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Financial Sustainable Growth System 2030 Evidence from Russian and Chinese Gas Companies

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ABSTRACT

The aim of the article is to study the prospects for sustainable financial growth of the gas industry in Russia and China until 2030. Unlike traditional interpretations, the authors consider financial sustainability as a result of the interaction and mutual influence of energy, environmental, economic and social processes grouped into subsystems. The authors analyzed the statistical indicators of the sustainable financial growth system of the largest oil and gas companies in Russia and China from 1996 to 2016. A model for calculating the financial sustainable growth system in the Python programming language was developed. The Lasso regression analysis method and the SARIMA model were used. The sustainable financial growth system index of oil and gas companies was substantiated. By means of the system methodology, the authors identified problems and systematized the contradictions in the organization of the sustainable financial growth in the gas industry of the two countries. As part of the proposed methodological approach, the original SARIMA model was built. The model explains the internal structure of the financial growth sustainability of the oil and gas industry in Russia and China. The authors calculated the sustainable financial growth system forecast for Russia and China until 2030. The calculations showed that in the future the system of sustainable financial growth in China's oil and gas industry may be disrupted. The authors offer ways to prevent the development of these negative trends. Namely: the promotion of social responsibility of state corporations, the development of green and social financing, the study of energy efficiency. In Russia, the stability of the financial growth of the oil and gas industry is characterized by stability over the entire forecast period.

Keywords: Russian and Chinese gas industry; environmental finance; financial sustainable growth; Financial Sustainable Growth Index (FSI); impact of social, energy and environmental factors on sustainable growth

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INTRODUCTION

In 1980s, researchers started a fundamental transvaluation of economic growth. They tried to analyze economic theory with a focus on environmental protection and social responsibility. For the first time, at the UN Conference on Environment and Development, they mainstreamed the importance of maintaining the environmental process and life support systems with the common goal of "sustainable development through conservation of living resources"[1]. "Sustainability" itself is considered in many contexts, including energy, ecology, economics, politics, society, technology, etc. Financial sustainability cannot be discussed outside the context. The new methodology should include interactions and relationships between external and internal factors of the system and be conscientious regarding the entire system as a fundamental touchstone of sustainability [1]. Today, determining the prospects for the financial growth itself is not enough. Sustainability as a holistic concept demands that financial growth be closely linked to social, ecological and wider energy environment.

This study tests the theory of systemic financial sustainable growth of the gas industry, as well as tools for its assessing and forecasting. The authors offer their own interpretation of the financial sustainable growth system which is considered as a result of the interaction and mutual influence of energy, environmental, economic and social indicators. They analyze the challenges of the strategy of financial sustainable growth for Russian and Chinese gas companies until 2030. Calculating the financial indicator to determine the prospects for financial growth is not sufficient. It is necessary to consider the social, ecological and energy environment. It is important to analyze the opportunities for stable growth for the environment and people with no further consequences. Thus, the research priority area is to model financial sustainable growth and to study the interaction between the financial, social, energy and environmental subsystems.

Research hypothesis: there is a relationship between financial factors and the social, energy and environmental subsystems of the gas industry in Russia and China whose nature affects financial sustainable growth. The authors try to confirm or deny transversal relationships between the subsystems.

The financial sustainable growth system is the most important prerequisite not only for the economic development of the countries as a whole, but also for individual industries and companies [1]. By means of the system methodology, the authors identified problems and systematized the contradictions in the organization of the financial sustainable growth in the gas industry of the two countries.

A lot of studies by both domestic and foreign authors are devoted to financial sustainable growth. There, the phenomenon of financial sustainable growth appears to be a managerial function oriented towards a competitive market. However, non-financial factors of sustainable growth in the oil and gas industry were not institutionalized. This hindered its adaptation to the rapidly changing competitive environment.

There is no exact and generally accepted definition of the financial sustainable growth system. There are no tools for describing methods to achieve financial sustainable growth.

Thus, R. Higgins, I. Ivashkovskaya, T. Geniberg et al. consider financial sustainable growth only as a financial function of the economic system, focusing on the qualitative characteristics of sustainable growth, though in the area of "corporate governance" [2–4]. A. Sheremet focuses on the need to consider the influence of environmental factors and social responsibility of business on financial sustainable growth [5]. In UN documents, the G20 Green Finance Study Group formulated a similar statement: when assessing the sustainability of financial growth, it is necessary to consider the impact of ecological, energy and social environments[2].

[1] United Nations Conference, 1992, Rio de Janeiro. UNCED. (1992). Earth Summit'92.

[2] European Commission Interim report — Financing a sustainable European economy. 2017:1–72. URL: https://ec.europa.eu/info/sites/info/files/170713-sustainable-finance-report_en.pdf (accessed on 14.06.2019); G20 Green Finance Study

Economic growth is directly linked to the so-called unacceptable costs of declining social welfare. According to Herman Daly, these costs arise as a result of "the social and environmental sacrifices made necessary by that growing encroachment on the eco-system" [6]. In his works, Herman Daly demonstrates the relationship between sustainable economic growth and environmental protection. Several researchers emphasized the relationship between energy efficiency, social responsibility and company financial performance. For example, Charles A.S. Hall emphasized that there is a "need to reintegrate natural sciences with the economy" and that the EROEI (Energy Return on Energy Invested) indicator should be a fundamental element of the new biophysical economy [7, 8].

METHODOLOGY

Data, software and modelling methodology

The study used publicly available statistical indicators of financial sustainable growth in Russian and Chinese oil and gas companies from 1996 to 2016 (see *Appendix*). The indices for the study were selected according to a stable financial assessment of growth functions. The data are classified according to areas of sustainable development with respect to finance, environmental, energy and social factors. The Department of Informatics and Computer Engineering of the Kostroma State University developed a model for calculating the financial sustainable growth system. The calculations are in the Python programming language[3] [9].

Important parameters of the model were determined by means of the Lasso regression analysis [10]. The authors built a linear regression and estimated confidence intervals for the parameter coefficients. The authors analyzed the parameter intervals not including 0 (a significant parameter with a confidence of 90%). Then, the linear regression of the significant parameters was built and the residuals were estimated. Lasso regression performs L1 regularization which adds a penalty equal to the absolute value of the magnitude of the coefficients. This type of regularization can lead to sparse models with several coefficients. Some coefficients can become zero, and then they are excluded from the model. Large residuals lead to the fact that the values of many coefficients approach zero which is ideal for creating simpler models. The Lasso regression analysis permits to minimize the cross-correlation between the parameters. The SARIMA model [11, 12] reveals autocorrelation in residuals after Lasso. The forecast is made based on the sum of the forecasts by the Lasso and SARIMA models.

Research methodology

The core typology of the systems grounds on their fundamentally different types depending on the characteristics in space and time. In this work, under the financial sustainable growth system the authors understand a complex of financial, social, environmental and energy processes in the economy separated into subsystems [1, 13]. All these subsystems — society, energy, environment and finance — are interconnected. The basis of the system is the financial subsystem [3]. It is a regulator in sustainable growth, since the environmental and social subsystems are developing due to funding. The development of the energy subsystem depends on the financial and social subsystems.

To assess the state of the financial sustainable growth system of the oil and gas industry, the authors offer an indicator that includes indices of all four subsystems: environmental, social, energy and financial [1].

The index of the "financial sustainable growth of the oil and gas industry" system is denoted as FSI; the financial subsystem index is FI; the environmental subsystem index is EnvI; the social subsystem index is SocI; the energy subsystem index is EI.

Group. G20 Green Finance Synthesis Report 2016. URL: http://www.g20.utoronto.ca/2016/P020160815359441639994.pdf (accessed on 14.06.2019).

[3] University of Michigan Coursera (2018) Applied Social Network Analysis in Python URL: https://www.coursera.org/learn/python-social-network-analysis (accessed on 14.06.2019); Sarker DMOF (2014) Python Network Programming book https://rutracker.org/forum/viewtopic.php?t=4987720 (accessed on 14.06.2019).

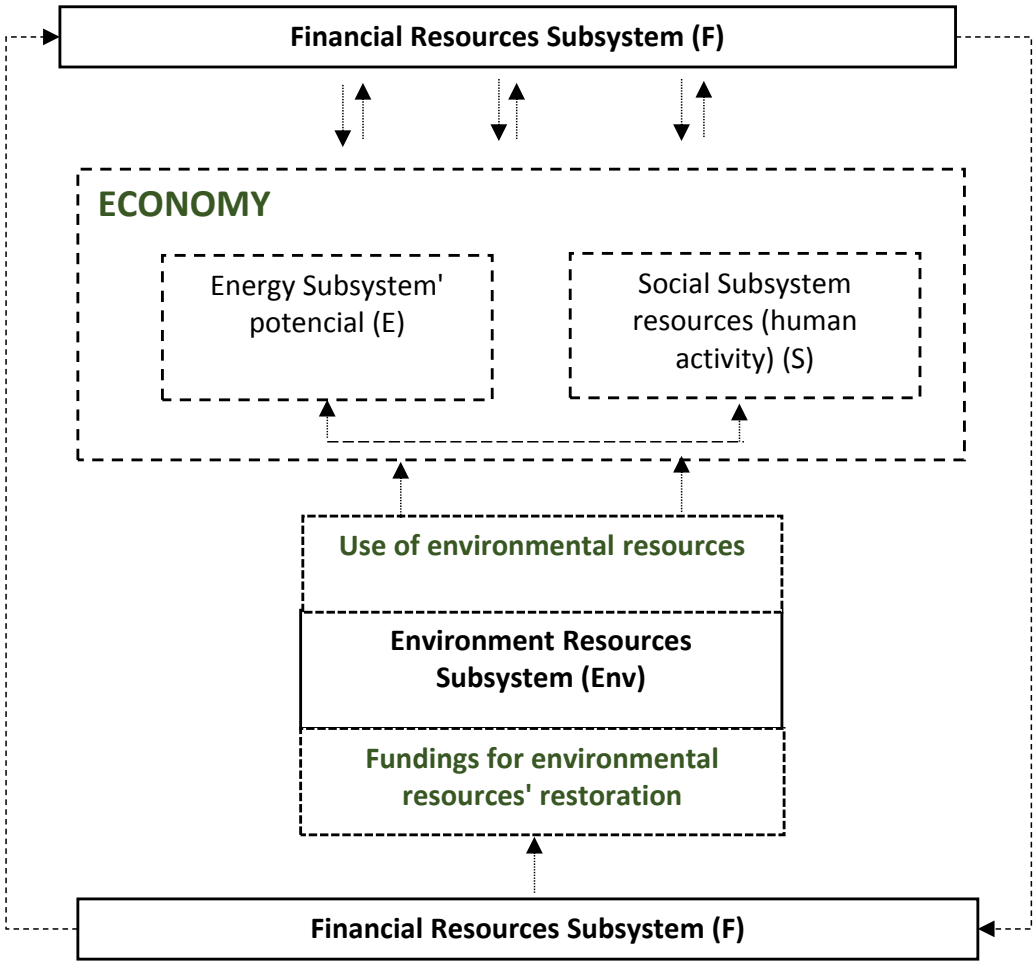

Fig. 1. **Financial subsystem interconnections with energy, environmental and social subsystems within the financial sustainable growth system**

Source: authors' interpretation of the system of financial sustainable growth based on research [14–18].

An individual index has been calculated for each subsystem for each time period characterizing the results of economic processes included in the subsystem [1].

Fig. 1 presents the characteristics of the financial sustainable growth system.

The authors transformed the initial data for each subsystem in the range from 0 to 1 using the following formula:

$$X_{index} = \frac{X - X_{min}}{X_{max} - X_{min}}. \quad (1)$$

The subsystem indices from 0 to 1 are normalized to guarantee the same weight of all variables.

The financial sustainable growth index (FSI) is calculated as the geometric mean of the indices of four subsystems:

$$FSI = \sqrt[4]{FI \times EI \times SocI \times EnvI.} \quad (2)$$

If the FSI is less than 0.2, then the system has a low level of transversal links between the subsystems. If 0.5 <FSI> 0.2, the interactions of the systems are poor. If the FSI is more than 0.5, but less than 0.7, the system is normally interconnected. If the FSI is more than 0.7, then the system is well interconnected [1].

RESULTS

Modelling results of financial sustainable growth index (FSI) for Russian oil and gas companies

The authors determined the parameters that most affect the financial sustainable growth index by means of Lasso regression. We con-

Table 1

Linear regression results (factors influencing SGI Higgins)

OLS Regression Results

Dep. Variable:	FSI	R-squared:	0.892
Model:	OLS	Adj. R-squared:	0.878
Method:	Least Squares	F-statistic:	122.8
Date:	Sun, 03 Feb 2019	Prob (F-statistic):	8.56e-41
Time:	12:53:48	Log-Likelihood:	278.45
No. Observations:	84	AIC:	-536.9
Df Residuals:	74	BIC:	-512.6
Df Model:	9		
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	-0.2762	0.053	-5.224	0.000	-0.380	-0.173
PRP	-0.0254	0.013	-1.985	0.047	-0.050	-0.000
ROEnv	0.1532	0.008	18.047	0.000	0.137	0.170
FOORPRINT	0.1698	0.029	5.764	0.000	0.112	0.228
BIOCAPACITY	0.2860	0.074	3.865	0.000	0.141	0.431
CR	0.1037	0.013	7.787	0.000	0.078	0.130
ROS	0.0439	0.008	5.232	0.000	0.027	0.060
ROCE	-0.0535	0.011	-4.755	0.000	-0.075	-0.031
ROE	0.0740	0.014	5.470	0.000	0.048	0.101
EBIT	-0.0481	0.006	-8.121	0.000	-0.060	-0.036

Omnibus:	1.814	Durbin-Watson:	1.257
Prob(Omnibus):	0.404	Jarque-Bera (JB):	1.415
Skew:	-0.119	Prob(JB):	0.493
Kurtosis:	2.411	Cond. No.	199.

Source: authors' calculations based on Python 3.4 program.

structed a linear regression and estimated the coefficients by choosing only the parameters whose admissible interval did not include 0 with a probability of 90% (*Table 1*).

$$FSI = F (PRP + ROEnv + FOORPRINT + + BIOCAPACITY + CR + ROS + ROCE + ROE + + EBIT).$$

The following factors affect the FSI: production-to-reserves ratio (PRP), return on equity, EBIT, environmental footprint, biocapacity, costs concerning environmental protection and decision of pollution question/ production, current assets / current liabilities, return on sales, and return on capital employed.

The authors found the residuals and built autoregression. You can see the actual data reduced by the modelling data (*Fig. 2*). Then, the authors checked the residuals of the data not recognized after Lasso regression. Autoregression is applicable for stationary residuals. We consider the Dickey-Fuller tests for the hypothesis that the data (residuals) are non-stationary. The authors intend to apply the SARIMA model to the residuals, and therefore, the simulation should show that the data in the form of noise fluctuate around zero. If not, the data are not stationary, and the SARIMA model will not show consistent results.

The Dickey-Fuller tests suggest that the observed series is described by a finite-order autoregressive model. The Dickey-Fuller test is: p = 0.000 098. If the Dickey-Fuller test p is less than 0.05, then the residuals are random and we can use the SARIMA model (*Fig. 3*).

We will do a visual search for autocorrelations and correlations in differences. The division on the right is an offset by one period back. If the black rod goes beyond the blue zone (error), then autocorrelation in the data is possible for this period. Thus, we made sure that we have autocorrelation in the data, and we can analyze the

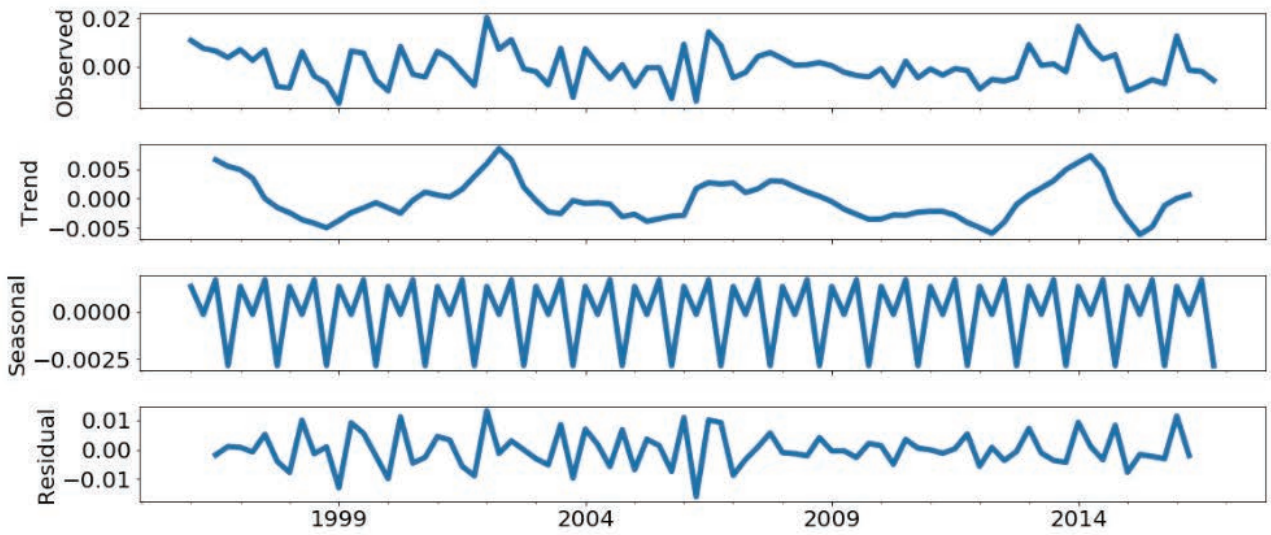

Fig. 2. **Structure of residuals after regression analysis**

Source: authors' calculations based on Python 3.4 program.

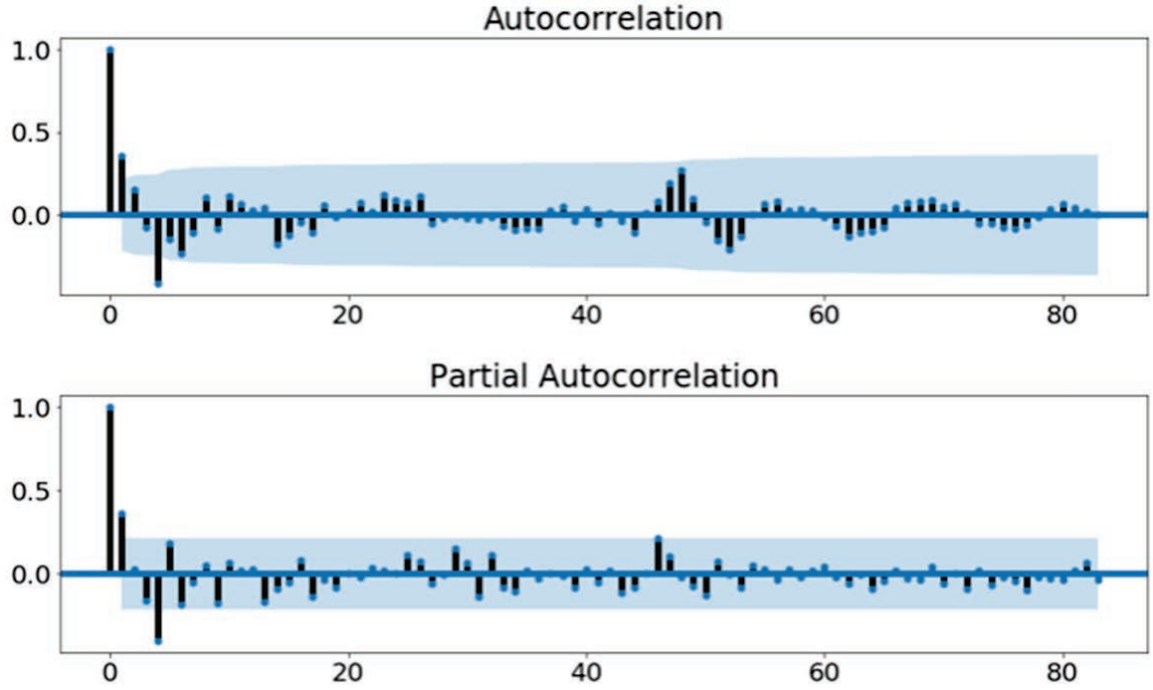

Fig. 3. **Significance of autocorrelation components**

Source: authors' calculations based on Python 3.4 program.

data using autoregressive analysis of residuals. If everything is in the blue zone, SARIMA autoregression will not result in anything.

Next, we select the optimal parameters of the SARIMA model by the Akaike information criterion (AIC). *Fig. 5* shows its parameters. *Table 2* shows the analysis results of the residuals.

Student's t-test: p = 0.907 407.

Dickey-Fuller test: p = 0.000 000.

The residuals are not biased (confirmed by the Student's t-test, p> 0.05 — the hypothesis of unbiased residuals is not rejected), the residuals have a stationary position (confirmed by the Dickey-Fuller test, p <0.05, the hypothesis of non-stationary residuals is rejected), they are not autocorrelated (confirmed by the Ljung-Box test, p> 0.05, — the hypothesis of the absence of autocorrelation is not rejected, there are no

Table 2

SARIMA model parameters for FSI model (Russia)

Statespace Model Results

Dep. Variable:	FSI	No. Observations:	84
Model:	SARIMAX(1, 0, 0)x(0, 0, 2, 4)	Log Likelihood	295.362
Date:	Sun, 03 Feb 2019	AIC	-582.724
Time:	12:57:40	BIC	-573.000
Sample:	01-01-1996 - 10-01-2016	HQIC	-578.815
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	0.4852	0.098	4.960	0.000	0.293	0.677
ma.S.L4	-0.5355	0.104	-5.162	0.000	-0.739	-0.332
ma.S.L8	0.3825	0.083	4.604	0.000	0.220	0.545
sigma2	5.032e-05	9.01e-06	5.584	0.000	3.27e-05	6.8e-05

Ljung-Box (Q):	38.06	Jarque-Bera (JB):	1.20
Prob(Q):	0.56	Prob(JB):	0.55
Heteroskedasticity (H):	0.69	Skew:	0.29
Prob(H) (two-sided):	0.34	Kurtosis:	2.90

Source: authors' calculations based on Python 3.4 program.

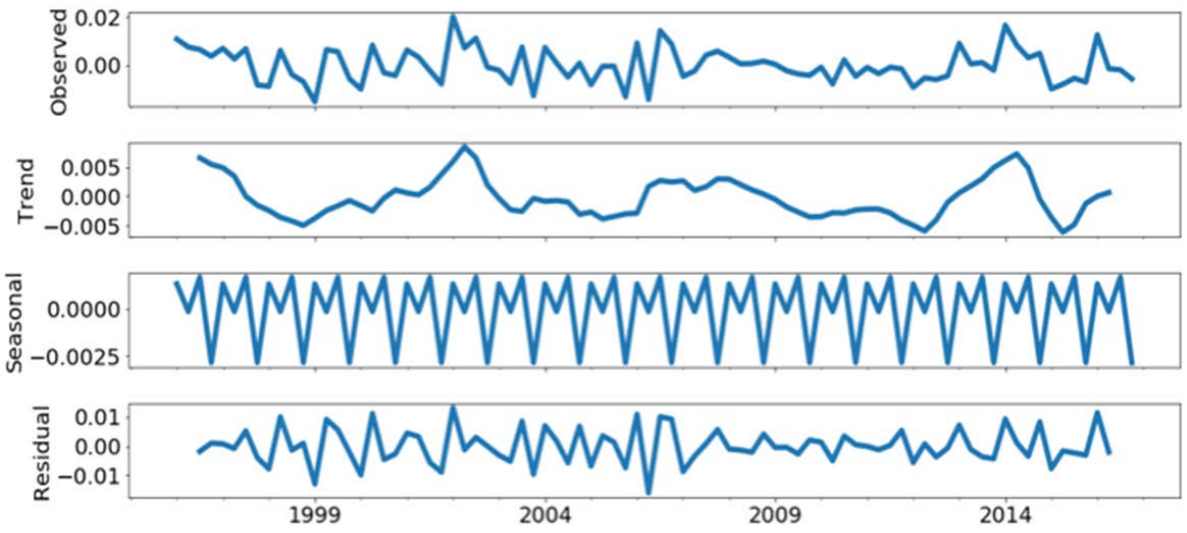

Fig. 4. **Analysis of residuals after the SARIMA model**

Source: authors' calculations based on Python 3.4 program.

significant dependences in the correlogram). We extracted all autoregressions. The residuals are heteroskedastic (*Fig. 4*).

As seen from the diagram, the residual distribution seems to be normal. Therefore, we can conclude that their further analysis will not bring results (*Fig. 5*).

Fig. 6 shows that the FSI is stable throughout the forecast period. However, according to the goals of the Energy Strategy of Russia for the period up to 2030 (ESRF, 2017), the average FSI level in Russian companies should increase to the level of 0.5–0.6. The authors' forecast does not confirm this statement. As we can see, with

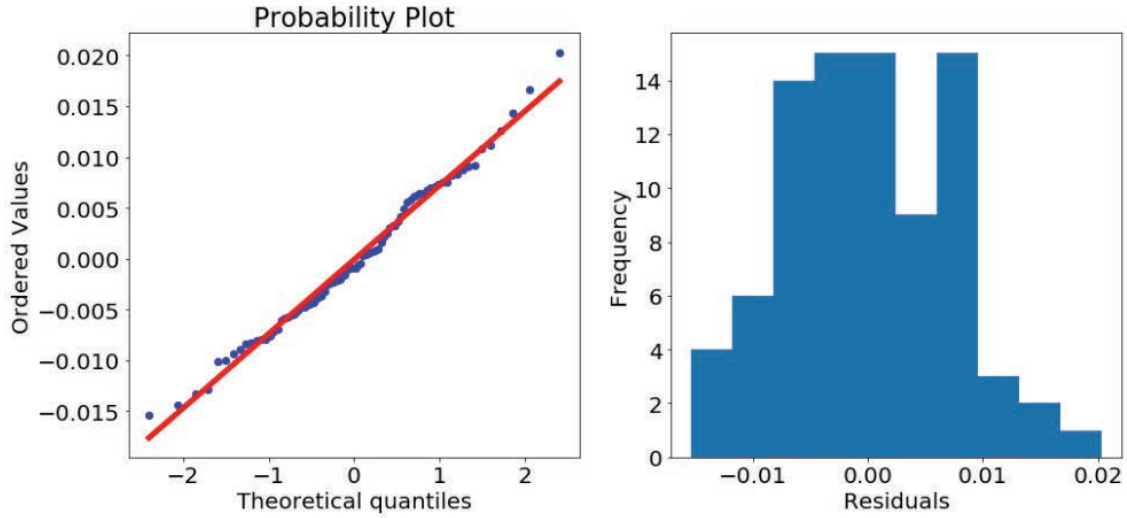

Fig. 5. **Estimated residuals distribution**

Source: authors' calculations based on Python 3.4 program.

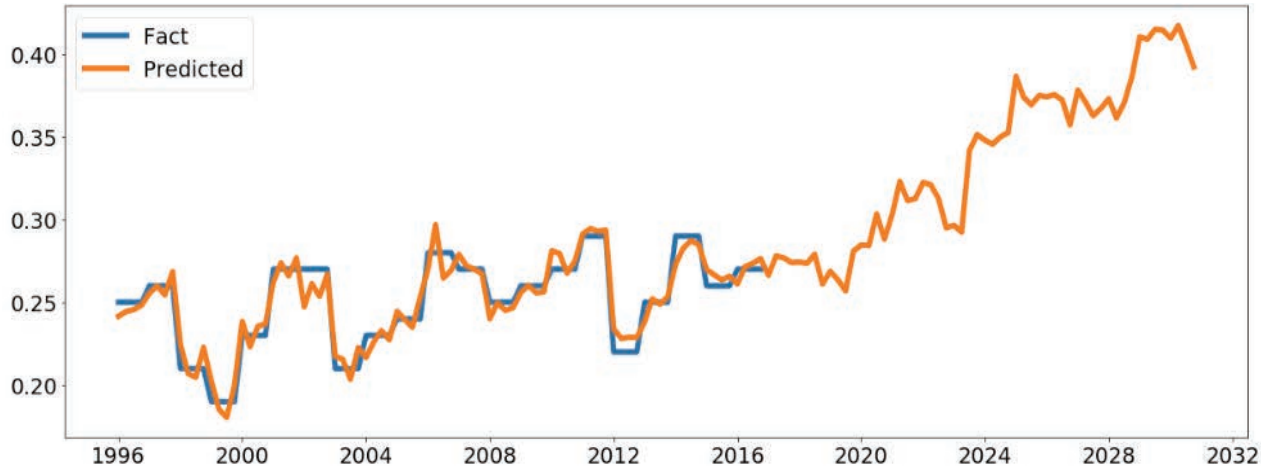

Fig. 6. **Forecast of financial sustainable growth until 2030 (Russian oil and gas industry)**

Source: authors' calculations based on Python 3.4 program.

regard to factors affecting the systemic financial sustainable growth index, there is a 90% probability that financial factors have the greatest impact on the system as a whole.

The authors identified external factors from the list of indicators used in this study to calculate the sustainability of the system.

Yparams = ['PRP','ROEnv','ER','FOORPRINT','BIOCAPACITY','ROEsr','DER',

xx = list (set. Intersection (set (Xparams), set (Yparams))).

Figure 7 clearly shows that the system is stable (sustainable) throughout the entire period. The value of the FSI criterion is primarily determined by external factors. The internal factors are in the negative zone. This indicates that the system seeks to reduce the value of the criterion, but the external environment does not let to do this. Accordingly, if the environment changes the FSI value can change dramatically. The system is balanced for Russian oil and gas companies.

Modelling results of financial sustainable growth index (FSI) for Chinese oil and gas companies

The authors determined the parameters that most affect the financial sustainable growth index by means of Lasso regression. Then, we constructed

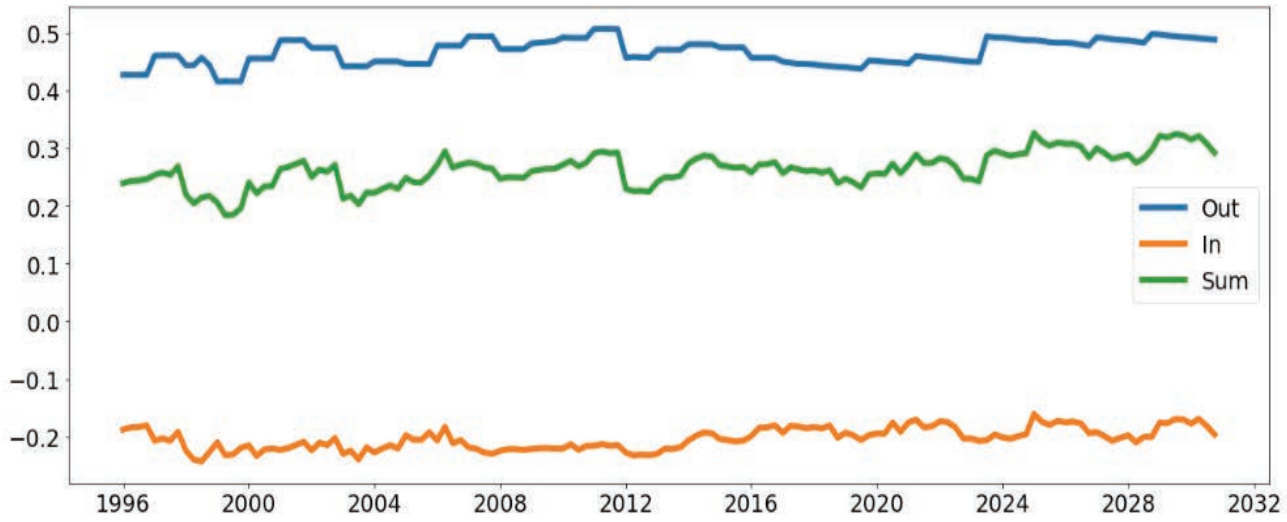

Fig. 7. **Impact of environmental factors (Out) and internal characteristics (In) of the system on the financial sustainable growth index**

Source: authors' calculations based on Python 3.4 program.

Table 3

Linear regression results (factors influencing SGI Higgins)

Dep. Variable:		FSI	R-squared:			0.711
Model:		OLS	Adj. R-squared:			0.671
Method:		Least Squares	F-statistic:			4191.
Date:		Sun, 03 Feb 2019	Prob (F-statistic):			1.62e-97
Time:		21:03:51	Log-Likelihood:			234.01
No. Observations:		84	AIC:			-446.0
Df Residuals:		73	BIC:			-419.3
Df Model:		10				
Covariance Type:		HC1				
	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.1013	0.007	13.518	0.000	0.087	0.116
ES	0.0502	0.017	3.040	0.002	0.018	0.083
ROEnv	-0.1683	0.025	-6.652	0.000	-0.218	-0.119
ER	-0.0554	0.013	-4.362	0.000	-0.080	-0.031
BIOCAPACITY	0.1013	0.007	13.518	0.000	0.087	0.116
ROEsr	-0.0380	0.014	-2.635	0.008	-0.066	-0.010
CR	0.1330	0.014	9.290	0.000	0.105	0.161
NWCT	0.0380	0.004	10.247	0.000	0.031	0.045
ROS	-0.1155	0.013	-8.839	0.000	-0.141	-0.090
WACC	-0.1526	0.016	-9.358	0.000	-0.185	-0.121
RG	0.0131	0.005	2.620	0.009	0.003	0.023
NPG	-0.0900	0.007	-12.196	0.000	-0.104	-0.076
Omnibus:		13.858	Durbin-Watson:			1.213
Prob(Omnibus):		0.001	Jarque-Bera (JB):			51.282
Skew:		0.116	Prob(JB):			7.31e-12
Kurtosis:		6.821	Cond. No.			1.54e+16

Source: authors' calculations based on Python 3.4 program.

a linear regression and estimated the coefficients by choosing only the parameters whose admissible interval did not include 0 with a probability of 90% (*Table 3*).

FSI = F (ES + ROEnv + ER + BIOCAPACITY + + ROEsr + CR + NWCT + ROS + WACC + RG + NPG),

Xparams = ['ES', 'ROEnv', 'ER', 'BIOCAPACITY', 'ROEsr', 'CR', 'NWCT', 'ROS', 'WACC', 'RG', 'NPG'].

The following factors affect the FSI: energy savings, environmental costs, current assets / current liabilities, net working capital turnover, return on sales, weighted average cost of capital,

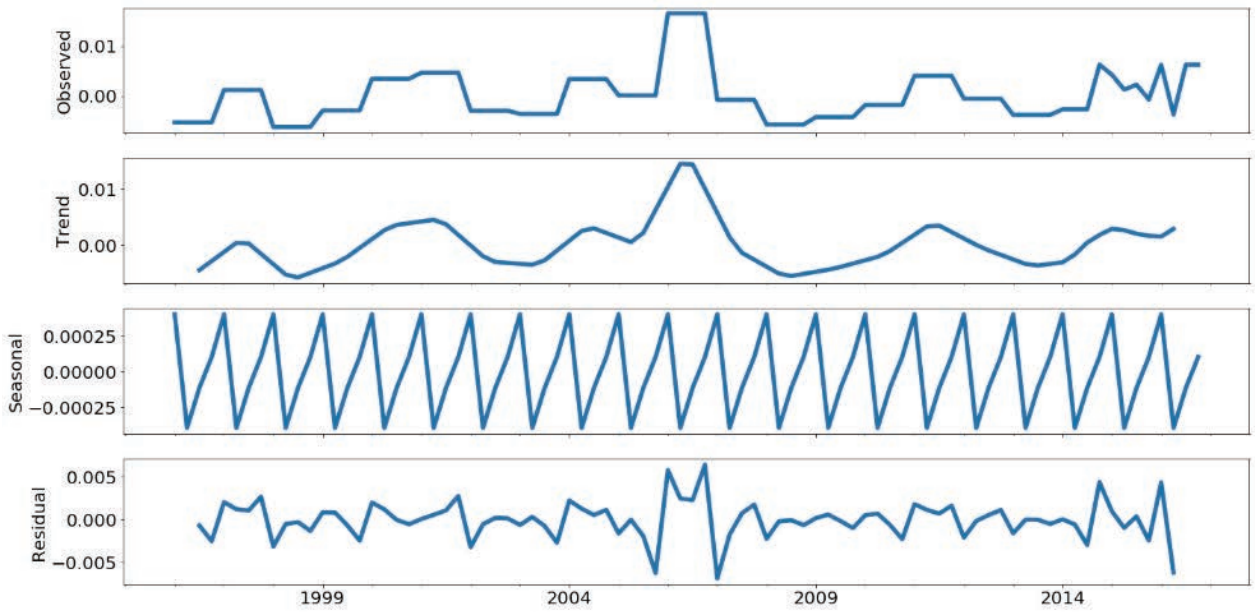

Fig. 8. **The residual structure after regression analysis**

Source: authors' calculations based on Python 3.4 program.

increase of a company's sales when compared to a previous quarter's revenue performance, increase of a company's net profit when compared to a previous quarter's net profit performance, environmental footprint, biocapacity, costs concerning employee benefits / net profit.

The authors found the residuals, built autoregression and revealed the actual data reduced by the modelling data (*Fig. 8*). Then, the authors checked the residuals of the data not recognized after Lasso regression. Autoregression is applicable for stationary residuals. We consider the Dickey-Fuller tests for the hypothesis that the data (residuals) are non-stationary. The authors intend to apply the SARIMA model to the residuals. The model should show that the data in the form of noise fluctuate around zero. If not, the data are not stationary, and the SARIMA model will not be effective.

Dickey-Fuller test: $p = 0.000098$.

Dickey-Fuller test $p < 0.05$, then the residuals are random and the simulation in SARIMA can be used.

The authors did a visual search for autocorrelations and correlations in differences. The division on the right is an offset by one period back. If the black rod goes beyond the blue zone (error), then autocorrelation in the data is possible for this period. Thus, we made sure that we have autocorrelation in the data, and we can analyze the data using autoregressive analysis of residuals. If everything is in the blue zone, SARIMA autoregression will not result in anything (*Fig. 9*). Next, we select the optimal parameters of the SARIMA model by the Akaike information criterion (AIC). *Fig. 13* shows its parameters. *Table 4* shows the analysis results of the residuals.

Student's t-test: $p = 0.998\,415$.

Dickey-Fuller test: $p = 0.000\,000$.

The residuals are not biased (confirmed by the Student's t-test, $p > 0.05$,— the hypothesis of unbiased residuals is not rejected), the residuals are stationary (confirmed by the Dickey-Fuller test, $p < 0.05$,— the hypothesis of non-stationary residuals is rejected), they are not autocorrelated (confirmed by the Ljung-Box test, $p > 0.05$,— the hypothesis of the absence of autocorrelation is not rejected, there is a slight distant correlation in the correlogram). We extracted all autoregressions. The residuals are homoskedantic (*Fig. 10*).

As seen from the diagram, the residual distribution seems to be normal. Therefore, we can conclude that their further analysis will not bring results (*Fig. 11*).

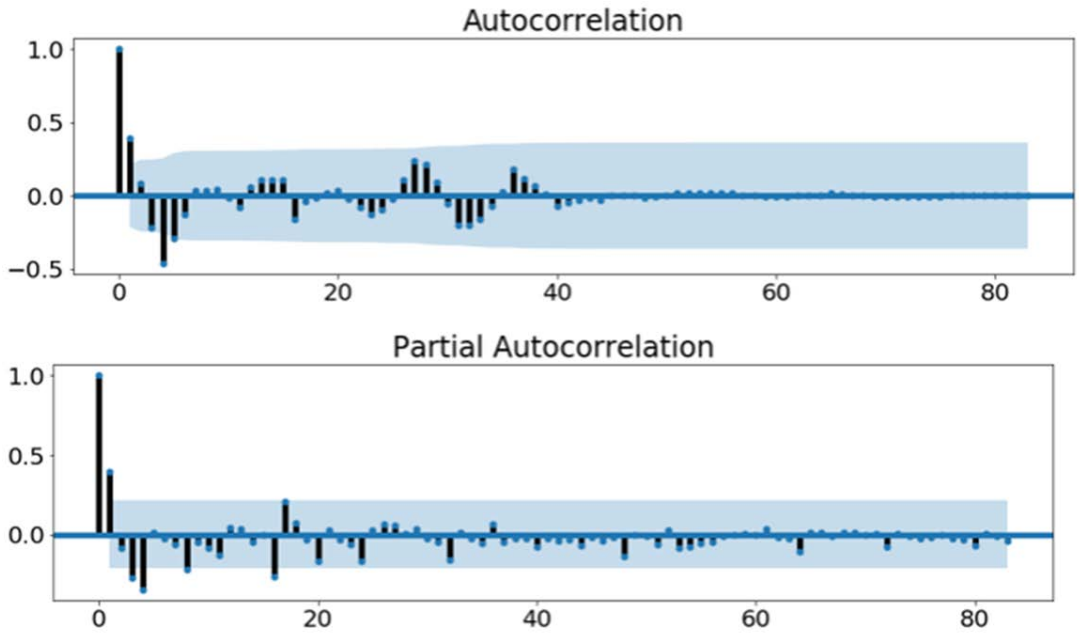

Fig. 9. **Significance of autocorrelation components**

Source: authors' calculations based on Python 3.4 program.

Table 4

SARIMA model parameters for FSI model (China)

Dep. Variable:		FSI	No. Observations:		84
Model:	SARIMAX(1, 0, 0)x(1, 0, 0, 4)		Log Likelihood		247.865
Date:	Sun, 03 Feb 2019		AIC		-489.729
Time:	21:09:40		BIC		-482.437
Sample:	01-01-1996		HQIC		-486.798
	- 10-01-2016				
Covariance Type:	opg				

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	0.3133	0.051	6.195	0.000	0.214	0.412
ar.S.L4	-0.3898	0.106	-3.665	0.000	-0.598	-0.181
sigma2	0.0002	1.17e-05	13.613	0.000	0.000	0.000

Ljung-Box (Q):	36.51	Jarque-Bera (JB):	216.00
Prob(Q):	0.63	Prob(JB):	0.00
Heteroskedasticity (H):	1.20	Skew:	-0.25
Prob(H) (two-sided):	0.63	Kurtosis:	10.84

Source: authors' calculations based on Python 3.4 program.

Fig. 12 shows that the FSI is relatively stable from 2005 to 2017 and can remain at the level of 2017 until 2024. If no prevention measures are taken, the financial sustainability of China's oil and gas complex may be severely destroyed by 2030. The authors suggest developing the environmental and social systems to maintain financial sustainability. It is necessary to give special consideration to such indicators as PRP, ROEnv, ER, FOORPRINT, BIOCAPACITY, ROEsr, DER.

The external environment of the oil and gas complex of China should influence the positive development of the situation.

Yparams = ['PRP', 'ROEnv', 'ER', 'FOORPRINT', 'BIOCAPACITY', 'ROEsr', 'DER'].

xx = list (set. Intersection (set (Xparams), set (Yparams))).

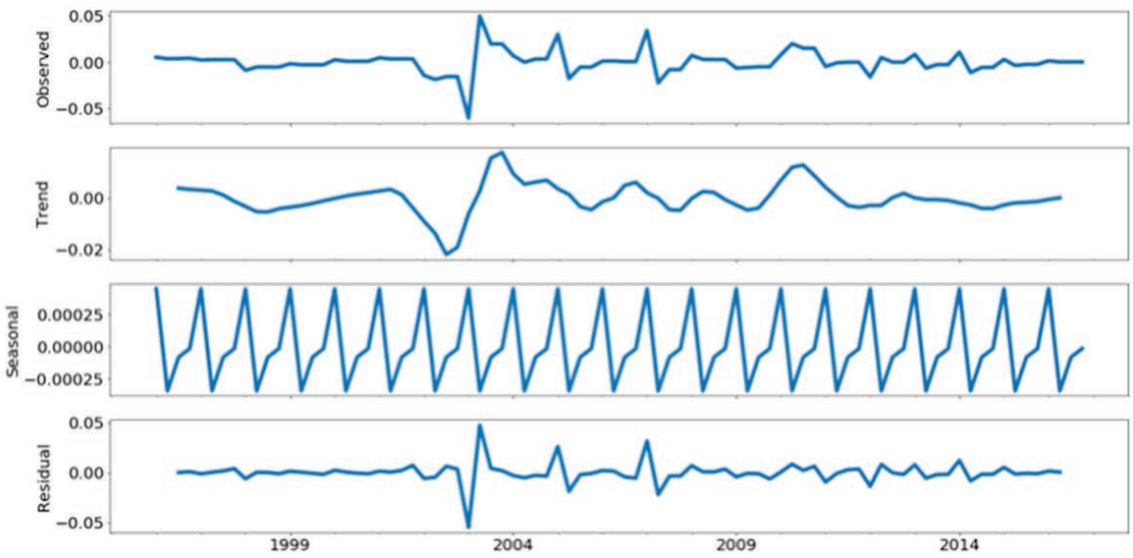

Fig. 10. **Analysis of residuals after the SARIMA model**

Source: authors' calculations based on Python 3.4 program.

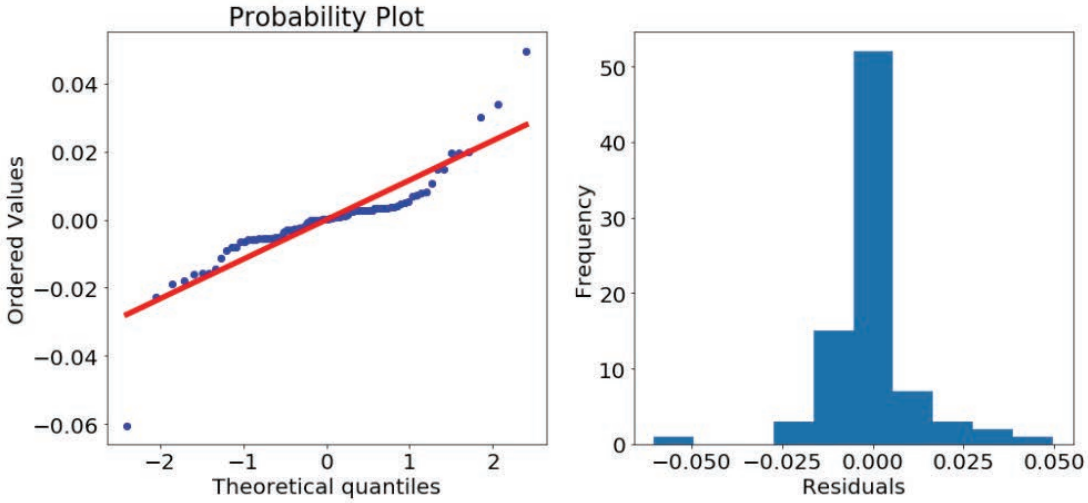

Fig. 11. **Estimated residuals distribution**

Source: authors' *calculations based on Python 3.4 program.*

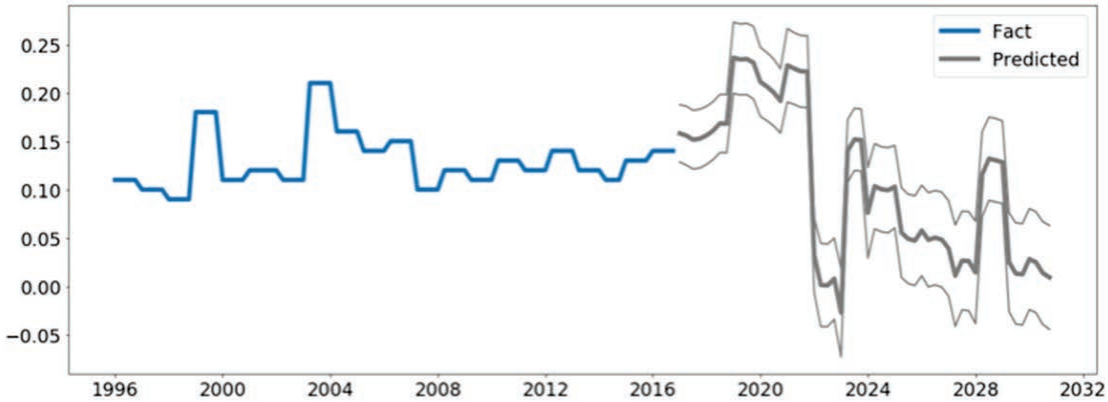

Fig. 12. **FSI forecast until 2030**

Source: authors' calculations based on Python 3.4 program.

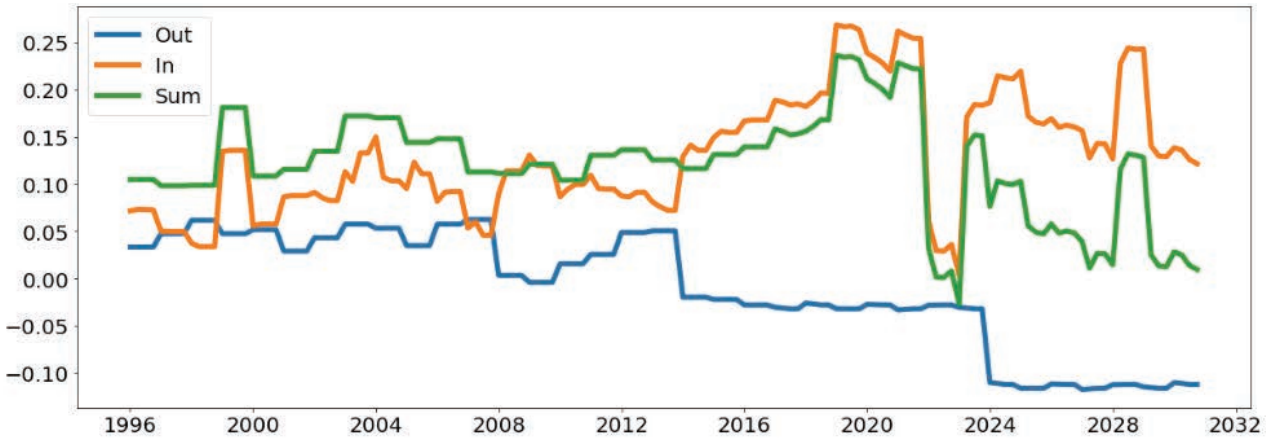

Fig. 13. **Impact of environmental factors (Out) and internal characteristics (In) of the system on the financial sustainable growth index**

Source: authors' *calculations based on Python 3.4 program.*

As follows from the data analysis, the FSI external component compensates for sudden changes of the internal component which ensured sustainability (*Fig. 13*). If the FSI external component does not respond to changes, the entire system will lose its balance. As seen from the figure, at present, the financial sustainable growth system of the oil and gas industry of China is unstable. However, the authors emphasize that this trend will not last long and will be replaced by sustainable growth. President of China Xi Jinping announced "eco-civilization" as a priority for the development of all sectors of the country's economy, including oil and gas. Currently, measures are being taken to introduce green finance at the oil and gas enterprises of the PRC, as well as measures aimed at ensuring green sustainable growth.

FINANCIAL SUSTAINABLE GROWTH STRATEGY 2030

Current priority areas of scientific, technical and sustainable development for the gas industry in Russia and China are multidimensional and polycentric studies. Similarly, financial analysis should base on linear and multidimensional spaces. Multidimensional financial analysis should be especially developed in oil and gas companies, since they are the driver of social progress.

In Russia, the concept of "financial sustainable growth" is associated solely with finance. Western and Chinese researchers also associate it with the welfare of society, environmental protection, and energy efficiency [1, 14–18]. This study proved the influence of the factors on the financial sustainable growth of Russian and Chinese oil and gas companies.

The authors analyzed the impact of the factors on the financial sustainable growth of Russian oil and gas companies whose FSI level is stable until 2030. According to the goals of the Energy Strategy of Russia for the period up to 2030[4], the average FSI level in Russian companies should increase to 0.5–0.6. The authors' forecast does not confirm this. As we can see, there is a 90% chance that in Russia the FSI is only affected by financial factors.

According to the goals of the energy strategy of China, Chinese oil and gas companies should on average achieve the sustainable growth index of 0.4–0.5 by 2030. The authors' forecast does not confirm this either. Chinese oil and gas companies will develop the impact of financial factors on the environment due to the unfavorable environmental situation in China; progress furthers in that direction.

[4] Draft Energy Strategy of the Russian Federation until 2035 (edited on 01.02.2017). URL: https://minenergo.gov.ru/node/1920 (accessed on 24.05.2019).

Since the financial sustainable growth systems of gas companies in the Russian Federation and the PRC have low indicators, it is necessary to identify potential obstacles to high indicators.

The main obstacle in the Chinese gas industry is the low level of social indicators and its dominating financial component. It is necessary to promote the social responsibility of gas corporations, to redistribute and emphasize the growth strategy from finance to "green", "social" and "energy" finance [6].

In the Russian gas industry, insufficient investment in environmental protection prevents high rates of financial sustainable growth [1]. The following needs to be done: to encourage state corporations to purchase from a supplier with an environmental certification, to increase investment in environmental projects. Besides, it is necessary to regulate this issue at the state level and introduce high taxes on manufacturing that can harm the environment.

The content analysis of the developed models made it possible to formulate quantitative assessments of the sustainability factors for the financial growth of the oil and gas industry. The assessments expand the scientific and methodological basis for its developing sustainability prospects, identify major development patterns and replenish the tools for strategic decisions:

- ensuring adequate financing of environmental protection measures, social responsibility and increasing energy efficiency and energy intensity as a condition for financial sustainable growth;
- maintaining financial statements in the context of financial sustainable growth system, focusing on non-financial indicators affecting most on financial sustainable growth;
- using integrated system indicators for assessing financial sustainable growth.

In the future, the authors see a continuation of the research in identifying the directions of the system parameters ensuring financial sustainable growth.

CONCLUSIONS

It is obvious that the relationship between sustainable growth and the financial strategy of gas companies should be closer. Non-financial factors and their impact on the sustainable growth index must be considered as an integral part of the stability analysis of the financial system as a whole. The proposed research hypothesis is based on the interconnection analysis of the financial sustainable growth subsystems. The transversal relationships between subsystems were confirmed.

The article considers the financial sustainable growth system evidenced from the gas companies of the Russian Federation and the PRC. The indicators that most influence and predetermine financial sustainable growth were justified. The relationships between the economic processes included in the subsystems were analyzed. As part of the proposed methodological approach, the original SARIMA model was built. The model explains the internal structure of the financial growth sustainability of the oil and gas industry in Russia and China:

1. Graphic and algebraic visualization in form of dynamic graphs.
2. The financial sustainable growth structure of the gas industry providing a picture of the financial, energy, environmental and energy factors affecting each other.
3. Typical trends in the financial sustainable growth in the oil and gas industry in Russia and China showing similar and different trends.

The research results in Russian gas companies reveal close links between energy, social and financial indicators, and no links between financial and environmental indicators. The situation for Chinese gas companies is the opposite: their financial indicators are more closely related to environmental and energy indicators. The links between financial and social indicators are not visualized.

Due to tobvious environmental problems in China, more attention is paid to ecology. At the 18th Party Congress, Chinese President Xi Jinping announced eco-civilization as a priority for the Chinese society. Russian oil and gas compa-

APPENDIX

Table

Research Indices' List

Subsystem name	Index	Name	Proxy	Calculation method
Sustainable Growth Index	Sustainable Growth Index	Higgins Sustainable Growth Index	SGR(H)	RM×AT×FL×R
Financial Indicators	Earnings before interest and tax	Earnings before tax	EBIT	Earnings before interest and taxing
	Return on Assets	Return on assets ratio	ROA	(EBIT/Total Assets)×100%
	Return on Sales	Return on sales ratio	ROS	Return on sales
	Return on Equity	Return on equity ratio	ROE	Net income/Equity
	Return On Capital Employed	Return on capital employed ratio	ROCE	EBIT / (Total Assets-Current Liabilities)
	Return on Fixed Assets	Return on fixed assets ratio	ROFA	EBIT / Fixed Assets
	Net working capital	Net working capital	NWC	Current assets-current liabilities
	Net working capital turnover	Net working capital turnover	NWCT	Revenue / Current Assets
	Current Ratio	Current ratio	CR	Current assets / current liabilities
	Revenue growth	Revenue growth	RG	An increase of a company s sales when compared to a previous quarter s revenue performance
	Net profit growth	Net profit growth for the period	NPG	An increase of a company s net profit when compared to a previous quarter s net profit performance
	Net assets growth	Net assets growth for the period	NAG	An increase of a company s net assets when compared to a previous quarter s net assets performance. Net assets = Total assets-Total Current liabilities
	Financial leverage	Financial leverage	FL	Total Assets/Equity
	Operation leverage degree	Operation leverage degree	DOL	% change in EBIT / % change in Revenue
	Debt equity ratio	Debt equity	DER	Total liabilities / Equity. Total liabilities = Equity-Assets
	Weighted Average Cost Of Capital	Weighted Average Cost Of Capital	WACC	WACC = rE × kE + rD × × kD × (1 – T)
Energy Indicators	Energy Indicators	Lambert Energy Index	LEI	Lambert Energy Index [13]
		Energy savings	ES	Energy Savings

End of Table

Subsystem name	Index	Name	Proxy	Calculation method
Environmental Indicators	Environmental indicators	Environmental costs	ROEenv	ROEnv = costs concerning environmental protection and decision of pollution question/ production
	Environmental rating	Environmental rating	ER	Rating of oil and gas companies according to the results of environmental policy implementation
	Production/Reserves ratio	Production/Reserves ratio	PRP	Production/Reserves ratio
	Footprint	Environmental footprint	FP	Environmental footprint
	Biocapacity	Biocapacity	BC	Biocapacity
Social Indicators	Revenue per employee ratio	Revenue per employee	RER	Total Revenue / Total Number of Employees
	Return on social expences	Return on social expences	ROEsr	Costs concerning employee benefits / net profit
	Return on Labour	Return on Labour	ROL	Costs concerning employee salary / net profit

nies focus primarily on their social responsibility to society.

The following factors affect the sustainable growth index in Russian oil and gas companies: production-to-reserves ratio (PRP); return on environmental costs (ROEenv), Return on sales (ROS), Return on equity (ROE), Return on fixed assets (ROFA); environmental footprint (FP), biocapacity (BC) current assets / current liabilities (CR), earnings before interests and tax (EBIT). The following factors affect the sustainable growth index in Chinese oil and gas companies: energy savings (ES); production-to-reserves ratio (PRP); return on environmental costs (ROEenv), Return on employees (ROL), Return on sales (ROS); biocapacity (BP); current assets / current liabilities (CR); net working capital capital turnover (NWC); weighted average cost of capital (WACC); revenue growth dynamics (RG) and net profit dynamics (NPG).

Based on the study results, the authors highlight how the sustainable growth system transforms and adapts to the specific needs of Russian and Chinese gas companies. It is a living organism requiring a multi-vector, complex financial analysis. One should carefully analyze non-financial factors that may affect the whole system.

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Kleiner G.B.— general conclusions and recommendations for improving the Russian oil and gas companies' sustainable financial growth system.
Bragina Z.V.— methodological base for the financial sustainable growth system.
Denisov A.R.— modelling processes in the Python program.

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ORIGINAL PAPER

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Investment Potential of the Manufacturing Industry*

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ABSTRACT

The article considers investment in fixed assets of the manufacturing industry as one of the main factors of its development. The manufacturing industry is shown to be the growth driver of national economy for developed and developing countries. The analysis of exports and imports of the first 15 countries in the ranking in terms of gross domestic product calculated at purchasing power parity (GDP at PPP) shows the leading role of the manufacturing industry in the global economy. At the same time, competitiveness in the global market is determined by high-tech products. Therefore, for the sustainable development of the Russian economy, it is necessary to create investment conditions for the advanced development of high-tech segments of the manufacturing industry. However, the current structure of investments in fixed assets contributes to the development of such services sector segments as "Transportation and storage", "Real estate operations". In the structure of investments in fixed assets, the largest share belongs to investments in buildings and structures, and intellectual property items account for no more than 10%. It is shown that the lack of investment resources is the main reason for the reduction (by 1.5 times) of the contribution to the value added of the manufacturing industry in Russia, production of machinery and equipment. This leads to an increase in dependence on imports, a fall in the share of products from high-tech sectors. To analyze the development potential of manufacturing industries, the authors introduced an indicator of investment intensity per 100 rubles of shipped industrial products. It was determined that enterprises with a joint Russian and foreign form of ownership lead in terms of investment intensity. At the same time, private enterprises, leading in terms of output, demonstrate weak investment activity. The low investment attractiveness of high-tech manufacturing sectors is shown. The regional structure of the manufacturing industry was analyzed. There is a high level of regional concentration of the manufacturing industry in Russia. At the same time, the authors show its relatively weak significance in the structure of the gross regional product in the majority of the constituent entities of the Russian Federation. It has been proposed to develop a program at the federal level for the advanced development of production in the high-tech and medium-technology high-level sectors for 10–15 years. It is proposed to create a supra-departmental executive authority to manage this program.

Keywords: manufacturing industry; high-tech sector; investment; GDP; fixed assets; financial performance; productivity; exports; imports; competitiveness in the labor market

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INTRODUCTION

According to economic science, today investment is one of the main factors in the development of the national economy in both developed and developing countries, and the manufacturing industry is its growth driver[1] [1, 2]. This statement is confirmed by the World Bank statistics. In countries leading by GDP at PPP and steadily developing countries such as China, India, Korea, Turkey, the share of investment in fixed assets is 41.9%, 28.5%, 31.1% and 30% respectively. At the same time, in 2017, the economic growth rates were 106.9%, 106.7%, 103.1% and 107.4% respectively.

In the eurozone countries, the share of investments averaged 20.4%, while the growth rate was 102.4%. The economic growth leaders in the Eurozone are the countries with a large share of investment in fixed assets. It should be noted that in developed countries economic growth rates on par with Russia are achieved with lower share values of investments in fixed assets in GDP, for example, 17.5% in Italy. There are few cases when high rates of economic growth were achieved with relatively small share values of investments in fixed assets [3].

The contribution of the manufacturing industry to Russia's GDP is only 13.5%. At the same time, in the economies of Germany, China and South Korea, this value is 20%, 30% and 28% respectively. Moreover, the economies of these countries are developing steadily, despite the turbulent dynamics of the global economy. In 2014–2017, GDP growth rates, on average, were 2%, 7% and 3%[2] respectively. There was a decline during this period in Russia, and in 2017–2018, the growth rate was approximately 1.5%[3].

[1] United Nations Industrial Development Organization, 2013. Industrial Development Report 2013. Sustaining Employment Growth: The Role of Manufacturing and Structural Change. Vienna. URL: https://www.unido.org/sites/default/files/2013–12/UNIDO_IDR_2013_main_report_0.pdf (accessed on 22.04.2019).

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[3] Rosstat official website. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/accounts/# (accessed on 06.05.2019).

Table 1 presents the data on the manufacturing industry contribution to the total exports of the 15 top countries in the ranking by GDP at PPPs.

It should be noted that together these countries produce 75% of the world GDP. Industrial products play a major role in their total exports. The analysis shows that in eight countries, manufactured products make up more than 80% of exports, in three countries they exceed or equal to 70%, and in the United States they are 62%. Only in three countries (Russian Federation, Brazil and Indonesia) industrial products do not make up the bulk of total exports.

High-tech and mid-tech manufacturing sectors account for 40–60% of the manufacturing exports of leading countries. The main share in the import of goods of these countries (60–80%) is also made by the manufacturing industry products. Thus, the manufacturing industry makes a major contribution to the world trade structure.

INVESTMENT POTENTIAL OF SEGMENTS OF THE RUSSIAN ECONOMY

Studying the conditions to build the investment potential of the manufacturing industry and its utility effectiveness will help to identify areas for improving the institutional support mechanisms for the sustainable and balanced development of the Russian economy. In this paper, for a quantitative analysis, the investment potential of various segments of the domestic economy will be estimated by the ratio of the value of investments in fixed assets of a certain segment of the economy to the gross value added produced in this segment. *Table 2* shows the corresponding values of this ratio for the segments of the economy, whose total contribution in 2016–2017 amounted to about 60–63% of the gross domestic product. This list includes segments of industry, construction and leading segments of the service sector.

Table 2 data analysis proves that the *Mining* is the most rapidly growing segment of the Russian economy in the reporting period. Its contribution to GDP increased by 1.1%. The contribution

Table 1

The contribution of the manufacturing industry to the export of goods and services of leading countries 2018

Place in the ranking of countries by PPP GDP	Country	Manufactures exports (% of merchandise exports)
1	China	93.6
2	USA	61.9
3	India	70.7
4	Japan	88.1
5	Germany	84.9
6	Russia	22.3
7	Indonesia	43.6
8	Brazil	37.6
9	Great Britain	76.7
10	France	80.3
11	Mexico	82.1
12	Italy	83.5
13	Turkey	80.2
14	South Korea	89.5
15	Spain	69.4

Source: compiled by the authors based on data from the International Monetary Fund and World Bank.

of remaining segments slightly changed. At the same time, the *Wholesale and retail trade; repair of motor vehicles and motorcycles* segment makes the greatest contribution. Thus, the Russian economy structure does not create conditions for sustainable development. The share of manufacturing industry is only 13.5%. It is mainly formed due to the production of medium-tech and low-tech level sectors [4]. This statement is correct for the *Transportation and storage* and *Real estate activities* segments. For this reason, the investment potential of these segments has little effect on the increase in value added.

The literature shows that in developed countries the investment potential is on average at the level of 20% [5]. It contributes to the formation of 2/3 of the GDP growth, since the high-tech and medium-tech high-level sectors contribute the most making up together about 47%[4] [6, 7].

As shown above, in the top 15 countries in the GDP ranking, medium and high technologies contribute more than 50% to the GDP of the manufacturing industry. In Russia they contribute no more than 25%, and the products of these sectors mainly build the export potential of developed countries.

It should be noted that a sufficiently high investment potential in the *Transportation and*

[4] United Nations Industrial Development Organization, 2015. Industrial Development Report 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development. Vienna. URL: https://www.unido.org/sites/default/files/2015–12/EBOOK_IDR 2016_FULLREPORT_0.pdf (accessed on 22.04.2019).

Table 2

The share of investment in GDP segments of the Russian economy

	Contribution to GDP, %		Share of investment in the sector's GDP, %	
	2016	2017	2016	2017
Mining and quarrying	9.6	10.7	36.4	33.9
Manufacturing	13.4	13.5	20.3	20.4
Construction	6.4	6.1	8.9	10.1
Wholesale and retail trade; repair of motor vehicles and motorcycles	14.7	14.5	5.6	5.4
Transportation and storage	7.2	7.1	43.3	45.0
Real estate activities	10.1	9.9	33.2	32.0

Source: Rosstat data and the authors' calculations.

storage and *Real estate activities* segments has little effect on the pace of their development. This is evidenced by the Rosstat data on investments and economic growth rates in 2014–2017 (*Table 2*). To a certain extent, this is due to the fact that the main focus of investments is not the acquisition of machinery and equipment, but the construction of buildings, structures, dwellings (*Table 3*).

The Rosstat data prove that the cost of machinery and equipment in the manufacturing industry is only 52% of the value of fixed assets. To be the growth driver of Russia's economic growth, it is necessary for the manufacturing industry that the cost of the machinery and equipment made a noticeably greater contribution to the total value of fixed assets of manufacturing industries. The opposite trend follows from the investment structure. It is aimed at increasing the value of buildings and structures. Moreover, only in 40% of organizations machinery and equipment are younger than 10 years; that is, the problem of production assets update is relevant. This conclusion is consistent with the survey of organizations on the objectives of investing in fixed assets. More than 60% of organizations use investments to replace worn-out machinery and equipment. In entrepreneurs' opinion, this is hindered by a lack of own financial resources, a high level of the commercial loan interest rate in the country and the uncertain economic situation. Besides, service enterprises are more economically efficient than manufacturing enterprises. There-

Table 3

Investments in fixed capital by types of fixed assets

	2010	2014	2015	2016	2017	2018
	Percent of total					
Total	100	100	100	100	100	100
including in:						
dwellings	12.2	14.5	15.6	15.4	14.3	13.6
buildings (except residential)and structures	43.3	40.8	43.7	45.2	45.2	43.8
machinery, equipment, means of transportation	37.9	36.3	31.5	30.6	31.8	33.7
other (including objects of intellectual property)*	6.6	8.4	9.2	8.8	8.7	8.9

* The share of investments in intellectual property does not exceed 3%.

Source: Rosstat data and the authors' calculations.

fore, the share of value added in the output for the manufacturing industry is 27%, and for the *Transportation and storage* and *Real estate activities* segments is 45% and 77% respectively. Thus, the current situation favors investment in the service sector to a greater extent than in the manufacturing industry.

Based on the results of the systematic studies initiated by the UNIDO, according to which the manufacturing industry is the growth driver of sustainable economic growth, it can be concluded that the domestic economy does not create conditions for sustainable growth and transition to a new technological structure[5] [8].

FINANCIAL AND ECONOMIC STATUS OF MANUFACTURING INDUSTRIES

Analysis of the investment distribution in fixed assets of the manufacturing industry by its various segments allows to identify the most attractive industries for the investor (*Table 4*) and thus, to determine their development potential.

The data in *Table 4* indicate that the investment attractiveness of manufacturing industries is practically correlated with the position of these industries in output. The sectors determining the technological development of the economy: production of computers, electronic and optical products; machinery and equipment; electrical equipment; medicines occupy positions below 10 out of 23 both in the ranking of investment and output. At the same time, investments in these sectors account for less than 2.5% of the total investment in the manufacturing industry. In general, the share of investments in the manufacturing industry in 1995–2017 was about 14.5%. Over this pe-

[5] United Nations Industrial Development Organization, 2013. Industrial Development Report 2013. Sustaining Employment Growth: The Role of Manufacturing and Structural Change. Vienna. URL: https://www.unido.org/sites/default/files/2013–12/UNIDO_IDR_2013_main_report_0.pdf (accessed on: 22.04.2019); United Nations Industrial Development Organization, 2015. Industrial Development Report 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development. Vienna. URL: https://www.unido.org/sites/default/files/2015–12/EBOOK_IDR 2016_FULL-REPORT_0.pdf (accessed on 22.04.2019).

riod, the share of investments doubled in such industries as production of coke and petroleum products, chemical production. The share of investments in metallurgy and the production of finished metal products almost did not change.

The share of investments in European industry is 15.3%, which is higher than the corresponding indicator in Russia, while in the countries of Eastern Europe (Hungary, Slovenia, Slovakia and the Czech Republic) it is about 25–28% [9]. It is not surprising that in developed countries with a stable economy, the contribution of the manufacturing industry into GDP is significant[6] [10].

Indeed, despite the global crisis of 2008, in Germany, France, Japan, South Korea in 2000–2012, the contribution to the value added of the manufacturing industry for the production of machinery and equipment increased respectively from 33% to 42%, from 26% to 31%, from 34% to 38% and from 41% to 48%[7]. In Russia, this indicator fell from 19 to 12% over the same period. Investments were directed mainly to the innovative development of production in the medium-tech low-level and low-tech sectors. Thus, the technological backwardness of the domestic economy from developed countries took place.

The analysis of the structure of the investments in fixed assets of the manufacturing industry by funding sources in 2016 shows that the organizations' own funds amounted to 70.3%, the attracted funds — to 29.7%, of which budget funds were 1.7%.[8]

The investments in fixed assets for the production of machinery and equipment (not including motor vehicles, trailers and semi-trailers), chemical and metallurgical industries in the total investment of the manufacturing industry are 6.8%, 19.9% and 13.2% respectively. Thus, the material and technical base of the manufacturing industry has the lowest level of investment.

However, the data on the specific balanced financial result (the balanced financial result per 1000 rubles of the shipped products cost) indicates that the production of computers, electronic and optical products and electrical equipment is quite efficient (*Table 4*). These industries occupy the 7th and the 9th places in the manufacturing industry, despite the fact that they are significantly inferior in terms of investment intensity. Production of tobacco products, metallurgical production and production of chemical products are leading in financial efficiency characterized by a specific balanced financial result.

Noteworthy is the relatively weak financial efficiency of the food industry. It is the 2nd in terms of cost of goods shipped.

Unprofitable manufacturing industries include, but are not limited to, production of machinery and equipment, vehicles and other finished products. Production of machinery and equipment is the most lagging behind, although its products largely determine the technological level of many segments in the Russian economy.

Development prospects for the Russian economy sectors are mainly determined by its competitiveness in the domestic labor market, largely characterized by the relative level of wages of its employees. In terms of wages, production of coke and oil products and production of tobacco products are leading among manufacturing industries (*Table 4*). Wages in these segments exceed wages in the production of machinery and equipment and electrical equipment segments by 2.5 times, and in the production of computers, electronic and optical products by 2 times. It should be noted that in 2010–2017, the indicated difference in wages practically did not change.

Currently, in the Russian economy segments making the largest contribution to GDP, a con-

[6] Forschungsunion, Acatech. Securing the future of German manufacturing industry. Recommendations for implementing the strategic initiative INDUSTRIE 4.0. Final report of the Industrie 4.0 Working Group. April 2013. URL: https://www.acatech.de/Publikation/securing-the-future-of-german-manufacturing-industry-recommendations-for-implementing-the-strategic-initiative-industrie-4–0/ (accessed on 22.04.2019).

[7] World Bank data. URL: https://databank.worldbank.org/data/reports.aspx?source=2&series=NV.IND.TOTL.ZS&country= (accessed on 06.05.2019).

[8] Rosstat official website. URL: http://www.gks.ru/free_doc/doc_2017/invest.pdf (accessed on 06.05.2019).

Table 4

Financial and economic condition of manufacturing industries

No.		Rating of manufacturing industries			Specific net financial result*	Index of wages**	
		by investment in fixed assets	by volume of shipped own-produced goods, works done and services performed	by net financial result		2010	2017
I	Manufacturing including:				59,25	1	1
1	manufacture of food products	4	2	4	39.16	0.85	0.78
2	manufacture of beverages	16	15	9	64.39	1.23	0.99
3	manufacture of tobacco products	18	22	13	172.19	2.56	2.46
4	manufacture of textiles	17	21	16	37.74	0.58	0.58
5	manufacture of wearing apparel	22	23	15	56.29	0.52	0.53
6	manufacture of leather and related products	23	24	20	–27.59	0.6	0.52
7	manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	8	16	18	4.26	0.67	0.67
8	manufacture of paper and paper products	9	14	6	101.16	1.08	1.03
9	printing and reproduction of recorded media	19	18	14	41.69	0.98	0.8
10	manufacture of coke and refined petroleum products	1	1	2	89.48	2.2	2.49

End of Table 4

11	manufacture of chemicals and chemical products	2	4	3	109.93	1.17	1.19
12	manufacture of basic pharmaceutical products and pharmaceutical preparations	14	17	8	108.77	1.14	1.41
13	manufacture of rubber and plastic products	13	11	12	37.10	0.83	0.8
14	manufacture of other non-metallic mineral products	11	8	11	27.94	0.94	0.8
15	manufacture of basic metals	3	3	1	143.76	1.34	1.29
16	manufacture of fabricated metal products, except machinery and equipment	6	5	7	25.43	0.92	0.93
17	manufacture of computer, electronic and optical products	10	9	5	76.51	1.07	1.22
18	manufacture of electrical equipment	15	13	10	47.6	0.96	0.94
19	manufacture of machineryand equipment n.e.c.	12	10	23	–162.38	1	0.97
20	manufacture of motor vehicles, trailers and semi-trailers	7	6	22	–30.86	0.94	0.99
21	manufacture of other transport equipment	5	7	19	1.04	1.18	1.17
22	manufacture of furniture	20	19	17	19.24	0.65	0.58
23	other manufacturing	21	20	21	–26.70	0.79	0.72
24	repair and installation of machinery and equipment	–	12	–	–	1.22	1.09

Note: * – Net financial result per 1000 rubles of the cost of goods shipped;
** – Index of average monthly nominal accrued wages of employees of organizations of various manufacturing industries.
Source: Rosstat data and the authors' calculations.

stant value of the share of wages in gross value added (about 40%[9]) has been established. However, the actual average monthly wage shows a noticeable difference in the Russian economy segments. For further analysis, the values of the average monthly nominal wages of employees of organizations, the average monthly wages in various segments of the economy were compared with the average monthly nominal wages of employees of organizations in the economy (*Table 5*).

Table 5 indicates that the wages in the manufacturing industry are more than 2 times different from the wages of employees in the financial and insurance sectors and in mining operations; they are 1.5 times different from the information and communication sectors. Besides, they are less than the wages of employees in the "Public administration and defence, compulsory social security".

In the ranking of economic sectors in terms of average monthly wages, the manufacturing industry occupied the 9th place in 2010, and the 8th place in 2017. In general, wages in the manufacturing industry stand at the level of the average wage in the Russian economy.

Thus, with the distribution of wage levels by segments of the economy, including manufacturing industries, serious problems arise in the effective use of human capital. The solution to the problem lies in the rapid development of high-tech manufacturing industries [11]. This will increase the gross value added produced by the real sector of the economy. However, it requires a marked rise in investment potential, at least up to 40–50% of the gross value added.

Further analysis shows the investment attractiveness of enterprises with different types of ownership (*Table 6*).

Table 6 presents the data on the intensity of investment in fixed assets of manufacturing enterprises. This indicator is determined by the ratio of investments in fixed assets of enterprises to the volume of output. The indicator measures investments per 100 rubles of manufactured products.

Table 6 indicates that the tactics of expanding production through investment in fixed assets gives maximum results in the chemical production sector. At the same time, joint Russian and foreign ventures and domestic private enterprises are leading. It should be noted that they produce 14% and 57% of the production sector respectively. Thus, in the sector as a whole, output will increase.

It is noteworthy that the highest investment values per 1 ruble of the cost of shipped products are observed at enterprises with joint Russian and foreign ownership. At the same time, domestic enterprises of a private type of ownership, the leaders in the share of output in various segments of the manufacturing industry, do not lead by the indicator mentioned above. In the other sectors presented in *Table 6*, they take 4–5th places by this indicator, but the production of rubber and plastic products.

Thus, the existing structure of investments in fixed assets of manufacturing enterprises does not fully contribute to the development of its various segments. The relatively weak investment activity of domestic enterprises of private ownership is apparently due to the low profitability of production because of its technological backwardness. Apparently, the source of financing at enterprises of joint Russian and foreign ownership is the parent company of foreign business participants in Russia. However, their interest in business development varies in different sectors of industry. Thus, enterprises of the production of electrical equipment, electronic and optical equipment sector have the lowest rate value of investment for enterprises of this ownership type. At the same time, their share in the output of this segment of the manufacturing industry is only 3%. Thus, foreign capital has little interest in the development of high-tech manufacturing sectors.

Let us calculate the share of gross value added in the output to characterize the economic efficiency of the production in various segments of the manufacturing industry (*Table 7*).

[9] Rosstat official website. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/wages/ (accessed on 06.05.2019).

Table 5

Index of average monthly nominal accrued wages of employees of organizations in various segments of Russian economy

No.		2010	2017	No.		2010	2017
I	Total economy	1.00	1.00				
1	Financial and insurance activities	2.39	2.17	10	Строительство / Construction	1.02	0.86
2	Mining and quarrying	1.90	1.90	11	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.88	0.82
3	Information and communication	1.45	1.50	12	Human health and social work activities	0.75	0.82
4	Professional, scientific and technical activities	1.59	1.46	13	Education	0.67	0.77
5	Electricity, gas, steam and air conditioning supply	1.22	1.14	14	Real estate activities	0.85	0.77
6	Transportation and storage	1.19	1.12	15	Water supply; sewerage, waste management and remediation activities	0.78	0.74
7	Public administration and defence; compulsory social security	1.20	1.11	16	Сельское, лесное хозяйство, охота, рыболовство и рыбоводство / Agriculture, forestry and fishing	0.53	0.66
8	Manufacturing	0.91	0.98	17	Accommodation and food service activities	0.64	0.61
9	Arts, entertainment and recreation	0.73	0.98				

Source: Rosstat data and the authors' calculations.

Table 6

The intensity of investment in fixed assets of manufacturing enterprises, 1 ruble of investments per 100 rubles of issue 2017

No.		Russian including				Foreign	Joint Russian and foreign
		State	Municipal	Private	Mixed Russian		
I	Manufacturing	5.7	4.9	4.8	3.0	5.1	9.6
	Including:						
1	chemical products	7.2	14.1	14.4	7.2	8.2	20.8
2	rubber and plastic products	4.2	–	2.1	9.8	6.7	6.5
3	basic metals and fabricated metal products	9.3	3.8	3.6	4.7	2.7	11.0
4	machinery and equipment n.e.c.	1.2	8.4	3.1	3.9	6.4	9.2
5	electrical and optical equipment	6.2	2.2	2.4	4.2	2.0	3.8

Source: Rosstat data and the authors' calculations.

It is noteworthy that the lowest economic efficiency in non-financial corporations is observed in the *Manufacturing industries* segment. Note that it is in these corporations that the bulk of the products of the corresponding segment are produced. The noted feature of the relatively low economic efficiency of manufacturing industries is also observed for government enterprises, households, and non-profit organizations serving households. Thus, the manufacturing industry cannot become a growth driver of Russia's economic development without a noticeable increase in its economic efficiency.

This leads to the fact that even in the domestic market, most products of domestic manufacturing industries are not competitive with imported products. This is evidenced by the results of the data analysis from *Table 8* which presents the following indicators:

Table 7

Gross value added by industries and sectors / output by industries and sectors

	2015					2016				
	a	b	c	d	e	a	b	c	d	e
Mining and quarrying	66.4	–	46.4	–	66.4	64.8	–	45.2	–	64.8
Manufacturing	29.1	46.5	15.1	–	28.7	27.5	43.6	14.2	–	27.2
Construction	47.7	0.0	46.1	–	47.6	49.6	0.0	47.5	–	49.5
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods	58.3	–	60.7	–	58.7	55.7	–	58.8	–	56.2
Transport, storage and communication	46.5	55.3	50.1	–	46.8	45.5	52.5	50.1	–	45.9
Real estate, renting and business activities	64.1	75.0	82.5	77.3	71.0	63.5	71.8	82.1	76.9	70.2

Note: a – non-financial corporations;

b – general government;

c – households;

d – non-profit institutions serving households;

e – total by sector.

Источник / Source: данные Росстата и расчеты авторов / Rosstat data and the authors' calculations.

1. *The share of the cost of domestic products of the i^{th} product group in the total value of these products sold in the domestic market defined as*

$$Qinside_i = \frac{P_i - E_i}{P_i - E_i + I_i},$$

where $Qinside_i$ is a share of the cost of domestic products of the i^{th} product group in the total cost of products sold on the domestic market; P_i is domestic production of the i^{th} product group; E_i is export of domestic products of the i^{th} product group; I_i is import of products of the i^{th} product group.

The indicator characterizes the competitiveness level of domestic products in the domestic market [12].

2. *The share of the value of export products of the i^{th} product group in the total value of these products* defined as

$$E\ potential_i = \frac{E_i}{P_i},$$

where $Э\ potential_i$ is a share of the value of export products of a particular commodity group of the manufacturing industry in the total value of this manufactured product; E_i is export of domestic products of the i^{th} product group; P_i is domestic production of the i^{th} product group.

The indicator characterizes the competitiveness level of domestic production on the foreign market for a particular product group and can take values from 0 (absolute dependence on imports) to 100% (absolute independence on imports) [12].

3. *The index of foreign trade turnover of domestic products in the foreign market calculated as*

$$I\left(for.turn.\right)_i = \frac{E_i - I_i}{E_i + I_i},$$

where $I\left(for.turn.\right)_i$ is the index of foreign trade turnover of domestic products of the i^{th} product group in the foreign market; E_i is export of domestic products of the i^{th} commodity group; I_i is import of products of the i^{th} commodity group.

The indicator characterizes the position of domestic products on the global market, its value ranges from –100% (absolute non-competitiveness) to + 100% (absolute competitiveness) [15].

The results of the analysis indicate that in the domestic market the provision of Russia's needs for machinery, equipment and vehicles, chemical products, plastics, elastic gum and rubber is carried out mainly due to imported products. On the contrary, the need for products from the *Metals and products made of them* commodity group in the domestic market is basically provided by domestic production. It should be noted that the provision of the first three of these product groups by domestic production is reduced by an average of 5%. The export potential of the Russian manufacturing industry increased. However, it happened mainly due to the products of industries included in the medium-tech segment of the low level (*Table 9*).

In the structure of exports, the products of industries included in the medium-tech low level and low-tech sectors are more than 80%. The low technological level of the manufacturing industry is evidenced by the cost structure for the production and sale of products. According to the Rosstat, material costs account for 75.3%, and for labor costs only for 8.7%. This does not allow the effective use of human capital to solve the problem of increasing the competitiveness of domestic industry.

In the context of the transition of the world economy to the sixth technological order to increase the competitiveness of domestic products in the global market, it is necessary to significantly change the cost structure for technological development presented in *Table 10*.

Table 10 data analysis shows that the cost of creating new technologies in Russia is only 25.2%, and in developed countries is more than 50%.[10] It can be concluded that innovative activity in manufacturing organizations aims at the reproduction of products using technologies borrowed from developed countries. Thus, to ensure a technological breakthrough in the manufacturing industry, it is necessary not only to increase the investment potential, but also fundamentally change its structure in terms of cost.

The Rosstat data analysis on the costs of organizations for technological innovations by funding sources in 2017 showed that 2/3 of the total costs are the organizations' own funds. The federal budget amounted to 12%, and the regional and local budgets totaled in 0.4%. Given the low profitability of the manufacturing industry (10.9%) and the high interest rate on commercial loans, it is difficult to expect an increase in the cost of technological development at the expense of or-

[10] Gorodnikova N.V., Gokhberg L.M., Ditkovskii K.A. and others. Indicators of Innovation: 2018. Statistical Book. National Research University I60 "Higher School of Economics". M.: NRU HSE; 2018. P. 344. URL: https://www.hse.ru/data/2018/03/23/1164003717/Indicators_of_Innovation_2018.pdf (accessed on 23.04.2019).

Table 8

The share of provision of domestically produced products to the needs of the domestic market for various product groups, export potential and the index of international cooperation in the exchange of goods from various sectors of manufacturing industry

		2016			2017		
No.	**Product group**	**a**	**b**	**c**	**a**	**b**	**c**
1	Machinery, equipment and vehicles	24.9	36.9	–67.5	20.3	41.2	–69.6
2	Chemical industry products	52.7	34.6	–25.9	48.0	38.9	–26.0
3	Plastics, caoutchouc and rubber	49.1	32.6	–36.4	44.0	38.0	–35.0
4	Metals and products from them	88.1	25.4	43.1	83.0	32.5	40.5

Note: a – the share of the cost of domestic products of a particular commodity group in the total value of these products sold on the domestic market;

b – the share of the value of export products of a specific product group in the manufacturing industry in the total value of these manufactured products;

c – index of foreign trade turnover of domestic products on the foreign market.

Source: compiled by the authors based on data from Rosstat and the Federal Customs Service.

Table 9

The structure of the export potential of the manufacturing industry, %

	2016			2017		
	a	**b**	**c**	**a**	**b**	**c**
Manufacturing	22.8	24.9	100	23.1	24.9	100
High tech	23.7	15.0	4.3	5.6	6.1	1.0
Medium-high-technology	14.2	16.1	12.6	18.2	17.8	16.4
Medium-low-technology	27.1	36.7	70.4	30.2	34.1	74.4
Low-technology	17.4	8.9	7.9	26.0	10.2	7.8

Note: a – export potential of the innovation sector;

b – export potential of total production;

c – structure of total exports.

Source: compiled by the authors on the basis of data from the Rosstat Collection "Science. Technology. Innovations", 2017–2019.

Table 10

The cost of technological innovation of manufacturing organizations by type of innovation and economic activity in 2017

No.	Type of innovation and economic activity	bln roubles	%	No.	Type of innovation and economic activity	bln roubles	%
1	Acquisition of machinery and equipment	282.4	46.3	6	Design	9.4	1.5
2	R&D	144	23.6	7	Acquisition of new technology	9.5	1.6
3	Engineering	99.1	16.2	7,1	Of which acquisition of patent rights, licenses	5	0.8
4	Other expenditures	53.9	8.8	8	Personnel training	1.3	0.2
5	Acquisition of software	10.3	1.7	9	Market research	0.4	0.1
10	Total	610.2	100				

Source: Rosstat data and the authors' calculations.

ganizations' own and borrowed funds. In addition, the sanctions limit the increase in foreign direct investment in the manufacturing industry. Currently they make up 0.3% of organizations' costs for these purposes.

It should be noted that the production of machinery and equipment is also not given due attention in the constituent entities of the Russian Federation. Indeed, 63% of the total volume of manufacturing products is produced by 15 constituent entities of the Russian Federation (*Table 11*).

It is noteworthy that in five constituent entities of the Russian Federation listed above, the manufacturing industry contributes less than 20% to the gross regional product (GRP). At the same time, in eight regions, mechanical engineering contributes less than 10% to the value added of the manufacturing industry. As shown above, this figure exceeds 30% in the structure of the manufacturing industry of economically developed countries. Production of computers, computer technology, electrical equipment, electronic and optical equipment

Table 11

Main indicators of the state of manufacturing industry leading by the level of industrial development of regions of the Russian Federation

No.	Субъект РФ	a	b	c	d	e
1	Moscow	14.95	12.00	4.40	6.20	8.70
2	Moscow region	5.96	20.80	10.50	8.90	9.70
3	St. Petersburg	5.81	16.70	5.20	10.70	27.60
4	Sverdlovsk region	4.54	30.90	4.60	4.20	12.90
5	Republic of Tatarstan	4.02	18.70	18.90	4.80	20.90
6	Tyumen region	3.95	3.80	11.20	1.00	1.70
7	Chelyabinsk region	3.44	35.50	3.10	2.80	9.50
8	Nizhny Novgorod Region	3.20	30.70	9.20	5.60	20.70
9	Republic of Bashkortostan	2.79	27.50	18.30	2.10	14.10
10	KKrasnoyarsk region	2.62	31.80	2.60	1.10	2.40
11	Samara region	2.57	22.40	20.70	5.50	41.20
12	Perm region	2.48	31.80	26.00	5.00	8.90
13	Leningrad region	2.44	30.80	5.50	3.00	12.70
14	Krasnodar region	2.35	11.40	2.70	0.90	3.90
15	Omsk region	2.04	37.30	6.50	2.80	3.10

Note: a – the average share of volume of shipped own-produced goods, works done and services performed by the manufacturi ng industry enterprises of regions of the Russian Federation in the total cost of the relevant goods, works and services of the manufacturing industry of the Russian Federation in 2015–2017, %;

b – contribution of the manufacturing industry to the gross regional product, %;

c – the share of production of chemicals and chemical products and production of medicines and materials used for medical purposes in the products of the manufacturing industry, %;

d – the share of production of computers, electronic and optical products and production of electrical equipment in manufacturing products, %;

e – the share of production of machinery and equipment not included in other groups; the production of motor vehicles, trailers and semi-trailers; production of other vehicles and equipment in manufacturing products, %.

Source: Rosstat data and the authors' calculations.

play an insignificant role in the structure of the manufacturing industry of these subjects of the Russian Federation. Thus, it can be concluded that in Russia low-tech industries play a leading role in the manufacturing industry.

CONCLUSIONS

The dynamic analysis of the economies of developed countries shows the significant role of investments in fixed assets of the manufacturing industry in creating conditions for sustainable development.

The study results indicate that the manufacturing industry is not the dominant factor in economic growth in Russia. It takes the 2nd place in terms of the share of contribution to GDP and the 4th place in the rating of investments in the gross value added produced there. The leading positions in terms of the share of contribution to Russia's GDP belong to services industries.

The low investment potential of the manufacturing industry preserves the lack of competitiveness of its products not only in the external, but also in the domestic markets, especially in the segments of high-tech products.

The structure analysis of investments in fixed assets of the manufacturing industry shows that they do not contribute to technological development. The main focus of investments is buildings and structures, and not intellectual property and the acquisition of machinery and equipment. As a result, the machinery and equipment are older than 10 years in 40% of organizations. Entrepreneurs note that they do not have the opportunity not only to introduce innovations, but also to replace the worn-out equipment. Consequently, the contribution of machinery and equipment to the gross value of manufacturing fell by 30% in 2000–2012. In contrast, in countries such as Germany, Japan, South Korea, France, it increased by an average of 10%.

The technological backwardness of the Russian manufacturing industry is being preserved, since innovation activity is mainly aimed at the development of the low-tech mid-level and low-tech manufacturing sectors and production using technologies borrowed from developed countries.

The actual wages in the manufacturing industry is 2 times less than in the sectors of finance, insurance, mining and few other industries. This determines the low competitiveness of the manufacturing industry, especially its high-tech segments in the labor market in Russia. As a result, the use of human capital faces serious problems.

Today, the own funds of organizations are the main source of investment in fixed assets of the manufacturing industry. The low profitability of its production and the high interest rate of loans limit the possibility to significantly increase investment in fixed assets. Chemical industry enterprises are most attractive for investors among other manufacturing industries. Among enterprises of various types of ownership in all sectors of the manufacturing industry, enterprises with foreign and joint Russian and foreign ownership are attractive for investors, although most of the output is provided by Russian private companies. It should be noted that foreign capital is not interested in the development of industries that determine technological progress in the Russian economy.

It is noteworthy that enterprises producing computers, electronic and optical products, electrical equipment with a specific balanced financial result are quite effective. However, in terms of the share of investments in fixed assets of the manufacturing industry, they have the lowest values of the share of gross value added in output among all economic segments in Russia.

National project "Labor Productivity and Employment Support" is implemented in the constituent entities of the Russian Federation. However, the structure of the manufacturing industry in the regions shows that the leading positions belong to low-tech and low-tech industries. This significantly limits the ability of the constituent entities of the Russian Federation to ensure the implementation of the Strategy for the scientific, technological and socio-economic breakthrough of Russia.

Thus, at the federal level it is relevant to lay out a priority development program of production in the high-tech and medium-tech

high-level sectors with a 10–15-year horizon, indicating the following objectives:

- the contribution of high-tech and medium-tech high-level products to the total volume of shipped products should be at least 50%; 20% of them should be products of high-tech industries;
- the share of the manufacturing industry in Russia's GDP should be at least 20%;
- the share in the export of manufacturing products should be at least 60%, with at least 20% of high-tech products;
- the domestic market should be supplied with high-tech domestic products by at least 50%.

To manage and coordinate this program implementation, it is advisable to create an overseas executive body. It will accumulate all necessary financial resources to carry out the tasks for Russia to move to the next stage of technological development. The positive experience of creating such an authority has been demonstrated in the military-industrial complex.

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Reserve Capital Buffer as an Instrument of Macroprudential Policy

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ABSTRACT

The analysis of Basel III main provisions shows that within the macroprudential policy, increasing the financial stability of the banking sector is achieved by growing the capital of banks and creating new tools to solve short-term liquidity problems. The proposed measures seem well developed, except one fact — the quantitative values of the regulatory requirements for growing the bank capital are insufficient to achieve the macroprudential policy objectives. This study aims to develop analytical tools allowing to form quantitative objectives of the macroprudential policy and to deliver them by streamlining the capital requirements of banks. The methods of comparative and GAP analyses were used in the study. The empirical analysis was performed with the data on the Russian stock index IMOEX dynamics, the data from the reports by the Bank of Russia and financial reports of systemically important Russian banks. According to the study results, a quantitative strategic objective of the macroprudential policy in the Russian Federation was determined, a gradual increase in the capital adequacy ratio of Russian banks to 40% was proposed, a calendar plan was developed to achieve the strategic objective stagewise in 10 years, and banks are realistic in achieving this objective. As a regulatory instrument to grow the capital adequacy of banks according to the target level, it is proposed to use an additional regulatory capital requirement in the form of a reserve buffer of a dynamic and adaptive nature. The empirical analysis of the possibilities and consequences of a new regulatory instrument application proved the expediency of its introduction to improve the effectiveness of the macroprudential policy in the Russian Federation.

Keywords: macroprudential policy; capital adequacy; capital buffer; banking sector sustainability

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INTRODUCTION

The 2008 global financial crisis showed that the requirements for financial resilience of banks were insufficient. This led to a new concept of a global regulatory framework, known as Basel III.[1] A stricter definition of bank capital was introduced as part of this concept which increased their loss-absorbing capacity. New requirements for capital adequacy were established. They included the formation of a conservation capital buffer at 2.5% and a countercyclical capital buffer[2] in the amount of 0.0%–2.5% of total risk-weighted assets (RWA). Along with the Basel agreement, it was envisaged to introduce a leverage indicator of at least 3% of the ratio of bank capital to total assets and off-balance sheet liabilities not risk weighted.[3]

The most important aspect of Basel III was the more stringent capital requirements for global systemically important banks (G-SIBs), which have a significant impact on the global financial system. Additional requirements for Tier I capital adequacy were set to G-SIBs. The markup to risk-weighted assets[4] ranged from 1% to 3.5%. At the same time, the Basel Committee on Banking Supervision noticed banks that are not identified as systemically important globally, but their bankruptcy may have a negative impact on the economy of a particular country. Special regulatory measures[5] were recommended to be applied to them. This led to an additional systemic importance buffer of banks at the level of national jurisdictions ranging from 0.0% to 2.0%.

In November 2015, the Financial Stability Board raised the requirements for financial sustainability of global systemically important banks by approving the standards for total loss-absorbing capacity (TLAC). The standard established minimum requirements for loss-absorbing and recapitalisation capacity for G-SIBs.[6] At the same time, the loss-absorbing capacity was understood as the capacity of additional resources in the form of Tier I capital and certain debt instruments that can be used to cover losses when resolving the insolvency of financial institutions. The requirements for the capacity of financial institutions to absorb losses were determined considering the funds actually required to settle obligations in case of failure of large credit organizations. The minimum TLAC requirements are set at 16% of the RWA and 6% of the leverage ratio denominator. The requirements come into force on January 1, 2019 in countries with developed markets, and from January 1, 2025 in countries with emerging markets. In the future (from 2022 for developed countries and from 2028 for developing countries), these requirements will be increased to 18% and 6.75% respectively. It is understood that due to TLAC, large banks will be able to go bankrupt and will not cause financial crises similar to that of 2008.

The analysis of the Basel III basic provisions allows to state that increasing the sustainability of some banks and the banking sector as a whole is ensured by increasing their capital buffer and creating new tools to absorb liquidity shocks. However, from the point of view of their impact on achieving macroprudential policy goals, the effectiveness of these innovations remains outside the legal framework. According

[1] Basel Committee on Banking Supervision. Basel III: A global regulatory framework for more resilient banks and banking systems, 2010. URL: https://www.bis.org/publ/bcbs189.pdf (accessed on 23.05.2019).

[2] Basel Committee on Banking Supervision. Guidance for national authorities operating the countercyclical capital buffer. Bank for International settlements, 2010. URL: https://www.bis.org/publ/bcbs187.pdf (accessed on 23.05.2019).

[3] Basel Committee on Banking Supervision. Basel III leverage ratio framework and disclosure requirements, 2014. URL: https://www.bis.org/publ/bcbs270.pdf (accessed on 23.05.2019).

[4] Basel Committee on Banking Supervision. Global systemically important banks: updated assessment methodology and the higher loss absorbency requirement, 2013. URL: https://www.bis.org/publ/bcbs255.pdf (accessed on 23.05.2019).

[5] Basel Committee on Banking Supervision. A framework for dealing with domestic systemically important banks, 2012. URL: https://www.bis.org/publ/bcbs233.pdf (accessed on 23.05.2019); Basel Commitee on Banking Supervision. Regulatory consistency assessment programme (RCAP) — assessment of Basel III G-SIB framework and review of D SIB frameworks — European Union, 2016. URL: https://www.bis.org/bcbs/publ/d372.pdf (accessed on 23.05.2019).

[6] Financial Stability Board. Principles on loss-absorbing and recapitalisation capacity of G-SIBs in resolution total loss-absorbing capacity (TLAC) term sheet, 2015. URL: https://www.fsb.org/wp-content/uploads/TLAC-Principles-and-Term-Sheet-for-publication-final.pdf (accessed on 23.05.2019).

to the Russian scientists [1], the new paradigm of financial regulation still retains some shortcomings reducing its effectiveness. Among these shortcomings, the authors focus on the delayed nature of the regulatory response to new risks. Besides, it should be noted that the upper limit of the increase in the general requirements for bank capital has not been yet determined. The issue of the combined effect of regulatory tools on the effectiveness of macroprudential policies, including the achievement of its strategic and current goals, has not been resolved. An analytical toolkit to determine quantitative goals of macroprudential policy and the mechanism to achieve them has not been developed. The study was motivated by the desire to resolve the question.

LITERATURE REVIEW

The research results in the works by Galati & Moessner [2], Zulkhibri [3] show that the literature on the effectiveness of macroprudential policy tools is still in its infancy and has so far provided only limited guidance for policy decisions. Theoretical studies of macroprudential policies show mixed results, and empirical studies on this issue are not conclusive.

In recent years, however, increasing efforts have been made to fill this gap. There is an increasing empirical work on the effect of some macroprudential tools on a range of target variables, such as quantities and prices of credit, asset prices, and amplitude of the financial cycle and financial stability. Criteria for assessing the quality of macroprudential policies are proposed. The research analyses the effects of introducing individual regulatory tools and proposes measures to optimize the portfolio of these tools.

Most works on this topic are devoted to assessing the impact of macroprudential instruments on banks' lending activity, financial stability and banking sector stability. So, Mankart, Michaelides, Pagratis [4] analyzed the impact of regulatory requirements for capital adequacy and leverage on bank lending. The authors concluded that the tightening of capital requirements for banks leads to a decrease in lending, reserves and an increase in bankruptcy, and the tightening of requirements for leverage leads to an increase in lending and a decrease in failure rates.

Olszak, Roszkowska & Kowalska [5] support the view that macroprudential policy has the potential to curb the procyclical impact of bank capital on lending and therefore, the introduction of more restrictive international capital standards included in Basel III and of macroprudential policies in general are fully justified.

Aysan, Disli & Ozturk [6] also conclued that the implementation of macroprudential tools has a positive impact on financial stability.

Gornall & Strebulaev [7] found that capital regulation lowers bank leverage but can lead to compensating increases in the leverage of borrowers. Despite this, doubling current capital requirements would reduce the default risk of banks by up to 90%, with only a small increase in bank interest rates.

Noreen, Alamdar & Tariq [8] assessed the relationship of capital buffer and risk over the business cycle in developing countries and proved the relevancy of bank's capital buffer and bank risk to the soundness and stability of financial position in banking sector.

Maurin & Toivanen [9] concluded that the adjustment of euro area banks to higher capital adequacy requirements reduces not only loan growth, but also the volume of transactions with securities, and the volume of securities decreases more significantly. At the same time, the volume of attracted resources is decreasing.

Belem and Gartner [10] conducted similar studies for the Brazilian banks. They investigated the relationship between bankruptcy cost and a large number of factors. The bankruptcy cost is a quantitative expression of the "too big to fail" and a bank "significance". As a result, it was found that bankruptcy cost is weakly related to all common factors. Consequently, introducing increased regulatory requirements for systemically important banks has no reason. The introduction may be forced; and then according to regulatory authorities, the soundness of systemically important banks should grow. The lack

of reasoning will not harm. It only means that with the expansion of regulatory requirements, the competitiveness of large banks will fall, and this will negatively affect their soundness.

Danarsari, Viverita & Rokhim [11] investigated the relationships between capital buffer and bank stability among commercial banks in Indonesia after the financial crisis of 2007–2008. Using dynamic regression, the authors proved that improvement of the capital buffer enhances bank stability.

Oduor, Ngoka & Odongo [12] analyzed the impact of enhanced banking capital adequacy requirements on financial stability in Africa. The authors found increased regulatory capital improves competitive pricing for foreign banks while it makes domestic banks less competitive mainly attributed to the high cost of sourcing and holding extra capital for domestic banks compared to foreign banks who can source cheaper capital from parent companies. Thus, the authors questioned the effectiveness of enhanced regulatory capital on stability and competitiveness of the African financial system.

Another important area of research is the assessment of the quality of macroprudential policies. Analyzing the approaches to capital regulation in Basel III, A.R. Admati [13] points out flaws in the rules, which include dangerously low equity levels; complex and problematic system of risk weights that exacerbates systemic risk and adds distortions, and unnecessary reliance on poor equity substitutes. According to him, the underlying problem in macroeconomic policy is a breakdown of governance and lack of accountability to the public throughout the system, including policymakers and economists. To proceed with this topic, A. Matysek-Jedrych [14] suggests assessing the quality of institutional mechanisms of macroeconomic policy based on constructing ratings of macroprudential authority accountability and transparency across the EU countries.

M. Dumicic [15] investigated the effectiveness of macroprudential policy in terms of its mitigating financial stability risks. The author concluded that macroprudential policies are more effective in slowing credit to households than credit to the non-financial corporate sector, mainly because the latter had access to nonbank and cross-border credit in addition to domestic bank credit.

Pfeifer, Holub, Pikhart & Hodula [16] examined the relationship between capital and leverage ratios. They found that the capital and leverage ratios complement each other and that the introduction of a macroprudential leverage ratio could, under certain circumstances, enhance the effectiveness of a macroprudential policy.

I. Larionova, E. Meshkova [17] analyzed the effectiveness of using financial leverage in order to increase the financial stability of Russian banks. Based on the analysis, the authors concluded that due to a significant excess of the planned level of financial leverage, banks compiled a high-risk portfolio of assets, not captured by the new standard. According to the authors, in order to increase the effectiveness of this regulatory instrument, the regulatory levels of leverage ratio should be differentiated for banks with different business models.

Zakaria & Fatine [18] propose that these instruments should be used only in specific economic and financial situations. According to the authors, the output gap, describing the economic cycle, and the Z-score are the intermediate variables for the activation of capital instruments. Moreover, the liquidity ratio and changes in bank profitability are the two early warning indicators for activation of liquidity instruments.

Bui, Scheule & Wu [19] draw attention to the controversy concerning the appropriate size of banks' capital requirements, and the trade-off between the costs and benefits of implementing higher capital requirements. The authors suggest that a moderate increase in bank capital buffers is sufficient to maintain financial system resilience, since credit supply may be hampered if bank capital levels are too high.

P.H. Kupiec [20] assessed the efficacy of the requirement for minimum "total loss absorbing capacity" (TLAC) at global systemically important banks. The author notes that to meet the stated goals, TLAC requirements must impose

minimum TLAC at all subsidiaries and restrict how TLAC funds can be invested. According to the author, an equivalent, but much simpler solution is to significantly increase regulatory capital requirements on systemically important bank subsidiaries.

R. J. Herring [21] also notes the regulatory complexity of financial stability. Using the example of capital regulation, he showed how complexity has grown geometrically from the introduction of the Basel Accord on Capital Adequacy in 1988 to the introduction of Basel III and the total loss-absorbing capacity (TLAC) proposal in 2015. Having analyzed the current welter of required capital ratios, the author proposed to eliminate 75% of them without jeopardizing the safety and soundness of the system. The author pointed out the evident advantages of a simpler, more transparent regulatory system.

To summarise the research results, it should be noted that despite obvious progress, they do not contain specific recommendations on setting quantitative goals of macroprudential policy and the mechanism to achieve them, including determining the maximum bank capital burden, correlating capital adequacy with macroprudential policy objectives and tools to achieve these goals.

In this regard, the aim of this study will be to develop an analytical toolkit to set quantitative goals of macroprudential policy and to deliver them by streamlining requirements for bank capital.

RESEARCH METHODOLOGY

Our hypothesis is that the long-term goals of macroprudential policy should be aimed at achieving stability in the national banking system. The main tool to achieve this goal should be an additional capital buffer that is dynamic and adaptive and formed as the difference between the target and actually achieved level of financial stability in the banking sector.

Implementing this idea implies using comparative and GAP-analysis methods and following the steps:

- to assess the general level of capital adequacy to secure stability in the banking sector;
- to shape strategic and current goals of macroprudential policy in order to secure stability in the banking sector by the end of a given period;
- to develop a new regulatory instrument that ensures delivering macroeconomic policy goals by filling the capital adequacy gap;
- to empirically analyse the opportunities and consequences of applying a new regulatory tool — an additional capital buffer.

RESEARCH

Assessment of general level of capital adequacy to secure stability in banking sector

By financial stability of national banking systems we mean their ability to absorb losses, that is, the capital that can be used to cover unexpected losses.

When choosing the level of capital requirements, we will rely on the financial crises research results performed by Allen & Gu [22], Cheng & Mevis [23].

Allen & Gu analyzed the causes of the 2007–2009 crisis and concluded that this crisis was triggered by three types of risk: panic, asset price falls and contagion.

Cheng & Mevis studied the Global Financial Crisis and the European crisis. The authors found that the banks in the euro area were hit by two shocks of different nature. The Global Financial Crisis hit mainly large banks through their losses on investment in securities. The subsequent crisis in the euro area hit more traditional banks specializing in lending activities, mainly due to the increased banks' credit impairment expenses. The first shock seemed to have a "one-off" effect on banks' profits while the effects of the second shock were more long-lasting and reduced banks' profits in peripheral Europe.

Based on the research data, we believe that the level of capital requirements for banks should be determined by the value of impairment of assets during the crisis. Using this criterion requires an answer to two key questions:

what assets should impairment be tracked by? what time interval should be used?

We believe that it is necessary to analyze a wide range of assets, mainly non-financial ones. Risk banking assets consist primarily of loans to non-financial corporations and investments in corporate securities. The profitability of securities depends on the financial condition of corporations in the same way as the repayment of their loans. As for loans to individuals, the solvency of these borrowers depends on the general state of the economy and on the state of the markets, i.e. almost on the same factors as the profitability of non-financial corporations. Considering that during a crisis, prices of all assets tend to change (fall) along similar lines, we believe that it is most convenient to use any broad stock market index calculated on stocks as an indicator. Shares are not purely financial instruments, since their fundamental price is formed from the value of the company's property and its business profitability. Moreover, the property of non-financial companies is formed by a wide range of non-financial assets. Along with fundamental factors, the share price also depends on the speculative component. However, a change in liquidity, i.e. the cash flow of "hot money" affects the value of shares only in the short term.

We propose to limit the time interval to a one year period. In shorter periods, the impact of liquidity shortages on asset prices is significant. Short-term liquidity problems in the acute phase of the crisis can be solved by providing short-term loans to banks by the Central Bank. In this regard, the solution of liquidity problems in the acute phase of the crisis at the expense of bank capital seems inappropriate.

The stock index needs to be adjusted for inflation, since today the inflation rate approximately corresponds to the value of the risk-free interest rate for real borrowers, and not to the rate of short-term loans for financial companies. Thus, the inflation rate characterizes an alternative investment option.

On the example of the Russian banking sector, we studied the practical aspects of the proposed approach to determining the general level of capital adequacy of banks considering covering unexpected losses. We used the IMOEX index as the stock index. This index is a price free-float composite index of the Russian stock market which includes the most liquid stocks of the largest Russian issuers, whose economic activities belong to the main sectors of the economy.

Here is what we did to adjust the IMOEX index for inflation. We converted the annual inflation values (Consumer Price Index= CPI) from official sources[7] into a CPI with a basis of 1.00 as of January 1, 1998. Then, we obtained weekly price index values by interpolation from annual values. Next, we divided the weekly IMOEX index values into the weekly price index values, and thus we got the IMOEX index values cleared of inflation.

Fig. 1 shows the IMOEX index dynamics adjusted for inflation in the period of 1998–2019.

Fig. 1 shows three periods of impairment of assets in the Russian economy. These periods correspond to the crises of 1998, 2008 and 2014. The 2008 global crisis was followed by a sharp impairment of assets in the Russian economy. The 2014 crisis was less pronounced than the 2008 crisis. During the 2014 crisis, the impairment of assets lasted a longer period, and the fall in asset prices was less significant than in 2008.

Fig. 1 shows the value of asset prices fall during the crises. We analyzed the 2008 crisis and considered the averaging period of one year (justified above). Here are the results. Right before the asset prices fall, the IMOEX index was at approximately the same level of 250 for more than a year. After a sharp asset prices fall at the end of 2008 and their subsequent rebound, the IMOEX index averaged 150. The maximum fall in the index corresponded to its value at the level of 66, but this drop was short-term and therefore should not be considered. Thus, in the 2008 crisis, assets impaired to 0.6 from the pre-crisis level, and

[7] Consumer Price Indexes in the Russian Federation in 1991–2019. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/tariffs/# (accessed on 02.07.2019).

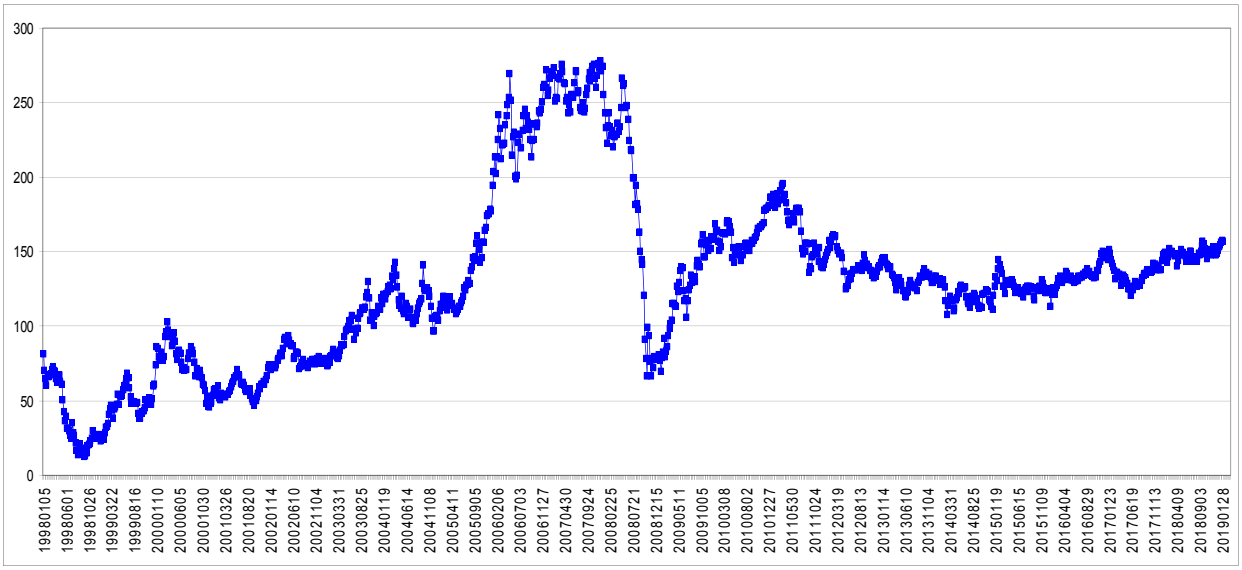

Fig. 1. **IMOEX index dynamics in the period from 1998 to 2019**

Source: historical IMOEX values from www.finam.ru. URL: https://www.finam.ru/profile/mirovye-indeksy/micex/export/?market=6&em=13851&code=MICEX) (accessed on 05.07.2019).

the asset prices fall was 40%. For this fall were not an issue for banks, their capital should be at least 40% of the value of risk assets.

We suggest considering this value as the maximum value of capital adequacy necessary to completely cover possible losses in the Russian banking sector arising in a crisis. This is a rather large amount compared to current capital adequacy ratio N 1. However, the experience of 2008 shows that banks' capital is clearly not enough to cover losses incurred during crises. For example, in the 2008 crisis, the US Federal Reserve had to use mechanisms for long-term refinancing of banks. Refinancing was carried out by repurchasing distressed securities from banks. The repurchase conditions were that the money received by banks possessed the qualities of equity. Similar things were happening in the euro area. A program of short-term bank refinancing was activated there. The idea of the program was in repurchasing securities and it lasted for 1.5 years. After this period, the repurchased securities from the ECB balance sheet disappeared and were not returned to the banks.

The Bank of Russia had to introduce additional measures to maintain the stability of the banking sector during the 2008 crisis. This is evidenced by the adoption of Federal Law No. 173-FZ of October 13, 2008 "On Additional Measures to Support the Financial System of the Russian Federation". This Law provided for deposit opening by the Central Bank of the Russian Federation in VEB.RF, for a total amount of up to $ 50 billion for one year allowing for the term prolongation, as well as employment of the funds of the National Welfare Fund for a total of up to 410 billion rubles. Deposits were opened so that VEB.RF were able to provide subordinated loans to Russian banks in the future. The law also provided for the Central Bank of the Russian Federation to submit unsecured subordinated loans (deposits, loans, bonded loans) to Sberbank of Russia for a total amount of 500 billion rubles for the period up to and including December 31, 2019. At the same time, the Central Bank of the Russian Federation obtained the right to compensate part of the losses (expenses) to credit organizations for transactions with other credit organizations with the revoked banking licenses. It is important that the funds allocated to support the banking sector were intended mainly for the largest banks and related organizations, for example, OAO "Agency for Housing Mortgage Lending".

Shaping macroprudential policy goals to achieve stability in the banking sector

When shaping macroprudential policy goals, we assume that the strategic goal of this policy is to achieve the maximum stability in the banking system by the end of a given time period, and the current goals are the stepwise achievement of the strategic goal. When determining the time period to achieve the strategic goal, it is necessary to abide by the gap between the strategic goal and the achieved capital adequacy of banks. The larger this gap is the longer the time period should be. Abidance by these terms will allow banks to increase their own funds in accordance with the tactical (established for the year) goals without undue effort.

Currently, the general capital requirements to banks include regulatory requirements in the form of ratios: ratio of own funds (capital) — N 1.0., common equity Tier I capital ratio — N 1.1., capital adequacy ratio — N 1.2., leverage ratio — N 1.4., as well as capital premiums. Capital premiums include conservation and countercyclical capital buffers, as well as a premium for the systemic importance of banks. At the same time, compliance with the minimum allowable numerical value of premiums is ensured by Tier I capital sources exceeding the amount required to comply with bank capital adequacy requirements. The nature of capital premiums sources and the quality of Tier I capital sources determine applicability of N 1.1. ratio for shaping strategic goals on the financial stability in the banking sector.

The strategic goal for the Russian banking sector will be to increase Common Equity Tier 1 Capital of banks to 40% of risk-weighted assets. Considering the level of capital adequacy reached by this sector as of December 1, 2018 in the amount of 8.5%[8], we can calculate Tier 1 Capital gain necessary to achieve the strategic goal. It will be 31.5%. Based on this, a ten-year period will be the real time for the Russian banking sector to reach stability. This will require a year-on-year increase in Tier 1 Capital of banks by approximately 3.0 percentage points. Knowing that the target values of Common Equity Tier 1 Capital of Russian banks will be introduced from January 1, 2020, the real time for the Russian banking sector to reach stability will be the end of 2030.

Given the current regulatory requirements, it's most likely that the strategic and current goals of macroprudential policy will not coincide with the level of capital adequacy formed by banks. In this regard, there is a need for an additional regulatory requirement to achieve the targets on time. This means that along with target indicator N 1.1. and the targets for existing capital premiums, targets for an additional regulatory requirement must be set as an additional capital buffer.

While setting target values, it is important to provide for a transitional period when banks can prepare for the new regulatory requirement. A lower level of the target values should be established for the additional capital buffer during this transition period. In particular, for the Russian banking sector, the target level of the general capital buffer as of 01.01.2020 should be set at the level of minimum values — 3.5%. This level will include achieving the targets for the value of: the conservation capital buffer — 2.5%, the buffer for the systemic importance of banks — 1.0%, the countercyclical buffer — 0.0% and the additional buffer — 0.0%.

Development of a new regulatory instrument that ensures delivering macroeconomic policy goals

Achieving macroprudential policy goals will largely depend on the introduction of a new regulatory instrument, an additional capital buffer. Let us call it a reserve capital buffer.

Essentially, the reserve capital buffer will be similar to the conservation capital buffer, since it aims at absorbing losses. However, this capital buffer will differ from the conservation capital buffer in a dynamic and adaptive manner as its size will be determined by the differential between the target and the achieved capital

[8] Overview of the banking sector of the Russian Federation, January 2019 URL: http://cbr.ru/Collection/Collection/File/19986/razv_bs_19_05.pdf (accessed on: 15.07.2019).

adequacy levels, both at the level of individual banks and the entire banking sector.

Considering the maximum capital adequacy required to completely cover potential losses caused by systemic risks, financial stability achieved by banks stepwise and the capital buffers already formed by banks, we offer the following algorithm to calculate the total and the reserve capital buffers for banks and the banking sector as a whole:

$$Xoi = Xzi - Xni, \quad (1)$$

where: *Xoi* —target total capital buffer of the bank(s) in the *i*-th year;

Xzi — target level of capital adequacy of the bank(s) in the *i*-th year;

Xni — regulatory level of capital adequacy of the bank(s) in the *i*-th year.

In this case, *Xoi* will consist of the following elements:

$$Xoi = Zi + Ki + Si + Ri, \quad (2)$$

where: *Zi* — target conservation capital buffer of the bank(s) capital in the *i*-th year;

Ki — target countercyclical capital buffer of the bank(s) in the *i*-th year;

Si — target premium to capital for the systemic importance of the bank(s) in the *i*-th year;

Ri — target reserve capital buffer of the bank(s) in the *i*-th year.

From equation (2) we can find *Ri*:

$$Ri = Xoi - (Zi + Ki + Si). \quad (3)$$

Given that in the reporting period banks can form capital buffers above standard values on a voluntary basis, the target reserve capital buffer of the bank(s) will include the following elements:

$$Ri = Rsi + Rdi, \quad (4)$$

where: *Rsi* — generated reserve capital buffer of the bank(s) at the beginning of the *i*-year;

Rdi — additional reserve capital buffer to be generated in the *i*-year.

Equation (4) can be used to find *Rdi*:

$$Rdi = Ri - Rsi. \quad (5)$$

Rdi definition is important in the strategic management of banks, since it forms the minimum margin of the return on their risk-weighted assets.

The calculation algorithm shows that the reserve capital buffer is not only an instrument for regulating the stability of banks and the banking sector, but also an instrument for strategic management of financial stability. In this regard, we believe that the reserve capital buffer should not only be regulatory, but should also be used to assess the quality of risk management and affect the remuneration to the owners and heads of banks.

Empirical analysis of the opportunities and consequences of applying a new regulatory tool

We examined the possibilities and consequences of applying the reserve capital buffer on the example of the Russian banking sector. We calculated the target level of the total and reserve capital buffers of banks in the i-th year based on the following assumptions:

- introducing requirements for the total capital buffer from January 1, 2020;
- establishing minimum requirements for the total capital buffer as of January 1, 2020 at a minimum level of 3.5% of risk-weighted assets;
- using of a three year transition period;
- achieving stability in the banking sector by the end of 2030.

Table 1 and *Fig. 2* present the calculation results of the target values of Tier I capital adequacy in the Russian banking sector.

As shown in *Table 1,* at the beginning of 2019, the Russian banking sector managed to form N 1.1. capital adequacy level in the amount of 8.5%. This was facilitated by introducing requirements for the conservation capital buffer in the amount of 1.875% and capital allowances for the systemic importance of banks in the amount of 0.625%, as well as the expected increase in these capital

Table 1

Target capital adequacy of Russian banks (2020–2030)

Date	Capital adequacy (*Xzi*)	Total capital buffer (*Xoi*)						
		Total	Including					
			Protective (*Zi*)	Counter-cyclical (*Ki*)	For systemic importance (*Si*)	Reserve (*Ri*)		
						Total	ncluding	
							Formed (*Rsi*)	Additional (*Rdi*)
01.01.2019*	8.5**	–	1.875	0	0.625	6.0	6.0	–
01.01.2020	8.0	3.5	2.5	0	1.0	0.0	5.0	0.0
01.01.2021	10.0	5.5	2.5	0	1.0	2.0	5.0	0.0
01.01.2022	13.0	8.5	2.5	0	1.0	5.0	5.0	0.0
01.01.2023	16.0	11.5	2.5	0	1.0	8.0	5.0	3.0
01.01.2024	19.0	14.5	2.5	0	1.0	11.0	8.0	3.0
01.01.2025	22.0	17.5	2.5	0	1.0	14.0	11.0	3.0
01.01.2026	25.0	20.5	2.5	0	1.0	17.0	14.0	3.0
01.01.2027	28.0	23.5	2.5	0	1.0	20.0	17.0	3.0
01.01.2028	31.0	26.5	2.5	0	1.0	23.0	20.0	3.0
01.01.2029	34.0	29.5	2.5	0	1.0	26.0	23.0	3.0
01.01.2030	37.0	32.5	2.5	0	1.0	29.0	26.0	3.0
01.01.2031	40.0	35.5	2.5	0	1.0	32.0	29.0	3.0

Source: compiled by the author.

Note: * – the achieved level is shown on 01.01.2019, the planned values are for the subsequent dates;

** – on 01.12.2018.

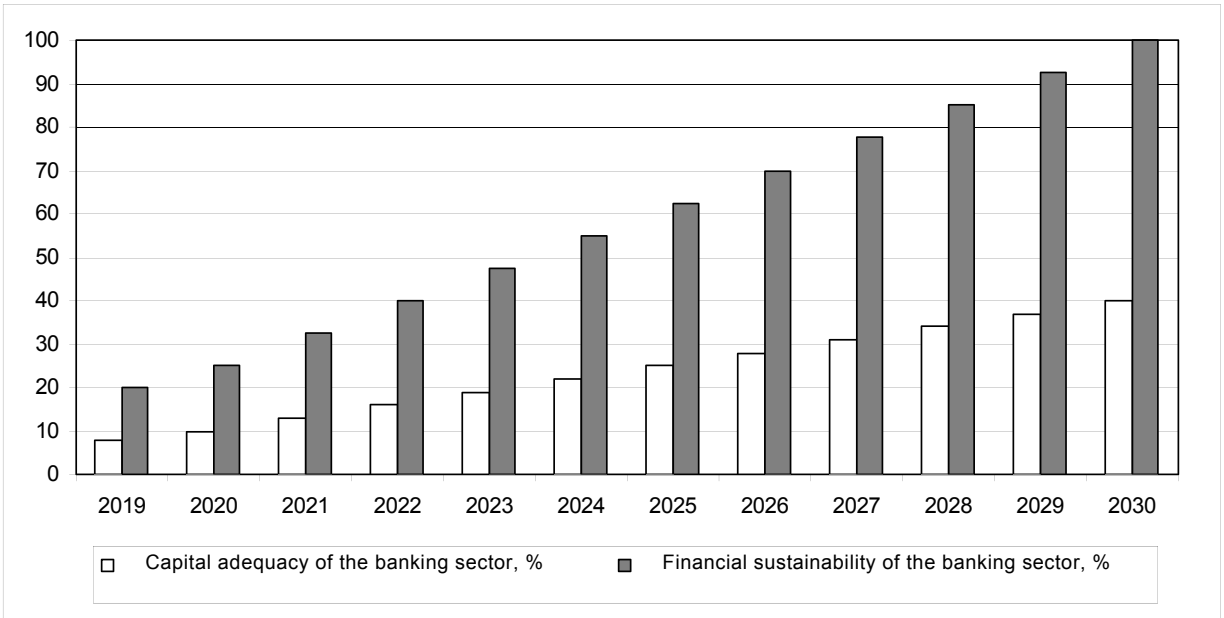

Fig. 2. **Capital adequacy and sustainability of the Russian banking sector**

Source: compiled by the author.

allowances as of January 1, 2020 to 2.5% and 1.0% respectively. *Table 1* also shows that the increase in the target values of the total capital buffer by 3.0 percentage points will start in 2022. This will lead to increasing requirements for the reserve capital buffer by a similar amount starting from January 1, 2023.

The maximum value of the year-on-year increase in the reserve capital buffer at the end of the transition period will be 3.0 percentage points. Achieving this indicator will require banks to maintain a return on risk-weighted assets not less than 3.0%. At the end of 2018, the return on risk-weighted assets in the banking sector amounted to 2.5%; and systemically important banks to 2.8%.[9] Therefore, we can expect that achieving a 3.0% return level by banks is possible.

We investigated the opportunities and consequences of applying the new regulatory instrument in relation to some banks on the example of Russian systemically important banks (*Table 2*). The analysis was carried out in the transition period, the most difficult time in introducing additional regulatory requirements.

Table 2 shows that during the transition period, a total capital buffer as an additional reserve capital buffer as of 01.01.2020 will only be required by VTB (0.2%), and as of 01.01.2021 by VTB (2.0%), Russian Agricultural Bank (0, 5%), Gazprombank (1.8%), Credit Bank of Moscow (1.8%), Raiffeisenbank (0.2%) and Rosbank (1.2%). Considering the return level of these banks in 2018, we expect that only Russian Agricultural Bank, Gazprombank and Credit Bank of Moscow may have some difficulties in meeting the requirement to create the reserve capital buffer. These banks will have to improve the efficiency of their activities to increase the return on of risk-weighted assets.

CONCLUSIONS

The idea of this work was to develop analytical tools to shape quantitative goals of macroprudential policy and ensure their achievement based on streamlining the capital requirements of banks.

We suggested considering the achievement of stability in the banking sector by the end of a given period as a strategic goal of macroprudential policy. We linked the stability in the banking sector with its ability to completely cover losses caused by a crisis, and the value of these losses — with the impairment of assets. Adjusted for inflation and calculated on national stock exchanges, stock indexes were offered as an indicator of impairment of assets.

We proposed introducing a new regulatory instrument — the reserve capital buffer — to achieve the strategic goal of complete stability in the banking sector. Essentially, the reserve capital buffer will be similar to the conservation capital buffer, since it aims at absorbing losses. However, this capital buffer will differ from the conservation capital buffer in a dynamic and adaptive manner as its size will be determined by the differential between the target and the achieved capital adequacy levels, both at the level of individual banks and the entire banking sector. Due to its specifics, that the reserve capital buffer is not only an instrument for regulating the stability of banks and the banking sector, but also an instrument for strategic management of financial stability. In this regard, we believe that the reserve capital buffer should not only be regulatory, but should also be used to assess the quality of risk management and affect the remuneration to the owners and heads of banks.

An empirical analysis of the opportunities and consequences of applying the developed analytical tools was carried out on the example of the Russian banking sector. For Russia, we chose the IMOEX index as the stock index. An analysis of the dynamics of this index showed that for the Russian banking sector, the total loss is 40% of risk-weighted assets. We used this criterion to shape quantitative goals of macroprudential policy implying a smooth transition from the achieved level of financial stability to complete stability in the banking sector. The studies have shown that

[9] Profit-to-Risk Ratios for Credit Institutions. URL: http://banki.iee.unn.ru/ (accessed on: 02.07.2019).

Table 2

Target values of total and reserve capital buffers for systemically important banks

Date	Total capital buffer (*Xoi*)							Reference: Profitability in 2018**
	Total	Including						
		Protective (*Zi*)	Counter-cyclical (*Ki*)	For systemic importance (*Si*)	reserve (*Ri*)			
					Total	Formed * (*Rsi*)	Additional (*Rdi*)	
Sberbank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	3.1	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	3.1	0.0	3.86
ВТБ / VTB 01.01.2020	3.5	2.5	0.0	1.0	0.0	0.0	0.2	
01.01.2021	5.5	2.5	0.0	1.0	2.0	0.0	2.0	2.31
Russian Agricultural Bank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	1.5	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	1.5	0.5	0.21
Gazprombank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	0.2	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	0.2	1.8	0.51
Otkritie Bank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	8.2	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	8.2	0.0	0.18
Alfa Bank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	3.5	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	3.5	0.0	4.75
Credit Bank of Moscow								
01.01.2020	3.5	2.5	0.0	1.0	0.0	0.2	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	0.2	1.8	1.21
Promsvyazbank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	6.1	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	6.1	0.0	5.69
Raiffeisenbank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	1.8	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	1.8	0.2	3.06
UniCredit Bank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	4.6	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	4.6	0.0	2.06
Rosbank								
01.01.2020	3.5	2.5	0.0	1.0	0.0	0.8	0.0	
01.01.2021	5.5	2.5	0.0	1.0	2.0	0.8	1.2	1.42

Source: Profit-to-risk ratio for credit institutions. URL: http://banki.iee.unn.ru/ (accessed on 02.07.2019).

Note: * – according to the financial statements of credit institutions. URL: http://cbr.ru/credit/main.asp (accessed on 07.02.2019);

** – indicates the profitability of risk-weighted assets.

complete financial stability in the banking sector can be achieved by the Russian Federation by the end of 2030 without undue effort of its institutional units. In general, the empirical studies carried out in relation to the Russian banking sector proved the feasibility of applying the developed analytical tools to increase the effectiveness of macroprudential policy in the Russian Federation.

At the same time, we should noted that the study is based on the IMOEX index allowing to estimate the value of impairment of assets during crises. Applying other indicators in further research on this topic may clarify our results. The proposed analytical toolkit for shaping quantitative goals of macroprudential policy and streamlining of capital requirements for banks can be the subject of further research in terms of its adaptation to the banking systems of different countries. Summarizing these research results will help to formulate general standards and requirements for the bank regulation at the level of national jurisdictions and thereby contribute to the further improvement of Basel III standards.

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Financial Support of Regions as a Tool to Equalize Budgetary Security of the Constituent Entities of the Russian Federation

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ABSTRACT

The authors have considered current forms and methods of financial support for the regions in Russia. The dynamic analysis allowed to obtain a comprehensive assessment of the interbudgetary transfers provided by the federal budget for the socio-economic development of the regions in recent years with a view to reducing their economic differentiation and ensuring the implementation of the state regional powers. The methods of economic and statistical analysis were used. The authors conclude that the main form of financial support for the regions of Russia is subsidies to equalize fiscal security. The study proved that the increasing financial assistance in the form of subsidies leads to a decrease of the budgetary support level of the regions. Financial support for the Russian regions in the form of subsidies and subventions has a number of serious shortcomings: the multi-channel financial assistance to the region and the lack of an integrated approach which leads to dispersal and low return on public funds and makes it difficult to control their spending; fragmentation of its provision; reduction of incentives for self-development; difficulty in assessing the amount of assistance needed; refinancing. The identified problems require further implementation of motivation mechanisms for the state authorities of the constituent entities of the Russian Federation to increase the tax revenues of the regional budget. The article outlines possible ways to form financial incentives for independent regional development. It is proposed to provide the regions with consolidated subsidies. The regions will be able to independently determine the directions for their spending. This will allow for a balanced transition from the state control over spending the subsidies to the control over the results of their allocation.

Keywords: region; interbudgetary transfers; budget security; financial support; fiscal federalism; socio-economic development; grants; subsidies; subventions; regional economics

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INTRODUCTION

One of the most important tasks of a federal state is to equalize the financial opportunities of the regions to guarantee equal rights for social and medical assistance, education and other services by all citizens regardless of their residence.

At present, a differentiation the constituent entities of the Russian Federation is preserved depending on their financial capabilities and socio-economic development. In the Russian context, studying the characteristics of various methods and types of financial support of the constituent entities of the Russian Federation to solve acute territorial problems remains essential.

Let us define the term "financial support of the regions" to consider the essence of the financial support of the regions. It is worth noting that only a few researchers provided a comprehensive definition of this concept in their works. However, they often limited themselves to the goals and objectives of these activities and did not clearly indicate the range of included actions. The definition is also absent in the Budget Code of the Russian Federation (hereinafter, the Code). At the same time, the term is actively used in legal acts.

In general, financial support is considered in the economic literature as the funds transferred from the federal budget to the regional one[1].

Defining the financial support of the regions, N.M. Sabitova refers to all forms of financing the regions from the federal budget, except for direct financing [1, p. 2]. She notes that the concept of financial support is not identical to and is wider than the concept of financial assistance. Financial assistance to the constituent entities of the Russian Federation is a monetary relationship that arises between authorities in the current system of delimiting tax and expenditure powers and methods of budget regulation regarding the transfer of part of the higher budget funds to the lower one due to the limited tax base of the latter [1, p. 5].

Based on the generalized analysis of scientific literature and legal sources, the financial support of the regions can be understood as one of the aspects of regional economic policy consisting in any provision of funds from the federal budget for the socio-economic development of the region in order to reduce the regional economic differentiation, acting within state regional authority, developing regional infrastructure and forming incentives for independent regional development.

The essence of financial support is manifested to the fullest extent in the current forms and implementation methods. Four main methods of financial support of the regions can be distinguished: gratuitous assistance to regional budgets, redistribution of debt burden, distribution of tax revenues, and targeted financing. Let us learn more about the immediate forms of their implementation.

RESULTS

The Code generally identifies forms of financial support and intergovernmental transfers. *Table 1* presents the main indicators of financial support of the regions in the form of intergovernmental transfers.

Over the past 4 years, the absolute value of interbudgetary transfers as a whole has changed insignificantly and remained almost at the same level. However, the growth rate has been slowly but steadily declining, and a negative increase has already been observed in the last two years. In% of GDP, the reduction is more significant, on average by 0.11% of GDP per year. The highest rate of reduction is demonstrated by "other interbudgetary transfers", as well as subsidies (–14.06%).

Speaking about the dynamics of interbudgetary transfers in the previous periods, we refer to the study of M.L. Vasyunina: "For 2007–2015, the volume of federal budget expenditures to provide them increased by more than 3.5 times" [2, p. 18].

Thus, the main form of financial support of the Russian regions is grants for equalizing

[1] Federal budget and regions: structure of financial flows. EastWest Institute. M.: MAX Press; 2001.

budget security. The Code envisages for such an institution as the Federal Fund for Financial Support of the Subjects of the Russian Federation. It represents the total grants for equalizing the budget security of the constituent entities of the Russian Federation in the federal budget expenditures. According to the Budget Code of the Russian Federation, grants are understood as interbudgetary transfers on a pro-bono basis without setting uses.

Grants for equalizing budget security are provided to the constituent entities of the Russian Federation whose estimated budget security is below the level established as a criterion for equalizing estimated budget security. The level of estimated budget security of the constituent entities of the Russian Federation is determined in accordance with Article 131 of the Budget Code of the Russian Federation[2].

The total amount of grants is determined considering the need to achieve a minimum level of estimated budget security of the constituent entities of the Russian Federation[3]. The minimum level is defined as:

$$minEBS = \frac{\sum_{i=1}^{n} BS_i}{n},$$

where BS_i — is the level of estimated budget security of a constituent entity of the Russian Federation before the distribution of grants;

n — is the number of the constituent entities of the Russian Federation not included in the list of 10 constituent entities of the Russian Federation with the highest budget security, and 10 constituent entities of the Russian Federation with the lowest budget security.

In a clear view, the budget security of the regions of Russia in 2018 is shown in the *Figure*.

One of the key factors affecting the amount of financial support of the region in the form of grants is the level of estimated budget security:

$$BS = \frac{ITP}{IBE},$$

where BS — is the level of estimated budget security of a constituent entity of the Russian Federation before the distribution of grants;

ITP — is the index of the tax potential of a constituent entity of the Russian Federation;

IBE — is the index of budget expenditures of a constituent entity of the Russian Federation.

Since the tax potential index (ITP) and the budget expenditures index (IBE) include numerous coefficients, the level of estimated budget security considers many objective conditions for the region's economic activity, such as: the value added created in the region's sectors, the sectoral structure of the regional economy, and the volume of industrial production, tax burden on the economy, remuneration of labor and its differentiation, housing and public utilities costs, price level, population resettlement, transport accessibility etc.

The most granted regions in the Russian Federation in 2018 are the Republic of Dagestan (59 065 832.5 thousand rubles), the Republic of Sakha (Yakutia) (43 944 997.70 thousand rubles) and the Kamchatka Territory (39 357 697.20 thousand rubles).

Note that the amount of grants from the federal budget is increasing (+19.33%). This indicates a significant shortage of the regions' funds compared to the budget expenditures that they could concentrate in their budgets considering their current development level. This is confirmed by the dynamics of the level of estimated budget security in most regions for the same period. 71 out of 85 regions (except the Vologda, Leningrad, Lipetsk, Omsk, Sakhalin, Tula, Tyumen, Ulyanovsk Regions, Perm Territory, Komi Republic, Khanty-Man-

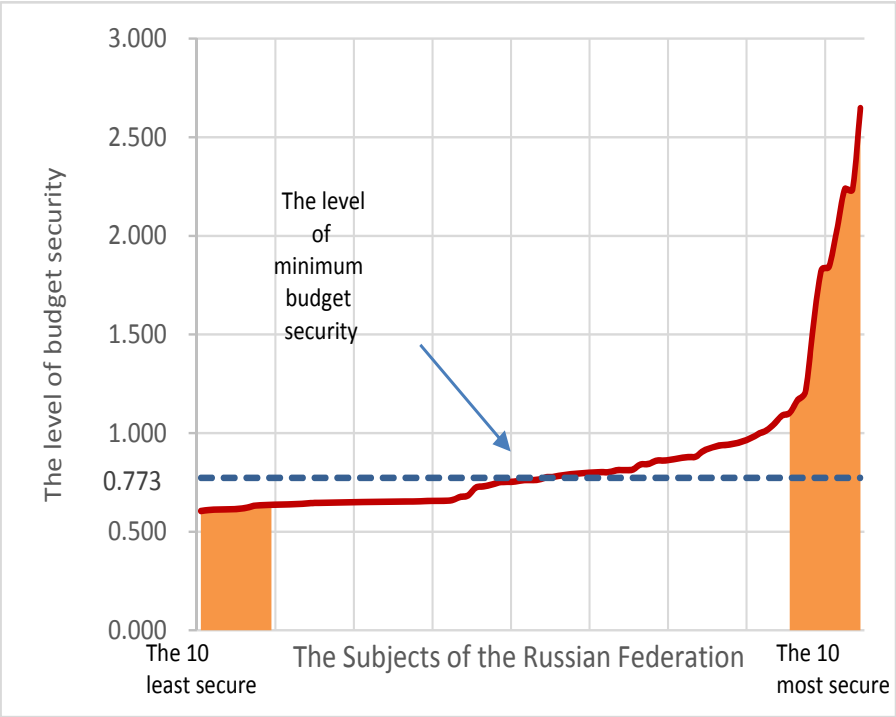
[2] The Budget Code of the Russian Federation of July 31, 1998 No. 145-FZ (as amended on December 28, 2017). URL: http://www.consultant.ru/document/cons_doc_LAW_19702/ (accessed on 19.09.2018).

[3] Decree of the Government of the Russian Federation of November 22, 2004 No. 670 (as amended on December 31, 2017) "On the distribution of subsidies for equalizing the budget security of the constituent entities of the Russian Federation" (together with the "Methodology for the distribution of subsidies for equalizing the budget security of the constituent entities of the Russian Federation"). URL: http://www.consultant.ru/document/cons_doc_LAW_86148/ (accessed on 19.09.2018).

Inter-budget transfers from the Federal budget

Indicator	2016	2017	2018	2019	2019 as % of 2016
Inter-budget transfers, total, million rubles	1 474 867.00	1 533 450.90	1 513 075.50	1 443 125.00	97.85
% growth rate compared to the previous year	105.59	103.97	98.67	95.38	
in % GDP	1.78	1.66	1.64	1.46	
as % of total Federal budget expenditures	8.99	9.17	9.43	9.03	
Including					
Grants	641 731.20	738 263.40	754 550.90	765 748.50	119.33
% growth rate compared to the previous year	116.53	115.04	102.21	101.48	
% of total amount	43.51	48.14	49.87	53.06	
Subsidies	328 931.70	349 465.90	325 934.40	282 677.90	85.94
% growth rate compared to the previous year	108.22	106.24	93.27	86.73	
% of total amount	22.30	22.79	21.54	19.59	87.83
Subventions	305 993.40	307 778.40	303 774.00	304 425.60	99.49
% growth rate compared to the previous year	99.76	100.58	98.70	100.21	
% of total amount	20.75	20.07	20.08	21.09	
Other inter-budget transfers	198 210.70	137 943.20	128 816.10	90273.10	45.54
% growth rate compared to the previous year	68.26	69.59	93.38	70.08	
% of total amount	13.44	9.00	8.51	6.26	

Источник / Source: данные Росстата и расчеты автора / Rosstat data and the author's calaculations.



Budget supply of constituent entities of the Russian Federation in 2018

Source: compiled by the authors on the basis of [4].

siisk autonomous district and Yamal-Nenets Autonomous District) show negative growth rates; 2 out of 85 show zero rates. At the same time, there is a relatively significant increase (more than 10% over 4 years) only in the oil and gas regions — Khanty-Mansiisk autonomous district (20.1%), Yamal-Nenets Autonomous District (10.7%) and Tyumen region (10.3%), as well as Sakhalin (32.6%) and Leningrad (18.7%) regions. In 71 regions, the situation is deteriorating, and in some regions [the Kamchatka Territory (–14.3%), the Republic of Ingushetia (–14.2%), Jewish Autonomous Oblast (–13.98%)] at a rather rapid pace. The largest reduction in this indicator in most regions took place in 2018 compared to 2017.

Based on the above, we can conclude that an increase in financial assistance in the form of grants does not lead to an increase in the level of budget security; on the contrary, it decreases.

Grants as a form of financial support face a few problems. The main drawback is that when the necessary amount of grants is calculated by the established methodology, an increase in the level of estimated budget security entails a decrease in the volume of financial assistance, both at the first and the second stages of its allocation. Thus, the region has reduced incentives to increase the value added of sectors of the economy, which leads to a decrease in attracting private investment, infrastructure development, provision of tax benefits, etc. However, the level of budget security and, therefore, the tax potential index is the value whose growth should be of interest to the region.

The discussed problems of financial support in the form of grants require introducing mechanisms to motivate the state authorities of the constituent entities of the Russian Federation to increase tax revenues of the regional budget. They can be maintaining the provided amount of grants during the next financial year after the level established as an equalization criterion is reached, or gradual reducing financial assistance considering planned indicators for the region's development. It is necessary to create a system of increased requirements in terms of efficiency

and effectiveness of the use of budget funds to the regions that receive financial support and do not demonstrate the growth of the regional economy [3–5][4].

Today, there is some ambiguous understanding of grants used in legal acts. Articles 129 and 131 of the Code include only grants for equalizing the budget security of the constituent entities of the Russian Federation in this form of financial support of the regions. They do not suggest any other interbudgetary transfers from the federal budget in the form of grants (except for equalizing budget security). In fact, besides grants for equalizing budget security there are other types of grants. Federal Law dated December 05, 2017 No. 362-FZ "On the Federal Budget for 2018 and for the Planning Period of 2019 and 2020" provides for such types as grants for partial compensation of additional expenses for increasing the remuneration of public sector employees and other purposes to the budgets of the constituent entities of the Russian Federation and the budget of the city of Baikonur for 2018, grants for partial compensation of additional costs expenses for increasing wages of public sector employees, grants to support measures to ensure the balanced budgets of the constituent entities of the Russian Federation. Considering their allocation, we can also identify grants for stimulating the development of the tax potential of the regions, grants for partial compensation of lost revenues of the budgets of the constituent entities of the Russian Federation due to the centralization of the tax on mineral extraction in the federal budget, grants for compensation of budget losses arising in the division of powers between federal bodies of state power, bodies of state power of the constituent entities of the Russian Federation and bodies of local self-government. Based on the above, we can conclude that defining in the Code only one type of grants for equalizing budget security is contrary to the current situation. We can note the inaccuracy in the definition of grants presented in the Code, since some of them are actually targeted by nature. To improve legal regulation, it is proposed to identify in the Code and to develop additional methods for certain types of grants, not formally defined in the Code, but existing in practice. The following types can be distinguished: grants to support measures to ensure balanced budgets, grants to encourage achieving the best values of performance indicators of state authorities, etc. [6, p. 128–131].

The second form of financial support named in the Code is subsidies to the budgets of the constituent entities of the Russian Federation. The definition of this form of financial support is established by law in Article 132: "Subsidies to the budgets of the constituent entities of the Russian Federation from the federal budget are understood as interbudgetary transfers provided to the budgets of the constituent entities of the Russian Federation in order to co-finance expenditure obligations arising from the exercise of the powers of state authorities of the constituent entities of the Russian Federation on subjects of jurisdiction of the constituent entities of the Russian Federation and subjects of joint jurisdiction of the Russian Federation and the constituent entities of the Russian Federation"[5]. That is, the intergovernmental subsidy is provided as an aid to the region to implement the powers legally assigned to this constituent entity of the Russian Federation. Moreover, expenditure obligations of the constituent entity of the Russian Federation, implemented through subsidies from the federal budget, may arise from the expenditure powers of the state authorities of the constituent entity of the Russian Federation both in the subjects of jurisdiction of the constituent entities of the Russian Federation and in subjects of joint jurisdiction.

Subsidies are the main form of financial support provided in the framework of program-targeted public administration [7–11]. The funds

[4] The level of estimated budget security and the budget expenditures index of the constituent entities of the Russian Federation for 2017–2019. URL: https://www.minfin.ru/ru/document/?id_4=116795 (accessed on 15.04.2019).

[5] The Budget Code of the Russian Federation of July 31, 1998 No. 145-FZ (as amended on December 28, 2017). URL: http://www.consultant.ru/document/cons_doc_LAW_19702/ (accessed on 19.09.2018).

for co-financing activities are provided in the form of subsidies. They are implemented at the expense of the budgets of the constituent entities of the Russian Federation within the framework of state programs of the Russian Federation or federal targeted programs implemented at the expense of the federal budget. The constituent entities of the Russian Federation and municipalities participate in state programs on a co-financing basis. According to the rules, regions must provide for their co-financing of federal funds (subsidies) for state programs in the amount of 5 to 30% (depending on the level of financial security of regional budgets).

Similar to grants, the maximum level of co-financing of expenditure obligations of a constituent entity of the Russian Federation from the federal budget is established for subsidies and depends on the level of estimated budget security of the constituent entity of the Russian Federation for the current financial year. The higher the rank of the region in terms of estimated budget security, the less financial support in the form of subsidies the region can receive.

A subvention to the budget of the constituent entity of the Russian Federation is a special form of financial support of the regions. Based on the definition given in the Code (Article 133), subventions to the budgets of the constituent entities of the Russian Federation from the federal budget are understood as interbudgetary transfers provided to the budgets of the constituent entities of the Russian Federation for the financial provision of expenditure obligations of the constituent entities of the Russian Federation and (or) municipalities arising from the exercise of the powers of the Russian Federation transferred for the implementation to state authorities of the constituent entities of the Russian Federation and (or) local authorities in the prescribed manner. Thus, the main difference between the subvention and other forms of financial support is that it is provided along with delegated powers transferred to the regional level from the federal level. Subventions are used as a tool for financing delegated powers [12]. Due to subventions, the greatest efficiency is achieved in providing state (municipal) services and performing state functions due to the economies of scale and the closest possible approximation of performers to the population. However, subventions are of the most targeted nature and only partially related to the actual regional socio-economic processes, since they are not allocated to the development of the region, but to exercise the powers of the federation in the region. Therefore, they can only partially be attributed to financial support of the region. At the same time, they can contribute to obtaining secondary effects, such as developing the region's infrastructure, increasing employment, improving the quality of services provided, etc., i.e. in cases when their established uses partially coincide with the region's own interests. Moreover, they do not directly depend on the indicators characterizing the own revenues of a constituent entity of the Russian Federation that once again confirms the conditionality of their classification as forms of financial support of the regions. Subventions, as well as the dynamics of changes in their volume in the Russian system of budget federalism do not correspond to international practice [13–16]. The mechanism of subventions that has developed in Russia blocks the migration of powers to a level where they would be exercised most efficiently, and this violates the principle of subsidiarity [17–19].

Financial support of the Russian regions in the form of subsidies and subventions has a number of serious shortcomings. The main ones are the multi-channel financial assistance to every region in need and the lack of an integrated approach, which leads to dispersal and low return of public funds, and makes it difficult to control their spending. This multi-channeling is manifested in multiple targeted transfers. At present, more than 100 types of subsidies and 30 types of subventions are provided from the federal budget. Increase in the types of targeted interbudgetary transfers makes their development translucent and not sufficiently effective. There is a dispersal of financial support. It is significant that on average there are four interbudgetary subsidies to one state program. Sometimes

subsidies with identical targets are provided under various state programs. This leads to inconsistency of decisions by the constituent entities public authorities on spending of financial assistance [2, 16].

Thus, subsidies can reach several dozen in certain areas of co-financing. The fragmentation of these subsidies does not let the regions use the received funds on urgent socio-economic problems. Moreover, the share of subsidies in the total amount of financial support is most often high.

The mentioned shortcomings in the provision of subsidies for state programs can be resolved by the so-called consolidated subsidies. Two main approaches can be recommended to consolidation of subsidies:

1) consolidation of subsidies in the framework of state programs. So, one or two subsidies should be allocated for one program (separately to finance current and capital expenditures);

2) more significant consolidation: consolidation of all subsidies (all subsidies for capital expenditures) within the framework of one state program.

Having received a single consolidated subsidy, the regions will be able to independently decide how to spend it. This innovation is necessary for the transition from control over the spending of subsidies to control over the results of their allocation. The latter should become more intense.

To make financial support in the form of subsidies and subsidies effective, it is necessary to eliminate negative incentives for independent development of the region or to create conditions when the received funds will in any case be used efficiently, for the benefit of the economy. In the latter case, it is advisable to apply a program-targeted approach focused on integrated socio-economic development combined with the approaches for the consolidation of subsidies.

The methodology for providing financial support exclusively to implement delegated powers (in the form of subventions) has its own imperfections. In terms of reduction, or optimization, of federal budget expenditures in recent years and a simultaneous increase in the number of delegated powers, state authorities of the constituent entities of the Russian Federation are often forced to raise their own funds to implement them. This was noted directly by representatives of the regions. This is most clearly expressed in the context of optimizing federal budget expenditures and an annual reduction in budget allocations by 10% since 2015. In particular, a decrease in the volume of a single subvention made the constituent entities of the Russian Federation fulfill their obligations (state registration of acts of civil status, state protection of cultural heritage of federal significance, etc.) at their own expense and reallocate budget allocations [2].

To bring the subventions in line with the costs of the implementation of delegated powers of the Russian Federation, it is necessary to conduct an audit of the spending powers of state authorities of the constituent entities transferred from the federal level. It is also necessary to develop standards for assessing the cost of their implementation and provide the estimates as part of materials for the development of the federal budget to the Ministry of Finance of the Russian Federation. Similar to the considered approach to organizing the provision of subsidies, a way to improve this form of financial support may be to consolidate subventions for the implementation of delegated state powers related to one classification group.

Article 132.1 of the Code contains the concept of "other interbudgetary transfers to the budgets of the constituent entities of the Russian Federation". Despite the nature of the concepts, they play their own role in regional development. Other interbudgetary transfers should include transfers allocated to the budgets of the constituent entities of the Russian Federation to provide transfers to municipalities where the territories with special administrative and legal status are located (closed administrative-territorial entities, science cities, special economic zones, etc.), as well as those related to financing secret articles of the federal budget and overdue accounts payable of the region for budget loans. An example of other interbudgetary transfers

Table 2

Limit value of budget loans to budgets of subjects of the Russian Federation for the period 2015–2020

Indicator	2015	2016	2017	2018	2019	2020
Limit value of budget loans to regions. thousand rubles	310 000 000.0	310 000 000.0	200 000 000.0	2 056 470.0	1 506 690.0	1 006 800.0
In % GDP	0.42	0.37	0.22	0.0021	0.0	0.0
% of total Federal budget expenditures	2.10	1.89	1.20	0.01	0.0	0.0

Source: compiled by the authors.

Table 3

The volume of the state internal debt of subjects of the Russian Federation under the article "Budget loans from other budgets of the budget system of the Russian Federation" in 2011–2017, thousand rubles

2011	2012	2013	2014	2015	2016	2017
3 400 873.52	419 380 274. 11	426 210 030.46	470 931 498. 79	647 451 802. 84	808 674 450. 86	990 494 107.69

Source: compiled by the authors.

is the allocation of subventions to finance additional expenses of the municipality if it is granted the status of a science city. As a rule, such settlements play the role of growth centers in the region and are of great importance for the socio-economic development of the constituent entity, so the regional authorities are very interested in these transfers.

Chapter 16 of the Code lists the main forms of financial support of the regions. Nevertheless, they do not exhaust all modern forms of its provision. Limiting the methods of financial support of the regions by the considered forms would be an identification of the "financial support" and "interbudgetary transfers" concepts. On the other hand, financial support is a broader phenomenon.

Budget loans can also be a form of financial support of the regions. Their main difference from the forms of financial support considered above is the need for repayment and the paid nature of the provision, while budget loans, as well as subsidies and subventions, are targeted. Such financial assistance is provided to the constituent entities of the Russian Federation for a period of up to five years on the terms of an agreement regulated by civil law, within the limits of budget allocations stipulated by budg-

et laws. At the same time, this form has many shortcomings that are currently clearly evident in Russia.

Let us consider the limit value of budget loans to the budgets of the constituent entities of the Russian Federation, provided for by laws on the federal budget. It is presented in *Table 2*.

As seen from the above data, this form of financial support over the past four years and in two planning periods tends to decrease both in absolute and in relative terms. Despite the decrease in the budget level, the amount of regional debt on budget loans does not decrease. Let us consider the dynamics of the financial assistance actually received by the regions of Russia in the form of budget loans. It is presented in *Table 3*.

Based on the data presented, the average growth rate of loans per year is:

$$\overline{T} = \left(\sqrt[6]{\frac{990\,494\,107.69}{3\,400\,873.52}} - 1 \right) \times 100\% = 157.46\%,$$

or in absolute terms

$$\overline{\Delta} = \frac{990\,494\,107.69 - 3\,400\,873.52}{7-1} = 164.52 \text{ billion rubles per year.}$$

A particular increase in debt occurred in 2015–2016, after a sharp deterioration in external economic and geopolitical conditions in 2014 which was growing, albeit at a slower pace, and after the economy emerged from the crisis in 2017.

Financial support of the regions in the form of budget loans has long-term risks. A significant increase in public debt of the Russian regions due to the accumulation of budget loans and other types of debt obligations negatively affects the financial stability of the budgets of the territories, as well as it limits investment opportunities. Despite the legislative consolidation of implementing bilateral relations between the state and the constituent entity on payment for the use and terms of repayment of loans, the volume of loans provided, according to statistics, is increasing every year. Together, these factors are responsible for the slowdown in the regional development.

At the same time, by increasing budget lending, the federal government seeks to refinance expensive commercial loans accumulated by the constituent entities of the Russian Federation. That is, despite some risks, this measure is aimed at improving the regional economy, as announced by the President of the Russian Federation in 2017.

Indeed, in many respects such statistical indicators are determined by the policy of refinancing the debts of the constituent entities of the Russian Federation. For example, according to Decree of the Government of the Russian Federation dated December 18, 2017 No. 2857-r, budget allocations for the provision of budget loans in 2017 from the federal budget to the budgets of the constituent entities of the Federation were increased by 55 billion rubles. The document notes that 'this is due to the need to ensure a balanced budget of the constituent entities of the Federation and refinancing of the debt obligations of the regions"[6].

Among other measures, one can propose to envisage the obligation to fulfill the obligation to repay the budget loan (this condition is established in the Code, but does not apply to borrowers — the constituent entities of the Russian Federation), providing justification for the need to attract borrowed funds, as well as the mandatory approval of the debt policy of the constituent entity of the Russian Federation.

CONCLUSIONS

All forms of financial support of the regions discussed above are the direct provision of funds to the regional budget. Redistribution of tax revenues between the levels of the budget system of the Russian Federation is an indirect form of financial support of the regions, different by na-

[6] Decree of the Government of the Russian Federation of December 18, 2017 No. 2857-r "On the increase in allocations to ensure the balance of regional budgets". URL: http://government.ru/department/69/events/?dt.since=20.12.2017&dt.till=20.12.2017 (accessed on 19.09.2018).

ture. The share of tax revenues from the federal taxes redistributed to the regional budgets is large. The regions receive a large amount of funds from excise taxes, one of the most significant revenue sources. Personal income tax is transferred to the consolidated budget of a constituent entity of the Russian Federation. The amount of corporate income tax calculated at a tax rate of 17% is credited to the regional budget, and most taxes are paid there, etc., although there are many opinions about the effectiveness of the current system, for example, regarding the transfer part of VAT and other taxes to the regions. After all, organizations are the VAT payers and carry out their activities on the territory of the constituent entities of the Russian Federation.

Thus, the financial support of the regions in conditions of high territorial differentiation makes it possible to solve tasks related primarily to maintaining socio-economic stability in the region and fulfilling all responsibilities of the regional authorities to the population. To sum up, we note again that currently the budgets of most regions are depending on the funds received as financial support. At the same time, forms of financial support have a number of shortcomings, including multi-channeling, fragmentation of its provision, reduction of incentives for independent development, difficulty in assessing the amount of necessary assistance, onlending, etc. The problems of financial support of the regions have long been under the attention of financial authorities. As a result of the transformations in the recent years, some shortcomings of the applied forms and methods of financial support have been partially eliminated.

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Shadow Banking: Regulatory Reform and Its Effectiveness

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ABSTRACT

Over the past three decades, a large group of non-bank financial institutions has been formed in the world economy. These institutions fall outside the realm of traditional banking and take an active part in the lending processes of economic turnover entities. The activities of these institutions, called the shadow banking system (SBS), led to an increase in systemic risks and had a negative impact on the state of the global financial system. This was distinctly displayed during the global financial crisis of 2007–2009. The subject of this article is a series of measures taken by the international and national financial control bodies after the financial crisis to eliminate most risky aspects of shadow banking and to strengthen the system of financial oversight and monitoring. The final aim of the analysis is to evaluate effectiveness of the measures on strengthening control and limiting risks applied by the control bodies of the G-20 countries in the course of the reform to enterprises of the traditional and shadow sectors of the financial system. The results of the analysis show that the reform strengthened positions of traditional banks and improved their ability to resist financial shocks. As to the shadow banking sector, contrary to the statements of the initiators of the reform the regulative measures did not eliminate the systemic risks peculiar to nonbank financial institutions and did not stop their growing activities. This situation threatens the stability of the global financial system and a possibility of a new financial slump retains.

Keywords: shadow banking system; regulatory reform; financial stability; systemic risk; oversight and monitoring

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INTRODUCTION

In western economic literature, a shadow banking system is usually regarded as various types of non-bank financial institutions. They are intermediaries facilitating the creation of credit and other banking services to business enterprises and the public, but are not subject to regulatory oversight by official oversight authorities, nor do they use financial support of the central bank in crisis situations. Their specific feature is the excessive risk-taking and dependence on fluctuations in the economic conditions. This triggers and enhances crisis processes in the financial sector and the economy as a whole [1–3].

At the G20 Leaders' Summit in November 2010, the task was set to develop a new strategy for recovering the financial system and reducing systemic risks posed by institutions in the shadow sector. The reform focused on two main areas: developing an intensive oversight system of shadow structures and measures to mitigate risks and to counter threats to stability in the banking and non-banking sectors of the financial system.

The task of the article is to characterize the current state, range of activity and risks of the shadow sector, to identify the essence of the main regulatory measures taken by international and national supervisory authorities in relation to financial institutions of the traditional and shadow sectors, and to assess the validity of statements by official authorities to completely eliminate the SBS risks threatening the stability of the global financial system by now.

STRUCTURE, RANGE AND RISKS OF SBS

Academic studies and official documents of financial institutions use a special classification of the shadow banking system institutions and estimate financial assets controlled by them. The most popular are the calculations by the *Financial Stability Board* (hereinafter referred to as the FSB) established by the G20 Leaders in 2009. The duties of this body are "to coordinate at the international level the work of national financial authorities and international standard-setting bodies in order to develop and promote the implementation of effective regulatory, supervisory and other financial sector policies". One of the important tasks is to review recent trends and developments in the global shadow banking system and develop recommendations for its oversight and regulation in order to reduce systemic risks[1].

The FSB materials provide an estimate of the financial assets in two country groups. The first group includes 29 jurisdictions (countries), the FSB current members, and the second includes 21 countries from the previous list plus 8 euro area countries represented as one jurisdiction (21 + EA)[2]. The second set uses data from the European Central Bank for the euro area countries[3].

For analytical purposes, several segments are distinguished in the SBS structure. The broadest segment by the number of included institutions is the Monitoring Universe of Non-Bank Financial Institutions (hereinafter referred to as MUNFI). It comprises all non-bank financial institutions in the observed countries.

Another, narrower version of non-bank financial institutions used in the FSB analysis is "Other Financial Institutions" (hereinafter OFIs). It does not comprise central banks, insurance corporations, pension funds, public financial institutions, financial auxiliaries or other institutions that are not directly involved in credit intermediation processes.

Finally, the narrowest (and the most significant for our study) SBS measure includes non-bank financial entity types involved in credit intermediation for the real sector and

[1] Financial Stability Board. Shadow Banking: Strengthening Oversight and Regulation. Basel; 2011. URL: http://www.fsb.org/wp-content/uploads/r_111027a.pdf (accessed on 15.02.2019).

[2] Both groups include the Russian Federation. The Central Bank of the Russian Federation takes part in measures for ensuring the financial stability and publishes regular quarterly reports on the systemic risks in the Russian banking system and non-credit financial institutions, as well as on the measures taken to mitigate and control risks.

[3] Financial Stability Board. Global Shadow Banking Monitoring Report 2017. Basel; 2018. URL: https://www.fsb.org/wp-content/uploads/P050318–1.pdf (accessed on 18.02.2019).

population. The activity of this segment is considered the most dangerous ("toxic", as it is often called) for the financial infrastructure due to its functioning specifics and the methods of attracting resources of its institutions. Moreover, unlike traditional (deposit) banks, the latter are not directly controlled by national supervisory authorities [4–6].

According to the FSB analytical service calculations, the total global financial assets of all financial corporations were estimated at $ 340 trillion by end-2016. Of these, the assets of *non-bank* institutions belonging to the MUNFI measure amounted to $ 160 trillion, comprising OFIs ($ 99 trillion) and the "toxic" SBS ($ 45 trillion)[4]. The vast majority of the assets of shadow banking institutions in the OFIs are concentrated in the USA (33%), the euro area countries (34%) and the UK (12%).

The institutional composition of the SBS narrow measure is associated with shadow structures classified into functional groups that can disseminate and enhance the negative impact of systemic risks on financial market conditions through various channels.

The first group is *collective investment vehicles* (hereinafter — CIVs). They play an important role in financial intermediation accumulating the free capital of the business sector and the savings of individual clients and investing them in long-term government and corporate securities. This is a high-risk financial activity as there is a real risk of panic withdrawal by customers of invested funds (in the form of shares, units of investment funds, etc.) in worsening financial conditions.

The CIVs group includes various types of investment funds — money market mutual funds, open-ended fixed income funds, credit hedge funds, real estate funds, mixed funds holding a mix of equity and credit assets, and others. This is the largest group comprising more than 2/3 (72%, 32.4 trillion dollars) of all "toxic" SBS assets.

The second group includes numerous non-bank institutions providing loans to various groups of the population and enterprises of the manufacturing sector. These institutions threaten the financial stability by their dependence on the market sources of short-term funding used to replenish the resource base. Any deterioration in the conditions for obtaining liquidity in the money market causes financial stress and leads to significant monetary losses and bankruptcies of these institutions. Moreover, the instability of the institutions of this group is due to the fact that a significant part of their customers has low incomes and a low credit rating, which prevents them from obtaining loans from banks in the traditional sector.

The group includes finance companies, auto finance companies, retail mortgage provision companies and equipment finance companies. They comprise 8% of the "toxic" SBS assets for a total of $ 2.7 trillion.

The third place (10% of assets, $ 3.4 trillion) belongs to non-bank institutions related to *securitization* of financial assets and issuance of various types of debt obligations, mainly secured by mortgage bonds. Securitization is a complex multi-stage process where shadow structures of various types are actively involved (see below for more details).

Broker-dealers ($ 3.8 trillion corresponding to 11% of total SBS assets) occupy the main place in the next group. They operate in the money and stock markets and are dependent on short-term funding (in the form of issuance and placement on the market of commercial securities, repos, etc.). They supply customers with securities serving as collateral for loans, intermediate in the sale of shares, bonds and derivatives.

The broker-dealers operations are closely related to the activities of deposit banks, and some large securities trading companies after the 2007–2009 crisis were included in bank holdings. This interweaving of the functions enhances systemic risks as it creates favorable conditions in the financial system for the rap-

[4] Financial Stability Board. Global Shadow Banking Monitoring Report 2017. Basel; 2018. p. 8. URL: https://www.fsb.org/wp-content/uploads/P050318–1.pdf (accessed on 18.02.2019).

id growth of difficulties arising in the shadow sphere. This contagion process triggered rapid development and exacerbation of the 2007–2009 global crisis.

The rest of the SBS assets belong to relatively small groups of non-bank structures, for example, companies that provide guarantees on loans and transactions with derivatives.

It should be emphasized that the activities of the shadow banking sector institutions are of a dual nature. On the one hand, non-bank financial institutions contribute to increasing the efficiency of financial intermediation by engaging additional funds in active economic circulation and satisfying the financial services needs of numerous market entities that cannot receive them on usual terms. "Non-bank financing provides a valuable alternative to bank financing and helps support real economic activity. For many corporates and households, it is also a welcome source of diversification of credit supply from the banking system, and provides competition for banks"[5].

At the same time, as already noted, shadow structures are a source of increased risk that through its complex interconnectedness with the financial system may spread to other sectors and trigger slumps.

For the last quarter of a century, use of the latest financial technologies by shadow structures has become a potential threat to the stability while competing for a place in the current system of financial relations. For example, securitization of financial assets became popular in the United States and in several European countries in the pre-crisis years. To a large extent, it was associated with the boom in mortgage loans in these countries. Traditional banks used these operations as a tool in the competition to lower costs and increase operating income. However, securitization would not have progressed to this stage if it didn't take an active part in the operations by shadow financial institutions.

It is necessary to discuss the specifics of such operations and the role of shadow institutions in their implementation in more detail. A commercial bank seeking to use some illiquid assets of its portfolio to release new debt obligations to the market is at the beginning of the securitization chain[6]. A pool of debt-based assets (usually mortgage bonds) is formed on this purpose, which is transferred to a specially created intermediary structure (special purpose vehicles, hereinafter SPV). The latter, together with other shadow sector institutions (financial companies, hedge funds and other SIVs institutions, broker-dealers of the securities market), issues new obligations and sells them to investors in different countries of the world. Funds from the sale of these securities to investors allow the issuing bank to replenish its liquidity reserve and use it for current needs.

The increased risk of asset securitization operations for investors is secretive due to many participants in the operation (both banks and non-bank financial institutions), their complex relationships and the low information content of the procedures. An important role is also played by high rankings, not always justifiably assigned to new securities by large credit agencies. All this mislead potential investors into thinking that the purchased securities were reliable and of high liquidity.

Another factor contributing to the quality deterioration of structured securities in the pre-crisis years was that issuing banks included subprime mortgages in securitization pools due to the lack of high-quality mortgage obligations[7].

With the onset of the 2007–2009 crisis, confidence in securitization operations rapidly decreased which led to a drop in the market value of issued securities and to large

[5] Financial Stability Board. Global Shadow Banking Monitoring Report 2017. Basel; 2018. URL: http://www.fsb.org/wp-content/uploads/P050318–1.pdf (accessed on 18.02.2019).

[6] Such secondary obligations secured by financial assets are called structured securities.

[7] At the end of 2006, in the USA, as part of a gigantic accumulated mortgage debt, estimated at $ 6.5 trillion, low-grade securities amounted to about $ 1 trillion, and a significant part of them was used to issue structured obligations.

monetary losses of banks, insurance companies, investment funds and ordinary investors who had these securities. The causes of the financial catastrophe and a negative role of the shadow sector in its development were widely discussed in banking and scientific worlds. The damage and breaking the foundations of the traditional banking sector were identified. There was a need to assess the potential risks of shadow structures and develop urgent measures to remedy the current situation.

The role of the main analytical and coordination center for developing policies and measures to reduce systemic risks in the global financial system was entrusted to the Financial Stability Board. International organizations developing financial standards made an important contribution to the study of shadow banking problems and the implementation of protective measures[8]. As a result, recommendations were formulated and legislative acts aimed at limiting risks and forming an extensive oversight and monitoring system at the international and national levels were adopted.

CHANGES IN THE REGULATORY SYSTEM OF SHADOW BANKING

At the G20 Leaders' Summit in November 2010 in Seoul, the task was set to develop a new strategy for recovering the financial system and reducing systemic risks posed by institutions in the shadow sector. The work focused on two areas. First, it was about developing *an intensive oversight system* of shadow structures which should ensure ongoing monitoring of SBS processes and identify the sources of the arising systemic risks. Second, it was necessary to develop *a policy to counter threats* in the banking and non-banking sectors of the financial system.

In the second area, special attention was paid to measures aimed at: reducing the interaction between banks and shadow structures, reducing liquidity and maturity mismatching in the balance sheets of non-bank institutions, as well as providing more information about shadow structures activities, especially about securitization of financial assets.

An important step in developing an effective oversight system was the introduction of annual global monitoring by the Financial Stability Board since 2011. The monitoring determines the main trends, scale of operations and risks in the shadow banking system based on the statistics of the countries-participants. The latest (seventh) report, published in May 2018, summarizes the results of the observations for 2016 in 29 jurisdictions, which account for 80% of global GDP[9].

The next step in the oversight system development was taken in 2013, when the G20 Leaders' Summit in St. Petersburg adopted a program on strengthening the oversight and monitoring of shadow banking activities[10]. The program was intended for the highest financial authorities of the countries-participants and provided for a regular analysis of the SBS institutions, as well as the development of methods to reduce systemic risks associated with non-bank structures in credit intermediation processes. Besides, the task was set to establish a closer information exchange between the countries-participants through the FSB to ensure a single approach to the implementation of reform measures.

In 2015, peer review was introduced to evaluate the measures on strengthening the oversight and monitoring of shadow banking activities. This contributed to enhanced information sharing and risk identification.

All of these measures let organize an extensive system of monitoring the development trends of the shadow sector and did the

[8] These include the Basel Committee on Banking Supervision (BCBS), the International Organization of Securities Commissions (IOSCO), the International Association of Insurers-Supervisors (IAIS), the Committee on the Global Financial System (CGFS) and several others.

[9] Financial Stability Board. Global Shadow Banking Monitoring Report 2017. Basel; 2018. URL: http://www.fsb.org/wp-content/uploads/P050318–1.pdf (accessed on 18.02.2019).

[10] Financial Stability Board. Policy Framework for Strengthening, Oversight and Regulation of Shadow Banking Entities. Basel; 2013. URL: http://www.fsb.org/wp-ntent/uploads/r_130829c.pdf (accessed on 15.02.2019).

groundwork for certain actions limiting the SBS negative impact on financial stability.

The second direction of the regulatory policy focused on developing measures to weaken the ties of traditional banks with shadow structures. In the pre-crisis years, sponsor banks actively collaborated with various non-bank institutions and provided them with an opportunity to use their financial resources to conduct operations. Ultimately, this provided shadow structures with the access to official sources of financing (for example, to the discount window of the central bank), which they were not allowed to use according to the current banking legislation.

Moreover, banks often included assets of shadow organizations involved in securitization operations in their accounting reports under the guise of their own off-balance sheet accounts. As a result, the bank benefited by applying low risk indicators to calculate the capital adequacy ratios in accordance with the rules of the Basel Committee on Banking Supervision.

To limit this practice, the accounting rules were changed in the countries-participants at the FSB initiative. Thus, the US Accounting Standards Board ordered the banks sponsoring shadow institutions to indicate the assets in their balance sheets in a separate line and cover them at the expense of equity at higher rates. Another example: the China Banking Regulatory Commission banned banks from using trust companies to conduct lending operations under the guise of property management. As a result, this practice significantly decreased, but new types of contact between Chinese banks and the SBS appeared.

The activities of the Basel Committee on Banking Supervision played a significant role in weakening the ties of traditional banks with shadow structures. In 2009, the Basel II Accord (adopted in 2004) increased the capital requirements of banks for liquid assets used in asset securitization operations[11]. Later, in the Basel III (2010), the capital requirements for banks were increased again. Besides, a liquidity coverage ratio was introduced (from the beginning of 2015) to create an additional cash reserve in banks in case of runs. The value of the coefficient should reach its maximum by 2019.

Later, the Basel III rules were adjusted and supplemented. Regulatory requirements were introduced for bank capital investment in shares of investment funds (since January 2017); derivatives margin requirements (September 2016), new liquidity ratios (since January 2019), the minimum standard for net stable funding ratios (since January 2018), and others[12].

As the analysis shows, the measures by the FSB and other international and national supervisory authorities to strengthen the positions of traditional banks and increase their resistance to shadow banking were generally successful. However, observed in recent years, the rapid growth of assets and operations of investment funds, broker-dealers securities, as well as emerging new forms of cooperation between shadow institutions and banks, slowed the development of this trend. The FSB analysts have to admit that current bank relations with the shadow business are even at a higher level than in the pre-crisis years[13].

Another set of regulatory measures was associated with excessive level of leverage and liquidity and maturity mismatching in the balance sheets of shadow structures. High leverage indicates the excessive use of credit sources of funding by non-bank financial institutions. High leverage and maturity mismatching is an addi-

[11] Basel Committee on Banking Supervision. Proposed enhancements to the Basel II framework. Consultative document. Basel: 2009. URL: https://www.bis.org/publ/bcbs150 (accessed on 15.02.2019).

[12] Basel Committee on Banking Supervision. Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools. Basel: 2013. URL: https://www.bis.org/publ/bcbs238.pdf (accessed on 15.02.2019).

[13] Financial Stability Board. Assessment of shadow banking activities, risks and the adequacy of post-crisis policy tools to address financial stability concerns. Basel; 2017. URL: http://www.fsb.org/wp-content/uploads/P300617–1.pdf (accessed on 18.02.2019).

tional factor which increases their vulnerability during periods of financial stress. It contributes to runs and makes investment funds and other shadow institutions sell assets at reduced prices. Ultimately, such disasters in the money market lead to erosion of the financial system stability.

The FSB activities in this area can be divided into three groups: 1) measures to strengthen the position of money market funds (MMF), especially susceptible to runs; 2) changes in the structural and other activities of securities market operators; 3) increasing the transparency and reliability of securitization of financial assets.

Let us start with the MMF reforms. In October 2011, the FSB published recommendations to limit shares repurchases by the MMF customers. Later, considering these recommendations, the International Organization of Securities Committees (IOSCO) developed new rules for the MMF activities. In particular, it envisaged reorganizing some funds by transferring them to another category with limited options for the shares repurchases by their holders[14]. In addition, new quality standards for assets were introduced. In the United States, where most of the MMF global assets are concentrated, the Securities Commission approved these changes. Some EU countries (France, Luxembourg, Ireland) took measures to reduce bank sponsorship of funds and to limit the right to immediate shares repurchase.

To streamline the work of intermediaries in the securities market, the FSB recommendations on reducing risks in financing securities transactions were published in 2013[15]. They dealt with issues of multilateral offsets for the sale of securities, monetary value of securities used as collateral for credit transactions and other procedures. Particular attention was paid to repo transactions[16], which are often used by securities market operators as a source of short-term funding. The greatest risk is associated with tri-party repos, where, besides the lender and the borrower, there is also a clearing bank that performs some intermediary functions (evaluation of securities lodged as collateral, payment clearing, etc.). These operations are associated with risks of intraday credits provided by the clearing bank to the participants in transactions, which leads to disruption of the settlement system and tightening credit conditions in the money market. The FSB recommendations were used in the United States, where the financial authorities control over the two large banks-providers of tri-party repos led to a reduction in operations using intraday credits from 100% in 2012 to 5% in 2015 of the amount of obligations on credits received[17].

In countries with developed stock markets, other regulatory measures were taken to reduce risks. In 2012, the US Financial Stability Oversight Council introduced leverage and liquidity limits for securities market operators and other non-bank institutions.

Another area of regulation is increasing openness and standardizing securitization of financial assets. As already mentioned, the mass issue and a large number of structured securities in the investors' portfolios were one of the reasons for the rapid development of the 2007–2009 global crisis. At the end of the acute phase of the crisis, international

[14] This is about transferring the MMF from the CNAV (constant net asset value) category to the VNAV (variable net asset value) category. For the MMFs of the VNAV type, the time periods for the shareholders to repurchase and the size of the commission for this transaction vary depending on the weekly changes in the average value of assets (securities in the fund's portfolio) for which the repayment period is due. For the CNAV funds, this condition is absent, the value of the shares is constant and independent of the assets value, and the shares are repurchased immediately upon presentation.

[15] Financial Stability Board. Policy Framework for Addressing Shadow Banking Risks in Securities Lending and Repos. Basel; 2013. URL: https://www.fsb.org/wp-content/uploads/r_130829b.pdf (accessed on 15.02.2019).

[16] REPO (repurchase agreement) is a form of short-term borrowing for dealers in securities (as a rule, government obligations). The dealer sells government securities to investors and agrees to repurchase it in the future.

[17] Financial Stability Board. Assessment of shadow banking activities, risks and the adequacy of post-crisis policy tools to address financial stability concerns. Basel; 2017:16. URL: http://www.fsb.org/wp-content/uploads/P300617–1.pdf (accessed on 18.02.2019).

financial organizations (FSB, IOSCO, BCBS) proposed a number of measures to simplify securitization procedures, to provide more information to investors and regulate the relationship between issuers and buyers of securities. Among them, a special place belongs to the rule according to which the issuer (or the sponsor of the issue) must *always* keep a minimum of issued securities in the portfolio as an additional guarantee of their reliability and high quality. In 2011, a minimum of 5% of the issue amount was set in the EU countries. The same minimum was later introduced in the United States.

Ratings assigned by credit agencies to structured securities issues were also touched upon. During the crisis, these ratings turned out to be significantly overestimated in many cases and did not correspond to the real market value of the securities. In May 2008, the International Organization of Securities Commissions (IOSCO) published the revised "Code of Conduct Fundamentals for Credit Rating Agencies"[18]. The rating agencies were instructed to strictly adhere to the rules set forth in the Code, in particular, to publish an explanation of the principles underlying the assessment for each rating.

Also, measures were taken to reduce the dependence of banks on ratings published by credit agencies. The FSB has developed a set of rules preventing the mechanical use of ratings by the regulated financial institutions. Most G20 members amended their financial legislation accordingly. However, in the Basel III, the use of ratings of some credit agencies was retained in calculating bank capital adequacy ratios.

EFFECTS OF TRADITIONAL AND SHADOW BANKING SYSTEM INSTITUTIONS REFORMS

The recommendations of the FSB and other international financial organizations have had a significant impact on the work of financial institutions. The results of these activities can be seen in the annual progress reports on reforms initiated by international and national supervisory authorities in the United States and other G-20 countries. Published in November 2018, "Implementation and Effects of the G20 Financial Regulatory Reforms" annual review emphasizes that "the reforms made the financial system more resilient and thereby reduced the likelihood and severity of future crises"[19].

However, the reforms had different effects on various sectors of the global financial system. The conclusion about the positive impact of the reforms should primarily be attributed to the traditional banking system which has become more resistant to economic shocks due to the increased capitalization of large banks and increased control over the leverage and liquidity level [7].

The thesis about the effectiveness of the reform measures is less relevant when it comes to the shadow banking sector. Nevertheless, the FRS materials on the SBS activities for 2017 state that, as a result of the measures taken, the systemic risks inherent in the shadow sector enterprises supposedly no longer pose a danger to the financial system stability: "*Aspects of shadow banking considered to have contributed to the financial crisis have declined significantly and generally no longer pose financial stability risk.*" (author's italics)[20].

Such statements are promotional by nature and deny the danger of shadow sector risks to the global financial system. However, it is not considered that the regulatory measures taken by the FSB and other supervisory authorities

[18] International Organisation of Securities Commissions. Code of Conduct Fundamentals for Credit Rating Agencies. Madrid: 2008. [URL IOSCOPD 271.pdf] (accessed on 15.02.2019).

[19] Financial Stability Board. Implementation and Effects of the G20 Financial Regulation Reforms. 4th Annual Report. Basel; 2018. URL: www.fsb.org/wp-content/uploads/P030717–2.pdf (accessed on 18.02.2019).

[20] Financial Stability Board. Assessment of shadow banking activities, risks and the adequacy of post-crisis policy tools to address financial stability concerns. Basel; 2017:1. URL: http://www.fsb.org/wp-content/uploads/P300617–1.pdf (accessed on 18.02.2019).

with respect to traditional banks and shadow institutions have qualitative differences[21]. As for traditional (deposit) banks, the reform affected important indicators determining the basic conditions for the banking system stability, such as the minimum amount of bank capital or a sufficient bank liquidity. These changes were reflected in the official legislative acts of the most countries participating in the reform.

Thus, in the banking systems of 24 jurisdictions, the Basel III recommendations on new bank capital requirements, liquidity ratios and acceptable levels of leverage were adopted and recorded in national laws. The same applies to meeting the requirements to increase limits on covering losses for global systemically important banks (introduced in all G-20 jurisdictions) and for national systemically important banks (introduced in 24 jurisdictions). The other measures of banking regulation are reflected in the legislation in a similar way.

The situation is different when it comes to the regulatory reforms addressing shadow institutions that perform banking functions. The measures concerned only certain aspects of their operating activities, such as weakening of some SBS communications links with traditional banking, changes in lending conditions for certain types of transactions with securities, limiting ratings to issues of structured obligations and other similar procedures. This did not affect solving such important issues as strengthening the capital base of shadow institutions, reducing liquidity and maturity mismatching of their financial reporting indicators, receiving financial assistance by these institutions from official structures in emergency situations, and other reasons for the increased instability of this sector. Naturally, these measures did not lead to any significant limitation of the SBS risks and a decrease in its negative impact on global financial processes.

According to statistics, in recent years shadow structures have shown a steady upward trend in assets and the expansion of operating activities. From 2013 to 2017, the global OFIs assets increased from $ 62 to $ 99 trillion, and the amount of assets most risky for the financial stability of shadow institutions is from $ 35 to $ 45 trillion. At the same time, the categories of shadow institutions growing at a faster rate are subject to runs in deteriorating market conditions. In 2011–2015, the assets of investment funds grew at the average annual rate of 12.9%, and in 2016–8.7%[22].

Speaking about the causes of shadow banking expansion and its successful striking at traditional banks, we should first point out the consistent tightening of the business rules in the regulated banking sector after the 2007–2009 crisis. To minimize risks and ensure the safety of bank depositors, supervisors, as already noted, repeatedly increased the requirements for bank capital adequacy in the framework of the Basel II and Basel III, introduced new liquidity ratios, limited the ability of banks to perform risky operations in the stock market, etc.

This inevitably led to an increase in transaction costs and a diminishing bank profit. To reduce losses, banks had to impose more stringent requirements on the financial security of customers and increase the services costs. This offered a strong inducement for some customers (especially those with low credit ratings) to address the services in the shadow sector, called *regulatory arbitrage* [9]. Shadow institutions are less discerning when choosing clients, offer more favorable conditions and take on increased credit risks. Their activities are expanding, and as a result there is the general risk level in the financial system is increasing [10].

Another factor stimulating the increased ac-

[21] This is indicated by economists who analyze shifts in the shadow banking system. For example, Sheila Judd, Canadian Global Risks Institute, notes: "However, regulation for shadow banks remains much less robust than it does for banks. In particular, the capital, leverage and liquidity reforms that have been implemented post the financial crisis apply only to banks, allowing shadow banks to take on higher levels of risk" [8, p. 1].

[22] Financial Stability Board. Global Shadow Banking Monitoring Report 2017. Basel; 2018. URL: http://www.fsb.org/wp-content/uploads/P050318–1.pdf (accessed on 18.02.2019).

tivity of shadow enterprises is associated with the use of the latest financial technologies which are in growing demand with business and consumer lending. An example is fintech development in recent years that enables to provide loans directly, cutting out classical financial intermediaries (P2P lending) [11]. The transactions are conducted online on matching platforms, supervised by shadow financial institutions[23].

A group of authors from the US National Bureau of Economic Research on studied the connection of fintech with the SBS rising influence convincingly and revealed that such operations are usually more convenient and accessible for participants in transactions than loans in traditional banking. As a result, banks are losing part of the consumer and mortgage market. In 2007–2015, the share of the shadow structures operations in the US mortgage market tripled, and the operations using fintech accounted for one third of the SBS total loans [12, 13].

The measures to tighten the operational supervision over shadow institutions will be searched as part of the ongoing global campaign on strengthening financial stability in the G-20 countries. This was repeatedly stated by the FSB executives[24]. However, as shown above, such a policy often has the opposite effect. It brings new customers into the shadow sector and stimulates the search for new opportunities for credit and other banking operations outside the scope of traditional banking. It leads to an accumulation of systemic risks in the financial system.

[23] In another fintech model, the lender, as in the previous version, communicates directly with potential borrowers. However, here the loan is originated by a partnering bank (i.e. after a bank lends funds, the loan is sold or assigned to one or more creditors).

[24] "The landscape of shadow banking activities continues to evolve. Consequently, identifying and assessing new and emerging risks remains essential in future". Domanski [14, p. 1].

CONCLUSIONS

The analysis shows that although the shadow banking sector, like the entire global financial system, suffered significant losses as a result of the 2007–2009 global financial crisis, shadow structures have been actively developing and expanding their activities in recent years.

The G20 campaign on improving the regulation of shadow banking helped mitigate some risky activities and procedures of shadow institutions, but did not affect the fundamental approaches of shadow structures leading to lower requirements when choosing customers and accepting higher risks. The financial instability of shadow structures, the lack of support from the authorities and the potential contagion of traditional banking institutions in case of financial disasters still pose a real threat to economic stability. In case of any serious deterioration in the conditions of economic development in the world business community, this situation will contribute to creating conditions for a new financial slump.

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Central Bank Digital Currencies: Key Characteristics and Directions of Influence on Monetary and Credit and Payment Systems

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ABSTRACT

The article is devoted to the study of prospects for digital currency issue by central banks as a new form of central bank money and to the potential of their influence on monetary and credit system. The aim of the article is to interpret and classify central bank digital currencies, to identify key characteristics of digital currencies and possible models of their issue, as well as to define the main directions of influence of digital currencies on the monetary and credit and payment systems. The scientific novelty of the article is in the systematization and comparison of different ideas about the implementation of sovereign digital currencies considering the use of distributed registry technologies. The study analyzed the projects of central banks on the issue of digital currencies and identified their features. Possible directions of influence of central bank digital currencies on the monetary and credit policy of the Central Bank and the activities of credit institutions were determined. It revealed that central bank digital currencies can be considered as a new form of money of the Central Bank, which can be issued to be used both in retail and in wholesale payments. Digital currencies may differ in some characteristics. The key ones are: a way to integrate into the monetary and credit system; emission technology; currency storage method; mechanism of mutual settlements and anonymity level. The study showed that the main incentives for introducing digital currencies are the possibility to provide an alternative and universally accessible legal means of payment, as well as to provide faster, more transparent and cheaper in-country and cross-border payments. The influence of digital currencies on the monetary and credit system and the monetary and credit policy of the Central Bank will largely depend on the scenario of their system integration. If cash is simply replaced in circulation by digital currencies, the effect on the Central Bank monetary and credit system and policy will not be significant. However, if central bank digital currencies are issued as an addition to cash, or are in parallel circulation, they can strengthen the transmission mechanism of the monetary and credit policy and increase the centralization of assets on the Central Bank balance sheet, as well as reduce the funding provided by credit institutions.

Keywords: digital currencies of central banks (CBDC); issue of digital currencies; distributed ledger; monetary and credit system; forms of money; payment system; electronic money; cryptocurrencies; retail payments; wholesale payments

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INTRODUCTION

New digital information technologies have been mainstreamed in the financial market over recent years. Distributed ledger technology (DLT) is one of the most advanced information technologies applied in the financial sector[1]. Among multiple use cases for distributed ledgers, central banks (hereinafter — the central bank) view the key ones in: issuing central bank digital currencies; developing cross-border payment systems; using interbank payments in the securities market; issuing bonds and managing their lifecycle, etc.[2]

The introduction and widespread use of the distributed ledger technology can revolutionise the payment, clearing and settlement processes in payment systems improving their efficiency and reducing settlement risks. The issuance of central bank digital currencies is one of the most important applications for the distributed ledger technology in the central bank activities. It is associated with a fundamentally new money equivalent issued by the central bank rather than with modernization of the current technologies for providing central bank services. However, implementing digital currencies into the existing monetary and credit system is not obvious. It involves financial and systemic risks both for the regulator and the participants in the monetary and credit and payment systems. In particular, now it is not clear what characteristics and forms of issue central bank digital currency will have, nor what advantages and disadvantages digital currencies will have compared with the contemporary monetary forms. The most important, it is not clear what potential impact the issue of digital currencies will have on the monetary and credit system.

Today, the possibility for issuing central bank digital currencies is a hot-button issue among economists and monetary regulators around the world. At the beginning of 2019, more than 60 central banks around the world studied the problems of issuing digital currencies, including: the US Federal Reserve, the Central bank of Canada, the Central bank of Japan, the People's Bank of China, the Central bank of Sweden, the Central bank of Russia and others[3]. The interest in central bank-issued digital currencies problems is not only due to comprehending the opportunities provided by new technologies in order to increase the efficiency of the monetary and credit and payment systems. It is also due to the concerns of international financial institutions, such as the International Monetary Fund (hereinafter referred to as the IMF), the Bank for International Settlements (hereinafter referred to as the BIS), the European Central bank and others regarding the stability of national monetary systems and the future of central bank money[4]. This concern is caused by the rapid development of a new class of financial instruments, crypto-assets[5], which are created and operate on the basis of the distributed ledger technology. Among them,

[1] A distributed ledger is a decentralized or distributed accounting system for data on financial transactions, in form of chains built of certain transaction blocks according to certain rules. The key features of the distributed ledger technology are: 1) decentralized distribution of equivalent copies of data among the system participants; 2) sharing and synchronizing data in the system according to the consensus algorithm; 3) lack of an administrator responsible for generating, managing and transmitting data. Distributed ledgers are one of the nine most advanced cross-cutting technologies in digital economy defined by the Government of the Russian Federation in 2018.

[2] For more details, see: Central Banks and Distributed Ledger Technology: How are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 7. URL: https://www.weforum.org/whitepapers/central-banks-and-distributed-ledger-technology-how-are-central-banks-exploring-blockchain-today (accessed on 26.07.2019).

[3] Central Banks and Distributed Ledger Technology: How are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 5.

[4] For example, see: Bank for International Settlements, Basel Committee on Banking Supervision, Statement on Crypto-Assets, 13.03.2019. URL: https://www.bis.org/publ/bcbs_nl21.htm (accessed on 15.06.2019).

[5] Crypto-assets are a new class of financial assets that are created and operate on the basis of the distributed ledger technology. They may comprise assets of various economic and legal nature: monetary, equity, debt, etc. Crypto-assets may include virtual currencies, stablecoins, security tokens, utility tokens and others. In some countries, including Russia, the term "digital financial assets" is used as an equivalent to "crypto-assets".

virtual currencies[6] or cryptocurrencies have a special place.

Decentralized cryptocurrencies are not nominated in any national currency. In the future, they can become common means of payment, subject to the settlement of issues related to their legal status.

The widespread use of cryptocurrencies for payment purposes can significantly diminish the demand not only for cash, but also for funds in settlement accounts of the central bank [2, p. 10]. Despite the possible similarities in the technology for issuing central bank digital currencies and cryptocurrencies, they have many differences. The main one is that the central bank digital currencies have a central issuer represented by the national monetary regulator. It is the lender of last resort. This means high liquidity and stable purchasing power of digital currencies, as well as the possibility to regulate their issuing volumes based on the objectives of monetary and credit policy.

Also, CBDCs differ from the so-called national cryptocurrencies issued in countries in difficult economic and financial situations, compounded by economic sanctions. Examples of such countries are Venezuela (El Petro), Iran (PayMon)[7]. In such countries, the decision to issue national cryptocurrencies is made by the political leaders, and the central banks are not actually independent monetary and credit institutions. At the same time, the central banks in these countries cannot ensure the stable purchasing power of the national currency. Therefore, they have to use physical commodity assets, such as oil in Venezuela or gold in Iran, as collateral for issuing national cryptocurrencies. The issuance of national cryptocurrencies is primarily aimed at attracting external financing and normalizing settlement relations bypassing economic sanctions, rather than increasing the efficiency of stable monetary and payment systems.

On the whole, the Bank of Russia adopts a negative attitude to cryptocurrencies. The regulator has repeatedly drawn attention of the financial market participants to enhanced risks associated with the use of and investment in cryptocurrency. It expressed the opinion of the premature admission of cryptocurrencies to circulation on the territory of the Russian Federation[8]. At the same time, the Bank of Russia economists believe that digital currencies issued by the central bank may potentially become the equivalent of cash if they turn out to be liquid and easy to use [3, p. 12]. The main incentives for issuing digital currencies by the central bank may be a low risk level and greater liquidity of the digital currency compared with other forms of money available to the general public. Under these terms, the scientific research on the rationale for issuing CBDCs and on the possible advantages and disadvantages of using CBDCs in calculations gain grounds and practical relevance.

The aim of the article is to interpret and classify central bank digital currencies, to identify key characteristics of digital currencies and possible models of their issue, as well as to define the main directions of influence

[6] *Functionally,* virtual currency can be defined as an electronic representation of monetary value that can be bought and sold in digital form and it functions as: 1) a means of exchange; and / or 2) a monetary unit; and / or 3) a store of value, but it does not have legal status in any jurisdiction (i.e., from a regulatory point of view, it is not a legal means of payment in most developed and developing countries). Institutionally, virtual currency can be interpreted as an electronic representation of monetary value issued by non-traditional issuers of modern forms of money — the central bank, credit institutions or specialized issuers of e-money — but can be used to a limited extent as an alternative to generally accepted forms of money in payments in electronic networks (for more details, see [1, p. 120]). Despite the fact that, from a formal point of view, the terms "virtual currency" and "cryptocurrency" are often used synonymously in economic studies, these terms are not identical. The term "virtual currencies" is broader and may include not only cryptocurrencies issued on the basis of the distributed ledger technology, but also currencies issued on the basis of other technologies, and may be inconvertible.

[7] In the beginning of July 2019, the political leaders of Cuba announced plans to issue a national cryptocurrency. See details: Cuba Considering Use of Cryptocurrency. SBS News. URL: https://www.sbs.com.au/news/cuba-considering-use-of-cryptocurrency (accessed on 20.07.2019).

[8] Use of private virtual currencies (cryptocurrencies). Bank of Russia press release. URL: http://www.cbr.ru/press/PR/?file=04092017_183512if2017–09–04T18_31_05.htm (accessed on 15.06.2019).

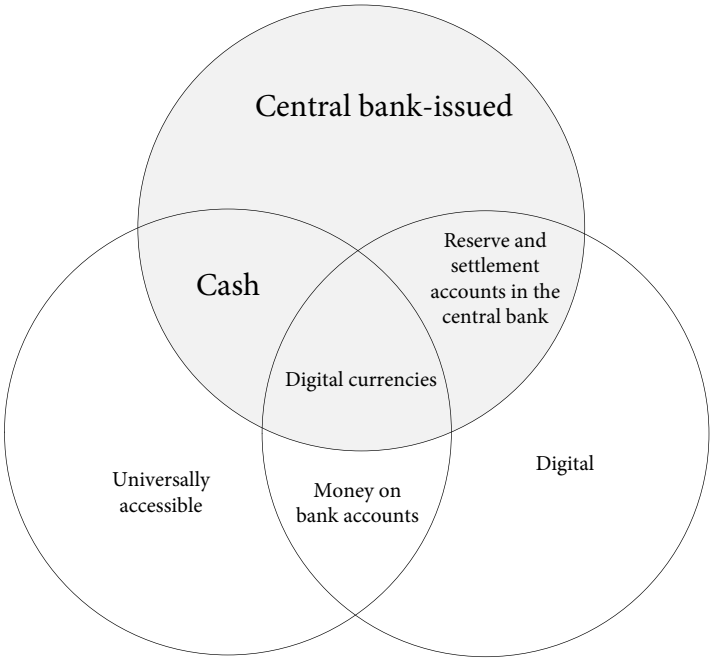

Fig. 1. **The typology of modern central bank money in the general structure of the form of money taking into account release of digital currencies**

Source: compiled by the authors.

of digital currencies on the monetary and credit and payment systems.

INTERPRETATION OF CENTRAL BANK DIGITAL CURRENCIES AND THEIR PLACE IN CONTEMPORARY TAXONOMY OF MONEY

Currently, there is no universally accepted definition of a central bank digital currency (CBDC) due to the different concepts underlying their issuance. In general, a central bank digital currency can be defined as an electronic obligation of the central bank expressed in a national monetary unit and acting as a means of exchange and store of value. At the same time, CBDCs should be considered as a new form of central bank money, different from traditional central bank money, and presented either as cash or as money on reserve and bank accounts in the central bank. Digital currencies, as a new form of central bank money, can take an intermediate place between traditional money forms as they can be universally accessible (like cash) and at the same time they can be issued electronically (like cash balances on reserve and settlement accounts in the central bank). *Fig. 1* presents a possible place for digital currencies between contemporary forms of central bank money.

Despite the similarity in the form of a value expression, CBDCs should also be distinguished from virtual currencies or cryptocurrencies issued, as a rule, in decentralized systems that do not have a clearly identifiable issuer, as well as electronic money[9] issued by clearly identifiable issuers, but on a private basis. *Table 1* shows the comparative properties of CBDCs, central bank cash, electronic money of private issuers and cryptocurrencies.

As can be seen in *Table 1*, the CBDC properties have much more in common with the cash of the central bank than with the electronic money of private issuers or cryptocurrencies, since the issuer's legal status and its

[9] We consider electronic money in the narrow sense. According to the European Emoney Directive: *"Electronic money means electronically, including magnetically, stored monetary value as represented by a claim on the issuer which is issued on receipt of funds for the purpose of making payment transactions, and which is accepted by a natural or legal person other than the electronic money issuer"* [4, p. 27].

Table 1

Properties of central bank digital currencies compared to other forms of money

Factor	CBDC	Central bank cash	Electronic money	Cryptocurrencies
Demand factors				
Intrinsic value	No	No	No	No
Requirement for issuer	Yes	Yes	Yes	No
Means of exchange	Yes (or limited)	Yes	Yes (limited)	Limited but growing in a networked environment
Monetary unit (at national level)	Yes	Yes	Yes	No
Store of value facility	Yes, but with inflation risk	Yes, but with inflation risk	Yes, but with inflation and liquidity risks	Yes, but with great volatility
Supply factors				
Order of issue	Monopoly	Monopoly	Centralized	Decentralized
Source of issue	Public	Public	Private	Private
Volume of issue	Flexible	Flexible	Relatively flexible	Not flexible
Rules of issue	Not defined	Issuance based on inflation targeting	Issuance based on equivalent exchange for other monetary forms	Computer protocol with limits
Change of issue conditions	Yes	Yes	Yes	Yes, subject to agreement with main miners
Cost of issue	Low	Low	Low	High (due to the cost of electricity for computing)

Source: compiled by the authors.

ability to choose the order of issue and control currency supply are of key importance. At the same time, to determine the specific CBDC properties, it is necessary to identify models of their issue.

Currently, two main options for issuing a CBDC can be considered[10]:

- *for retail (general purpose) payments*[11];
- *for wholesale (specialized) payments*[12].

Technologically, digital currencies can be issued either in the form digital tokens[13], or in the form of accounts. A key distinction between token- and account-based money is the form of verification needed when it is exchanged. Token-based money relies on the ability of the payee to verify the validity of the payment object. The problems for digital tokens are electronic counterfeiting and double-spending. There is a risk that a payer could try to use the "same" token on two different transactions. By contrast, systems based on account money depend on the ability to verify the identity of the account holder. A key concern is identity theft, which allows perpetrators to transfer or withdraw money from accounts without permission Based on the empirical experience in the development of payment systems, it is most advisable to use a token-based digital currency for retail payments and an account-based digital currency for wholesale payments.

A general purpose CBDC could be made an alternative safe, robust and convenient payment instrument in the circumstances of fast displacement of traditional cash from circulation. Unlike non-cash payment instruments, the digital currency of the central bank can inherit important characteristics of cash, namely: to be a legal means of payment and to maintain the anonymity of payment transactions. One of the main advantages of wholesale CBDCs is that they may enhance settlement efficiency for transactions involving securities and derivatives.

Currently proposed implementations for wholesale payments — designed to comply with existing central bank system requirements relating to economic efficiency, capacity and operational safety — look broadly similar to, and not clearly superior to, existing infrastructures.

Figure 2 presents a detailed taxonomy of contemporary forms of money, considering potential issue of digital currencies of the central bank and cryptocurrencies.

Figure 2 illustrates the contemporary taxonomy of money in the form of a diagram from the intersection of ellipses. It includes the four key properties of money: issuer, form, availability, characteristics of the network where money is issued. Therefore, either the central bank or credit and non-financial institutions can act as issuers of money. Money can be issued both in physical form and in digital form. Cash may be universally accessible or restricted. Money can be issued in a peer-to-peer or hierarchical network[14].

Currently, the main projects of retail CBDCs are e-Peso, Jasper, Ubin and Fedcoin. Wholesale CBDCs are represented by CAD coin and Inthanon (for more details, see *Table 2*). Besides, the central bank's money includes funds in the accounts of required reserves of credit organizations with the central bank, funds in correspondent accounts of commercial banks with the central bank, as well as funds that private individuals may deposit with the central bank in some countries. A striking example of universally accessible forms of money[15] not issued

[10] Central bank digital currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 7.

[11] Retail (general purpose) payments are universal payments between individuals and legal entities and banks.

[12] Wholesale (specialized) are payments of limited purpose between central banks or between the Central Bank and commercial banks.

[13] A digital token in CBDC systems can be a digital form of a national currency (a digital token of value) in the form of an electronic monetary obligation of the Central Bank, which can be used in retail payments by analogy to cash. Tokens can be stored on various electronic value storage devices.

[14] National cryptocurrencies were not included in this taxonomy.

[15] Universally accessible money are funds accessed and used in payments without restrictions, primarily for individuals and legal entities.

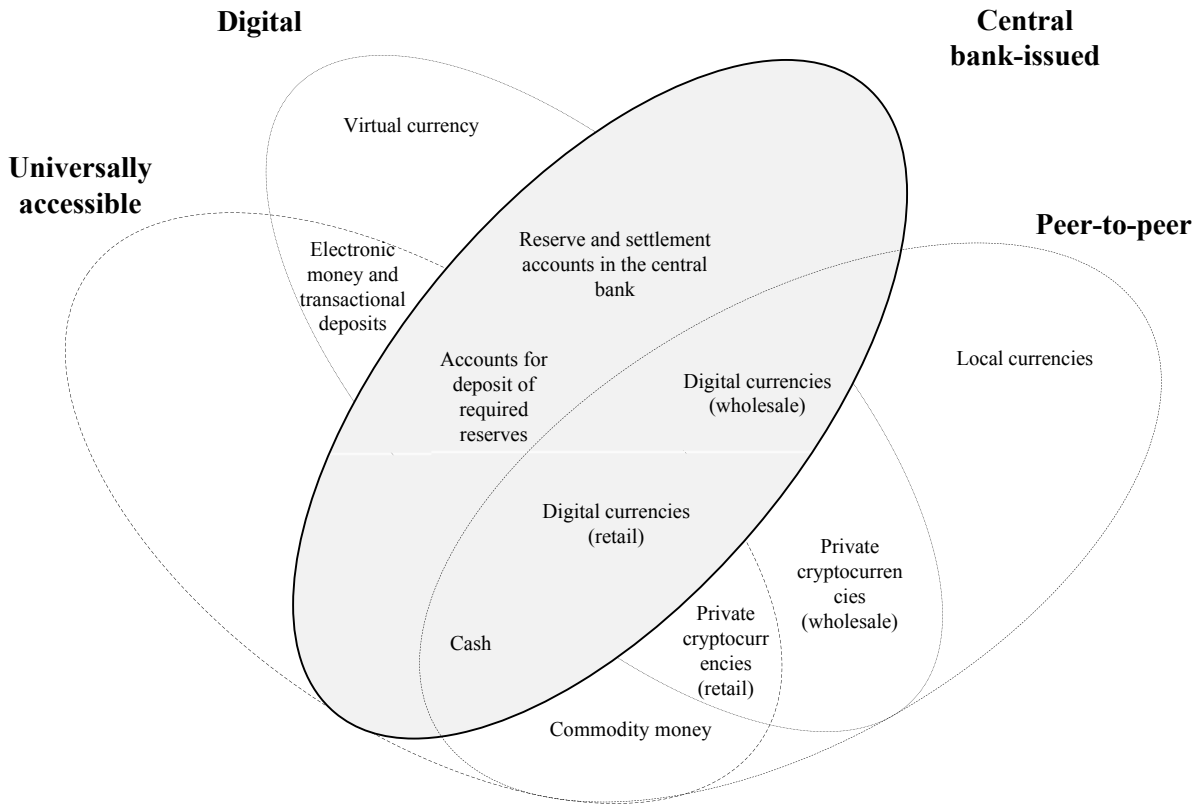

Fig. 2. **Developed typology of modern forms of money**
Source: [5, p. 60–61].

by the central bank are primarily decentralized cryptocurrencies: Bitcoin, Litecoin, Dash, etc., as well as electronic money systems: virtual wallets WebMoney (Russia) and Yandex.Money (Russia), Octopus e-wallets (Hong Kong), Ez-link (Singapore), Rakuten Edy (Japan) [6, p. 55–58] and others. Money, not universally accessible, is only available for and can be used by specialized institutions or participants of payment systems. For example, in the summer of 2019, the social network Facebook announced the launch of its own cryptocurrency Libra[16], and the Telegram messenger is actively working on creating its own cryptocurrency GRAM. At the same time, the issue of cryptocurrencies of private issuers is assumed on a centralized basis, since they do not correspond to the characteristics of cryptocurrencies in the traditional sense [7].

KEY CHARACTERISTICS OF CENTRAL BANK DIGITAL CURRENCIES

Each of the CBDC forms may have different economic, functional and technological characteristics determining the specifics of their implementation and use. The analysis of CBDC specifics made it possible to identify seven key characteristics which include: 1) technology of issue; 2) currency storage; 3) anonymity; 4) transfer mechanism; 5) integration into the monetary and credit system; 6) availability; 7) interest payments.

Technology of issue. In most current cryptocurrency systems, the issue and accounting of transactions with digital tokens is based on the blockchain[17]. These tokens are issued as part of peer-to-peer horizontal networks that

[16] Libra White paper. URL: https://libra.org/en-US/white-paper/ (accessed on 20.06.2019).

[17] Blockchain, a DLT subtype, is a database consisting of a chain of blocks, each of them containing the information about previous ones. All this information is stored decentralized simultaneously on all computers of the system participants.

do not have a clearly identifiable issuer. New units of cryptocurrency are issued, as a rule, as a result of mining, forging or other procedures[18]. Apparently, in the case of the central bank, the issuance of token-based retail CBDCs can mainly be based on a private blockchain[19] or another technology, which would allow the central bank to centralized control and money supply management. At the same time, some key technological advantages of the decentralized DLT will be lost including complete anonymity of data, transparency of transactions and low transaction cost. Therefore, the central bank will have to choose a technology to issue digital currency that balances the ability to control the money supply, to maintain an acceptable level of anonymity and to ensure low transaction cost for its users.

It is believed that to issue wholesale digital currencies for interbank settlements, an open blockchain may also be of little use. At the same time, the DLT is actively developing which contributes to the emergence of new projects for issuing digital currencies. For example, the first development phase of Inthanon, the blockchain-based CBDC, that was successfully demonstrated in May 2019 by the Central Bank of Thailand. Within the framework of the project, an open-source prototype of the Corda platform solution was created that automates the provision of liquidity to eight commercial banks participating in the project and providing 24/7 interbank settlements[20].

Currency storage. In most cases, when digital currencies are issued for retail payments in the form of digital tokens, electronic wallets directly owned by the owner of the funds act as a storage device. In case of wholesale CBDCs, the currency can be stored in the form of accounts directly at the central bank.

Anonymity. A token-based CBDC can, in principle, be designed to provide different degrees of anonymity in a way that is similar to private digital tokens. A key decision is the degree of anonymity vis-à-vis the central bank, balancing, among other things, concerns relating to money laundering, financing of terrorism and privacy which is a technologically challenging task[21]. An account-based CBDC, as a rule, does not imply any anonymity.

Transfer mechanism. The transfer of cash is conducted on a peer-to-peer basis, while central bank deposits are transferred through the central bank, which acts as an intermediary, and only after that the settlement is complete. In this regard, a retail CBDC may also have to provide direct transfer by analogy to cash. The only difference will be that such a digital currency will be transferred by electronic storage devices. A CBDC may be transferred either on a peer-to-peer basis or through an intermediary, which could be the central bank, a commercial bank or a third-party agent.

Integration into the monetary and credit system. Digital currencies can be implemented in the existing monetary and credit system in three ways. First, as a replacement for cash in

[18] "Mining" is a process for obtaining new units of cryptocurrency based on the "proof-of-work" algorithm. The algorithm is based on rewarding participants who proved the hash function by means of computing tools, thereby signing the block and making the transaction. Forging is an alternative mining process for obtaining new units of cryptocurrency. It is based on the "proof-of-stake" algorithm. The algorithm is based on rewarding participants who by means of computing tools managed to confirm the share of cryptocurrency stored in their account of the total volume of cryptocurrency mined, thereby signing the block and making the transaction.

[19] Private (closed) blockchain is a blockchain where access permissions to data and transactions are restricted to a certain narrow circle of organizations or one organization. Private blockchain is centralized. Federal blockchain is a private case of this blockchain with no mining. To find a consensus on transactions, the "proof-of-authority" algorithm is used here with authorized validators as participants. In such a way, the speculative-commercial interest of this blockchain is eliminated for market participants, and it is replaced by a reputation interest, since the validators are motivated to maintain the transaction process in order to keep their validation status.

[20] The Outcome and Findings of Project Inthanon Phase I and the Project's next steps. URL: https://www.bot.or.th/Thai/PressandSpeeches/Press/News2562/n562e.pdf (accessed on 26.07.2019).

[21] The Riksbank's E-Krona Project. Sveriges Riksbank, Report 2. 2018. p. 23.

circulation (the transition from cash to digital currencies as a legal means of payment). Second, as an addition to cash while keeping cash in circulation (competition with non-cash payment systems). Third, as a form of money as the equivalent to cash (competition with deposits in commercial banks). How a digital currency can be transformed into cash and non-cash money and interact with them depends on the chosen issuance model of digital currency.

Availability. Currently, access to traditional central bank money, except cash[22], is limited to central bank operating hours. In the case of digital currency for retail payments, it seems that the central bank will need to provide mandatory access to such funds 24/7. A wholesale CBDC could be available only during certain specified times (such as the operating hours of wholesale payment systems)[23].

Interest payments. As with other forms of digital central bank liabilities, it is technically feasible to pay interest on both token- and account-based CBDCs. The positive interest rate (for example, with a fixed interest below the key rate or differentiating interest depending on the amount of funds in the account) on CBDCs can encourage demand for CBDCs, especially at the stage of their initial integration into the monetary and credit system, and stimulate competition with deposits of credit institutions. The ability to charge interest for the central bank has its additional advantages, since a change in the rate on CBDCs would make it possible to vary the cost of money and, as a result, the demand for it[24].

[22] It goes about funds in settlement accounts and accounts of required reserves at the central bank.

[23] In real-time gross payment systems (RTGS), it is generally accepted that money transfer orders and money transfers are made in real time, however, the processing time of money orders and transfers themselves is usually limited to the operating hours of the systems, i.e., they do not work 24/7.

[24] Central Bank Digital Currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 6.URL: https://www.bis.org/list/cpmi_all/sdt_1/page_2.htm (accessed on 26.07.219).

MODERN PROJECTS FOR ISSUING DIGITAL CURRENCIES OF THE CENTRAL BANK

Historically, the Bank of England was the first central bank to initiate a global discussion about the prospects for introducing central bank digital currencies in 2014 [8, p. 276]. Then, the central banks of other countries, including the Bank of Sweden, the Bank of Canada, the Bundesbank, the US Federal Reserve and the Monetary Authority of Singapore began to study possible and legal issuing of CBDCs. At the beginning of 2019, 70% of central banks conducted research on the issue of CBDCs [9, p. 7]. Of the 63 central banks participating in the BIS survey in 2019, each regulator at least conducts research on the feasibility of issuing CBDCs. Nevertheless, among the central banks which began to study CBDCs in 2019, more than half have moved on to experiments or more "hands-on" proof-of-concept activities to test new technologies [9, p. 7]. However, this work is only investigative in nature and do not imply plans to issue a CBDC. Only 8% of regulators have progressed to running pilot projects, while successful projects include the digital currency model of the Central Bank of Sweden, the Central Bank of Uruguay, as well as the Central Bank of Canada and the Monetary Authority of Singapore.

The Central Bank of Sweden (Riksbank) has come closest to creating a model for issuing a retail CBDC, electronic krona (e-Krona). The initiative of the Bank of Sweden is largely due to a sharp decrease in cash use [10, p. 11]. According to Riksbank forecasts, the share of cash operations in Sweden should be reduced to 0.5% by 2020, which will allow Sweden to come closer to the idea of creating a cashless society [11, p. 107]. The e-Krona project is also supported by a significant number of representatives from the banking sector and business in Sweden. Riksbank suggests two possible models for issuing e-Krona: based on distributed ledgers and account-based[25].

[25] The Riksbank's E-Krona Project. Sveriges Riksbank, Report 1. 2017:4–5.

The first model provides for a system where private or legal entities can open an account in e-Kronas directly at Riksbank and gain access to a single database allowing for the exchange of information and transfers in the interface of the payment system of the Central Bank of Sweden. A model can also be implemented with only the main functions provided by Riksbank, such as storing e-Kronas in their accounts, operations for crediting and withdrawing funds from accounts and transfers between accounts. Responsibility for direct communication with account holders in e-Kronas will remain with external payment service providers[26].

The second model provides for a system where digital currencies will be stored locally on — in an electronic wallet or in an app on a mobile phone. Payments and transfers will go through card readers or contactless payments, ensuring offline payments. As in the case of electronic money[27], the value-based e-Krona stored on the device can ensure anonymity of payments within the framework established by laws on combating money laundering and limits. The responsibilities of Riksbank will include: developing and testing the system, ensuring the protection of payment information, developing technical specifications of cards, issuing cards, currency exchange and customer service.

The Central Bank of Norway is also considering the possibility of issuing CBDCs in two models — based on distributed ledgers and account-based. However, the regulator is not yet ready for a complete replacement of cash and is considering CBDCs as an additional means of payment[28].

The Central Bank of Uruguay was the first in the world to introduce an experimental model of a retail CBDC — electronic peso (e-Peso)[29]. Launched in October 2017, the six-month pilot programme was implemented among 10 thousand users of the ANTEL mobile operator, who were asked to download a mobile application to get access to a digital wallet. The platform made it possible to make payments in a number of outlets and make money transfers to other registered users through the national Red Pagos payment card system. Moreover, the e-Peso digital notes circulating in the pilot programme had their unique serial numbers and corresponding registration with the Central Bank of Uruguay, and also fell under the same legal rules with cash[30].

The regulator and the participants in the pilot project appreciated the experience of the e-Peso experimental use in retail payments and noted the high coordination of work and the absence of technical incidents during the entire testing period. At the same time, the head of the Central Bank of Uruguay, M. Bergara, expressed the opinion that at present, the full-scale issue of e-Peso in circulation to replace paper banknotes is not demanded. If the regulator decides to switch to digital banknotes, the citizens will be offered a transition period to get used to the new payment technology[31].

The intentions to develop CBDCs based on the distributed ledger technology have already been published by the Bank of Canada (CAD coin) [12, p. 12], the Bank of Thailand (Project Inthanon)[32], the US Federal Reserve (Fedcoin) [13, p. 4–6] and the Monetary Authority of Singapore (Project Ubin) [14, p. 12]. At the beginning of March 2019, the Bank of

[26] Directive 2015/2366 of the European Parliament and of the Council on Payment Services in the Internal Market, 25 November 2015. URL: https://eur-lex.europa.eu/eli/dir/2015/2366/oj (accessed on 15.06.2019).

[27] For more details, see: [4, p. 123–140].

[28] Central Bank Digital Currencies. Norges Bank Papers. 2018. No 1. p. 47.

[29] El BCU Presentó un Plan Piloto Para la Emisión de Billetes Digitales. Central Bank of Uruguay, November, 2017. URL: https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete_Digital_Piloto.aspx(accessed on 15.06.2019).

[30] Licandro G. Uruguayan e-Peso on the context of financial inclusion. Basel, November, 2018. URL: https://www.bis.org/events/eopix_1810/licandro_pres.pdf (accessed on 01.05.2019).

[31] El BCU presentó un plan piloto para la emisión de billetes digitales. Central Bank of Uruguay, November, 2017. URL: https://www.bcu.gub.uy/Comunicaciones/Paginas/Billete_Digital_Piloto.aspx (accessed on 14.03.2019).

[32] Thai Economy: The Current State and the Way Forward. Dr. Veerathai Santiprabhob's speech for BIS, Nomura Investment Forum Asia. 2018. p. 2.

Canada and the Monetary Authority of Singapore completed a joint test of cross-border payments using their own digital currency systems "Jasper" and "Ubin", built on two different networks of distributed ledgers. The tests showed great potential for increasing efficiency and reducing risks when using different systems of digital currencies in cross-border payments[33].

In *Table 2*, we summarized the results of our study of the characteristics of the main projects on issuing digital currencies of the world central banks in 2019.

As follows from *Table 2*, the issue of CBDCs is provided for both retail and wholesale types. At the same time, some central banks assume that CBDCs will be a substitute for cash (the Central Bank of Sweden, the Central Bank of Norway, the Central Bank of Uruguay), while others believe that digital currencies will complement the existing forms of central bank money (Central Bank of Canada, Monetary credit management of Singapore, etc.). Also, the vast majority of the projects stipulate that digital currencies will be issue based on distributed ledgers and to use digital currencies, users have to open accounts that will be managed by the central bank[34].

Besides the projects discussed above, the plans to issue CBDCs are currently published by the Central Bank of Pakistan. At the beginning of 2019, it announced the intention to completely switch to central bank digital currencies by 2030[35]. The People's Bank of China also unveiled the plans to issue central bank digital currencies, though not using the distributed ledger technology[36]. According to his chapter, CBDCs will not work on a peer-to-peer basis ensuring anonymity of transactions. The regulator will be able to track all transactions using digital currencies in order to prevent money laundering and illegal activities with digital currencies.

In Russia, the intentions to develop a national digital currency and conduct research in this area were first announced at the St. Petersburg International Economic Forum in summer 2017[37]. Later, the Bank of Russia put forward an idea to develop a single supranational digital currency of Russia and the partners from the Eurasian Economic Community[38]. In general, despite the fact that the Russian regulator considers cryptocurrencies as a highly speculative and volatile asset, it sees great prospects for using the distributed ledger technology, including in its own activities, and therefore, tests these technologies together with other market participants[39]. In June 2019, the Bank of Russia announced that it was considering an option to issue its own digital currency while assessing the technology maturity and public willingness to accept non-anonymous means of payment[40].

Some international financial institutions, such as the IMF, also support the central bank's idea to issue digital currencies. At the fintech festival in Singapore in November 2018, the IMF Managing Director C. Lagarde suggested that such projects will help increase the availability of financial services, security and consumer

[33] Central Banks of Canada and Singapore Conduct Successful Experiment for Cross-Border Payments Using Distributed Ledger Technology. Monetary Authority of Singapore. URL: http://www.mas.gov.sg/News-and-Publications/Media-Releases/2019/Central-Banks-of-Canada-and-Singapore-conduct-successful-experiment-for-cross-border-payments.aspx (accessed on 15.06.2019).

[34] In fact, this means that being advantageous for regulators, CBDCs will not be able to provide the same anonymity for economic agents as cash does.

[35] State Bank of Pakistan Eyes Issuance of Digital Currency by 2025. URL: https://www.dawn.com/news/1473310/state-bank-eyes-issuance-of-digital-currency-by-2025 (accessed on 15.06.2019).

[36] Official report of the People's Bank of China. URL: http://www.pbc.gov.cn/ goutongjiaoliu/113456/113469/3008070/index.html (accessed on 15.06.2019).

[37] Bank of Russia started development of a virtual national currency. Interfax News Agency. URL: https://www.interfax.ru/forumspb/564986 (accessed on 15.06.2019).

[38] Bank of Russia will begin discussion of a single digital currency with partners in the EAEU and BRICS in 2018. Interfax News Agency. URL: https://www.interfax.ru/business/593815 (accessed on 15.06.2019).

[39] E. Nabiullina: Attempts to anonymously use cryptocurrencies are suspicious.Interfax News Agency. URL: https://freedman.club/glava-cb-rf-elvira-nabiullina-schitaet-chto-v-kriptovalyutah-bolshe-nedostatkov-chem-polzi/ (accessed on 16.06.2019).

[40] Central Bank is considering to launcha digital currency. RIA Novosti. URL: https://ria.ru/20190615/1555596009.html (accessed on 15.06.2019).

Table 2

Characteristics of the main projects on the issuing digital currencies of the Central Bank in the world in 2019

Name of regulator	Name of project	Type of digital currency	Integration method	Technology of issue	Storage method	Settlement mechanism	24/7 availability	Anonymity
Bank of Sweden (Riksbank)	e-Krona	Retail	Potential cash replacement	Account-based / based on distributed ledgers	Users open accounts managed by the central bank / on debit cards or mobile applications	Possible without intermediaries in a value-based model	Provided	Possible
Central Bank of Norway	CBDC	Retail	Potential cash replacement	Account-based (centralized and decentralized models) / based on distributed ledgers	On debit cards or mobile applications / on prepaid cards or sim cards	Possible without intermediaries in a decentralized value-based model	Provided	Possible
Central Bank of Uruguay	e-Peso	Retail	Potential cash replacement (limited issue in test mode)	Account-based	On digital wallets on mobile phones	Impossible without intermediaries	Provided	Partially provided
US Federal Reserve	Fedcoin (USD tokens)	Retail	Additional to cash	Based on distributed ledgers	Users open accounts managed by the central bank	Possible without intermediaries	Provided	Not provided
Central Bank of Canada	CAD coin (in terms of Jasper Project)	Wholesale for settlements in financial markets	Additional to cash	Based on distributed ledgers (Platform Corda)	Users open accounts managed by the central bank	Impossible without intermediaries	Not provided	Provided
Central Bank of Thailand	Project Inthanon	Wholesale for interbank settlements	Simultaneous existence	Based on distributed ledgers (Platform Corda)	Users open accounts managed by the central bank	Impossible without intermediaries	Not provided	Not provided
Monetary Authority of Singapore	Project Ubin (SGD tokens)	Retail	Additional to cash	Based on distributed ledgers (Platform Ethereum)	Users open accounts managed by the central bank	Impossible without intermediaries	Provided	Not provided

Source: compiled by the authors.

protection, while maintaining confidentiality of payments[41].

According to a more conservative point of view of the BIS Committee on Payment and Settlement Systems, implementing CBDCs in the existing monetary and credit system can lead to instability in financing deposits in commercial banks[42].

ISSUE INCENTIVES AND INFLUENCE OF DIGITAL CURRENCIES ON MONETARY AND CREDIT AND PAYMENT SYSTEMS

Value of issue of digital currencies for payment systems

Discussing the operation of payment systems in terms of issuing central bank digital currencies, it is important to identify potential scenarios for the impact on the population — the holders of payment instruments and the payment system architectures.

One of the main incentives to issue a central bank digital currency for the population can be a safe and universally accessible payment instrument at declining demand for cash (Fig. 3). Despite the fact that technological innovations on the whole have significantly increased the convenience and efficiency of electronic tools compared to cash in retail payments at the national level, this trend is not observed at the cross-border level. As a rule, cross-border payments are slower, less transparent and more expensive than domestic payments. In this regard, digital currencies seem to be the most perspective in this area.

As follows from *Fig. 3*, an important incentive to issue a central bank digital currency is the possibility to increase the stability of existing retail payment systems. For example, if the functioning of a private retail payment system is disrupted due to a technical malfunction or sanctions imposed on a payment service provider, economic agents will be able to make electronic payments by a central bank digital currency. In this case, central bank digital currencies can increase liquidity and reduce credit risk in payment systems.

At the same time, using central bank digital currencies in wholesale payments can increase efficiency and improve risk management in interbank settlements. The potential benefits of using CBDCs can increase even more if non-bank credit institutions are involved in the calculations by facilitating the use of new technologies for transferring assets, verifying their authenticity and managing risks.

However, a number of legal, technical and operational restrictions must be removed so that CBDCs became widely accessible. In particular, it is necessary to resolve the issue of whether CBDCs will be legal tender in national jurisdictions. Another important condition for issuing CBDCs is the development of reliable mechanisms to mitigate cyber risks, especially in systems based on the distributed ledger technology. The potential consequences of violating the integrity of the CBDC accounting system as a result of cyber attacks can be significant due to the universal use of digital currency. The projects on issuing CBDCs should be developed considering the international requirements of the Group for the Development of Anti-Money Laundering and Terrorist Financing measures (hereinafter — the FATF), since the number and the volume of transactions using digital currencies may be significant and used not only in national, but also in cross-border payments.

Influence of digital currencies on monetary and credit system and monetary and credit policy of the central bank

The issuance of a CBDC is unlikely to change the basic mechanism for implementing the monetary and credit policy of the central bank, including using open market operations and regulating the key interest rate. However,

[41] Lagarde C. Winds of Change: The Case for New Digital Currency. IMF Managing Director Singapore Fintech Festival. 2018. p. 4.

[42] Central bank digital currencies. Committee on Payments and Market Infrastructures BIS Report. 2018. p. 2.

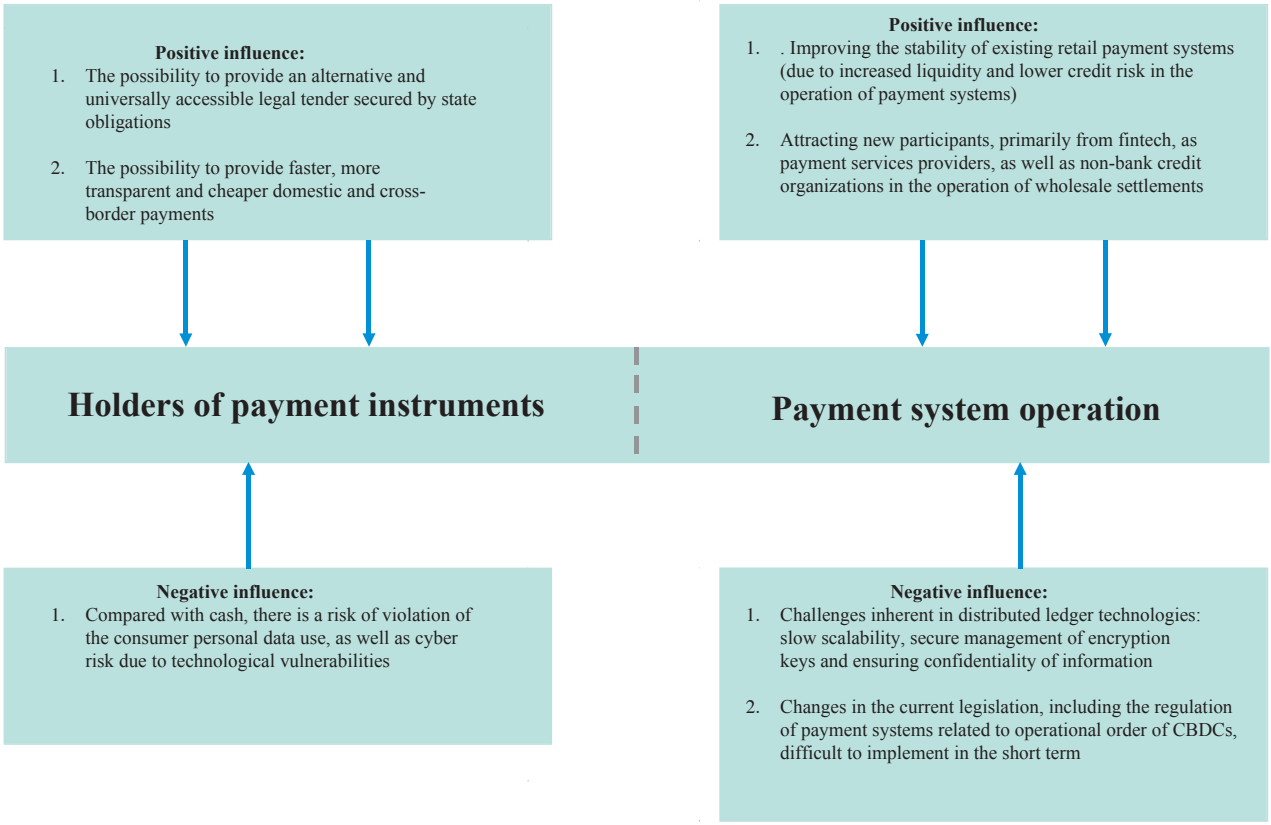

Fig. 3. **Incentives for issuing central bank digital currencies**

Source: compiled by the authors using the data of Central Banks and Distributed Ledger Technology: How Are Central Banks Exploring Blockchain Today? World Economic Forum's White Paper. 2019. p. 9.

if the volumes of CBDCs keep growing and are not compensated by a corresponding decrease in cash circulation, there may be problems concerning the need to expand assets that the central bank can hold as collateral[43]. At the same time, introducing a CBDC in one country may have negative effect on the countries that do not use such currencies. There may be an overflow of deposits in the country that issued the digital currency, especially if they bring interest income. Therefore, to maintain financial security, it may be required to coordinate monetary and credit policy at the international level, involving not only central banks, but also the IMF and the FATF.

The influence of CBDCs on the monetary and credit policy will largely depend on the form and method of their integration into the monetary and credit system. *Table 3* presents scenarios for introducing digital currencies and groups them in increasing order of influence of the central bank's regulatory role in the monetary and credit sphere.

As follows from *Table 3,* CBDCs can substitute cash, complement cash, or be simultaneously used with cash. In case cash is replaced, the effect on the monetary and credit policy of the central bank will be insignificant. A more significant effect will be observed when CBDCs are issued complementary to cash or used simultaneously with cash. The opportunity for individuals to store digital money directly in the central bank can lead to two main areas of influence on the monetary and credit policy: 1) to strengthen the transmission mechanism of the monetary and credit policy; 2) to reduce lending volumes provided by credit institutions.

[43] This is about providing additional cash issuance, i.e. an increase in liabilities on the balance sheet of the central bank should be compensated by an increase in assets.

Table 3

Scenarios for the introduction of central bank digital currencies

Method to integrate digital currencies	Description of integration scenario	Digital currency profits	Influence on monetary and credit system	Influence on monetary and credit policy
1. Cash replacement (competition and replacement of cash in circulation)	Transition from cash to CBDC	Usability and possible anonymity in payments	Component replacement in MO unit	Insignificant
2. Addition to cash (competition with payment systems)	Outflow of funds from current accounts in the digital currency of the central bank	Easy payments for goods and services and improving stability in the operation of payment systems	Possible impact on the structure of components in M1 aggregate	Significant: the growing role of the central bank in the market of payment systems
3. Simultaneous use of cash (competition with deposits in commercial banks)	Outflow of funds from deposits in the digital currency of the central bank	Easy payments for goods and services, as well as possible interest accrual	Possible impact on both the structure and volume of the components of aggregates M1 and M2	Significant: change in liabilities of the central bank and commercial banks

Source: compiled by the authors using the data from the Bank of Russia Research and Forecasting Department.

Strengthening the transmission mechanism of monetary and credit policy can be achieved by a direct impact on the value of money. Usually, there is a time lag between the change in the key rate of the central bank and the change in deposit and lending rates. If interest income linked to the key rate is accrued on the CBDCs stored in the central bank, the reaction of economic agents will be faster, especially if the CBDCs imply both settlement and deposit accounts. Growing rates will stimulate demand for digital currency, leading to a corresponding decrease in investment in other forms of money or assets and vice versa [15, p. 4]. The interest accrual on current and / or deposit accounts in a CBDC may attract depositors of credit institutions. As a result, a change in the key rate of the central bank will affect economic agents directly, and not through intermediaries represented by commercial banks.

Apparently, central banks will be able to compensate for the reduction in deposits in the accounts of credit institutions by providing them with liquidity. This process will be largely similar to the balance sheet changes of the central bank and commercial banks with an increased cash demand. If the demand for a CBDC is significant in terms of insufficient liquidity from commercial banks, the central bank will have to increase its balance sheet assets by acquiring additional assets from the non-financial sector [16, p. 14]. Thus, issuing a CBDC can increase the effectiveness of traditional instruments for influencing interest rates in the financial system.

However, the benefits of such centralization of banking assets in the central bank are not obvious. First, the monetary and credit policy implementation will be more complex with the growth of the balance sheet, which can lead to increasing number and volume of operations carried out by the regulator. Besides, an increase in net assets may lead to changes in the debt market and the capital market. Second, digital currency will compete with the money of commercial banks. Due to growing CBDCs, an ongoing decrease in bank deposits may reduce the size and change the structure of liabilities of commercial banks, and hence the cost of funding [17, p. 92]. This may lead to a decrease in the volume of assets of commercial banks intended for lending to individuals and legal entities.

Influence of digital currencies on the activities of credit institutions

Of note, in most cases, an ill-conceived approach to issuing CBDCs can lead to a decrease in lending by banks to the real sector and have a negative impact on the real sector of the economy. Nevertheless, some studies show that a CBDC does not necessarily affect the amount of lending by banks to the real sector. So, economists M. Kaphof and K. Nun admit that with a certain method of issuing digital currency, the amount of loans issued by commercial banks to the private sector can remain unchanged [18, p. 20]. This may happen if a CBDC is provided with government bonds, and it will be acquired only in exchange for such bonds. Thus, either banks or non-bank financial institutions will sell assets (for example, through repo transactions) and purchase digital currency for themselves or their customers. As a result, government bonds disappear from private sector assets, and liabilities — from bank deposits. Lending to non-financial organizations is not affected, instead, the volume of circulating state debt is reduced; some of it is transferred to the balance sheet of the central bank through intermediary of banks, reducing rates on public debt [19, p. 40].

A CBDC implementation may also affect the competitiveness of various credit institutions. As a highly liquid and risk-free asset, the CBDC may start competing with deposits in large, systemically important commercial banks. These banks are considered the most stable, and therefore offer low deposit rates in exchange for low risks. Given the low nominal interest rates on deposits with systemically important banks, a CBDC may become an alternative to many fixed-income deposits. This will make the central bank a competitor

to commercial banks in terms of raising funds even when interest on the digital currency of the central bank is not paid. The similar situation is with cash.

Medium and small banks, on the one hand, can benefit from the issuance of digital currencies, and the traditional advantage of large banks will be largely leveled. Their competition with systemically important banks will move from the risk-profitability to the price-quality category. On the other hand, trust in deposit insurance systems, and therefore in small banks, has been growing in many countries in recent years, regardless of central bank digital money. Despite the fact how close the substitutes are for commercial bank deposits and the central bank digital currency, the deposit insurance system will keep playing an important role in the operation of any banking system. This is especially important during banking crises, accompanied by an active transfer of deposits both in traditional cash and foreign currency, and in CBDCs.

Due to increasing use of decentralized and private cryptocurrencies, as well as stablecoins, implementing CBDCs has more potential advantages than disadvantages. When solving legal, technical and operational issues and mitigating cyber risks, digital currencies issued by the central bank can increase the efficiency and security of operations of the monetary and credit and payment systems.

CONCLUSIONS

As a result of research and analysis of the world big factual material, we came to the following original conclusions:

1. The issuance of digital currencies by central banks based on the distributed ledger technology[44] or another information technology may cause emerging a new form of central bank money. It will differ both from cash and from traditional cash balances on reserve or settlement accounts in the central bank. Of note, high liquidity combined with low risk of digital currencies, while ensuring their usability in payments and savings in terms of the expanding use of decentralized virtual currencies and cryptocurrencies of private issuers, which are highly volatile and risky assets, can be the main incentives for central banks to issue digital currencies.

2. As the study showed, digital currencies can be issued and used not only for retail payments, but also for wholesale payments. The issue of digital currencies can be technologically implemented either through the issue of digital tokens, or based on the accounts opened with the central bank. At the same time, the characteristics of digital currencies for token-based retail payments can largely coincide with modern characteristics of cash, except ensuring complete payment anonymity.

3. The key characteristics of central bank digital currencies that may influence the positioning of digital currencies in the monetary and credit system are: technology of issue; currency storage; anonymity; transfer mechanism; integration into the monetary and credit system; availability; interest payments. Most of the projects on issuing digital currencies, analyzed as part of the study, are characterized by using the distributed ledger technology to issue digital currencies when funds are stored either in accounts with the central bank or in electronic wallets of users. Most systems do not provide an opportunity to transfer funds without an intermediary. Today, the most advanced projects on retail CBDCs are e-Krona (Central Bank of Sweden), e-Peso (Central Bank of Uruguay) and others. Wholesale CBDCs are developed as part of CAD coin projects (Central Bank of Canada), Inthanon (Central Bank of Thailand) and etc.

4. The introduction of both retail and wholesale CBDCs can bring a number of potential benefits to payment, clearing and settlement systems. When considering the development of CBDCs, it is necessary to compare this decision with existing payment and settlement decisions. It is also necessary to consider the influence that

[44] In this case, it is most likely that central banks will use a closed or so-called federal blockchain.

digital currencies can have on the competences of the central bank both when implementing monetary and credit policy and ensuring financial stability. The main advantages of issuing CBDCs are the ability to provide an alternative and universally accessible legal tender and to provide faster, more transparent and cheaper domestic and cross-border payments. The main disadvantages of issuing digital currencies are the possible violation of the financial stability of credit institutions, the reduction of their liquidity level in the stock market, as well as emerging cyber risks.

5. The study showed that the influence that CBDCs can have on the contemporary monetary and credit system largely depends on the way they are integrated in the system. In our opinion, when replacing cash in circulation with central bank digital money, the effect on the monetary and credit system and policy of the central bank will be insignificant. The greatest effect will be achieved in the case of simultaneous circulation of central bank digital money and cash, since the ability to store money directly with the central bank can strengthen the transmission mechanism of the monetary and credit policy and reduce the volume of loans provided by commercial banks. This will lead to a change in the structure of liabilities both of the central bank and credit institutions. However, in our opinion, these changes are not critical and can be offset by monetary and credit regulation and the availability of bank deposit insurance systems.

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Investment Portfolio Optimization on Russian Stock Market in Context of Behavioral Theory

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ABSTRACT

The paper investigates possible investment portfolio optimization considering behavioral errors. The research rationale is due to the adaption of the investment recommendations for unqualified investors on the Russian stock market. In economic literature, the consequences of behavioral effects are not detailed enough when making a portfolio of Russian securities. The aim of the article is to make the most optimal portfolio based on the risk/reward ratio. The author made a hypothesis on applying various periods of profitability analysis to improve profitability indicators and increase the subjective probability of its achievement. To build a portfolio model, the behavioral portfolio theory and its optimization through linear programming were used. The study was based on modeling the investment portfolio of the most liquid stocks on the Russian stock market. Modified elements of the cumulative prospect theory with behavioral coefficients were used as indicators of profitability and probability. Based on the analysis results, the model of semi-annual portfolio analysis was proposed as a tool for portfolio optimization. The investor review of the portfolio semi-annual rate of profitability led to its best final index of effectiveness. In the medium-term assessment of portfolio profitability, the influence of behavioral factors decreases while maximizing returns with medium high risk. The research result is consistent with the basics of behavioral economics as the prospect theory regarding risk and loss aversion. Moreover, the factor of frequency of access to information and the degree of naive portfolio diversification with high profitability are promising areas for the development of research in behavioral finance. However, determining by the investor the objective probability to achieve the expected return level by using specific benchmarks is controversial.

Keywords: behavioral finance; behavioral portfolio theory; portfolio optimization; cumulative prospect theory; stocks portfolio; Russian stock market

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INTRODUCTION

The modern economic theory provides two points of view on the premise of human rationality in economic models. According to the expected utility theory, on which the modern portfolio theory [1] is based, the investor is inclined to independently calculate all the risks. The behavioral theory followers in economics believe that an investor tends to make mistakes in evaluating information, probabilities, and estimating losses and gains. The behavioral theory, in particular, was considered in the context of portfolio optimization in finance. On this basis, behavioral models were presented to compile an investment portfolio [2–4].

The current investment portfolio models use an approach where it is divided into "rational" and "irrational" parts, depending on the type of the investor or his investment goal. However, the questions remain:

- To what extent is the use of the standard modern portfolio theory optimal, if behavioral errors of a person's perception are also reflected while drawing up the "rational" part of the portfolio?
- Since these errors are highly probable to come up even in rational portfolio based on optimization of the risk / return ratio, what methods can improve the results of the portfolio considering behavioral errors when overestimating or underestimating probabilities and risks?

Behavioral models are an interpretation of the modern portfolio theory. However, the meaning of risk assessment, profitability and utility is different. In behavioral models, objective parameters are replaced by subjective ones. As a result, the obtained utility is not the product of the risk and return on the asset, but the perception of profitability and the probability of its receipt. At the same time, the numerical value of the profitability of the irrational investor differs from the subjective understanding of profitability, since the latter includes a distorted understanding of the "gains" and "losses" ("profits" and "losses"). Collectively, behavioral distortion affects the fact that the modern private investor tends to ignore rational recommendations to compile a portfolio. It is necessary to reformulate the basis of the rational portfolio theory in adopting the model by a non-rational private investor subject to behavioral errors.

Due to the crises of 1998, 2008 and 2014 in Russia, the population faced the phenomena of devaluation in the financial market, currency depreciation and revocation of bank licenses. Together, these phenomena led to the desire of private investors to minimize the risks of investing savings. The stock market with a high level of risk of financial investments and no guarantees of investment insurance seemed to be an unreliable direction of investment for this category of the population. Therefore, private investors did not consider investing in the stock market as a way to increase passive income. As a result, investments in the stock market often began to be considered solely in terms of the high risk and speculative nature of trading. The lack of experience of operations in the stock market and the developing ideas about the risk nature of stock investments led to a low level of financial literacy of private investors. To overcome the behavioral effect of avoiding losses through a complete rejection of investment is a pressing issue to improve financial literacy. For this, it is necessary to change the perception of risk level in the stock market. The development of behavioral portfolio theory can help develop a mechanism for selecting such assets that together will narrow the boundaries of the accepted risk. Considering behavioral factors will allow to satisfy investors' requests for risk and at the same time will enable them to gradually explore the mechanisms of the stock market.

The above problems of differences in the understanding of behavioral utility and the presence of pronounced behavioral effects of attitude to risk (in the context of financial crises) determine the importance of studying options to optimize and improve the investment portfolio efficiency at a low level of financial literacy of private investors.

LITERATURE REVIEW

The seminal paper of the irrational nature of human behavior in the economy was the article by D. Kahneman and A. Tversky [5], dedicated to the presentation of the "prospect theory". The paper proved the relationship between the behavior in case of risk and uncertainty of prospects (probability). So, people tend to underestimate the situation with an uncertain probability and overestimate the situation with an exact probability. This leads to the fact that there is a "certainty effect" which means rejecting risk in situations with guaranteed income and seeking for risk in situations with guaranteed losses. Moreover, there is an "isolation effect" which ignores all possible prospects and leads to the choice dependence on the question. Later, this effect was developed into the explanation of the "framing effect" [6, 7], an assessment of preferences depending on the wording of the offer of a product or service.

The probabilities in the utility theory by D. Kahneman and A. Tversky are replaced by estimated "decision weights", and the utility function is replaced by losses and gains, in contrast to the expected utility function. The decision weights are usually lower than the real probability, except for cases with a low probability. It was the reevaluation of low probability compared with high probability where D. Kahneman and A. Tversky saw the appeal of insurance and gambling in general for consumers. The utility function by D. Kahneman and A. Tversky generally resembled the approach by H. Markovitz in the welfare function.

Thus, D. Kahneman and A. Tversky suggested that a distorted perception of information (ignoring some alternatives) and overestimation of one's own confidence leads to underestimating real probability and violating the axioms about a rational choice between alternatives. Accordingly, two key points of the utility theory in formulating the prospect theory are the errors of logic in simplifying information and overestimating the known information (and, accordingly, underestimating the unknown information). That is, besides the change in the sense of utility, the estimates of gains or losses, the theory made it dependent on the assessment of probability, not the risk level.

Later, the prospect theory by D. Kahneman and A. Tversky was supplemented by "diminishing sensitivity" and "loss aversion" effects. The utility function by A. Tversky and D. Kahneman [8] in the "cumulative prospect theory" included three main features:

1. The function is constructed relative to the gains and losses and a certain "reference point" that refracts it.

2. The function has the property of "diminishing sensitivity" which indicates the dependence — the bigger the sums of money are, the smaller the psychological difference between equal intervals of the sums of money.

3. The tendency to avoid losses (losses are perceived to be more substantial than gains).

The ratio of risk and probability in the extended theory included two phenomena:

1. Seeking for risk in case of losses and avoidance of risk in case of gains at high probability of loss or gain.

2. Seeking for risk in case of gains and avoidance of risk in case of losses at low probability of loss or gain.

This was due to the fact that people tend to overestimate low probabilities and underestimate moderate and high probabilities of events (losses or gains). The functions of the decision weights are located side by side, but the function of estimating the probability of gains is a little more curved than the probability function of losses. Therefore, avoiding of risk for gains is more specified than seeking for risk for losses in case of moderate and high probabilities of these events (gain or loss).

The development of the portfolio theory is associated with the work by J. Williams [9] "The Theory of Investment Value". It introduced the concept of discounted future growth, which was a discounted cash flow of future dividends. That is, the company's stock prices were determined by future dividends. J. Williams was the first who tried to use mathematical tools to calculate future value.

Based on his work, H. Markowitz [1] presented the development of the theory for assessing the profitability of an investment portfolio, which was later called the "Modern Portfolio Theory".

His work was devoted to the analysis of the most optimal investment portfolio in terms of increasing profitability and reducing risk. He refuted the portfolio theory only from the point of view of maximizing the discounted expected income and added dependence on income dispersion to the model, as the investor seeks to reduce the risk of loss of income at the end of investments. According to this theory, a diversified portfolio is anyway more preferable for the investor than a portfolio without diversification. Compiling a portfolio itself involved two steps: a retrospective assessment of the returns on securities and then an assessment of their potential future returns.

For a long time, this interpretation of the asset utility valuation theory in terms of risk / return (CAPM model) was the main practice in compiling investment portfolios.

The theory of risk / return assessment through the utility theory was developed in the work by H. Shefrin and M. Statman [3], who considered the problem of compiling a portfolio from a behavioral point of view. In the developed behavioral portfolio theory, utility theories were analyzed through profitability and risk considering the prospect theory and "mental accounting" proposed by R. Thaler [10]. Mental accounting meant the concept of dividing the numerical expression of utility in the consumer's mind into separate "accounts", i.e. independent target sections in the consumer budget. A specific feature of the "accounts" was their independent assessment in terms of profitability or loss-making relative to the past periods. Based on the theory by psychologist Lopes [11] in the SP / A formula (investors evaluate the categories of "security" and "potential", limited by the level of the investor's desire), the authors propose two portfolio options: with one and with two mental accounts. The portfolio is determined based on the ratio of probability (risk and level of expectation by Lopes) and expected welfare (according to H. Markowitz). In case of a portfolio with two mental accounts, it is proposed to add a pyramidal structure (one account is to accumulate savings for large acquisitions, the other is to save for a rainy day, with no specific aim). The effective boundary line of H. Shefrin and M. Statman portfolios does not coincide with the effective average dispersion boundary according to the theory by H. Markowitz. Subsequently, H. Shefrin and M. Statman [12] applied the criterion proposed earlier [13] when studying the impact of psychological factors on the design and marketing of structured financial products.

Psychological foundations in the portfolio theory are also reflected in works by other scientists. Thus, J. Lakonishok [14] documented the frequency of using various types of option strategies; A. Poteshman and V. Serbin [15] revealed the irrationality of options strategies; and J. McConnell and E. Schwartz [16] presented how individual investors use rates from bank accounts to fund options. S. Das and M. Statman [17] applied the theory to options and structured products.

Later, a generalization of the Markowitz theory with the mental accounting theory was proposed by S. Das [18]. It was suggested to formulate a portfolio as a whole according to the Markowitz mean-variance portfolio theory, but to separate the portfolios according to their intended purpose (according to the mechanism of mental accounting) and keep track of each portfolio according to the theory by H. Shefrin and M. Statman.

The subsequent development of the theory is associated with the adjusting indicators of the behavioral model. In the work by S. Das [19], the concept of risk in the modern portfolio theory instead of the standard deviation was replaced by achieving the goal by investors. Researcher E. De Giorgi [20] showed the importance of the prospect theory instead of the mean-variance analysis in the portfolio optimization considering the principles of integrated private capital management (including real and financial assets). Later, E. De Giorgi [21] proposed breaking

down the investment process into two stages: setting goals and investing for each goal according to a specific strategy by separating the goals into short-term and long-term ones. Moreover, E. De Giorgi and S. Legg [2] applied the model by N. Barberis and M. Huang [22] using "narrow framing" and "loss avoidance" to construct a mathematical portfolio model. E. De Giorgi [23] also gave a mathematical formulation of the "naive diversification" model (that is, the phenomenon of preference for uniform diversification between all assets or preferences of a certain type of known assets).

Changes in the parameters of the behavioral portfolio theory are presented in *table 1*.

As it is seen from *table 1*, the introduction of behavioral factors in the portfolio theory took place in stages. Certain aspects of the behavioral theory were used to justify such effects as loss aversion, framing (dependence of the perception of information on its presentation form), mental accounting, and behavioral finance phenomena such as a section of behavioral economics that studies behavioral effects in the stock market (for example, " naive diversification"). In this case, the first stage of implementation was characterized by a key replacement of indicators with behavioral, estimated values, and subsequently the behavioral theory was considered as an integral part of the general portfolio optimization theory.

The study of the behavioral effects in the Russian market was based on the identification of the phenomena already seen in the US stock market. Therefore, the behavioral finance was developed to a greater extent. Thus, V.R. Evstigneev considered the decision-making mechanism in the foreign exchange market based on the expectations of other participants [24]. Decision models in the foreign exchange market based on the Bayesian procedure were also proposed by Yu.V. Yeltsov [25]. In the securities market V.R. Evstigneev proposed to formalize the cognitive dissonance effect through the matrix operator of the observed securities yield vector [26]. Also V.R. Evstigneev proposed a prediction model by an investor based on a predictable random process leading to the rejection of maximizing utility in favor of attempts to hit the jackpot in each individual case [27]. In her work, V.A. Goretskaya noted the importance of applying the prospect theory as the basis of the behavioral finance for decision-making in the stock market [28]. The issues of information asymmetry in the financial market of Russia were also considered by V.P. Ivanitsky and V.A. Tatyannikov [29].

Thus, to analyze the situation on the Russian market, the assessment of the behavioral model is of particular interest. This is explained by the need to assess the impact of behavioral errors of the private investor who tends to overestimate the probabilities of losses and gains on compiling an investment portfolio. The main aim of the research was to study the parameters of portfolios compiled considering behavioral errors. The objectives of the study were to find the most optimal variant of the behavioral portfolio and to identify the main parameters of the best portfolios in terms of efficiency and risk / return ratio. The paper simulates possible options for compiling portfolios based on the distorted perception of recommendations according to the modern portfolio theory. After the impact of the behavioral effects on the final result was identified, the options were calculated with an assessment of portfolio returns for long periods of time: quarter, half a year, a year.

AXIOMATICS

Before we proceed to the model presentation, it is necessary to determine the basic axiomatic provisions on the utility theory and the type of investor for whom the portfolio is compiled. It should be noted that the behavioral portfolio models differ from the standard economic theory in terms of the utility. In case of the average variance model, the final value is the utility of a rational investor, i.e. expected utility. In case of behavioral models, another utility value is considered, namely: the irrational investor utility, i.e. distorted rational utility according to the perception of objective utility (profitability) relative to the reference point (reference point) and

Table 1

Development of behavioral aspects in portfolio theory

Behavioral portfolio theories	Criteria			
	Portfolio optimization factors	**Portfolio diversification**	**Optimal portfolio**	**Basic utility theories**
J. Williams (1938)	Discounted future dividend flow	Missing	Dividend yield maximization	Utility maximization
H. Markowitz (1952)	Risk and return	Based on the correlation between asset returns	Minimization of the average variance and maximization of profitability	Maximization of utility while minimization of risk
H. Shefrin and M. Statman (2000)	Probability (risk and aspiration level) and expected wealth	Pyramid structure of 2 mental accounts	Curve of coincidence of the level of expected wealth and the level of risk (probability), with different levels of aspiration	Prospect theory
S. Das, H. Markowitz, J. Sheid and M. Statman (2010)	Probability and return	Markowitz theory for the total portfolio, Shefrin and Statman theory for mental accounts	A number of optimums of behavioral portfolio theory on a common risk-return curve	Prospect theory and utility maximization while minimization of risk
S. Das, D. Ostrov, A. Radhakrishnan and D. Srivastav (2018)	Probability and goals' achievements	Achievements of goals by time	Minimization of the average variance and intersection with the wealth function	Maximization of wealth while minimization of risk
E. De Giorgi (2011)	Use of framing, loss aversion and naive diversification	Achievements of goals by different time periods with different strategies	Minimization the Kahneman and Tversky utility curve and maximization of return	Prospect theory and utility maximization using subjective probability

Source: compiled by the author based on the analysis of references [1, 3, 9, 18, 19, 21].

probability distribution. Thus, comparing the objective values of the average variance theory with the indicators of the subjective utility of the behavioral models is not correct due to the different nature of the studied utilities.

Moreover, the model specification in question does not include the option of short sales (thus, only positive shares of assets in the portfolio are considered); there are no restrictions on the maximum number of assets in the portfolio, and an uneven probability distribution of future returns is used.

The need to apply the mentioned restrictions is due to the axiomatics of the investor's behavioral type who has subjective preferences and errors in perceiving information ("inexperienced" investor). The investor has the following characteristics:

- lack of qualified investor status (according to the Russian standards);
- lack of access to professional programs of asset managers (Bloomberg, Reuters terminals);
- low level of financial literacy;
- little or no trading experience.

The stated characteristics of the investor type are necessary to analyse a clean, distorted utility curve inherent to an irrational investor. Changing these parameters to greater investor awareness will distort the initial position of the utility curve and the psychological perception of gain and loss. This is a special case and is not a part of the behavioral theory considering the lack of information about the market as a fundamental point in decision making.

One should also distinguish between the concepts of "objective", "expected" profitability and risk (standard deviation) and the concepts of "subjective", "distorted", "behavioral" profitability and "subjective", "behavioral" probability. These terms are used in the work to distinguish between the calculation of the expected return and the magnitude of the risk and their alternatives perceived as "profitability" and "probability" of its achievement reduced or increased by the value of the behavioral coefficients. One should also distinguish between "objective" probability, which is the size of the probability distribution between past maximum and minimum values, and "subjective" probability, i.e. the value of the "objective" probability, which is perceived considering the behavioral coefficients. The terminological distinction between these concepts is essential to understand the logic of action of the behavioral model and its essential difference from similar terms in the expected utility theory.

SURVEY SAMPLE

The fixed parameters of models from the original prospect theory and the cumulative prospect theory were used in the work. The values of the coefficients are shown in *table 2*.

The difference between the behavioral models is the use of factors γ, δ as parameters of the probability estimate distortion (re-evaluation of low probabilities and underestimation of high probabilities, respectively), as well as α, β as risk aversion and search factors relative to gain (loss) and λ as a loss aversion factor that affect perception of the objective profitability, as well as the use of subjective probability as a risk factor, rather than variance. The cumulative prospect theory was used as the underlying behavioral model, which includes all the above-mentioned behavioral parameters (both probability estimates and risk estimates).

The behavioral parameters reflect the bend of the yield perception curve and probability estimates. Their values are constant and determined according to the empirical data in the prospect theory proof. The values are widely used in the behavioral analysis and are axiomatic in the behavioral theory.

The models were based on the data on bank interest rates for individuals of the Bank of Russia, on the volume of circulation of securities on the Moscow Exchange and on FINAM quotes for each month in 2011–2018. The risk-free rate was calculated based on the retrospective data on the average interest rate on deposits of less than a year, except demand deposits. The same rate was taken as a reference point (reference) in calculating profitability according to the prospect theory. Quotations of 48 most liquid shares

Table 2

Fixed parameters of behavioral models

Parameter	Value
λ, loss aversion factor	2.25
α, β, risk aversion and search factors	0.88
δ, small probability factor	0.61
γ, high probability factor	0.69
k, level of separation of probabilities into "large" (above level k) and "small" (below level k)	0.33

Source: compiled by the author based on data [5, 8].

(the first quotation list) at the end of the month for the same period were taken as assets. These included both ordinary shares and preferred shares. Other categories of assets were not considered in this study due to the shorter market circulation time. For comparison purposes, only shares of Russian companies were selected over the long period.

The research methodology was based on the interpretation of the modern portfolio theory in a behavioral form. It should be noted that such an element of the Markowitz theory, as diversification by reducing the correlation between assets, was not used in the behavioral model. This is a drawback and an important feature of the behavioral model, since in this case the object of the analysis is not the criterion for reducing portfolio risk through a decrease in the dependence of assets, but the perceived portfolio return relative to a certain benchmark (also in dynamics) and assessing the probability of achieving such a return in the future. Moreover, the analysis of information is limited to the data that are strictly accessible to the irrational investor: the average bank interest rates whose changes are felt by private investors (preferring deposits), the profitability of an asset relative to its price in the same period a year ago (caused by the mental peculiarity to calculate profitability for a round number — a year, ignoring seasonal factors at the beginning and the end of the year), and the probability "to break the price level" in the past. In the study, the price level in the past has the same strong influence as the price level of the benchmark.

Thus, the study is based on the existing parameters of behavioral distortions of the return and risk curves, as well as on the empirical data of the parameters of the average rate on deposits for the year and asset prices for 96 periods.

MODEL

The main aim of this work was to consider the possible consequences of the behavioral errors in assessing profitability in portfolio optimization on the example of the Russian stock market. The cumulative prospect theory (CPT) was taken as the basis of the behavioral model [8, 30]. This theory takes into account such behavioral factors as loss avoidance, weighting prospects, risk aversion and search, and use of a reference point.

As a portfolio returns assessment method, a behavioral portfolio model was applied considering the behavioral theory parameters for each period. Each model consisted of a sample of indicators of annual profitability (a month of the current year to the same month of the previous one) with a frequency of analysis once a month, once every 3 months, once every six months and once a year. This use of samples was explained by the need to analyze the dependence of the behavioral model effectiveness on the number of times the investor visits the portfolio return statistics.

According to the cumulative prospect theory, the optimization model is the following:

$$CPT(x)=\sum_{s=1}^{S}\pi(p_s)v\left(\sum_{i=1}^{N}r_{si}\omega_i\right)\to max, \qquad (1)$$

where

$$\overline{r}(x)=\sum_{i=1}^{N}\overline{r}_i\omega_i\geq d, \qquad (2)$$

$$\sum_{i=1}^{N}\omega_i=1\ ,\text{at}\ \omega_i\geq 0, \qquad (3)$$

where $\pi(p_s)$ is a function of the subjective probability dependence (a subjective assessment of the probability to reach the asset price considering behavioral parameters γ, δ of the objective probability distortion) on the objective probability (probability to reach the asset price based on its maximum and minimum prices in the period); r_{si} is the average return on the asset; ω_i is its shares in the portfolio; s is a perception indicator of the current price gain relative to the previous value of the price so that (r_0 is a reference point indicator):

- if $s=0$, i.e. $r_s=r_0$, then the investor's gain is 0;
- if $s>0$, i.e. $r_s>r_0$, then the investor considers the outcome as a gain from this investment;
- if $s<0$, i.e. $r_s<r_0$, then the investor is aware of the loss.

In case of the following function of value from the return on an asset:

$$v(r(x))=\begin{cases}(r_i-r_0)^{\alpha}, \text{if } r(x)\geq r_0,\\ -\lambda(r_0-r_i)^{\beta}, \text{if } r(x)<r_{0,}\end{cases} \qquad (4)$$

where r_0 is the value of the reference point in a given period; r_i is an asset return; α, β are the risk aversion and search factors relative to the gain (loss); λ is the loss aversion factor.

In this case, the subjective probability $\pi(p_s)$ is a function of the objective probability (p_s) by formula π

$$\pi(p_s)=\begin{cases}\pi^{-}\left(\sum_{j=1}^{s}p_j\right)-\pi^{-}\left(\sum_{j=1}^{s-1}p_j\right), & s=1,\ldots,k,\\ \pi^{+}\left(\sum_{j=s}^{S}p_j\right)-\pi^{+}\left(\sum_{j=s+1}^{S}p_j\right), & s=k+1,\ldots,S,\end{cases} \qquad (5)$$

where the bends of the dependence function of the subjective probability are determined through the relations

$$\pi^{-}(p_j)=\frac{p_j^{\delta}}{\left(p_j^{\delta}+(1-p_j)^{\delta}\right)^{1/\delta}},\ \text{where } j=1,\ldots,k, \qquad (6)$$

$$\pi^{+}(p_j)=\frac{p_j^{\gamma}}{\left(p_j^{\gamma}+(1-p_j)^{\gamma}\right)^{1/\gamma}},\ \text{where } j=k+1,\ldots,S, \qquad (7)$$

where γ, δ are the distortion parameters of the objective probability estimate.

Profitability was determined by the formula of logarithmic profitability:

$$r_i = \ln\left(\frac{P_i}{P_0}\right)\times 100, \quad (8)$$

where r_i is the annual return for the i-th period;

P_1 — stock price at the end of the i-month;

P_0 — stock price at the end of the i-period in the previous year.

Dispersion (standard deviation) and the Sharpe ratio were calculated by the generally accepted formulas [31].

Therefore, in the behavioral models, the risk assessment was calculated based on the probability weights (with the parameters of relation to probability), and the profitability was calculated considering the relation to the reference point (deposit rate) and the loss aversion and risk search (aversion) parameters.

The essence of comparing models is to distort the perception of profitability and risk when applying the parameters from the cumulative prospect theory. In case of parameters α, β, λ in the prospect theory, it was enough to replace profitability by a function of subjective estimation of profitability for each period (revaluation at the end of the month, every three months, every six months, the year). However, the integration into the cumulative prospect theory model with parameters γ, δ seemed to be a more difficult task.

Previously, there were used the models considering the algorithms for selecting values by the Monte Carlo method. A similar approach was previously applied taking into account the heuristic method of calculation [32]. However, this approach is a difficult option from the point of view of the algorithm for calculating probability indicators. In the behavioral model, it is possible to apply an approach where the calculation will be based on benchmarks known to the irrational investor; for example, the maximum and minimum return on an asset in a given time period.

The work suggests the following formula to estimate objective probability based on the current value of an asset at the end of the month. This formula is an interpretation of the objective probability estimation in the expected utility theory by M. Hayes [33]. The difference is that the maximum value in the past is taken as the limit value, and the average value of return for the entire period is taken as a guideline.

$$p_j = 1 - \left|\frac{2\left(r(x) - \overline{r}(x)\right)}{r_m - r_n}\right|, \quad (9)$$

where the conditions are met:

$$r_m = \begin{cases} r_{max}, & \text{if } r_{max} - \overline{r}(x) > \overline{r}(x) - r_{min} \\ \overline{r}(x) + \left(\overline{r}(x) - r_{min}\right), & \text{if } r_{max} - \overline{r}(x) \le \overline{r}(x) - r_{min} \end{cases} \quad (10)$$

$$r_n = \begin{cases} r_{min}, & \text{if } r_{max} - \overline{r}(x) > \overline{r}(x) - r_{min} \\ \overline{r}(x) - \left(r_{max} - \overline{r}(x)\right), & \text{if } r_{max} - \overline{r}(x) \le \overline{r}(x) - r_{min}, \end{cases} \quad (11)$$

where r_m and r_n — maximum and minimum asset return;

$r(x)$ — current asset return;

$\overline{r}(x)$ — asset return average value for the entire period;

r_{max} and r_{min} — maximum and minimum return for the entire period.

The calculation by this formula is due to the need to impose a probability distribution on the possible spread of the asset value in a given period. The largest return corresponds to the equality of the asset return average value for the period, the smallest — to the value of the maximum difference between the price of the asset and its average value (relative to the maximum or minimum profitability of the asset for the entire period). To simplify the calculations, the maximum return was taken as 100%, the minimum (maximum or minimum value) was taken as 0%. In fact, the probability parameter will only be as close as possible to this value, but not equal to it.

Further, subjective probability is calculated by the formulas given above. Maximizing or minimizing the overall utility and variance is the optimization task (when compiling many effective portfolios). In this study, we used the search for solutions to nonlinear problems by the generalized reduced gradient OLS method in the Excel application.

Таблица 3 / Table 3

Comparison of average risk, return and portfolio quality in behavioral models

Model	σ, risk, % per annum	*r*, return, % per annum	Sharpe ratio	Return on bank deposit, % per annum	Excess return, % per annum
CPT	18.09	20.89	0.79	6.59	14.3
CPT-3	16.95	19.22	0.74	6.58	12.64
CPT-6	17.56	22.05	0.88	6.79	15.26
CPT-12	17.13	18.12	0.67	7.28	10.84
Avg. value	17.21	20.07	0.77	6.81	13.26

Source: compiled by the author.

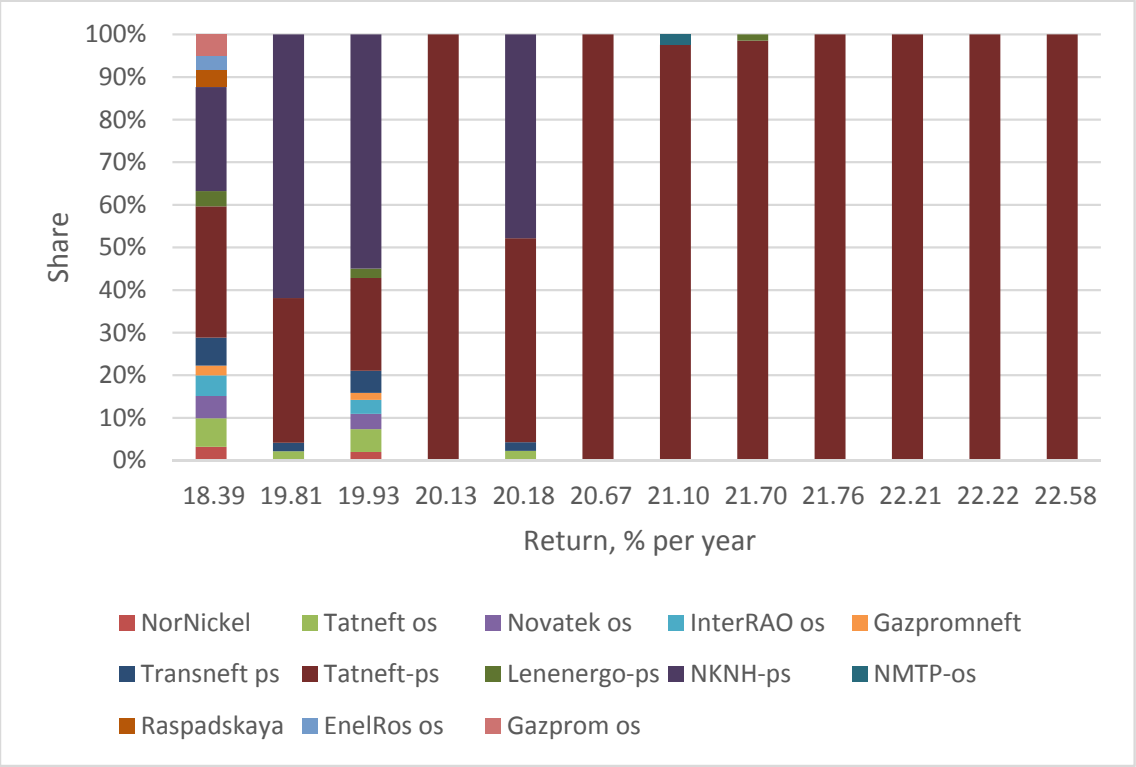

Fig. 1. **Optimized stock portfolios structure of the CPT model**

Source: compiled by the author.

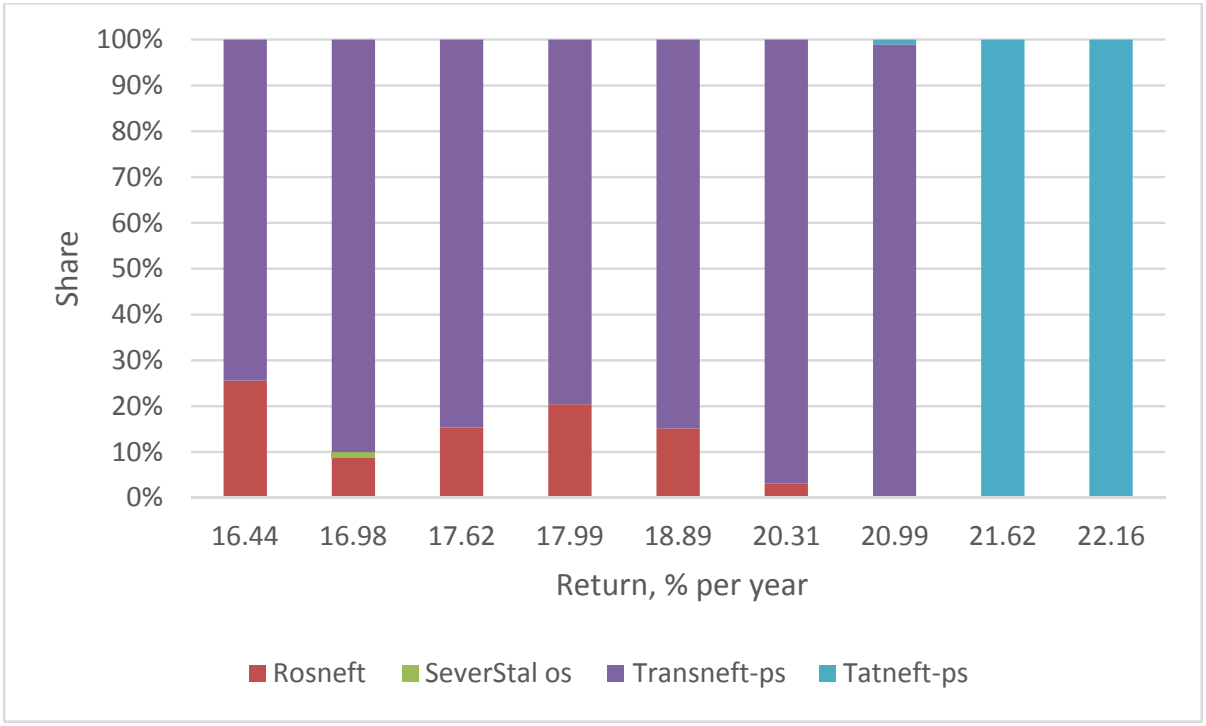

Fig. 2. **Optimized stock portfolios structure of CPT-3 model**

Source: ccompiled by the author.

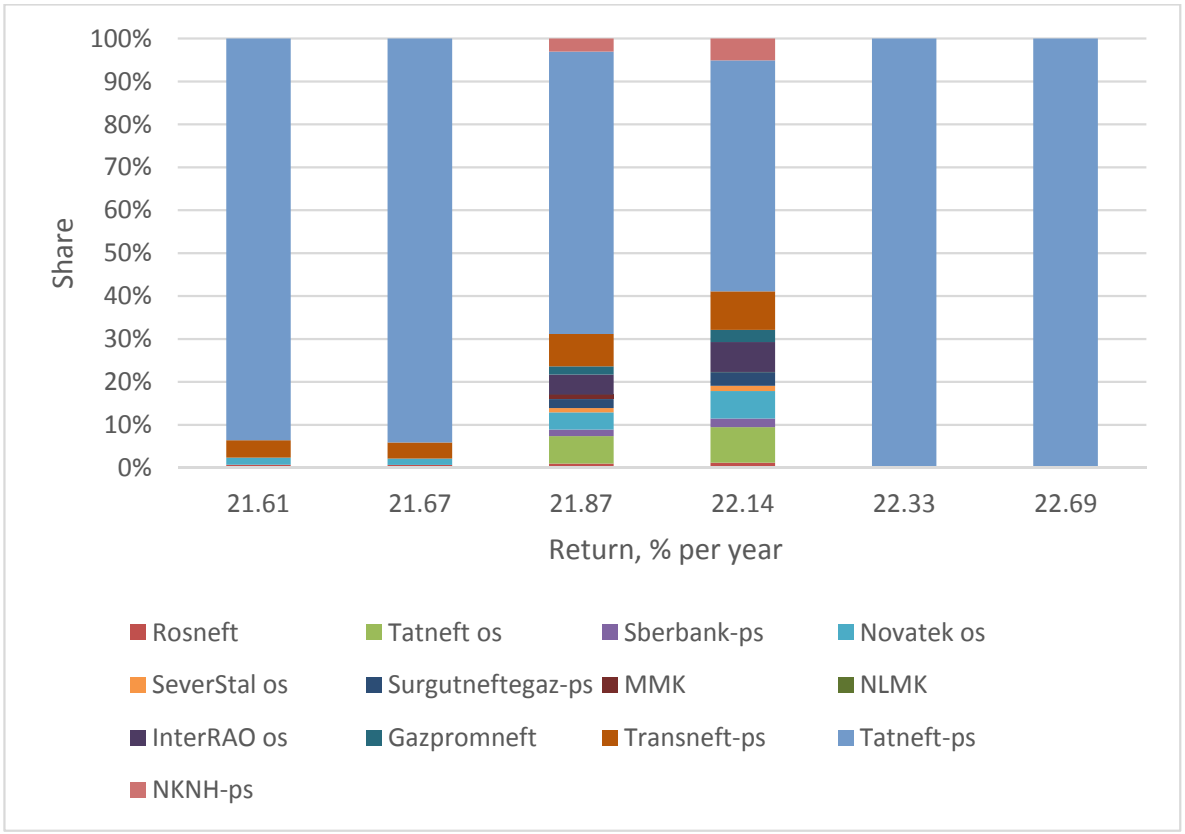

Fig. 3. **Optimized stock portfolios structure of CPT-6 model**

Source: compiled by the author.

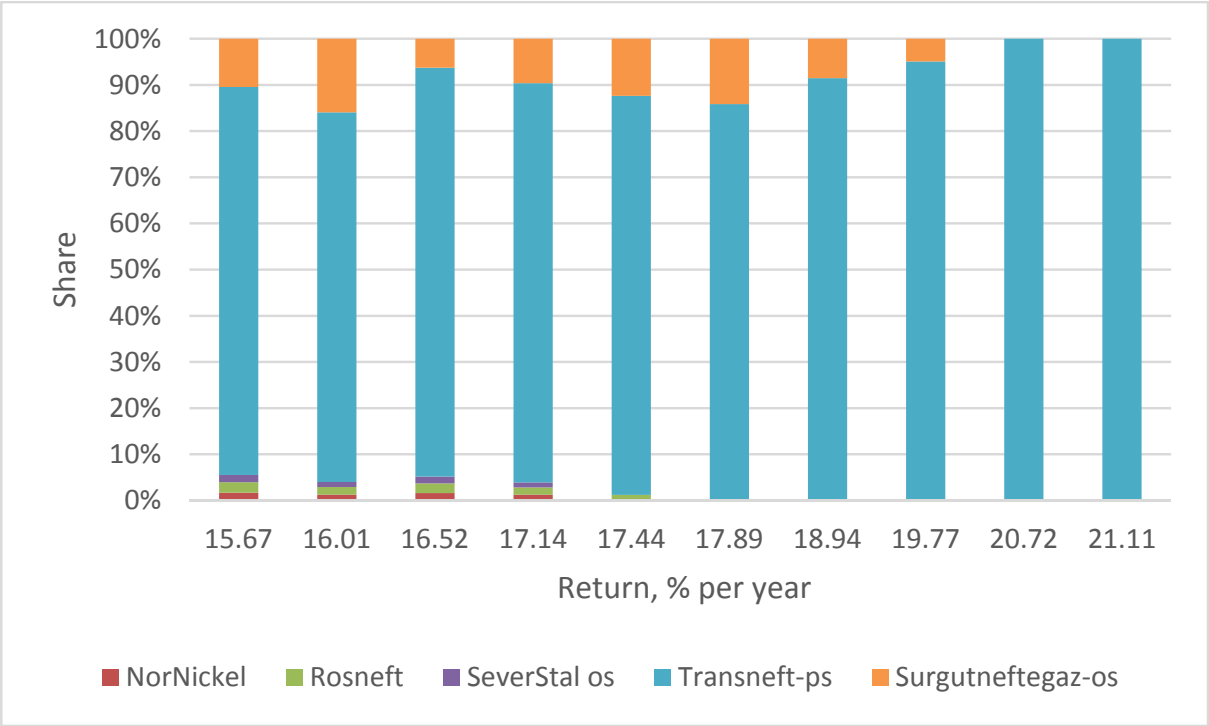

Fig. 4. **Optimized stock portfolios structure of CPT-12 model**

Source: compiled by the author.

RESEARCH RESULTS

Modeling resulted in an effective set of portfolios in each model: the behavioral portfolio theory when calculating the return in each month (CPT), and also every 3, 6, 12 months (CPT-3, CPT-6, CPT-12).

Table 3 shows the main indicators of return, risk and portfolio management efficiency (Sharpe ratio). It should be noted that these indicators are recalculated considering undistorted risk indicators (standard deviation of profitability) and profitability according to the H. Markowitz model, since in this case objective values are compared. The average values of indicators among all effective portfolios of each group are indicated.

As can be seen from the data above, the average return in the behavioral model portfolios varies with time. At the same time, the magnitude of the accepted risk first decreases, and then it remains at an average level. The highest risk values remain with a monthly portfolio review. In this case, the semi-annual revision model has the highest Sharpe ratio. The same model has the highest average return. This indicates a preference for higher returns and higher risk on average when choosing by a behavioral portfolio model.

Experimental stock portfolios were also modeled based on the data above. The results are presented (*Fig. 1–4*) by the ratio of the shares of assets in the portfolio according to different levels of return of the border of the effective portfolio set. An effective portfolio set in the behavioral theory is a set of portfolios with minimal risk at each level of return.

According to the distribution of shares in the portfolios, it can be noted that behavioral portfolios tend to concentrate on a particular stock in the portfolio, which increases with the investor's desire to acquire greater returns (*Fig. 2, 4*).

Within the CPT model, portfolio diversification is observed at lower returns. However, with an increase in the desired return, the same orientation occurs towards investment in the same share. CPT and CPT-6 models show a higher level of return with more uneven diversification (*Fig. 1, 3*).

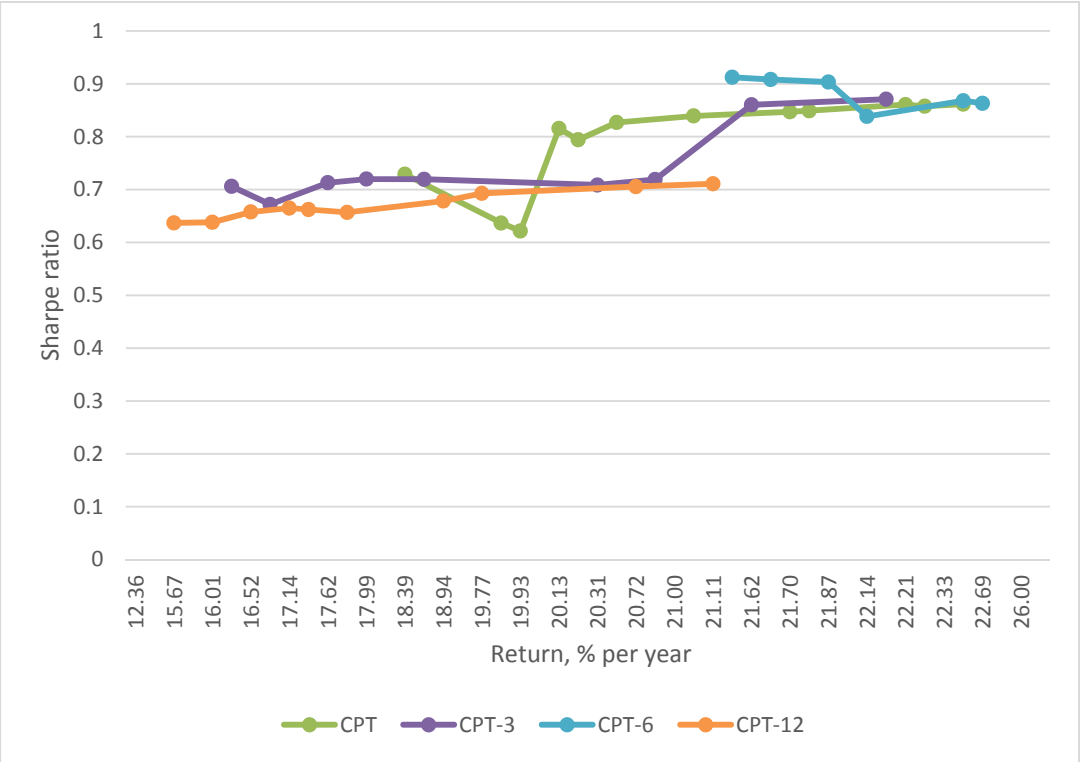

Fig. 5. **Sharpe ratio indicators depending on portfolio returns**

Source: compiled by the author.

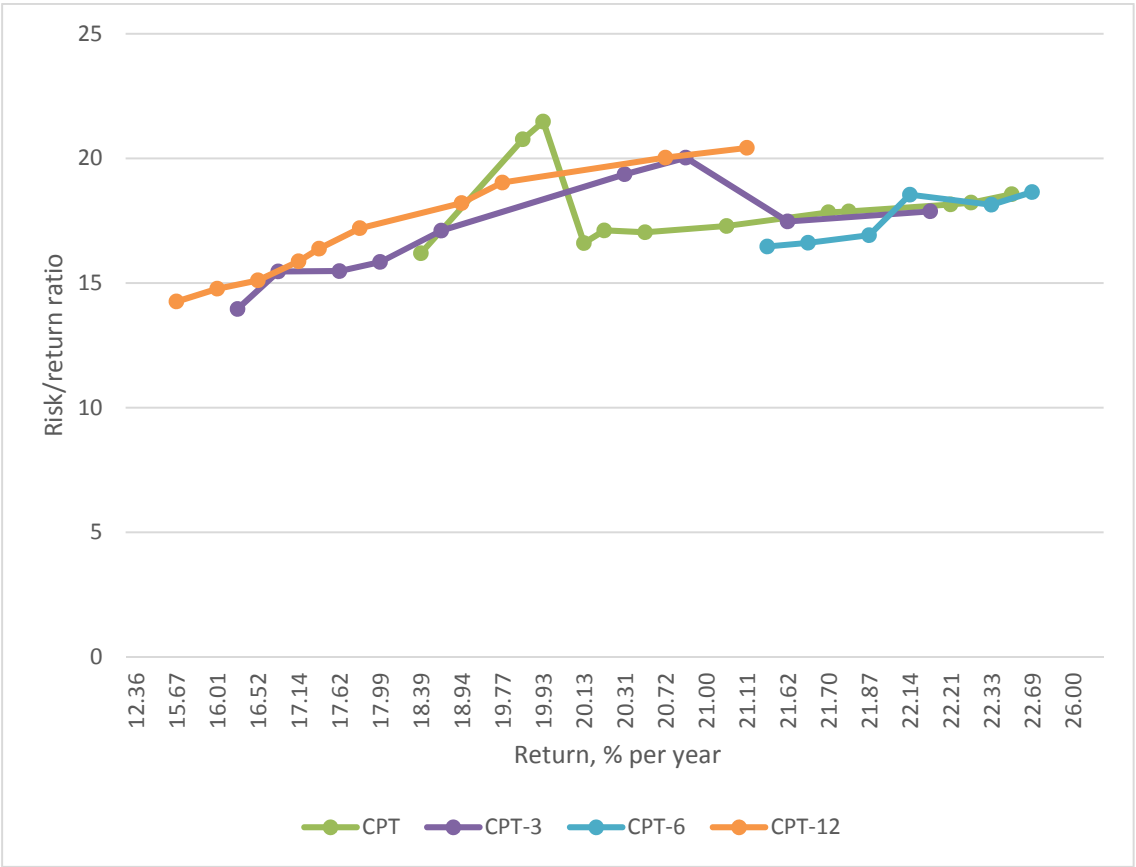

Fig. 6. **Portfolio Risk / Reward Ratios**

Source: compiled by the author.

In CPT model (*Fig. 1*) with a monthly portfolio assessment, diversification is achieved at return levels at 18–19% returns per year (starting from 13 securities to 4 securities at 20% return). As the return in the model grows, the number of securities included in the portfolio decreases. Already with a 20% return, the portfolio model focuses on investing in only one security (Tatneft-p).

In CPT-3 model (*Fig. 2*), portfolio diversification is lower than in CPT model. The number of securities in the portfolio is 2–3 types of shares. At a return rate of above 21% per year, diversification also disappears from the model. The main investment in this model is Transneft-p.

The diversification of securities analysis in the portfolio with the portfolio assessment every six months (*Fig. 3*) allows to conclude that it mostly diversifies at the level of 21–22% per year (13 securities). At return levels below and above this interval, there is no diversification. In this case, the largest share, in any case, also belongs to the investments in Tatneft-p.

In the model with a portfolio review once a year (*Fig. 4*), the largest share of investments also belongs to the Transneft-p shares, as well as in CPT-3 model. In general, the diversification model resembles CPT-3 model. However, 15–17% return per year, a larger number of assets (up to 5 shares) are included in the portfolio.

The common feature for all models is the tendency to choose one dominant security for investment with high return (over 20%) and a greater level of diversification at lower levels of return. However, CPT-6 model, the leader in terms of returns and the Sharpe ratio, is characterized by a high level of diversification with a high return of 21–22%. For most investment, Transneft-p or Tatneft-p shares were preferred in the models.

Considering the portfolio efficiency level, it can be established that among the behavioral ones, semi-annual CPT-6 model has the highest indicator of the Sharpe ratio (*Fig. 5*).

Looking at the ratio of risk and return, a lower level of risk in the optimal model can be noted in general. It increases significantly with higher return, while behavioral models CPT and CPT-6 are more advantageous at return over 22%, i.e. assessment models for a month and six months (*Fig. 6*).

Thus, the behavioral models have apparent defects in diversification balance. Unlike the average variance model, they do not include an indicator responsible for the level of covariance between asset returns. Nevertheless, the behavioral models show the general tendency of the irrational investor to choose a higher portfolio return in the future with a higher level of risk. Thus, the Sharpe ratio (model efficiency) in CPT-6 model is characterized by the highest value (*Fig. 6*) with the highest risk / return ratio (*Fig. 5*). It should also be noted that the assets selected as the sole stock in the portfolio have a tendency to grow steadily for several years, which indicates the maximum desire of the investor to avoid losses at volatility and to choose an obvious trend. As a rule, such stocks have a growth chart with no visible drawdowns. This attracts inexperienced investors who are oriented towards stable growth and "guaranteed income". There is definitely no diversification of assets in this case. To minimize objective risk, the expected return for inexperienced investors should be limited.

The next direction to study behavioral effects may be changing the objective probability indicator by correlating the prices of maximum and minimum for different periods (in this case, the entire time series is taken), including additional behavioral financial effects (naive diversification identified in the portfolio analysis results), as well as including in a bond portfolio. Besides, determining the reference point remains debatable. In this work, the average rate on deposits with banks was used as the main benchmark for the private investor. However, it is possible to further consider a comprehensive benchmark indicator, including the key rate, refinancing rate, and other monetary policy instruments of the Central Bank.

CONCLUSIONS

The analysis of the behavioral investment portfolio models results from the shares of Russian companies on the Moscow Exchange allowed to formulate the most optimal model of the irrational private investor's preferences in the Russian market. The model of reviewing and adjusting the portfolio every six months leads to decreasing the influence of behavioral effects. As a result, it brings large profits at the highest portfolio efficiency. This model is also characterized by a sufficient level of diversification (13 types of securities).

Using these models from the point of view of risk reduction is controversial, since they do not consider the correlation index of assets among themselves. However, these models are intended to reflect the consumer's desires and increase the consumer's utility in terms of their ideas about risk and loss aversion. In terms of the model validity, its irrational nature should be considered, which at the same time is more preferable for this type of the investor and will subsequently lead to more strict adherence to the investment plan.

According to the simulation results, the following points can be noted:

- When calculating the behavioral model for a six-month period, the indicators came as close to optimal as possible.
- The behavioral models are less diversified with high returns, but give greater returns with the same level of diversification (in models CPT, CPT-6).
- The behavioral models are more effective at high returns and risk.

The authors suggested a hypothesis on the need to change the term for evaluating the return on assets in the portfolio for behavioral effects on the medium-term, since the effect of behavioral errors in the cumulative prospect theory is ultimately leveled off due to the lack of attention to frequent price fluctuations leading to an increased distortion in the perception of objective statistical indicators. Risk assessment, therefore, is not distorted at each iteration of the profitability assessment of each period and the standard deviation as a risk measure. It is important to note the inability of the quarterly and annual models to approach the indicators of the optimal model.

It should be considered that errors in diversification and perceptions of subjective probability and estimated profitability can show the preferences of investors with behavioral deviations towards the ratio of greater risk and greater profitability. On average, the risk in behavioral models varies less than in case of the optimal model, which also indicates the importance of the risk aversion tool. It is possible that a focus on naive diversification and the predominance of a particular asset in the portfolio during semi-annual or monthly monitoring may make the portfolio more profitable at moderate to high risk.

The study results can be used in studying the modern behavioral economic theory to compare differences in assessing the results of the expected utility theory and subjective behavioral utility. Moreover, the features of compiling a portfolio under the conditions of behavioral errors in the perception of portfolio profitability can be used to compile investment portfolios for unqualified investors by investment advisers in the brokerage business.

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Estimation of Impact of Quantitative Easing Policy on EUR/USD using Behavioral Equilibrium Exchange Rate Model

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ABSTRACT

The article examines the impact of the policy of the USA quantitative easing and the euro area on the nominal EUR/USD exchange rate. After the economic crisis of 2008–2009, the policy of quantitative easing gained popularity among the world's largest economies. The largest programs were implemented by the US Federal Reserve (US Federal Reserve System) and the European Central Bank (ECB). However, the impact of the actual purchase volume of securities on the EUR/USD exchange rate within these policies has been little studied in modern literature. The author collected the data from 1999 to 2018 on the exchange rate, macroeconomic and market indicators, and calculated the monthly actual purchase volumes of securities under the asset purchase program of the United States and the euro area. The behavioral equilibrium exchange rate model was used. The linear model specification and the error correction model identified no significant impact of the ECB quantitative easing policy expressed in the actual purchase volume of securities. However, for some specifications, it has been proven that the increase in purchases of securities by the US Federal Reserve leads to a weakening of the dollar against the euro. The cointegration test revealed a long-term dependence of the EUR/USD exchange rate on the accumulated volumes of acquired assets. Thus, an increase in the purchase volume of securities led to a weakening of the dollar against the euro. The insignificant impact of the European Central Bank quantitative easing policy could have been caused by market expectations formed prior to the actual purchase of ECB securities in the market.

Keywords: macroeconomics; finance; economic policy; non-standard monetary policy; quantitative easing; euro area; European Central Bank (ECB); Federal Reserve System; exchange rate; EUR/USD; VECM; BEER

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INTRODUCTION

Studying exchange rate dynamics is an important task for economic policy and financial markets. For example, the government plans export revenues and companies make revenue forecasts based on exchange rate forecasts. The EUR/USD exchange rate is one of the most popular and often traded world currency pairs, therefore it is of interest for this study.

In present-day conditions, after the 2008 economic crisis, the United States and the euro area countries resorted to unconventional monetary policy, in particular, policies of quantitative easing and zero interest rates. In 2008–2014, The United States conducted the largest-scale asset purchase program as part of quantitative easing policy, and in 2015–2018, the European Central Bank substantially expanded its asset purchase program. Such a policy was expected to strengthen the transmission mechanism of the conventional monetary policy which would help accelerate economic growth and achieve the target inflation rate. The impact on exchange the rate is less predictable.

This paper examines the impact of the quantitative easing policies on the nominal EUR/USD exchange rate.

In 2015–2018, the quantitative easing policy of the euro area countries was due to a decrease in long-term interest rates on bonds as shown in the work by M. Ferrari, J. Kearns [1]. All things equal, this can reduce the flow of investment into the country and weaken the exchange rate.

Among the factors affecting the exchange rate, interest rate differential, risk premium, public debt and terms of trade were identified in the literature [2]. In this study, most of the factors are used as control variables, and the target variable is the actual volume of purchase of securities under the quantitative easing program in the US and the euro area.

The aim of the study is to estimate the impact of the ECB and the FRS quantitative easing policies on the nominal EUR/USD exchange rate. Unlike previous works on similar topics, the impact of the quantitative easing policies in these two countries is estimated simultaneously. To estimate the impact on the EUR/USD exchange rate, the author used the volumes of purchased securities obtained from the ECB and the FRS data. Besides, the work uses two behavioral equilibrium exchange rate (BEER) models, a linear model and an error correction model with several specifications. The following factors are used as controlling factors: difference between short-term and long-term interest rates, oil price, spread between growth rates of industrial production, difference between the inflation rates, growth rate of money supply, and volatility index VIX.

As a result, this work did not reveal a short-term significant effect of the ECB quantitative easing policy on the on the EUR/USD exchange rate, however, the impact of the US quantitative easing policy is significant for some specifications. The cointegration analysis showed a long-term relationship between the euro and the variables reflecting the volume of purchases of securities. The structure of the article comprises the review of the literature on exchange rate models, the description of the quantitative easing policies in the USA and the euro area, the description of the model used by the author to estimate the impact of the quantitative easing policies, the results of the model evaluation with discussion and the conclusions.

LITERATURE REVIEW

In recent decades, presented in the foundational work by M. Ferrari and J. Kearns [1], behavioral equilibrium exchange rate models have begun to gain popularity. These models explain the exchange rate dynamics in an abridged (non-structural) form allowing to evaluate the model just by econometric methods. The paper [1] also presents a linear model for the exchange rate dynamics.

The frequency of the data largely determines the opportunity to use various observable factors affecting the exchange rate. In the short term (on daily and intraday data), such factors as interest rates, volatility indices and unemployment rates are highlighted [3], however, long-term variables such as money supply and industrial output are generally unavailable.

The studies of the impact of the quantitative easing policy on the daily euro rate [4] revealed

weakening of the euro against the dollar one and two days after the quantitative easing policy was announced. In work [3], intraday data showed weakening of the exchange rate in the country (several exchange rates against the US dollar were used) after the news about stimulating unconventional monetary policy. The overnight indexed swap (OIS) change was used as a variable reflecting the policy change.

Volatility clustering is also observed in the daily rate data [5] which can be described by the GARCH models.

Monthly data allow to identify more long-term trends in the exchange rate dynamics used for forecasting and the factors affecting it. However, one of the fundamental articles on forecasting the exchange rate [6] revealed the predominant predictive power of the random walk model for the current value of the exchange rate over several models that use fundamental factors to forecast the exchange rate.

However, more current works propose many fundamental factors that together can explain the valid part of the exchange rate change. Work [7] already demonstrates an improvement in the predictive power of a model based on the fundamental factors compared with a random walk.

One of the most popular factors highlighted in the literature is uncovered interest rate parity. Uncovered interest rate parity determines the expected change in the exchange rate depending on the spread between the interest rates in the economies.

$$\Delta s^e = \frac{1+i_d}{1+i_f} - 1$$, where Δs — is the expected change in the exchange rate (in units of foreign currency); i_d^e — is the short-term interest rate in one country; i_f^e — is the short-term interest rate in another country.

However, uncovered interest rate parity often does not work in the short term, for example, due to capital flows. Capital from other countries is sent to a country with a higher interest rate (carry trade operations). As a result, the country's currency may strengthen. The effect of uncovered interest rate parity is usually reflected in the spread between short-term interest rates of the countries.

Work [8] estimated the effects of the quantitative easing measures by the ECB and the Federal Reserve on the EUR/USD exchange rate by means of the model based on covered interest rate parity. The policy shocks were identified based on a change in the balance sheet of assets and liabilities of the central bank.

The interest rate parity itself is not sufficient to explain the exchange rate dynamics, since the data do not show the effect of parity under rational expectations. The forward value of the exchange rate is a poor indicator to change the value of the spot exchange rate. The so-called "uncovered interest parity puzzle" means the deviation of the exchange rate dynamics from the results of uncovered interest parity. In work [9] this deviation is explained by risk premium.

Another popular factor determining the exchange rate dynamics is purchasing power parity. It suggests the effect of the spread in inflation on the exchange rate.

$$\Delta s^e = \frac{1+\pi_d^e}{1+\pi_f^e} - 1$$, where Δs — is the expected change in the exchange rate (in units of foreign currency); π_d^e — is the expected inflation in one country; π_f^e — is the expected inflation in another country. This factor, as well as uncovered interest rate parity, is insufficient to explain the exchange rate dynamics, but the inflation rate differential is often used as one of the factors in BEER models.

Among the early models explaining the nominal exchange rate dynamics by fundamental factors, several basic types are used. The monetary model [10–12] assumes the dependence of the exchange rate on the relative demand for money in the two countries. In sticky-price monetary models (as opposed to flexible price monetary models), only long-term fulfillment of purchasing power parity is assumed. When using this model in empirical work, several fundamental factors affecting the exchange rate are identified. Among

them: monetary aggregates, a gap in aggregate output, interest rates, trade balance, inflation and terms of trade.

The portfolio balance model [13] introduces the premise of the imperfect asset substitutability of the two countries. In this model, the exchange rate, in addition to the spread in interest rates, is determined by government securities in national currency.

Various econometric models were used to estimate the impact of the quantitative easing policy. J. Boeckx, M. Dossche, G. Peersman [14] proposed to estimate the impact of asset purchases on the euro. The Deutsche Bundesbank report for January 2017 on the purchase of Eurosystem bonds and the euro exchange rate[1] used the non-structural BVAR model with variables:

- nominal effective exchange rate of the euro;
- ECB assets intended for the implementation of monetary policy;
- ECB liquidity used for monetary policy;
- ECB main refinancing rate;
- harmonised index of consumer prices for the countries of the euro area;
- industrial production index;
- Euro Stoxx 50 stock market index volatility.

As a result of the model evaluation in work [14], a decrease in the exchange rate at an increase in the assets of the ECB was revealed.

In other works, structural models reflecting the influence of the quantitative easing policy on the rate were also built. The study by G. Adler, R. Lama, and J. Medina [15] built a dynamic stochastic general equilibrium model for the two countries, considering the impact of the quantitative easing policies on the exchange rate.

Using the panel quarterly data, C. Engel, N. Mark, K. West [16] offered and built a factor model that used the information embedded in the exchange rates to forecast. The resulting model presented some forecasting results that exceeded a basic random walk model.

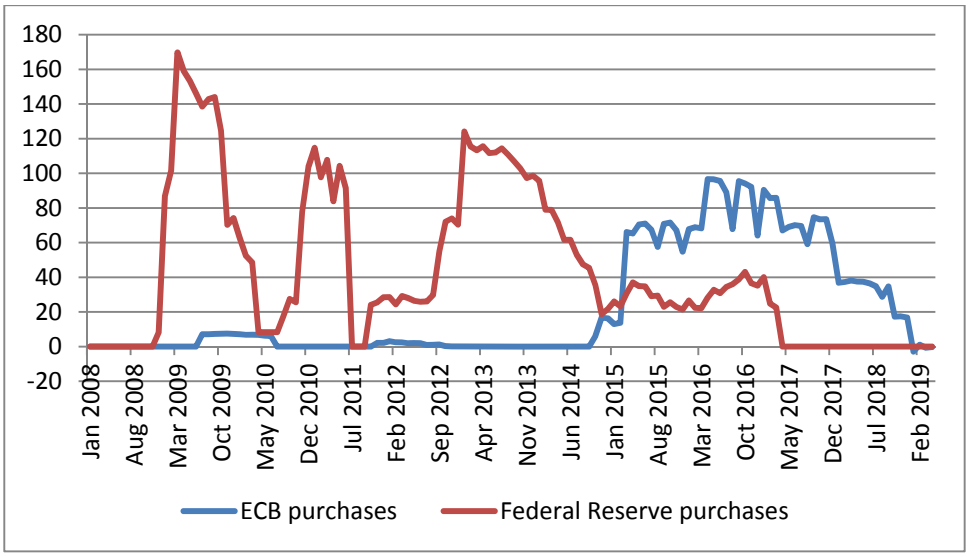
In general, most of the works converge on the influence of unconventional measures of monetary policy close to the effect of conventional measures. Quantitative easing policy reduces long-term interest rates in the economy, which leads to a decrease in investment attractiveness and a weakening currency.

QUANTITATIVE EASING POLICY IN THE US AND EURO AREA COUNTRIES

Before the global economic crisis, unconventional monetary policy, such as policies of zero interest rates and quantitative easing, was rarely used, and the volume of purchases of securities was relatively small. After the 2008–2009 global economic crisis, economic growth and inflation were steadily slowing in the world's leading economies: the US and the euro area. The US annual price growth was negative, and the GDP was declining. Central banks used several unconventional measures of monetary policy to stimulate the economy since conventional measures had exhausted themselves: interest rates reached zero [17]. Those measures included the quantitative easing policy which consisted in purchasing securities from the private and public sectors by the central bank and expanding the balance of the central bank according to the classification of unconventional monetary policy [18]. As a result, the US Federal Reserve expanded its asset purchase program to stimulate the economy and maintain inflation. In 2008–2014, the FRS bought more than $ 5 trillion in the open securities market. The three-stage program mainly included the purchase of treasury bonds, bonds of mortgage agencies Fannie Mae and Freddie Mac and mortgage-based securities (MBS) of these agencies.

The first stage of the program began at the end of 2008 and included the purchase of MBS in the amount of $ 1.25 trillion and the purchase of agency bonds in the amount of $ 175 billion (*Fig.*). At the second stage of the program (November 2010 — June 2011), the US long-term government securities were purchased for $ 600 billion. The operational twist between the second and third stage (September 2011 — December 2012) included the exchange of short-term bonds for long-term bonds in the amount of about $ 600 billion.

[1] Deutsche Bundesbank, The Eurosystem's bond purchases and the exchange rate of the euro, Monthly Report, January, 2017. URL: https://www.bundesbank.de/resource/blob/707604/ad5d6a4c1a430a1bfee21a378572f87a/mL/2017–01-anleihek-aeufe-eurosystem-data.pdf (accessed on 18.07.2019).



Volume of securities purchased under asset purchase programs, billion dollars

Note: the volume of asset purchased by ECB converted from EUR into USD at the exchange rate at the time of the purchase

Source: ECB, FRED, calculated by the author.

At the third stage (September 2012 — October 2014), long-term government bonds were bought at a rate of about $ 45 billion per month and MBS about $ 40 billion per month.

After the 2008 crisis, the ECB started its quantitative easing policy in relatively small volumes. In 2015–2018, in order to strengthen the transmission mechanism of conventional monetary policy and to combat low inflation and GDP growth after the crisis, the ECB substantially expanded its asset purchase program consisting of four subprograms: corporate sector purchase program, public sector purchase program, covered bond purchase program, asset-backed securities purchase program. The largest volume of purchases was accounted for by the public sector purchase program. Purchases of securities under the ECB program took place simultaneously with the policy of zero interest rates in the euro area.

Unlike the US asset purchase program, this program was ongoing. Another feature of this program is the differences between countries whose securities were purchased. Purchases were made in accordance with the "capital key" which determines the volume of purchases depending on the country's GDP. Thus, the largest volume of purchases by country belonged to countries with a high debt burden (Italy), and with a low one (Germany, France). The total volume of purchases of securities under the ECB quantitative easing program amounted to about $ 3.1 trillion in equivalent at the exchange rate at the time of purchase.

Quantitative easing policy primarily affects assets purchased. The works by A. Vissing-Jorgensen, A. Krishnamurthy and R. Motto, C. Altavilla, G. Carboni, [4, 19] demonstrated a decrease in the yields of long-term bonds of the USA and the euro area countries as a result of the policy based on changes in market expectations after the central banks announced unconventional monetary policy measures. The authors explain the mechanism for reducing rates by several channels (signaling channel, default risk channel, portfolio rebalancing channel, and others), via which the announcements of the quantitative easing policy affect long-term government bond rates.

In general, the quantitative easing policy is an important part of monetary and general economic policies of the United States and the euro area countries, so they can play an important role in shaping the EUR/USD exchange rate and other local and global macroeconomic indicators.

EXCHANGE RATE MODEL

This article analyzes monthly data to evaluate the exchange rate model. The base specification

of the BEER model uses the linear model of the following form:

$$y_t = c + \beta X_t + \varepsilon_t,$$

where y_t — is the dependent variable; X_t — is a set of explanatory variables, ε_t — are random shocks; β — is the coefficient vector.

To evaluate the model, monthly data from 1999 to 2018 are used from FRED, the ECB database, S&P Dow Jones Indices and EIA. The average monthly change in the EUR/USD exchange rate is taken as the explanatory variable. The following variables are used as explanatory variables:

- three-month interest rates in the interbank market for the USA and the euro area countries which reflect the influence of the inflow of carry trades according to uncovered interest rate parity;
- ten-year government bond yields of the USA and the euro area countries (yield index, aggregated by country);
- M2 money aggregates for the USA and the euro area countries (seasonally adjusted);
- indices of industrial production (manufacturing) for the USA and countries of the euro area (seasonally smoothed) which reflect economic activity;
- Brent oil price (FOB) in the European market which partially reflects the terms of trade;
- spread in the inflation rate expected by the market between the US and the euro area, reflecting the change in the exchange rate as a result of the effect of the disparity in inflation (purchasing power parity);
- global volatility index VIX based on the option for the US stock index S&P 500 which reflects the risk premium;
- volumes of asset purchases by the ECB and the FRS according to the quantitative easing policy (target variable).

Volumes of purchases of securities in terms of asset purchases in the US and the euro area were calculated based on the ECB and the FRS data.

Market expectations are used as expected inflation. They are calculated from inflation-indexed bonds and straight bonds by formula

$$\pi^e = \frac{1 + y_{IPS}}{1 + y} - 1,$$

where π^e — is the market expected inflation; y_{IPS} — are yields on inflation-indexed government bonds; y — are government bond yields.

The stationarity of the variables in the model was verified by the Dickey-Fuller test.

The vector error correction model (VECM) is used as an extension of the model. The model allows consider the long-term dependence of the exchange rate on the fundamental variables, such as the oil price or the disparity (ratio) between the price level in the USA and the euro area. The specification for a short-term variable (exchange rate change) is similar to the base specification.

The VECM model is as follows:

$$\Delta X_t = C + \Lambda X_{t-1} + \beta_1 \Delta X_{t-1} + \varepsilon_t,$$

where ΔX_t — is the vector of the differences of the studied variables; X_t — is the vector of explanatory variables; Λ — is the coefficient matrix of cointegration vectors; β_1 — is the matrix of lag coefficients of the differences of the studied variables.

To identify cointegration between the variables the Engle-Granger and Johansen tests with one lag for the variables were used before estimation the model. Next, the VECM model based on cointegrating variables was estimated.

RESULTS

The estimation results of the base model demonstrated a diverse effect of the variables depending on their inclusion and transformation. *Table 1* shows the estimation results of three specifications of the basic model with the largest number of regressors and various transformations of the volume of purchases of securities under the quantitative easing program. The variables in the table and their corresponding names are presented in the appendix. The shortest series of expected inflation limited the sample from 2009. Depending on the specification, the differences of the logarithms of the oil price and the spread of money supply growth between the euro area and the United States turned out to be stably significant variables for the differences of the logarithms of the EUR/USD exchange rate (the dependent variable in the model). In most model

Table 1

Basic models of the USD/EUR exchange rate log-differences

	(1)		(2)		(3)	
Constant	1.012	***	1.358	***	1.279	***
	(0.373)		(0.414)		(0.366)	
infl_spr	−0.015		−0.005		−0.003	
	(0.017)		(0.016)		(0.016)	
st_int_spr	−0.007		−0.005		−0.004	
	(0.005)		(0.005)		(0.004)	
lt_int_spr	0.004		0.000		0.002	
	(0.007)		(0.007)		(0.006)	
M2_spr	−1.002	***	−1.238	***	−1.270	***
	(0.379)		(0.382)		(0.370)	
IP_spread	0.111		0.084		0.064	
	(0.193)		(0.188)		(0.197)	
VIX	−0.000		−0.001	*	−0.001	*
	(0.001)		(0.000)		(0.000)	
ld_EuropeBrentSpotPriceFOB	0.073	***	0.057	***	0.055	***
	(0.019)		(0.021)		(0.019)	
l_ECB_purch	−0.001		–		–	
	(0.002)					
l_US_purch	0.002		–		–	
	(0.002)					
l_cumul_ECB_purch	–		−0.000		–	
			(0.003)			
l_cumul_FED_purch	–		−0.013		–	
			(0.012)			
d_l_cumul_ECB_purch	–		–		0.001	
					(0.004)	
d_l_cumul_FED_purch	–		–		0.133	***
					(0.046)	
Adjusted R-squared	0.087		0.100		0.129	
Time period	04.2009–12.2018		04.2009–01.2019		04.2009–01.2019	
P-value (F)	0.000		0.000		0.000	

Note: * – variable is significant at 10%-significance level.

** – variable is significant at 5%-significance level.

*** – variable is significant at 1%-significance level.

Source: calculated by the author.

Table 2

Johansen test results

Rank of cointegration matrix	Trace statistics	Maximum eigenvalue statistics
0	144.87	103.40
	(0.000)	(0.000)
1	41.470	28.018
	(0.175)	(0.041)
2	13.452	8.420
	(0.869)	(0.870)
3	5.032	2.855
	(0.804)	(0.946)

Note: the p-values of the test statistics are showed in parentheses.

Source: calculated by the author.

specifications, the quantitative easing policy variables turned out to be insignificant. The only variable that reflects the US quantitative easing policy in the specification in the third column of *Table 1* turned out to be significant. The positive effect of the stimulating quantitative easing policy of the FRS on the EUR/USD exchange rate (weakening of the dollar against the euro as a result of increased purchases by the FRS) was revealed, which generally corresponds to the results of the other studies. This can be explained by the fact that long-term rates in the US economy are falling making investment in it less attractive. The dollar in this case may weaken. The impact of the ECB's quantitative easing policy turned out to be insignificant.

For the cointegration vector of the EUR/USD exchange rate, the Brent oil price variables, the disparity between the price level in the USA and the euro area and the logarithm of the accumulated volume of purchases of securities were chosen, since they can reveal a long-term dependence of the EUR/USD exchange rate. Before the Johansen test was conducted, the variables had been tested for stationarity by the Dickey-Fuller test. All of the above variables turned out to be non-stationary in levels, but stationary in disparity, which allows to continue analysing cointegration between the variables.

The Engle-Granger test with a constant and without a constant with a lag selected by the Akaike criterion did not reveal cointegration between the EUR/USD exchange rate and other variables.

Nevertheless, the Johansen test with an unlimited constant and one lag revealed a cointegrating vector: the equation of the euro exchange rate with oil prices, the purchasing power disparity (the ratio between the level of consumer prices) and the accumulated volumes of purchases of securities according to the quantitative easing policy (the hypothesis of the absence of cointegrating vectors was rejected for trace statistics and the maximum eigenvalue based on a p-value of less than 1%). The test results are shown in *Table 2*.

The Johansen test results enable the VECM use to identify the long-term relationship between cointegrated variables and the short-term relationship between stationary variables. The VECM model evaluation results are presented in *Table 3*. The first specification provides an equation for a cointegrating vector. The equation indicates that in the long term, the EUR/USD exchange rate depends on the oil price, the price disparity between the US and the euro area and the volume of purchases of securities according to the quantitative easing policy.

The second specification provides an equation for the short-term dependence of the change in the EUR/USD exchange rate on the changes in Brent oil prices, the short-term rates differential, the long-term rates differential, the volatility index VIX, the money supply differential, the disparity changes, the spread between industrial production growth rates, and the changes in purchases of securities according to the quantitative easing policy and the correction term. In the VECM model, the correction

Table 3

Results of the estimation of the VECM model for the USD/EUR exchange rate

	(1)		(2)	
	l_EURUSD		d_l_EURUSD	
l_EuropeBrentSpotFOB	−0.089	константа	0.012	**
	(0.119)		(0.005)	
l_disparity	−3.299	d_l_cumul_ECB_purch	0.004	
	(3.726)		(0.010)	
l_cumul_ECB_purch	0.004	d_l_cumul_FED_purch	0.018	**
	(0.042)		(0.007)	
l_cumul_FED_purch	0.019	ld_EuropeBrentSpotPriceFOB	0.049	***
	(0.028)		(0.016)	
		d_l_disparity	0.516	
			(0.322)	
		VIX	−0.001	***
			(0.000)	
		st_int_spr	0.003	
			(0.002)	
		lt_int_spr	0.004	
			(0.003)	
		IP_spread	−0.075	
			(0.138)	
		EC 1	−0.052	***
			(0.015)	
Time period			02.1999–01.2019	
Adjusted R–squared			0.098	

Note: * — variable is significant at 10%–significance level

** — variable is significant at 5%–significance level

*** — variable is significant at 1%–significance level

Source: calculated by the author.

coefficient turned out to be significant at 1% level. This dependence indicates the negative influence of the adjusting component in the model bringing the euro closer to the long-term value, which corresponds to the theoretical conclusions. Among the control variables, the oil prices and the index VIX were significant at 1% level. The equations of the vector model for the remaining variables are not of interest for this work.

The insignificant impact of the volume of purchase of securities in the framework of the ECB quantitative easing policy can be explained by several factors. First, volume of purchases of bonds may be insufficient to significantly affect the demand for the euro. Second, the cross-country differences in the fundamental macroeconomic indicators for the euro area could reduce the impact of the quantitative easing policies on the exchange rate. For example, lower volumes of purchases of securities by Italy, the country with a relatively high debt level, compared with a large volume of purchases of securities by Germany, with a relatively low debt level. Finally, the actual purchases could be less significant than the expectations regarding the quantitative easing policy. Since the quantitative easing policy in the euro area implied a predetermined volume of purchases of securities, the market could have considered these volumes before the actual purchases. The US quantitative easing policy was less certain about the actual volume of purchases that could have given greater importance to the actual purchases of securities.

CONCLUSIONS

The purpose of this study was to estimate the impact of the quantitative easing policies on the EUR/USD exchange rate. The quantitative easing policy was applied after the economic crisis to achieve the target inflation rate and to stimulate economic activity in the USA and in the euro area. The differences between the approaches to the policy implementation were both in the structure of the purchased securities and in the volume of purchases. The volume of purchases of securities in the United States was greater, and a significant share in their structure was held by mortgage-based securities. The feature of this work is that the impact of the quantitative easing policy in the USA and the euro area were estimated simultaneously.

To identify the effect of the quantitative easing policy, two BEER models were used on monthly data: the basic linear model and the error correction model (ECM). The study found no evidence of a significant impact of the ECB purchases according to the quantitative easing policy. However, in some specifications, the FRS quantitative easing policy was significant. According to the estimated linear and VECM models, the purchase of the US Federal Reserve securities led to weakening the dollar against the euro, which is consistent with the theory. As a result of the quantitative easing policy, the long-term rates in the economy are declining, making the US investments less attractive, and the dollar is weakening due to the increased capital outflows. The Johansen test revealed a long-term dependence of the EUR/USD exchange rate, oil prices, price level disparity on the volume of purchases under the quantitative easing program in the US and the euro area.

The FRS quantitative easing policy was more longlasting and extensive, therefore its effect could be more pronounced than that of the ECB's. The effect of the ECB quantitative easing policy could be insignificant due to the small volume of purchases relative to the market or the effect could be blurred due to the difference in fundamental indicators for countries in the euro area. Besides, the expectation effect of the quantitative easing policy for the US and the euro area could be different. In particular, the announcements of the US quantitative easing policy did not always contain monthly volumes of purchases of securities, especially mortgage-based securities. On the other hand, the ECB announcements often contained monthly volumes of purchases of government securities, which could instantly shape market expectations and affect asset prices. The announcements of unconventional monetary policy measures affected the interest rates in the economy that was also confirmed in the works by K. Hausken, M. Ncube and R. Motto, C. Altavilla, G. Carboni [4, 20].

The work may be continued by studying the exchange rate dynamics depending on the quantitative easing policy on daily data. Also, the VECM model may be modified. It can be used, for example, to consider the ECB policy of zero interest rates which can be taken into account in different modes for the model. Another direction for further work may become the study of announcements regarding unconventional monetary policy measures that affect market expectations. However, this direction has been studied in more detail in the literature.

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APPENDIX

List of variables used in the models

Variables in the model	Variable description	Transformation	Source
infl_spr	Expected inflation from the difference in government bond yields indexed and non-indexed for inflation	Spread in monthly growth rates between countries	FRED, S&P Dow Jones Indices
st_int_spr	Yields at 3 monthly rates in the interbank market	Spread between countries	FRED
lt_int_spr	Yields on 10 year government bonds *	Spread between countries	FRED
M2_spr	M2 of the USA and euro area	Spread in monthly growth rates between countries	FRED, ECB
IP_spread	Indices of industrial production of manufacturing enterprises for the USA and euro area	Spread in monthly growth rates between countries	FRED
VIX	Index VIX	–	FRED
l_EuropeBrentSpotFOB	Brent oil price (FOB)	Logarithm	EIA
ld_EuropeBrentSpotPriceFOB	Brent oil price (FOB)	Differences of logarithms	EIA
l_ECB_purch	Volume of purchase of securities under the quantitative easing program of the euro area	Logarithm	FRED
l_US_purch	Volume of purchase of securities under the quantitative easing program of the USA	Logarithm	ECB
l_cumul_ECB_purch	Volume of purchase of securities under the quantitative easing program of the euro area	Logarithm of accumulated purchases for the entire sampling period	FRED
l_cumul_FED_purch	Volume of purchase of securities under the quantitative easing program of the USA	Logarithm of accumulated purchases for the entire sampling period	ECB
d_l_cumul_ECB_purch	Volume of purchase of securities under the quantitative easing program of the euro area	Differences of logarithms of accumulated purchases for the entire sampling period	FRED
d_l_cumul_FED_purch	Volume of purchase of securities under the quantitative easing program of the USA	Differences of logarithms of accumulated purchases for the entire sampling period	ECB
l_disparity	Consumer price indices in the US and the euro area	Logarithm of the ratio of price indices of the euro area to the US	FRED, ECB
d_l_disparity	Consumer price indices in the US and the euro area	Differences of logarithms of the ratio of price indices of the euro area to the United States	FRED, ECB

Note: * – weighted returns for euro area.

Source: compiled by the author.