. To that end, the authors attempt to build a model that evaluates the impact of possible adjustments on the critical functional areas of the development of the financial system (as a result of the “penetration” of distributed data storage technologies into the system of operational processes), and the dynamics of the gross domestic product.

2. Methods

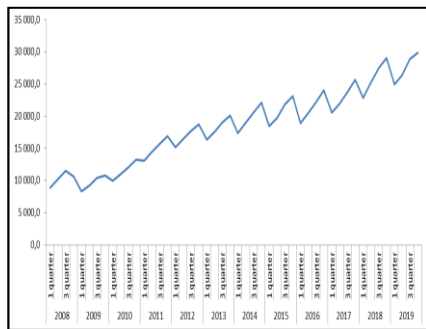
In accordance with the presented algorithm, the model is further constructed and the corresponding estimates are implemented to determine the degree of impact on GDP from the transformation of certain areas where the financial market performs its functions. The solution to this problem allows us not only to understand the sensitivity of the

country's economic dynamics to adjustments occurring in individual functional segments of the financial market, but also to determine the potential for economic growth as a result of changes in the considered areas of the financial sector resulting from “penetration” of the Blockchain technology, which is important within the context of this work.

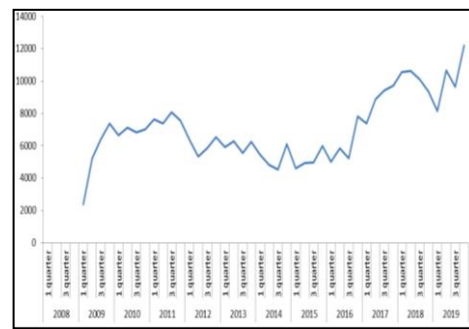
The gross domestic product acts as an indicator determining the parameters and dynamics of economic growth. The financial sector is determined by the following indicators: trading volume in the stock market; the volume of money transfers made through the Bank of Russia payment system; balanced financial result of organizations’ activities. The work used quarterly data from official sources. The calculations were carried out using the statistical package Views. Table 1 shows the variables of the developed model, their symbols and data sources. The quarterly dynamics of the considered indicators for the period from 2008 to 2019 are presented in Figure 2.

Table 1. Description of the variables of the developed model

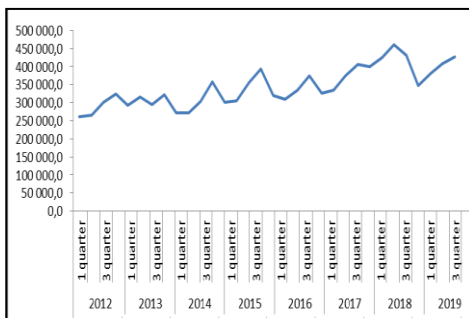
Variable	Designation	Data source
Dependent		
Dependent	GDP	Rosstat
Independent		
Trading volume on the stock market, billion roubles	$V_{exchange}$	Moscow Exchange
The volume of money transfers made through the Bank of Russia payment system, billion roubles	$V_{transactions}$	Bank of Russia
Balanced financial performance of organizations, billion roubles	V_{finres}	Rosstat



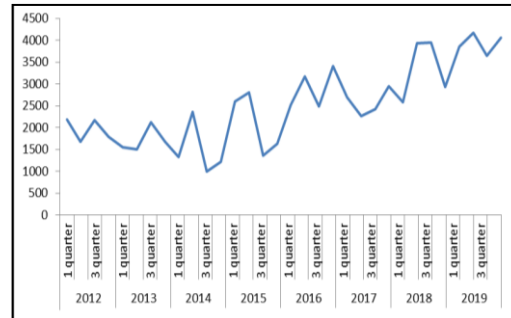
Dynamics of changes in GDP from 2008 to 2019, quarterly data, billion roubles.



Dynamics of changes in the volume of exchange in the stock market from 2008 to 2019, quarterly data, billion roubles.



Dynamics of changes in the number of money transfers from 2008 to 2019, quarterly data, billion roubles



Dynamics of changes in the balanced financial result from 2008 to 2019, quarterly data, billion roubles

Figure 2. Quarterly dynamics of indicators used in the model for the period from 2008 to 2019

An important methodological aspect that predetermined the model construction procedure is that in the case of studying financial time series, the use of traditional methods of correlation and regression analysis can lead to problems expressed in the bias, insolvency, and inefficiency of the estimates obtained. This means that such a model may not be suitable for further analysis and forecasting.

The study of dependencies between stochastic time series can be carried out using the cointegration analysis method. The initial step in the analysis is to determine the cointegration rank. Moreover, in order to find the cointegration rank between GDP and exogenous factors, a preliminary analysis of the selected series should be carried out. First of all, we need to make sure that the series under study are first-order integrated series. The stationarity of the first difference was checked using the Dickey-Fuller test, which involves checking the following condition (concerning the analyzed time series): $y_t \sim I(1)$, if the series of the first differences $\Delta y = y_t - y_{t-1}$ is stationary $\Delta y_t \sim I(0)$.

$$\Delta y_t = \beta_0 + \beta_1 t + \varphi_{y_{t-1}} + \chi_i \sum_{i=1}^m \Delta y_{t-1} + \mu_t \tag{1}$$

The test results of the considered time series for stationarity are shown in Table 2.

Table 2. Results of testing for stationarity

Variables	t- stat	Prob.	Conclusion
GDP	-3,85	0,003	stationary
V _{exchange}	-8,67	0,000	stationary
V _{transactions}	-3,27	0,02	stationary
V _{finres}	-7,7	0,000	stationary

Thus, the obtained estimates demonstrate that the studied series are stationary at a 5% significance level as applied to the analysed time series.

In addition to checking for the presence of a unit root, it is necessary to check for causal relationships between indicators using the Granger method. Granger’s basic idea is that the causes of X_t precede the effect of Y_t and affect future y values, while the corollary values do not affect future x values [10].

$$y_t = \alpha_1 + \sum_{i=1}^n \beta_i x_{t-1} + \sum_{i=1}^n \alpha_i y_{t-1} + \mu_{1t} \tag{2}$$

$$x_t = \alpha_2 + \sum_{i=1}^n \chi_i x_{t-1} + \sum_{i=1}^n \alpha_i y_{t-1} + \mu_{2t} \tag{3}$$

Granger causality testing results are shown in Table 3.

Table 3. Analysis of short-term relationships between time series (Granger causality)

Pairwise Granger Causality Tests			
Date: 04/16/20	Time: 22:02		
Sample: 1 48			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause FINANCIAL_RESULTS	30	9.48128	0.0009
FINANCIAL_RESULTS does not Granger Cause GDP		6.85357	0.0042
TRADING_VOLUME does not Granger Cause FINANCIAL_RESULTS	30	3.70272	0.0390
FINANCIAL_RESULTS does not Granger Cause TRADING_VOLUME		2.05851	0.1487
TRANSACTIONS does not Granger Cause FINANCIAL_RESULTS	30	6.85527	0.0042
FINANCIAL_RESULTS does not Granger Cause TRANSACTIONS		9.12469	0.0011
TRADING_VOLUME does not Granger Cause GDP	42	1.03591	0.3650
GDP does not Granger Cause TRADING_VOLUME		0.18752	0.8298

TRANSACTIONS does not Granger Cause GDP	30	27.5825	5.E-07
GDP does not Granger Cause TRANSACTIONS		28.1409	4.E-07
TRANSACTIONS does not Granger Cause TRADING_VOLUME	30	0.84202	0.4427
TRADING_VOLUME does not Granger Cause TRANSACTIONS		4.07733	0.0293

In accordance with the results, the null hypothesis is refuted for most pairs of time series at a 5% significance level.

The hypothesis of the absence of a causal relationship is accepted for the following pairs of time series:

- Balanced financial performance of organizations and GDP;
- The volume of stock exchange and GDP;
- GDP and stock exchange volume;
- Volume of money transfers made through the payment system of the Bank of Russia and the volume of stock exchange.

If the set of time series is an integrated first-order process, then the application of the regression model can lead to biased, untenable and ineffective estimates. Such series are called cointegrated and apply the cointegration equation.

To test cointegration, the assessment method used in this study includes the Johansen Juselius cointegration test (Econometrics, 2007):

$$Y_t = A_1 Y_{t-1} \dots + A_n Y_{t-n} + B X_t + \varepsilon_t \tag{4}$$

Cointegration equation:

$$\Delta Y_t = \rho Y_{t-1} + \sum_{i=1}^{m-1} T_i \Delta Y_{t-i} + \varphi X_t + \varepsilon_t \tag{5}$$

Where:

$$\rho = \sum_{i=1}^n A_i - I_n \quad T_i = - \sum_{j=i+1}^n A_j \tag{6}$$

The results of the Johansen test are shown in Tables 4, 5.

Table 4. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.901897	87.79125	54.07904	0.0000
At most 1 *	0.581962	36.71301	35.19275	0.0340
At most 2	0.415066	17.52499	20.26184	0.1141
At most 3	0.229206	5.727349	9.164546	0.2129

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 5. The coefficients of the cointegration equation

1 Cointegrating Equation(s):			
Normalized cointegrating coefficients (standard error in parentheses)			
GDP	FINANCIAL_RESULTS	TRADING_VOLUME	TRANSACTIONS
1.000000	4.769440	0.760665	0.049250
	(0.05266)	(0.04906)	(0.01011)

Based on the implemented iterations, the following equation of the desired dependence is obtained:

$$GRP = 0,76 * V_{exchange} + 0,04 * V_{transactions} + 4,76 * V_{finres} \quad (7)$$

3. Summary

The developed cointegration equation indicates the presence of a positive effect on the GDP of the considered exogenous factors, which allows us to quantify the degree and possible potential of their influence from the standpoint of the impact of the "blockchain implementation" in economic processes on them.

It is important to note that the modelling results obtained demonstrate that the factor of "Balanced financial performance of organizations" has the greatest impact on the GDP dynamics. Thus, the penetration of blockchain technologies into financial markets with the subsequent generation of the effect of increasing the capital liquidity of business entities (as a result of localization / minimization of transaction fees from financial institutions) will significantly contribute to the intensification of GDP growth dynamics. In this regard, we can undoubtedly argue about positive externalities generated by the use of blockchain technologies in the system of operational processes of business entities in terms of crypto transactions.

From the point of view of impact on the dynamics of the gross domestic product, the smallest effect is due to the factor reflecting the adjustment in the sphere of the volume of money transfers made through the Bank of Russia payment system. This may indicate that the transition of part of financial transactions to the blockchain environment will not have a noticeable effect on the parameters of economic growth. Considering the low income share level of credit organizations due to commission income (about 1%), it can be stated that the reduction in financial results under this item is not significant for credit institutions of the financial sector of the Russian economy.

Thus, the fears put forward by some experts about the sustainability of the national economy development in the context of the penetration of blockchain technologies into the financial market can be questioned, because, as estimates in the model show, the transfer of financial settlements to blockchain is characterized by extremely low elasticity of impact on GDP. In this case, of course, it is important to understand that blockchain technologies pose the risks of developing illegal money circulation schemes in view of their decentralized order of functioning. However, here there are arguments that help to refute this conclusion (Tilooby, 2018; Mougayar, 2016 & de Meijer, 2016). Meanwhile, given that in the present study, the authors' attention is focused solely on assessing the economic effects that result from the penetration of distributed data storage technologies into the socioeconomic environment, other aspects related, for example, to the assessment of possible risks and threats resulting from "blockchain implementation" will not be considered in this paper. Our future works will be devoted to the attention paid to these extremely important issues.

4. Conclusions

In conclusion, we would like to note that given the very high rate of penetration of blockchain technologies into the real sector of the economy (Safiullin et al., 2019), as well as in the field of view of the expert and scientific community, it becomes extremely important to overcome the vacuum in understanding the essence and importance of distributed data storage technologies until they became a reality and would finally penetrate the sphere of business processes of economic entities.

This study is an attempt to strengthen the position of formalized approaches to the study of the scientific and practical problems posed against the background of the overwhelming prevalence of quality approaches to the study of blockchain technologies. Undoubtedly, the constructed model does not allow detailed disclosure and quantification of the impact on GDP due to key areas of the financial market development (in terms of exposure to the latest blockchain technologies). However, its potential is very important for understanding the sensitivity of economic growth dynamics to adjustments in financial markets that occur as a result of integration of blockchain technologies into the system of operational processes. This, in turn, opens up new possibilities for interpreting the prospects and feasibility of legalizing blockchain technologies and opening up new opportunities for holding discussion platforms on this topic.

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