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MODELLING THE IMPACT OF MACROECONOMIC FACTORS ON COUNTRY'S FINANCIAL STABILITY: EVIDENCE FROM THE RUSSIAN FEDERATION[5]

Promoting financial stability is one of the main priorities for the governments of countries seeking to achieve sustainable economic growth. The article aims to assess and model the impact of macroeconomic factors on the financial stability of the Russian Federation in the period 2010-2030 using ADF, OLS, VAR, ARCH, VECM and other techniques. In addition, the linear causal relationship between a group of 6 macroeconomic indicators and the financial stability of the Russian Federation was studied. The results of this research show that Russia's financial stability depends mainly on exports of crude oil and natural gas, price stability, volume of government debt, deficits and surpluses of the state's budget, exchange rate stabilization of national currency, and effectiveness of the banking system. Additionally, events taking place in Eastern Europe, the Middle East and the African continent may negatively affect Russia's financial security if it fails to take the necessary preventive measures.
Keywords: Macroeconomic modelling; financial stability; inflation rate; government budget balance; Balance of Payment; government debt; Russian Federation
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1. Introduction

Achieving and promoting financial stability is one of the main priorities for the governments of countries seeking to achieve sustainable economic development (Ozili, Iorember, 2023; Barra, Zotti, 2022) and one of the key factors affecting the functioning of a country's financial system (Shkolnyk, Kozmenko, Kozmenko, Orlov, Shukairi, 2021). Financial stability is dependent on a financial system that can provide financing for production operations, the import of goods and services, risk management and insurance, management of savings, and borrowing of funds. Financial instability will normally, in one way or another, lead to the destruction of the country's production processes, increased indebtedness, inability to pay debts as they become due, and inability to access productivity assets from external sources.

Maintaining financial stability in conditions of economic unrest is an important function of the state (Kondrat, 2011). The goal of financial stability is closely related to its definition: the ability of state institutions to provide financing for domestic and foreign economic activities while maintaining a limited level of inflation and an acceptable level of debt. Adoption of a macroprudential policy, which involves partial prudential supervision, helps to establish the first line of defence against the accumulation of financial imbalances (European Central Bank, 2023) that threaten financial stability.

Financial stability insurance for the economy of the Russian Federation depends mainly on exports of crude oil and natural gas (World Bank, 2015). According to BP (British Petroleum Company, 2021), the oil reserves of the Russian Federation in 2020 amounted to 107.8 billion barrels of oil, or approximately 14.8 % of the world's crude oil reserves. Russia ranked 6th in the world in terms of oil reserves. According to OPEC Russia's natural gas reserves amounted to 187 trillion cubic meters, and the Russian Federation ranked 1st in the world (OPEC, 2013). Since 2003, Russia has become less dependent on exports of natural resources, and despite the rise in global energy, oil and gas prices, these only account for 3.7% of Russia's GDP.

In 2014, the Russian financial system faced the risk of a decline in the real value of Russian exports as a result of the drop in global oil prices, and accordingly to ensure financial stability and stabilize the exchange rate a number of policies were adopted. For example, the Ministry of Finance sold foreign exchange in the amount of US$1.5 billion, and the CBR introduced 28- and 365-day foreign currency loans to 11 banks with capital of over RUB100 billion etc. (World Bank, 2022).

The instability of global energy supplies, as a result of their vulnerability to factors such as the conflict in the Middle East, the global financial crisis, the Ukrainian crisis, and the emergence of renewable energy alternatives, may constitute a major threat to the financial stability of oil-exporting countries, including the Russian Federation. In government policy terms, the primary goal of financial stability is to maintain financial soundness and, ensure the stable financing of the government's domestic and foreign economic activities while keeping inflation and debt sustainable through a combination of tools and policies.

The researchers I. A. Sergeeva and A. Yu. Sergeev (2016) showed that the main problems facing Russian financial stability relate to the depreciation of the national currency, rising

inflation, Western economic sanctions, capital outflow from Russia and the shadow economy (Fedotov, 2021), and the introduction of the digital ruble in business relations between individuals and companies (Norets, 2022).

To minimize the risk of financial instability, particularly the types of economic stability that determine the integral development of the socio-economic space of Russia, it is necessary to protect the interests of the country (Gadzhiev, Kiseleva, Skripkina, Konovalenko, Trofimov, 2022). Given the great importance of financial stability in the Russian economy, we seek in this research to model the main factors affecting the Russian financial stability index. The level of financial stability is determined by a complex group of relative macroeconomic indicators, including the ratio of public debt to GDP, the inflation rate, the ratio of the state budget to GDP, return on bank assets, the ratio of balance of payments to GDP, and U.S. Dollar to Russian ruble exchange rate.

2. Theoretical Background

The main purpose of macroeconomic modelling is to study the causal relationship between variables that affect the resulting indicator, i.e. financial stability, in the short or long term. J. Tinbergen (1939) was the first to apply mathematical models in this area. Since then, to meet the growing demand for modelling processes in order to assess financial stability, a large number of macroeconomic mathematical models have been developed.

According to T. Vasylieva, O. Jurgilewicz, S. Poliakh, M. Tvaronavičienė and P. Hydzik (2020), a methodology based mainly on calculating a weighted average of the country's overall compliance with key international standards, rules and principles in a given segment can be used to determine the country's quality management index for a financial or any other market (Yossifov, Das, Sundararajan, 2003). This methodology allowed the researchers to create benchmarks for comparing different countries, by determining the financial position of each country.

In the view of V. Robertas and A. Vasiliauskaitė (2022) financial stability can be considered from a variety of perspectives, their research proposes that microeconomic and macroeconomic indicators should be taken into account when assessing financial stability. The results of this research make it possible to identify the regulatory measures that would most effectively contribute to ensuring financial stability in individual OECD countries.

The question of how to model the impact of macroeconomic factors on financial stability has attracted the attention of many researchers and other experts interested in the field of economic mathematical modelling, and this in turn has led to the use of many different modelling methods. Among the most important contemporary methods used in mathematical modeling are: SOFSM, VAR, ECM and GMM.

In their research, P. Sarlin and T.A. Peltonen (2013) used a Self-Organizing Financial Stability Map (SOFSM) to create a two-dimensional representation of a multidimensional financial stability space, which allows individual factors impacting systemic risks to be separated from each other. They tested the robustness of the model by varying the thresholds, the policymaker's preferences, and the forecasting horizons.

In order to investigate the causal relationship between economic performance and financial stability in the European Union, J. Creel, P. Hubert and F. Labondance (2015) used the seminal framework of Beck and Levine (2004) and a GMM panel with instrumental variables, and concluded that financial instability has a negative effect on economic growth.

To study the causal relationship between financial stability and US monetary policy before and during the Great Recession, A. Wischnewsky, D. Jansen and M. Neuenkirch (2021) used text-mining techniques based on Taylor's rule models. They concluded that perceptions of negative financial stability coincided with situations in which monetary policy was adjusted by an amount greater than that indicated by the standard Taylor rule factors.

A model developed by H. Mabkhot and H.A.H. Al-Wesabi (2022) used panel cointegration analysis, which depends mainly on the stability of time series variables of the same order in order to reveal the impact of macroeconomic factors (gross domestic product, inflation, exchange rate, oil sector revenues and other factors) on financial stability in the Gulf Cooperation Council countries to reveal economic and financial imbalances in those countries.

In order to determine the level of access and efficiency of Ukraine's financial system in the period 2007-2019, based on 29 financial indicators, I. Shkolnyk, S. Kozmenko, O. Kozmenko, V. Orlov, and F. Shukairi (2021) used a matrix of characteristics relating to the stability of the financial system, which was created by experts from the IMF. To determine the integrated indicator that characterizes the state of financial stability, the authors used Harrington's desirability function. This methodology allowed them to conclude that the stability of the financial system in Ukraine in the period 2007-2019 was acceptable.

In research conducted by I. Kozlovtceva, A. Ponomarenko, A. Sinyakov and S. Tatarintsev (2019), the authors studied the relationship between a commodity-export economy, commodity price volatility and fiscal policy and the latter's impact on financial instability using panel structural VARs and local projection models. They concluded that a commodity-exporting economy should have a countercyclical fiscal policy in order for inflation targeting to become countercyclical in a commodity cycle. To apply this to the specific case of the Russian economy, we note that it is considered an oil-exporting economy. Therefore, it should be noted that in the event of sharp fluctuations in international oil prices, adverse measures must be taken to reduce the effects of inflation and thus neutralize the risks to the financial stability of the state.

In a study by T.T.K. Oanh, L.T.T. Van, and L.Q., Dinh (2023) using the PVAR method, the causal relationship between financial inclusion, monetary policy, and financial stability was studied in 58 countries, including, high and low development financial countries. Using this method, the researchers concluded that in high-financial development countries, financial inclusion negatively affects the rate of inflation and the volume of the money supply while affecting financial stability. In developed countries with low financial resources, it was observed that financial inclusion positively affects financial stability and reduces inflation. In the same way, by applying the panel vector autoregressive (PVAR) methodology, simple panel data models, and the generalized least squares model, J. Jungo, M. Madaleno and A. Botelho (2022) were able to model the causal relationship between financial inclusion and monetary policy, and the ways in which they affect financial stability and inflation control in

countries in sub-Saharan Africa and Latin America and the Caribbean. Using threshold vector autoregression methodology. This methodology was used by T. T. V. Tran (2022) to derive an explanatory model of the impact of financial stability or its absence on the economic activities of Asian countries. Based on this model, an early warning technique was developed, extracted from the financial stress index, in order to reduce financial instability and its impact on the country's economic activities.

Using the Nonlinear Autoregressive Distributed (NARDL) model in order to determine the relationship between monetary policy and financial stability in the Gulf Cooperation Council countries, A. H. Elsayed, A. N. Naifar, and S. Nasreen (2023) concluded that monetary authorities react significantly to negative or positive shocks to financial stability, both in the short and long terms.

One of the common methods used to model macroeconomic financial stability indicators, which has been applied in many modern studies, is the error correction model (ECM), which aims to avoid spurious regression resulting from the presence of cointegration between the series. Some of the most notable modern studies that applied this model are described below.

Using the ECM, A. Hudaya and F. Firmansyah (2023) were able to assess the positive impact of interest rates on financial stability in Indonesia by the growth relationship 1 to 4 respectively, this means a 1% increase in interest rates increased financial stability by 4%.

The ECM was also was used by O.F. Chukwudi & J.T. Henry (2019) to study the causal relationship between monetary policy and financial stability in Nigeria. This method enabled the researchers to identify a significant balanced relationship between monetary policy and financial stability, which is able to adapt to imbalances adapt in the long term to imbalances.

T. M. Hlongwane, & J. P. S. Sheefeni, (2022) used a vector ECM to determine the causal relationship between shocks in the South African macroeconomic stability and stability. This methodology revealed the impact of economic activity and inflation-related shocks on financial stability in South Africa in the short and long term. The same methodology was used by M. R. Magwedere & G. Marozva (2023) to measure the causal relationship between household debt, income inequality and financial stability in South Africa. Using this method, the researchers were able to measure the negative effects of increased household indebtedness on the financial stability of the country. To measure the impact of gold prices on financial stability in India, the ECM was also applied by R.N. Mishra, & G. J. Mohan (2012).

K. Shehzad, L. Xiaoxing, F. Bilgili and E. Koçak (2021) applied an ARDL-based ECM to assess the impact of the economic and health crisis caused by COVID-19 on financial stability in the United States, Their study concluded that the long-term financial imbalance caused by the pandemic-related economic and health crises contributed to financial instability in the United States.

An analysis of previous studies reveals a wide range of methods that can be used to model the impact of macroeconomic factors that affect the stability of the financial system. One of the most effective methods of these is the multiple ECM. This method has been used by many contemporary researchers, including A. I. Anwar, N.R. Kurniaty, S. Wulandari, R. Fitrianti (2020) and M. R. Ridha (2020).

We can therefore conclude that the ECM is one of the most important methods to eliminate the problem of spurious regression as a result of cointegration in time series and to find ways to resolve this problem in time series analysis, as effectively applied in many contemporary studies (R. F. Engle & C. W. J. Granger, 1987, C. W. J. Granger & P. Newbold, 1974). In our research, we therefore mainly rely on these studies when using the multiple ECM method.

3. Methods and Date

To measure the stability of the financial system in the Russian Federation, in our research, we rely on the main indicators used to measure the financial performance of the state in the period 2010-2022, as presented in the State Strategy for the Economic Security of the Russian Federation in 1996. These are as follows: Price stability, Volume of external and internal government debt (total debt), Deficits and surpluses of the state's general budget, stability of the banking system, stability of the national currency exchange rate, and status of the Balance of Payments:

1) Price stability plays an important role in maintaining the purchasing power of the national currency, which in turn contributes to improving the financial and economic security of the state and sustaining maximum employment over the medium term (Williams, 2022).
2) The ratio between government debt Tagkalakis, A.O. (2014). and a country's GDP determines the extent to which the state is able to pay its obligations. The lower the debt-to-GDP ratio, the better the state is able to fulfil its obligations towards domestic and international creditors. Geopolitical and economic considerations, including interest rates, war, recession, and other variables, influence a country's borrowing practices and its decision to increase debt.
3) Deficit/surplus in the state budget (Cuadrado-Ballesteros, Bisogno, 2022). The budget deficit is defined as the excess of total spending over total receipts (revenues), excluding loans taken out in the current year. This is the amount that the government would have to borrow to cover all its due debt. There is a direct relationship between the deficit and the amount of borrowing: the larger the budget deficit, the higher the government-borrowing rate.
4) One of the most important indicators determining the stability of the banking system (H.B. Ghassan, S. Fachin, 2016) is the rate of return on assets. This rate reflects how much one ruble of assets brings in net profit or loss. If the banking system achieves an annual profit, then the banking sector is classed as efficient.
5) The balance of payments (Gadanecz, Jayaram, 2009) is a record of all international commercial and financial transactions carried out by the population of a country and consists of three components: the current account, the financial account, and the capital account. The balance of payments shows whether a country is saving enough money to finance its imports. It also shows whether the country has enough economic production to finance its growth.

6) The stability of the exchange rate (Eichengreen, 1998) of the national currency against international currencies such as the US dollar, euro, pound sterling and Japanese yen plays an important role in foreign trade and financial exchanges, thereby ensuring the country's economic and financial security. Given the importance of the US dollar in global commercial and financial exchange, in this study, we will analyze the relationship between the national currency and the US dollar.

In order to model the impact of these indicators on financial stability we used statistical methods, such as vector autoregressive models (VAR-models), analysis of cause-and-effect relationships, analysis of ARCH volatility, etc.

Returning to the practical reality of each of the previous indicators, there are several actual situations that countries can go through, as shown in Tables 1 and 2. For the purposes of measuring financial stability, we divided these situations into 15 standard categories.

Table 1. Possible levels of indicators: Inflation rate (%), gross government debt as a proportion of GDP (%); Government budget balance as a proportion of GDP (%)

Cases	Inflation rate (%)		Gross government debt as a proportion of GDP (%)		Deficits and surpluses of government budget balance as to GDP (%)	
	Level	Interpretation	Level	Interpretation	Level	Interpretation
15	[0;1]	No influence	[0;1]	No influence	[11;+∞]	Very optimal
14	[2;3]	Weak	[2;4]	Weak	[8;10]	Optimal
13	[4;5]	Noticeable	[4;6]		[5;7]	Very good
12	[6;7]	Moderate	[6;8]	Noticeable	[2;4]	Good
11	[8;9]	High	[8;10]		[1.5;1.99]	Very stable
10	[10;11]	Very high	[11;12]	Moderate	[1;1.49]	Sustainable
9	[12;13]	Strong	[13;15]	High	[0.5;0.99]	Quite a balance
8	[14;15]	Very strong	[16;20]	Very high	[0;0.49]	Equilibrium
7	[16;17]	Serious	[21;30]	Strong	[-0.1;-0.99]	Weak
6	[18;25]	very serious	[31;50]	Very strong	[-1;-2]	Very weak
5	[25;50]	extremely serious	[51;75]	Serious	[-3;-5]	Noticeable scarce
4	[51;100]	Destructive	[76;125]	Very serious	[-6;-10]	Moderate deficit
3	[101;500]	Highly destructive	[126;175]	Beginning of financial collapse.	[-11;-15]	High deficit
2	[501;1000]	Very highly destructive	[176;300]	Threat of loss of state sovereignty	[-16;-25]	Unstable
1	[1001;+∞]	Devastating	[301;+∞]	High threat of loss of state sovereignty	[-26;-∞]	Very unstable

Source: Prepared by the authors.

Table 2. Possible levels of indicators: ROI (%), Deficits /surpluses in BOP as a proportion of GDP (%), Growth of RUB to USD rate (%)

Case	ROI (%)		Deficits /surpluses in BOP as a proportion of GDP (%)		Growth of RUB to USD rate (%)	
	Level %	Interpretation	Level %	Interpretation	Level	Interpretation
15	[11;+∞]	Optimal	[11;+∞]	Optimal	[-26;-∞]	Optimal
14	[8;10]	Extremely good	[8;10]	Extremely good	[-20;-25]	Extremely good
13	[5;7]	Very good	[5;7]	Very good	[-14;-20]	Very good
12	[2;4]	Good	[2;4]	Good	[-8;-13]	Good
11	[1.5;1.99]	Very stable	[1.5;1.99]	Very stable	[-4;-7]	Very stable
10	[1;1.49]	Sustainable	[1;1.49]	Sustainable	[-1;-3]	Sustainable
9	[0.5;0.99]	Quite balanced	[0.5;0.99]	Quite balanced	[-0.01;-0.99]	Quite balanced
8	[0;0.49]	Effective	[0;0.49]	Equilibrium	[0;0.49]	Equilibrium
7	[-0.01;-0.99]	Inefficient	[-0.01;-0.99]	Weak	[0.5;0.99]	Weak
6	[-1;-2]	Noticeably ineffective	[-1;-2]	Very weak	[1;2]	Very weak
5	[-3;-5]	Moderately ineffective	[-3;-5]	Noticeable scarce	[3;4]	Noticeable scarce
4	[-6;-10]	Highly inefficient	[-6;-10]	Moderate deficit	[5;8]	Moderate deficit
3	[-11;-15]	Extremely inefficient	[-11;-15]	High deficit	[9;15]	High deficit
2	[-16;-25]	Position close to bankruptcy	[-16;-25]	Unstable	[16;25]	Unstable
1	[-26;-∞]	Position very close to bankruptcy	[-26;-∞]	Very unstable	[26;+∞]	Very unstable

Source: Prepared by the authors.

In Table 2, level No. 15 is the best performance score and level No. 1 is the worst

The formulae used to determine the score for each performance indicator are as follows:

$$\text{WINF\_R} = \left(\frac{\text{INF\_R}}{\text{INF\_R}_{max}}\right)^2 \quad (1)$$

$$\text{WGD\_GDP} = \left(\frac{\text{GD\_GDP}}{\text{GD\_GDP}_{max}}\right)^2 \quad (2)$$

$$\text{WGB\_GDP} = \left(\frac{\text{GB\_GDP}}{\text{GB\_GDP}_{max}}\right)^2 \quad (3)$$

$$\text{WG\_ROI} = \left(\frac{\text{G\_ROI}}{G\_ROI_{max}}\right)^2 \quad (4)$$

$$\text{WPOB\_GDP} = \left(\frac{\text{POB\_GDP}}{\text{POB\_GDP}_{max}}\right)^2 \quad (5)$$

$$\text{WRUB\_USD} = \left(\frac{\text{GRUB\_USD}}{\text{GRUB\_USD}_{max}}\right)^2 \quad (6)$$

Where:

WINF_R: Country's weighted index for inflation rate %

WGD_GDP: Country's weighted index for general government debt as a proportion of GDP (%)

WGB_GDP: Country's weighted index deficits and surpluses as determined by the government budget balance as a proportion of GDP (%)

WG_ROI: Country's weighted index return on assets (%)

WBOP_GDP: Country's weighted index for deficits and surpluses in the balance of payments as a proportion of GDP (%)

WGRUB_USD: Country's weighted index for the annual growth of the Russian ruble to USD rate (%)

INF_R: Country's actual inflation rate (%)

GD_GDP: actual general government debt as a proportion of GDP (%)

GB_GDP: actual deficits and surpluses in the government budget balance as a proportion of GDP (%)

G_ROI: actual return on assets (%)

BOP_GDP: actual deficits and surpluses in the balance of payments as a proportion of GDP (%)

GRUB_USD: Country's weighted index for growth of the Russian ruble to USD rate (%)

INF_R_{max}, GD_GDP_{max}, GB_GDP_{max}, G_ROI_{max}; $POB\_GDP_{max;}$ RUB_USD_{max}: The critical indicators in Level No. 15 are shown in Tables 1 and 2.

Thus the indexes: WINF_R; WGD_GDP; WGB_GDP; WG_ROI; WPOB_GDP; WGRUB_USD must be within the range∈ [0.01 – 1]; where 1 is the best, and 0.01 is the worst performance indicator

By multiplying together the financial indicators and applying the multivariate comparative analysis method, we get the assumed financial stability index (LF_STAB) for the country as follows

$$\text{LF\_STAB} = \sqrt[6]{\left(\frac{\text{INF\_R}}{\text{INF\_R}_{max}}\right)^2 * \left(\frac{\text{GD\_GDP}}{\text{GD\_GDP}_{max}}\right)^2 * \left(\frac{\text{GB\_GDP}}{\text{GB\_GDP}_{max}}\right)^2 * \left(\frac{\text{G\_ROI}}{\text{G\_ROI}_{max}}\right)^2 * \left(\frac{POB\_GDP}{\text{POB\_GDP}_{max}}\right)^2 * \left(\frac{\text{GRUB\_USD}}{\text{GRUB\_USD}_{max}}\right)^2} \quad (7)$$

$$\text{LF\_STAB} = \sqrt[6]{(WINF\_R)^2 * (WGD\_GDP)^2 * (WGB\_GDP)^2 * (WG\_ROI)^2 * (WPOB\_GDP)^2 * (WGRUB\_USD)^2} \quad (8)$$

The output of the Financial Stability Index calculation must be within the range LF_STAB ∈ [0 – 1].

In this way, we can impose levels of financial stability of the state based on the results of the multiplication of the previous financial indicators, as shown in Table 3.

Table 3. Critical levels of financial stability and their interpretation

Level	Weak	Noticeable	Moderate	High	Very high
Interpretation	$\int \leq 0.01 - 0.2$	$\int \in [0.2,0.4]$	$\int \in [0.4- 0.6]$	$\int \in [0.6 - 0.8]$	$\int \in [0.8 - 1]$

Source: Prepared by the authors

Moreover, the level of financial stability of the country is determined in the range from 0.01 to 1. The higher this indicator, the more stable the sovereignty of the state. 0.01 represents the worst possible financial stability score.

4. Empirical Analysis and Results

Based on the calculation of elevated macroeconomic indicators using the above models, we obtain the results shown in Table 4, below.

Table 4. Weighted indexes for the financial stability of the Russian Federation in the period 2010-2022

Year	WINF_R	WGD_GDP	WGB_GDP	WG_ROI	WBOP_GDP	WRUB_USD	LF_STAB
2010	0.54	0.54	0.22	0.54	0.75	0.54	0.49
2011	0.64	0.54	0.64	0.64	0.75	0.54	0.62
2012	0.64	0.54	0.54	0.64	0.64	0.07	0.42
2013	0.64	0.54	0.22	0.54	0.44	0.11	0.35
2014	0.36	0.44	0.11	0.36	0.64	0.02	0.20
2015	0.36	0.36	0.16	0.28	0.75	0.00	0.16
2016	0.64	0.36	0.11	0.44	0.54	0.04	0.25
2017	0.87	0.28	0.22	0.44	0.64	0.64	0.46
2018	0.75	0.28	0.64	0.54	0.75	0.07	0.40
2019	0.75	0.28	0.64	0.54	0.64	0.11	0.42
2020	0.75	0.22	0.44	0.54	0.64	0.04	0.32
2021	0.54	0.22	0.44	0.44	0.75	0.11	0.35
2022	0.75	0.22	0.44	0.44	0.75	0.54	0.49

Source: Prepared by the authors

In theory, the linear relationship between variables is demonstrated using the least square method. Using this method to study the relationships between financial indicators and the financial stability index (LF_STAB) in the Russian Federation in the short and long terms we obtain this equation:

$$LF\_STAB = 0.176224 - 0.125622 * EINF\_R - 0.045247 * EGD\_GDP + 0.261041 * EGB\_GDP + 0.442407 * EG\_ROI - 0.155195 * EBOP\_GDP + 0.407526 * EGRUB\_USD \quad (9)$$

Table 5 shows the output data of the mathematical model calculated using Eviews 12.

Table 5. Output data of the linear mathematical model

Coefficients	Parameters	Std. Error	t-Stat.	P-value
C	0.176224	0.114438	1.539908	0.1745
WINF_R	-0.125622	0.094302	-1.332129	0.2312
WGD_GDP	-0.045247	0.094107	-0.480805	0.6477
WGB_GDP	0.261041	0.055392	4.712591	0.0033
WG_ROI	0.442407	0.132195	3.346620	0.0155
WBOP_GDP	-0.155195	0.105687	-1.468436	0.1924
WRUB_USD	0.407526	0.038073	10.70377	0.0000
R^2	0.992783	Mean dep. VAR		0.379231
Adj. R^2	0.985566	S.D. dep. VAR		0.127440
Std. Error	0.015311	AIC		-5.216748
Obs.	0.001407	SIC		-4.912545
F	40.90886	HQC		-5.279276
Significance F	137.5582	DW stat.		2.787374

Source: Prepared by the authors.

According to the data in Table 5, the relationship between financial variables and the financial stability index of the Russian Federation is very close to linear. One common method to improve the linearity of the mathematical model is to convert the model into logarithmic form (J.G. MacKinnon and L. Magee, 1990, A. Al Humssi, M. Petrovskaya and M. Abueva, 2023), as shown in the following model:

$$LF\_STAB = \beta0 + \beta1 * WINF\_R + \beta2 * WGD\_GDP + \beta3 * WGB\_GDP + \beta4 * WG\_ROI + \beta5 * WBOP\_GDP + \beta6 * WGRUB\_USD \quad (10)$$

$$\rightarrow$$

$$Log(LF\_STAB) = \beta0 + \beta1 * log(WINF\_R) + \beta2 * log(WGD\_GDP) + \beta3 * log(WGB\_GDP) + \beta4 * log(WG\_ROI) + \beta5 * log(WBOP\_GDP) + \beta6 * log(WGRUB\_USD) \quad (11)$$

After transforming the mathematical model into a logarithmic form, we get the results in Table 6.

Table 6. Output data linear mathematical model in logarithmic form

Coefficients	Parameters	Std. Error	t-Stat.	P-value
C	0.032276	0.046488	0.694291	0.5135
LOG(WINF_R)	0.122079	0.057160	2.435752	0.0466
LOG(WGD_GDP)	0.065015	0.033350	2.494947	0.0491
LOG(WGB_GDP)	0.122858	0.020005	6.141390	0.0009
LOG(WG_ROI)	0.453911	0.069600	6.521757	0.0006
LOG(WBOP_GDP)	0.155025	0.062949	2.462710	0.0489
LOG(WGRUB_USD)	0.175186	0.007170	24.43370	0.0000
R^2	0.998588	Mean dep. VAR		-1.030765
Adj. R^2	0.997177	S.D. dep. VAR		0.382402
S.E. of regress.	0.020318	AIC		-4.650897
SSR	0.002477	SIC		-4.346694
Log-likelihood	37.23083	HQC		-4.713425
F-stat.	707.4561	DW stat.		2.638414
Prob.(F-stat.)	0.000000			

Source: Prepared by the authors

We notice that the linearity of the model has improved significantly, as shown in the following model:

*Log(LF_STAB) = 0.032275966 + 0.122079005*log(WINF_R) + 0.0650150*log(WGD_GDP) + 0.1228580*log(WGB_GDP) + 0.4539113*log(WG_ROI) + 0.1550248*log(WBOP_GDP)+ 0.175185976652*log(WGRUB_USD)* (12)

The main problem with this model is that it is not suitable for long-term forecasting purposes, so we will have to apply some additional tests to it. The starting point is the stationarity model, applied to the time series of variables. One of the methods used to detect the unit root is the Augmented Dickey-Fuller (1979) model, which takes the following form (9):

$$\Delta Y_t = \delta_0 + \delta_1 Y_{t-1_t} + \delta_2 T + \sum_{i=1}^{m} \Delta Y_{t-1} + u_t \quad (13)$$

Where t – time index; δ_0 – constant; $\delta_2 T$- linear time trend coefficient; Y_t the time trend;δ_1 – a-1, a Δ— first-order difference operator $\Delta y_t = y_t - y_{t-1;}$ m — order of the first order autoregressive process; u_t error.

Using ADF methodology, we get the results shown in Table 7, in which S stands for stationary and N stands for nonstationary.

Table 7. Output of the stationarity test using the ADF approach

	WINF_R	WGD_GDP	WGB_GDP	WG_ROI	WBOP_GDP	WRUB_USD	LF_STAB
Level 0	N	N	N	S	S	N	N
Difference 1st	S	S	S	S	S	S	S
Difference 2d	N	S	S	S	S	S	S
Reuslt ADF test Stationary in	1st	1st ;2d	1st ;2nd	0;1st ;2nd	0;1st ;2nd	1st ;2nd	1st ;2nd

Source: Prepared by the authors.

Using the Engle and Granger approach for cointegration, in Table 7 it was found that the time series of the variables are stable and of the same degree at the first difference, with a probability (P-value) of 5-10%.

The next step is to check the stationarity of the residuals of the model. To find the unit root of the test (i.e. to test the stationarity) of the residuals of the model, we used the ADF test (Table 8).

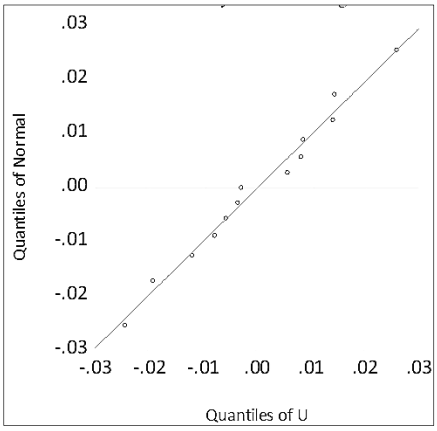
Table 8. Output of stationarity test using the ADF approach

Null Hypothesis:	Time-series of model residuals has a unit root (Lag Length 0)		
Test critical values:	1% level	5% level	10% level
	-4.121990	-3.14492	-2.71375
t-Statistic	-4.868160	-	-
Probability	Critical P-value < 5 %	Actual P-value 0.31 %	
Result	Reject the null hypothesis		

Source: Prepared by the authors.

It is clear from Table 8 that the time series of the residuals are stable at level 0, and this is confirmed by the graph in Figure 1, which shows that the residuals are normally distributed.

Figure 1. Scatterplot graph for log-transformed Model Log(LF_STAB$_t$)



Source: Prepared by the authors.

We thus adjust the equation for the long-term mathematical model as follows:

$$[Log(LF\_STAB_t) - Log(LF\_STAB_{t-1})] = 0.0147186642438 + 0.132339077913*[Log(WINF\_R_t) - Log(WINF\_R_{t-1})] + 0.217146284739*[Log(WGD\_GDP_t) - Log(WGD\_GDP_{t-1})] + 0.098977440478*[Log(WGB\_GDP_t) - Log(WGB\_GDP_{t-1})] + 0.499929407611*[Log(WG\_ROI_t) - Log(WG\_ROI_{t-1})] + 0.2659181487*[Log(WBOP\_GDP_t) - Log(WBOP\_GDP_{t-1})] + 0.175255881767*[Log(WRUB\_USD_t) - Log(WRUB\_USD_{t-1})] - 0.0618976157839*U(-1) \quad (14)$$

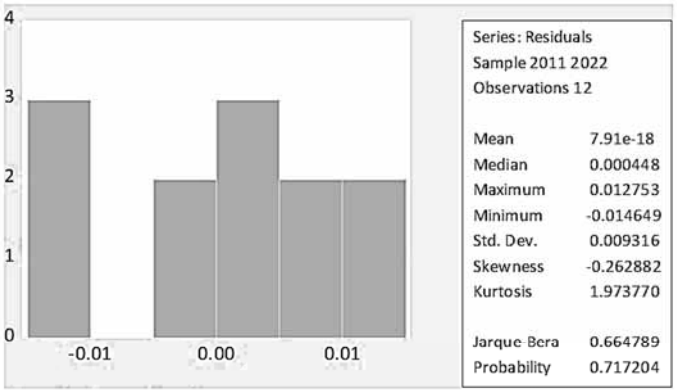
The outputs of the log-transformed Model for the long term are shown in Table 9.

Table 9. Outputs of the log-transformed Model (ECM model)

Coefficients	Parameters	Std. Error	t-Stat.	P-value
C	0.014719	0.008900	3.653786	0.04735
D(LOG(X1))	0.132339	0.043662	3.030976	0.0387
D(LOG(X2))	0.217146	0.084701	3.036367	0.0424
D(LOG(X3))	0.098977	0.015436	6.411955	0.0030
D(LOG(X4))	0.499929	0.056421	8.860757	0.0009
D(LOG(X5))	0.265918	0.062578	4.249355	0.0132
D(LOG(X6))	0.175256	0.004947	35.42660	0.0000
U(-1)	-0.0618976	0.594570	-3.041049	0.03566
R^2	0.999314	Mean dep. VAR		1.85E-17
Adj. R^2	0.998113	S.D. dep. VAR		0.355649
S.E. of regress.	0.015448	AIC		-5.267935
SSR	0.000955	SIC		-4.944664
Log-likelihood	39.60761	HQC		-5.387621
F-stat.	832.3158	DW stat.		1.795992
Prob.(F-stat.)	0.000004			

Source: Prepared by the authors.

In order to test for heteroskedasticity we applied a log-transformed model. In this research, we used the Breusch-Pagan-Godfrey (1979) Harvey (1976) and ARCH (Engle, R. F.,1982) tests, as shown in Figure 2.

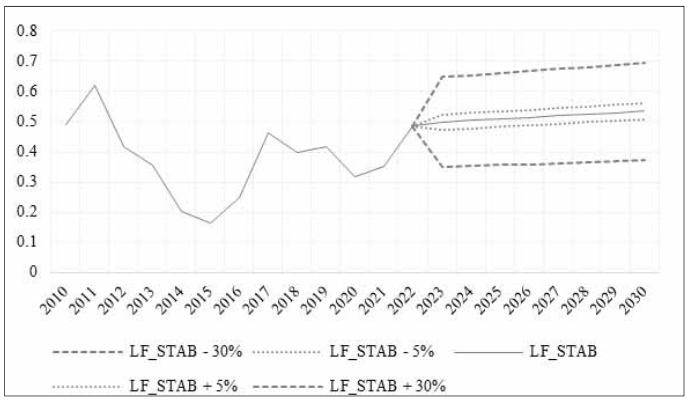


Heteroskedasticity Test: Harvey			
F-statistic	0.735375	Prob. F(7,4)	0.6617
Obs*R-squared	6.752736	Prob. Chi-Square(7)	0.4551
Scaled explained SS	25.90114	Prob. Chi-Square(7)	0.0005
Heteroskedasticity Test: ARCH			
F-statistic	0.462040	Prob. F(1,9)	0.5138
Obs*R-squared	0.537140	Prob. Chi-Square(1)	0.4636
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.609950	Prob. F(7,4)	0.3380
Obs*R-squared	8.856510	Prob. Chi-Square(7)	0.2631
Scaled explained SS	0.479122	Prob. Chi-Square(7)	0.9995

Source: Prepared by the authors.

Applying the Harvey and ARCH tests, we concluded that no heterogeneity was present in the log-transformed Model. We can therefore use this model in order to forecast the financial stability of the Russian Federation in the short and long term. Assuming the continuation of the current conditions affecting the development of the Russian economy, including COVID-19, military conflict in the Middle East and North Africa (Chaplyuk, Akhmedov, Zeitoun, Al Humssi, 2023; Chaplyuk, Alam, Abueva, Hossain, Al Humssi, 2021), and the special operation in Ukraine, etc., the level of financial stability of the Russian Federation will be within the range [0.50 – 0.53] as shown in figure 3. This means that in the near future, the financial stability of the Russian Federation will be at an average level.

Figure 3. Forecast of the index of financial stability of the Russian Federation for the period 2023-2030



Source: Prepared by the authors.

Based on the above calculations, we can conclude that if the Russian economy can continue to maintain an annual growth rate of 1%, then the indicator of financial stability will be stable and secure.

If we take into account the current events in the Eastern European region, the Middle East and the African continent, these factors may negatively affect the financial stability of the Russian Federation in the coming period, as shown in Figure 3 (the hypothetical case LF_STAB – 30%). The development of a set of economic measures aimed at the formation of an effective socio-economic policy is the main prerequisite for ensuring the long-term financial stability of the country.

5. Discussion of Results

Analyzing data on the financial stability of the Russian Federation in the period 2010-2022, we can see that it is dependent on many internal and external factors. The internal variables include the volume of government spending and revenues, fluctuations in the exchange rate of the national currency, and the policy adopted to tackle inflation, while the external ones include the global financial crisis, sharp fluctuations in global energy prices, COVID-19, and economic sanctions.

By applying the model established in this research (the ECM), it can be seen that achieving financial and economic stability as a whole in the Russian Federation depends mainly on achieving stability in all macroeconomic areas, such as budget policy, taxes, investment, foreign trade, price inflation rate, indebtedness, the credit and banking system, financial circulation, cash supply, stock markets and insurance and exchange rates.

The ECM demonstrates that there is a linear relationship between anti-inflation policy and financial stability, and thus whenever decision-makers seek to rein in inflation to acceptable

limits, price stability in relation to goods and services in the domestic market will positively affect financial stability.

The ECM also explains the impact of government borrowing policy on financial security. This is a positive correlation, as a decrease in government loans will alleviate the burden resulting from loans and thus from fulfilling obligations to lenders, whether domestic or international. In other words, the decision-makers' efforts to reduce debt to a minimum level will create an incentive for the state to find alternative sources of income, such as stimulating investment and production activities and attracting foreign direct investments.

According to the ECM, government budget policy plays an important role in ensuring the financial security of the state through rational reduction of government spending and the increasing and diversifying of sources of income.

The ECM also demonstrates that the banking and borrowing policy of the Central Bank and other banks operating in the country plays a vital role in ensuring not only financial stability but also economic stability in the country, and the maintenance of a balance between money supply and money demand will lead enable the country to achieve sustainable financial stability and secure the financing needed for its economic activities.

The ECM shows that the relationship between the growth of a surplus in the balance of payments and financial stability needs to be coordinated. This is explained by the fact that conducting an effective foreign trade policy by increasing exports, compensating for imports and attracting foreign investments will enable Russia to avoid an imbalance in the balance of payments and thus achieve financial stability.

The ECM also shows if the Russian ruble exchange rates were stable it would have this effect on the financial stability of the country, as it would help to maintain continuity in financing imports, fighting inflation, and attracting investments, and this, in turn, would lead to achieving financial and economic security for the Russian Federation in general.

The optimal use and coordination of these tools may be sufficient to mitigate the negative effects of the current economic sanctions and are within the capabilities currently available to the Russian Federation.

Limitations of using the model

The model discussed here (the ECM) may help decision-makers in the Russian Federation to make short- and long-term future economic plans related to Russia's financial and economic security in the period up to 2030.

The model was created based on open-access data available to the authors during the study period, which may differ from the actual data, and the authors were unable to access the actual data fully, and this may affect expectations of future results of using the model.

6. Conclusion

The purpose of the study was to model and predict the impact of macroeconomic indicators on the financial stability of Russia. These indicators include the inflation rate (%), government debt as a proportion of GDP, the state budget as a proportion of GDP (%), return on bank assets, the balance of payments as a proportion of GDP (%), the rate of the national currency (RUB) as against the US dollar in the period 2010-2022. The ADF, OLS, ARDL and Granger analysis were used.

Analyzing the financial stability status of the Russian Federation in the period 2010 – 2022, we can conclude that it is dependent on many internal and external factors. The internal variables include the volume of government spending and revenues, fluctuations in the exchange rate of the national currency, and the policy adopted to tackle inflation, while the external ones include the global financial crisis, sharp fluctuations in global energy prices, COVID-19, and economic sanctions.

Our research shows that assuming the continuation of the current conditions of the Russian economy, the level of financial stability of the Russian Federation will be within the range of 0.50 – 0.53 in the period 2023 – 2030. This means that in the near future, the financial stability of the Russian Federation will be at an average level. Thus, it can be concluded that if the Russian Federation is able to maintain an annual growth rate of 1%, this will have a positive impact on the level of financial stability of Russia, and ensure economic stability.

Achieving financial and economic stability as a whole depends on achieving stability in all areas of the economy, such as budgetary policy, tax, investment, inflationary price, currency, the credit and banking system, financial and monetary circulation, and the stock and insurance markets. The use of these instruments will ensure that the sanctions that Western countries have placed so much faith in will not be able to significantly affect the financial stability of the Russian economy.

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