

Assessment of Prospects for the Use of Decentralized Finance (DeFi) Mechanisms in Export-Import Operations in the Region

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ABSTRACT

The sanctions restrictions imposed on the Russian economy have predetermined the risks of reduced control and blocking cross-border financial channels for international payments. Under these circumstances, an important element of the state's economic policy is the development of adaptation solutions that ensure the ability to minimize the risks associated with transformation of foreign economic activity. One of the mechanisms that forms the basis for solving this problem is the use of decentralized finance (DeFi) in the practice of international settlements. Meanwhile, it should be noted that in this area of financial and economic relations today there are a number of open issues – ranging from the conceptual framework to the impact of these fintech innovations on the prospects for the stability of national financial systems and economic development in general. These issues acquire a special level of relevance at the regional level. The subject of the study is the prospects and mechanisms for using DeFi tools in the system of cross-border payments within the region. The object of the study is the foreign trade operations of the Republic of Tatarstan with the People's Republic of China. The purpose of the study is to develop and test methodological approaches for assessing the potential impact of fintech DeFi tools on the organization foreign economic activity in the region on the stability of gross GRP dynamics. The authors used methods of cointegration analysis, scenario modeling, substantiation of the studied patterns using regression analysis methods, etc. The information and statistical basis for the study were derived from data from the Federal State Statistics Service of the Russian Federation, the National Bureau of Statistics of China, as well as data from the territorial statistical authority of the Republic of Tatarstan. The study resulted in the systematization of the macroeconomic effects of using DeFi technologies for organizing international payments. A series of macroeconomic models have been developed that made it possible to identify and justify the potential for economic growth in the region through the practical application of DeFi tools in the system of organizing transnational settlements under sanction restrictions.

Keywords: decentralized finance (DeFi); blockchain; financial markets; sanctions pressure; export-import operations; international payments; region; macroeconomic externalities; economic growth

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INTRODUCTION

Over the past few years, as blockchain has been intensively developed worldwide, related technology platforms have actively progressed, forming new directions in fintech. These include decentralized finance (DeFi), which has not yet been comprehensively studied. Empirical assessment of the emerging effects and externalities generated by DeFi markets remains a challenge.

There are studies that reveal the features and potential impact of these technological solutions on financial systems at the global, national, and regional levels. However, these studies mostly rely on heuristic methods that do not use quantitative or empirical assessment. This methodological challenge is further exacerbated when the question of switching international financial transactions to DeFi arises at the regional level. The question of what macroeconomic benefits and risks arise from the integration of regional economic entities into transnational, decentralized payment systems is still an open one. In the context of increased external pressure on national economies, such as restrictions on access to global clearing systems, this issue has become increasingly relevant and important for the scientific and expert community.

Given this context, the paper seeks to develop methodological tools to help address the issue at the meso-level.

It is important to note that the authors' focus is solely on the search for macroeconomic externalities, without considering the regulatory framework for decentralized finance at the national and regional levels, or the interoperability of blockchain platforms across different country jurisdictions.

In Russia, there are currently active discussions about the development of digital platforms for the practical use of digital financial assets in international payments. This makes the issues discussed in the study more relevant. For example, the explanatory note to Draft Law No. 540256-8 "On

Amendments to the Federal Law on Digital Financial Assets and Digital Currency¹" notes that, in the context of increasing sanctions pressure, it is necessary to transition to new instruments for international settlements, as traditional interbank settlement methods are rapidly becoming less relevant.

LITERATURE REVIEW

The main driver of the development of DeFi was the emergence and active development of the cryptocurrency market in the world. Meanwhile, various tokenized assets are currently being absorbed into the decentralized finance market, which significantly contributes to attracting the number of active users into the DeFi orbit.

The interest in the market of decentralized finance is determined by the following factors [1–5]:

- automation of transactions without the participation of global clearing operators in the process;
- anonymity, which makes it possible to conduct transactions without taking into account the risks of sanctions pressure on financial institutions;
- scaling up the development of financial markets within the framework of the inclusion of a wide number of business entities;
- diversification of channels for the implementation of transnational payment services;
- the growth of business activity as a result of the creation of a trust environment in DeFi as part of the elimination of intermediaries involved in transactions (the use of smart contracts in transactions), etc.

As an additional factor contributing to the active development of the decentralized finance market, it is also necessary to include the digital transformation of economic processes in the world and the intensification of processes related to the legalization of

¹ Draft Federal Law No. 540256-8 On Amendments to the Federal Law on Digital Financial Assets and Digital Currency and on Amendments to Certain Legislative Acts of the Russian Federation.

cryptocurrencies, tokenized assets, and the global diffusion of stablecoins and other digital financial assets that act as connecting elements between traditional financial markets and DeFi [6–8]. For example, in the work of E.I. Cevik et al. it is noted: "... in the context of global digital transformation, the creation of alternative financial payment systems based on blockchain and digital assets derived from it is becoming a promising mechanism for organizing financial transactions at the transnational level" [6].

It is important to note that there is a very wide range of scientific articles in the literature [9–15], the subject of research of which are issues and methodological approaches to substantiating the feasibility of using DeFi technologies in the system of organizing transnational financial transactions. Meanwhile, the vast majority of them are heuristic or expert in nature. For example, in the work of V.V. Kuznetsova and O.I. Larina [9], the authors focus on the risks of introducing digital currencies into retail circulation. The prospects of their practical application are substantiated on the basis of a logically constructed system of heuristic arguments. In the research [10, 12], scientists, relying on the review and systematization of technological externalities of DeFi technologies, justify the expediency of their integration into the transnational turnover of international payments. The prospects of using DeFi tools in practice are also discussed in detail in [13]. Through the prism of systematization of potential macroeconomic effects, the authors convincingly prove the emerging opportunities in the field of increasing the efficiency of foreign trade operations within the framework of using DeFi. In addition, the researchers focus on the risks of integrating business entities into the markets of decentralized finance, expressed in a decrease in the level of control over international transactions by central regulators.

It should be noted that the research methods used in scientific papers in the

vast majority of cases are associated with a fairly high level of subjectivity, although, from our point of view, it is very reasonable, based on the conclusions put forward in these works regarding the prospects of using blockchain in forming a new configuration of cross-border transactions. However, the assessment of the externalities generated by blockchain ecosystems in the organization of international payments should still be based on quantitative analysis methods and appropriate processes for constructing economic and mathematical models. This task is undoubtedly more complex and requires a systematic study of all issues related, first of all, to the identification of externalities of the economic order and their subsequent formalized assessment.

MATERIALS AND METHODS

Without going into the technical and regulatory details of the decentralized finance market, Figure 1 illustrates the author's vision of a potential approach to transnational payment systems for foreign trade between Russia and China. This focus on China stems from the fact that it has been a major foreign trading partner of the Russian Federation in recent years, and given the current geopolitical landscape, will significantly influence the future of Russia's foreign trade in the medium term.

The principal characteristics of the proposed scheme for conducting transnational payments for the supply of goods for export are the use of officially recognized digital financial assets (CFAs) in the legal field of the Russian Federation, acting as tokenized debt obligations of the exporter to the importer. As soon as the goods are delivered, the smart contract cancels the value of the CFA and the Russian CFA operator will automatically transfer funds to the exporter in the transaction currency (*Step 8 of the flowchart*).

The implementation of the proposed scheme for organizing transnational payments

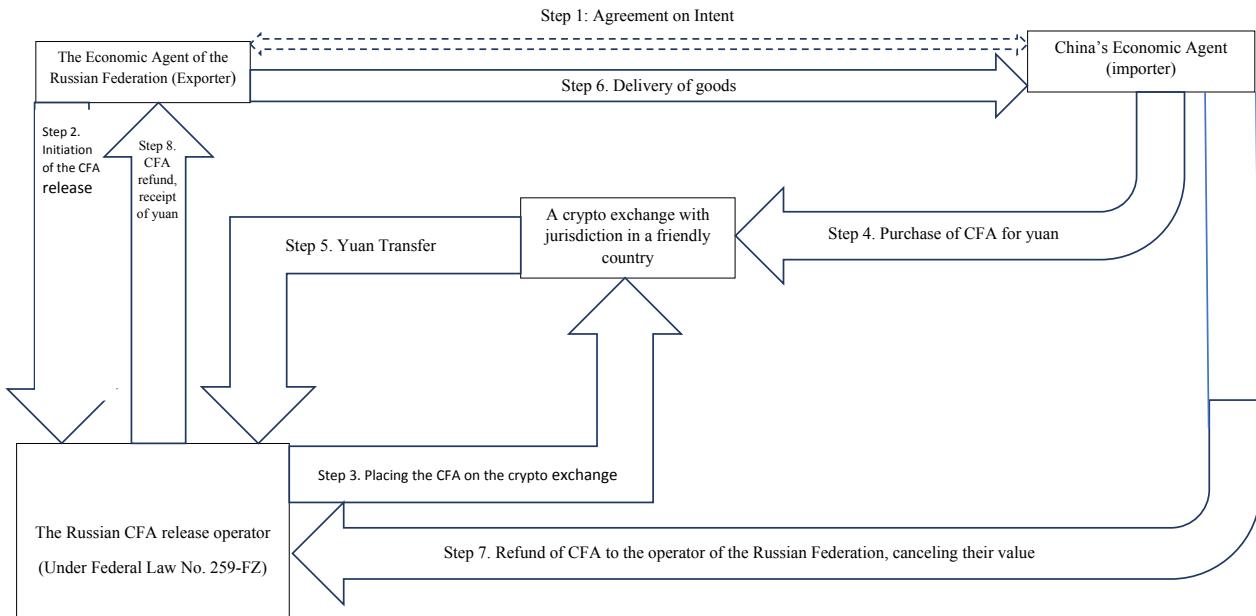


Fig. A Potential Mechanism for the Application of CFA in the Framework of Export Operations (on the Example of the Supply of Products to China)

Source: Developed by the authors.

Note: CFA is a debt obligation that acts as a collateral instrument for the importer.

will contribute to solving the most important task related to ensuring the rhythm of Russia's international transactions in the face of sanctions pressure. Before analyzing the approaches justifying the use of DeFi in the context of growing pressure on the Russian economy, it is necessary to systematize the main macroeconomic effects that this pressure causes. Let's focus on the following aspects:

1. Restriction of economic agents' access to transnational financial transactions entails a decrease in imports, which, in turn, determines the risk of rhythmic supply of goods of final and intermediate consumption into the economic system and, consequently, disruption of the rhythm of economic dynamics. It is important to note that, in accordance with the neoclassical approaches of economic theory, a decrease in imports forms the basis for an increase in net exports and an increase in gross domestic product. However, this model is fair in conditions of natural economic development without artificial external constraints. Under the conditions of sanctions, a total disruption of import supplies leads to a disruption in the

stability of the rhythm of development of import-dependent industries, evolutionarily integrated into the system of international supply chains during the pre-sanctions period.

2. Restricting access to financial transactions at the transnational level creates conditions for slowing exports, which act as a key factor in the growth of the final product. This issue is especially relevant for national economic systems with a high level of export dependence. Taking into account that the Russian Federation and its regions are significantly dependent on the supply of products abroad, limiting the access of consumer countries of Russian exports to payment for products entails a violation of the rhythm of export operations.

3. The restriction of import supplies creates conditions for the emergence of a structural deficit in the economy, which increases the pressure on price growth, in accordance with the AD-AS model, and the subsequent decline in gross domestic product.

4. Disruption of transnational financial and transactional channels contributes to a decrease in foreign investment in the national economy, which creates risks of a slowdown

in gross domestic product (neoclassical aggregate supply model).

5. The transformation of export-import operations contributes to structural distortions in the trade balance, which entails the risk of increased volatility of the national currency.

The presented set of macroeconomic effects, actualizing the search for alternative solutions in the system of organizing transnational payments (based, among other things, on DeFi technologies), has a somewhat limited format and does not include a full range of externalities under the conditions of sanctions pressure. At the same time, a review of a significant body of scientific literature [16–19] and expert analysis reports from world development institutions (such as the World Economic Forum, Organization for Economic Cooperation and Development, and Bank for International Settlements) allows us to reasonably conclude about the overall consistency of the proposed benefits from the perspective of the feasibility of using DeFi in organizing foreign economic activities in the new institutional and market context.

RESULTS

Based on the presented approaches that reveal the nature of the generated macroeconomic effects as a result of the potential use of DeFi technologies in the system of ensuring transnational payments, an attempt is further made to test the proposed solutions. The Republic of Tatarstan has been identified as the object of research. Empirical estimates are based on transnational-level cash flows generated within the framework of the region's foreign trade with the People's Republic of China (PRC). The choice in favor of China is due to the shift in foreign trade flows of the Russian Federation and the region under study to this country. According to the results of a descriptive analysis of statistical data, the volume of import growth from China to Tatarstan has more than tripled over the

past three years, and the share of imports from China in the Russian Federation is more than 57%². In this regard, it seems advisable to focus on the foreign trade turnover of the region in question with this country, which acts as a strategic trading partner of the Republic of Tatarstan and the Russian Federation as a whole.

In a structured form, the presentation of the results obtained will be demonstrated on the basis of proof or refutation of the hypotheses put forward that fit into the paradigm of generated macroeconomic effects arising from the use of DeFi technologies in the international payment system.

Hypothesis 1. The integration of the economic entities of the region into DeFi ensures the rhythmic supply of imports and the stability of economic dynamics in the face of sanctions pressure on the national economy.

Statistical time series were used to prove or disprove the hypothesis. They show the dynamics of the GRP of the Republic of Tatarstan (endogenous variables) and the growth rate of imports to the region (exogenous variables).

The length of the time series is based on quarterly data for the period from 2015 to 2021. The choice of this interval is due to the need to find a relationship between the parameters under consideration outside the period of increased sanctions turbulence, the expression of which is a violation of export-import chains within the framework of sanctions pressure on the national economy of the Russian Federation sample 2022. This methodological approach will allow us to detect the desired patterns in conditions of relative stability of the economic system of the region. Extrapolating the results obtained to the scenario parameters of the transformation of import flows during the disruption of cross-border supply chains will reveal the potential for threats associated

² EMAIL ADDRESS. Government statistics. Revenues of the consolidated budget of the subject of the Russian Federation and the territorial state extra-budgetary fund. URL: <https://www.fedstat.ru/indicator/61936> (accessed on 11.07.2024).

with possible corrections in the dynamics and volumes of supplies to the region of products from abroad.

An important methodological feature of the search for the relationship between the studied parameters is the inclusion in the calculations of an intermediate statistical indicator — “Revenues of the consolidated budget of the constituent entity of the Russian Federation”. This is due to the results of statistical significance obtained during testing of the constructed models.

In a structured form, the system of equations involved in evaluating the relationship between GRP and the volume of imports supplied to the region takes the following form:

$$\begin{cases} Inc = a + b * Imp \\ GRP = c + d * Inc, \end{cases}$$

where Inc — revenues of the consolidated budget of the Republic of Tatarstan, billion rubles; Imp — imports to the region, million US dollars;; GRP — gross regional product of the Republic of Tatarstan, billion rubles.

The final result of the calculations was the following system of equations:

$$\begin{cases} Inc = 41,4 + 0,052 * Imp \\ GRP = -87,51 + 8,13 * Inc. \end{cases} \quad (1)$$

The presented calculation results demonstrate the statistical significance of the obtained equations. ($R^2 \geq 0.88$; criteria P — values less than the specified significance level of 0.05).

The interpretation of the result shows the following:

- an increase in imports to the region by 1 million US dollars forms the prerequisites for an increase in consolidated budget revenues by 0.052 billion rubles (*Equation 1*);

- an increase in consolidated budget revenues by 1 billion rubles forms the potential for GRP growth by 8.13 billion rubles (*Equation 1*).

Based on the estimates obtained, an increase in imports of \$ 1 million determines the growth potential of the gross regional product of the Republic of Tatarstan by 0.42 billion rubles ($0.052 * 8.13$), which is equivalent to an increase of 0.011% (under current price conditions).

Relying on previously obtained estimates that reveal the specifics of the volume of imports supplied to the Republic of Tatarstan from China, as well as relying on scenario data analysis methods, table 1 presents possible options related to limiting the supply of products from China to the region as part of blocking financial transactions.

Based on previous estimates of the volume of imports from China to the Republic of Tatarstan, as well as using scenario data analysis methods, Table 1 shows the possible consequences of restricting the supply of products from China when financial transactions are blocked.

Thus, based on the results obtained, it can be stated that the transition of the region's financial transactions with China to a system of economic relations based on DeFi instruments creates the potential to offset the risks of a slowdown in GRP growth (up to 12.85% per year) as part of the scenario of a large-scale reduction in imports from China to the region (-50%). If the current channels of transnational payments settings are maintained, which are blocked by sanctions pressure, the potential for a slowdown in the economy of the Republic of Tatarstan can be estimated at up to -2.75% per year.

Hypothesis 2. The integration of the economic entities of the region into DeFi ensures a rhythmic supply of exports and helps to reduce the damage from external sanctions pressure on the region.

Blocking international financial transactions entails disruption in the export supply chain, which acts as a key factor in the aggregate supply model.

The use of DeFi-based international payment mechanisms helps to minimize the risks of disruption in the system of

Table 1

Scenario Analysis of the Potential for the Economic Growth in the Republic of Tatarstan in the Context of Adjusting Imports Volumes from China as a Result of Sanction Pressure on Russian Financial Institutions

Indicator	Current values (based on data for 2023)	Scenarios	
		-10.7%, which corresponds to the dynamics of a decrease in import shipments from China in 2024 as part of the tightening of secondary sanctions	-50%
The volume of imports from China, million dollars	2335.7	2085.8	1167.8
GRP, in %	103.6	-2.75*	-12.85*

Source: Calculated by the authors.

Note: * Calculated based on the identified patterns that determine the impact of import supplies on a possible GRP adjustment.

Table 2

Scenario Analysis of the Economic Slowdown in Tatarstan as Part of Localization Efforts for Export Supplies to China due to Sanctions

Indicator	Current values (based on data for 2023)	Scenarios		
		-28%, which corresponds to the dynamics of a decrease in export shipments to China in 2024 as part of the tightening of secondary sanctions	-50%	-100%
Export volume to China, USD million	218.6	157.4	109.3	0.0
GRP, in %	103.6	-0.15	-0.27	-0.55

Source: Calculated by the authors.

organizing export operations as a result of the emerging independence of business entities from existing international clearing services (SWIFT, etc.).

The study of the hypothesis is based on an assessment of the impact of changes in export supplies (within the framework of the potential for its reduction under external pressure) on the parameters of the formation of the gross regional product. The statistical time series for the period from 2015 to 2021 (quarterly data) were chosen as the empirical basis of the study.

The modeling of the desired dependence is implemented within the framework of constructing a system of equations of the form:

$$\begin{cases} Inc = a + b * E \\ GRP = c + d * Inc, \end{cases}$$

where E — export volume, USD million.

The results of the obtained estimates are presented in the system of equations 2.

$$\begin{cases} Inc = 45,98 + 0,012 * E \\ GRP = -87,51 + 8,13 * Inc. \end{cases} \quad (2)$$

The obtained models are characterized as statistically significant, which is confirmed by the parameters revealing the values of the R-squared coefficients, as well as the results of the conducted analysis of variance. ($R^2 \geq 0.88$; criteria P — values less than the specified significance level of 0.05).

The interpretation of the obtained estimates makes it possible to identify the following key patterns:

- export growth of the Republic of Tatarstan by 1 million dollars. contributes to an increase in consolidated budget revenues by 0.012 billion rubles;
- an increase in consolidated budget revenues by 1 billion rubles creates a GRP growth potential of 8.13 billion rubles.

Aggregating the analysis results allows us to draw the following main conclusion: an increase in exports by \$ 1 million creates

the conditions for an increase in the gross regional product of the Republic of Tatarstan by 0.098 billion rubles ($0.012 * 8.13$), which is equivalent to an increase of 0.0025% (at current prices and the corresponding level of the region's GRP in 2023 (4 trillion rubles)).

Based on the data of the export potential of the Republic of Tatarstan, which is being formed as part of the implementation of foreign trade activities with China, Table 2 presents the results of scenario modeling of export restrictions to China as part of the sanctions pressure on the Russian Federation and the strengthening of secondary sanctions against China by the Western Bloc countries.

The results of the data scenario modeling indicate a noticeable level of influence of the region's export supplies to China on the dynamics of the economic growth of the Republic of Tatarstan. So, for example, if the negative momentum characterizing the decline in exports persists in 2023, the expected reduction in the dynamics of GRP growth in the framework of foreign trade activities with China is estimated at -0.15% . And in the case of a total reduction in exports to China, the expected GRP losses of the Republic of Tatarstan are estimated at -0.55% of GRP.

Hypothesis 3. A reduction in import supplies under the conditions of sanctions restrictions creates the prerequisites for the formation of a deficit, the unfolding of inflationary processes and the slowdown in economic growth.

As a result of the decrease in import supplies, prerequisites are being formed for increasing the shortage of goods and, consequently, unwinding the inflationary spiral in the economy. At the same time, as is known, in accordance with the neo-Keynesian model of aggregate demand and aggregate supply (AD-AS), price increases push the point of macroeconomic equilibrium towards a decrease in supply, which leads, in terms of national accounts, to a reduction in gross domestic product.

A clear confirmation of this theory is the estimates obtained, revealing the features

Table 3

Scenario Analysis of the GRP Dynamics of the Republic of Tatarstan in Light of a Slowdown in China's Import Supplies as Part of the "Inflationary" Factor

Indicator	Current values (based on data for 2023)	Scenarios		
		-10.7%, which corresponds to the dynamics of a decrease in import shipments from China in 2024 as part of the tightening of secondary sanctions	-50%	-100%
The volume of imports from China, million dollars.	2335.7	2085.7801	1167.85	0
GRP, in%	103.6	-0.175	-0.817	-1.635

Source: Calculated by the authors.

Table 4

An Analysis of the Macroeconomic Impact of the Transition of Export and Import Operations in the Republic of Tatarstan to the DeFi Platform, from the Perspective of China

Macroeconomic externalities *				
Indicator	The effect of "rhythmic international payments for the purchase of imports under external sanctions pressure"	The effect of "rhythmic international payments for export supplies in the context of external sanctions pressure"	The effect of "deceleration of inflationary processes within the framework of eliminating the import deficit"	Cumulative effect
GRP growth potential, in %	+2.75%	+0.15	+0.175	+3.075

Source: Developed by the authors.

Note: * The estimates were made as part of the research focus on the fixed volume of export-import operations with the People's Republic of China.

of the impact of the consumer price index on the dynamics of the GRP of the Republic of Tatarstan. Calculations were made for the period 2015–2019 (quarterly data).

According to the implemented calculations, a decrease in import volumes by 1% creates the prerequisites for an increase in the consumer price index (CPI) by 0.0023% (*Equation 3*).

$$P = 96.06 - 0.0023 * Imp, \quad (3)$$

where P — consumer price index, in% compared to the previous quarter; Imp — imports to the region, USD million

The presented calculation results demonstrate the consistency of the constructed model ($R^2 = 0.76$; criteria P — values less than the specified significance level of 0.05).

In turn, a 1% increase in the consumer price index contributes to a decrease in the dynamics of the region's GRP by 0.31% (*Equation 4*).

$$GRP = 134.003 - 0.31 * P. \quad (4)$$

The statistical significance parameters of the model also take on high values. ($R^2 = 0.74$; criteria P – values less than the specified significance level of 0.05).

Aggregating the resulting chain of relationships into a single result, it should be noted that within the framework of the “price factor” under consideration, a decrease in imports by \$ 1 million creates the prerequisites for an increase in the CPI by 0.0023%. In turn, a 1% increase in the CPI determines a decrease in the level of GRP by 0.31%. In the consolidated format, this effect can be represented as follows: an increase in import supplies by \$ 1 million determines the potential for a slowdown in economic growth in the region by 0.0007% (0.0023% * (-0.31)).

It is important to emphasize that the discovered relationships are valid in conditions of relative stability in the system of socio-economic development. In conditions of turbulence, they may not work, since government policy in the crisis phase of economic growth deliberately generates budget impulses in order to stimulate economic dynamics for a short time. Under these conditions, price growth and economic growth are synchronized.

Based on the results obtained, as well as based on data revealing the features of the slowdown in the supply of imports of goods and services to the Russian Federation (-10.7% in 2024) and extrapolating these dynamics to the supply of imports to the Republic of Tatarstan from China, Table 3 provides a scenario analysis of the potential slowdown in economic growth in the region within the framework of the considered “inflation/price” a factor caused by an increase in the shortage of goods.

The obtained results show that the inflationary impact caused by a decrease in imports to the region is not as significant as the two other factors. This demonstrates the peculiarities of the effects of disruption to the rhythm of export and import operations (*Hypotheses 1 and 2*), and their impact on possible GDP growth rates.

Based on the results obtained and generated in accordance with the proposed principles of leveling the threats of sanctions and technological capabilities of using DeFi, *Table 4* provides an aggregated assessment of macro-level consequences for the region under study.

CONCLUSIONS

The presented estimates provide a basis for understanding the potential benefits of using DeFi technologies in the system of transnational payment organizations. The cumulative increase in the gross regional product of the Republic of Tatarstan is estimated to be 3.5%, based on the macroeconomic effects of transitioning support processes for foreign economic transactions from China to decentralized finance (DeFi) transactions. This result is significant from a macroeconomic perspective, supporting the argument for the use of decentralized finance technologies in building transnational financial “gateways”.

In conclusion, it should be noted that DeFi technologies, in terms of their potential applications in international settlements, have become increasingly interesting today in both the scientific and expert communities. However, it should also be noted that the question of how to justify the prospects for transferring transaction organization processes to a blockchain environment remains an unresolved issue today. This is due to both theoretical and methodological limitations in this area. The fact that there are practically no studies in scientific and journalistic literature that address the question from the perspective of formalized assessments justifies this conclusion. Therefore, the present work intends not so much to fill this theoretical gap, but rather to initiate a discussion on developing theoretical and methodological approaches to studying generated externalities for national and regional economic systems in the context of the possible transition of payment systems to blockchain space.

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Authors' declared contribution:

M.R. Safiullin — development of a research concept, setting goals, objectives and defining areas of practical application of DeFi tools in the system of organizing transnational settlements under the conditions of sanctions restrictions.

L.A. Elshin — development of research hypotheses, scenario modeling of the analyzed time series, substantiation of the studied patterns using regression analysis methods.

M.D. Sharifullin — collection and processing of an information and statistical database, development and testing of methodological approaches to assessing the potential impact of fintech DeFi tools in the organization of foreign economic activity in the region on the sustainability and prospects for intensifying the dynamics of its economic growth.

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