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Security of the Money Supply with Gold and Foreign Exchange Reserves as a Leading Indicator of the Ruble Exchange Rate

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ABSTRACT

The purpose of the study is to determine of the influence of the Russian money supply provision with gold and foreign exchange reserves (GFR) on the exchange rate of the Russian ruble in dynamics and to form of approaches to the practical application of the results. **The objectives** of the study are: theoretical substantiation of the form of connection between the money supply of GFR and the national currency exchange rate; analysis of the relationship of these indicators according to the data of the Russian economy for 27 years at the 1994–2022; reinforcement of theoretical claims with data from empirical analysis; formation of methodological foundations and determination of directions for the practical application of the results obtained. **The research methodology** is based on graphical data analysis. The **results** of this analysis identified the presence of time lags in the reaction of the ruble exchange rate to the dynamics of the provision the Russian money supply with GFR; determine the specific value of the ratio of the volume of GFR and the money supply as a boundary, at which the national currency trend will be observed. Based on the results obtained, **it was concluded** that it is possible and necessary to use the relationship of the analyzed indicators not only as a leading indicator of the dynamics of the ruble exchange rate, but also as an active tool to manage the exchange rate of the national currency in a way that normalizes economic activity.

Keywords: ruble exchange rate; gold and foreign exchange reserves; dollar exchange rate; devaluation; monetary policy; money supply; exchange rate; monetary aggregates; monetary policy

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INTRODUCTION

Foreign sanctions have created an unusual situation in the world, Russian economy and Russian currency market, which is the result of political conditions, artificial restrictions, severing trade links, and rising inflation in a relatively short period of time. Historical experience shows that such world economic anomalies are temporary. The guarantee of this — is their scale. Regardless of the duration of their effect, the situation normalizes when it returns to its pre-anomaly state.

The Russian economy and its foreign exchange market are no exception. The importance of the Russian economy for the world community shows that future normalization of economic relations is inevitable. This means that the Russian currency will be increasingly influenced by market factors. This will require the use of indicators that will allow economic agents to plan their activities, including those related to the dynamics of the ruble.

Passive acceptance that things are back to normal is insufficient. Active acceptance of the situation implies preparation for successful activity of economic agents in the realities of the future — "play ahead of the curve". One of the components of this game — is the search and application of leading indicators of the ruble exchange rate, as the dynamics of the exchange rate is one of the most important factors affecting the economic and, consequently, social situation in the country.

Dynamics of ruble exchange rate to major world currencies is important for Russian exporters, consumers of both imported products and domestic ones containing imported components. In normalized economic relations, it is important for investors to plan their investments. The predictability of the ruble reduces investors' risks, adding stability —

one of the incentives to increase investments that create new jobs generating tax payments.

For a wide group of economic actors, if not the most accurate forecast of fluctuations of the ruble exchange rate (which, as practice shows, is extremely difficult to implement), the forecast of the trend of this rate for the near future is necessary. This raises the issue of the selection and application of an exchange rate indicator that has not only the property of leading change in relation to the change in the exchange rate of the ruble, but also the properties of comprehensibility of the logic of its formation to a broad mass of users, simplicity, and speed of calculation.

There is no requirement to accurately determine the short-term exchange rate of this indicator. It is not about its use in speculative exchange trading. Here it refers to the indicator that determines the turning points of the exchange rate.

The issue arises as to the practical application of such an indicator, since in the modern economy there is a wide range of indicators used to predict the change in the exchange rate. To this end, consider the features of the existing approaches to the study.

REVIEW OF STUDIES

First of all, exclude from the review mathematical models and algorithms for forecasting the exchange rate applied exchange trading robots. The reason — is that these algorithms focus on determining the short-term dynamics of the exchange rate [1]. And also — most economic subjects are unfamiliar with forex-trade programming and intricacies, which leads to a lack of comprehension of their work.

Similar situation with Elliott wave models [2]. Even the great experience of their use in the Forex market does not always allow us to understand: whether the current depreciation is the beginning of the second wave or it is a decline within the continuing first wave. As a result, a significant proportion of analysts interpret these waves after the fact or use neural networks [3], which makes such models for the most part a stock trading tool, understandable to narrow professionals.

Analysis of the dynamics of the ruble exchange rate based on the balance of payments data of the Russian Federation [4] was distributed, which is extremely relevant in the current economic conditions of Russia. But, as indicated above, the global scale of the problems is indicative of their abnormality. Consequently, and the ratio of export and import volumes as the main indicator of the dynamics of the ruble exchange rate has application within this abnormality. When normalizing the situation in the currency market, the dynamics of international financial flows is probably not an indicator of changes in the exchange rate, but one of the components of such a broader indicator.

Forming an indicator, actively use factor and structural analysis methodologies to identify the influence of the country's economic policies on the national currency [5]. Regression analysis is widely used, for example, to assess the impact of changes in monetary policy on the value of the ruble [6]. However, describing the technique of obtaining a result in such models to their prospective ordinary user will be difficult and will not be suitable to a large variety of individuals. In addition, each study considers the dependence of the exchange rate on a narrow factor.

Foreign authors also pay special attention to variables that influence exchange rate movements. Determine the positive link of the real exchange rate to the level of net foreign assets [7], the influence of government expenditures on the national currency exchange rate through their impact on the dynamics of consumer spending [8]. Dependence of the exchange rate on the monetary model [9], impact on the exchange rate structure of the economy through Balassa-Samuelson effect is modeled [10]. Note also a number of classical papers, which examine the correlation between the exchange rate and the terms of trade [11], justify the overvaluation

of the role of the current account in the formation of the exchange rate, determine the impact of capital mobility on the dynamics of the currency [13] and — the exchange rate's relationship to the country's monetary and fiscal policy [14]. Portfolio analysis techniques are actively used in the paper [15]. The authors investigate the crisis exposure of nations with various currency systems in the paper [16].

But most of these and similar papers consider not indicators, but factors that influence the exchange rate. Similar approach and in the papers of foreign researchers researching the dynamics of the ruble exchange rate [17]. Little is known regarding the influence of the budget rule on world exchange rates. The paper provides a thorough understanding of this impact [18]. It is not comprehensive, but it does suggest the disadvantages inherent in an indicator from the point of view of its wide application by persons far from currency pricing. For its implementation in normalizing economic situations, a simple, and to some extent understandable, leading indicator of exchange rate trend dynamics is required. Such as the money supply of the country gold and foreign exchange reserves. The idea of calculating it is based on the hypothesis of the dependence of the exchange rate on the resources available to the national banking system [19].

THEORETICAL ANALYSIS

Dependence of ruble exchange rate on gold and foreign exchange reserves is obvious and does not need proof. Since it is the volume of reserves that allows the Central Bank in the absence of abnormal conditions to conduct foreign exchange interventions to support the ruble exchange rate. However, rather than condemning the preceding set of indicators for their lack of openness for the general public, explain the basic logic of the chosen indication.

Let just two currencies to be used in the national economy — Russian ruble (*RUB*) and world reserve — (*WR*). For the analyzed period, the value of the national currency in the national economy is 200 rubles. National currency to world reserve exchange rate is 1 *RUB:* 1 *WR*. The Bank of Russia's task — is to keep this rate on par.

Let in the vaults of the Bank of Russia is 160 *WR*. Thus, the national currency has a world reserve of less than 100%:

$$\frac{160WR}{200RUB}\times 100\% = 80\%.$$

Suppose the situation in the national economy deteriorated and its natural and legal entities increased demand for the world reserve currency. To stabilize the exchange rate, the Bank of Russia is forced to use the world reserve currency from its reserves in exchange for Russian rubles. Let at the original rate of 1: 1 Bank of Russia sold 20 *WR* to legal entities in exchange for 20 Russian rubles. In such a new environment, money supply in the national economy:

$$200\ RUB - 20\ RUB = 180\ RUB.$$

Bank of Russia reserves to be:

$$160\ WR - 20\ WR = 140\ WR.$$

Availability of national currency in reserve currency will decline from the original 80% to:

$$\frac{140WR}{180RUB}\times 100\% = 77,78\%.$$

Continued expansion in reserve currency demand will need more actions by the Bank of Russia, worsening the proportion of global reserve currency provisioning. If this pattern continues, the Bank of Russia will exhaust its total reserve currency intervention, at which point it will lose its power over the exchange rate.

Consequently, under conditions of incomplete provision of the country's money supply with foreign currency reserves, it is possible to support the stable exchange rate of the ruble through the implementation of

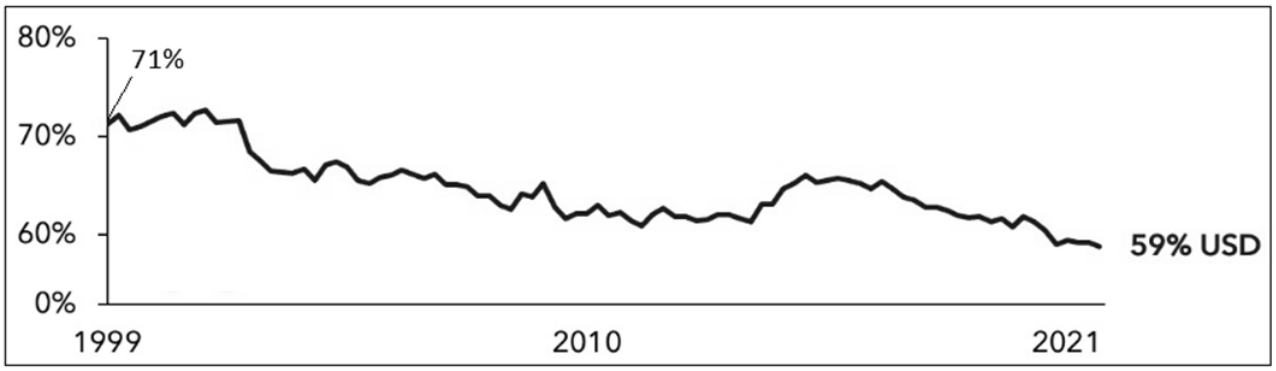

Fig. 1. **The Share of the US Dollar in the Reserves of the Central Banks of the World**
Source: Compiled by the author according to [20].

currency interventions by the Bank of Russia, but in the short or medium term, when the economic situation in the country has deteriorated temporarily, and the dynamics of its improvement is ahead of the dynamics of exhaustion of foreign currency reserves of the Bank of Russia. If the situation deteriorates in the long term and the demand for reserve currency remains high, devaluation of the national currency as a result of such support seems inevitable.

Despite the obvious correlation of the analyzed indicators, the question arises: what percentage of the Russian Federation's gold and foreign exchange reserves in terms of convertible ruble, at which the dynamics of the ruble exchange rate change the upward trend by a decrease and vice versa? It is possible to answer by analyzing the dynamics of both the ruble and the supply of Russian money supply with gold and foreign exchange reserves in the long term.

At the same time, the volume of national money in the Russian economy will be understood "the amount of cash in circulation and fund balances of non-financial and financial (except credit) organization — residents of the Russian Federation and individuals — residents of the Russian Federation on settlement, current and other accounts on demand"[1] — monetary aggregate M2.

The division of the country's money into cash and non-cash parts is accompanied by the analysis of banks' assets and liabilities. In order to keep the convertible ruble's exchange rate steady, the Bank of Russia, which offers a world reserve currency, buys the money supply it previously produced, reducing the level of ruble assets held by banks. But the volume of ruble monetary liabilities of these banks will remain unchanged. As a result, the stability of not only the ruble but also the national banking system becomes a factor in the overall stability equation for the Bank of Russia. Stability on one of these fronts will diminish stability on the other. As a result, in an attempt to ensure the stability of the banking system of the country, saturating it with ruble liquidity, the Bank of Russia will be forced to increase the money base in the context of a reduced volume of gold and foreign exchange reserves, which is also the current situation in the direction of ruble devaluation.

The above conclusions suggest the following hypothesis: the decline in the supply of the country's money supply with its gold and foreign exchange reserves precedes the devaluation of the convertible national currency. And vice versa — the rise in this security will result in the ruble strengthening.

For practical purposes, we shall substitute the US dollar for the neutral "world reserve currency". The author recognizes and supports dedollarization tendencies, but in the global

[1] Monetary aggregates. Bank of Russia. URL: https://www.cbr.ru/statistics/macro_itm/dkfs/monetary_agg/ (accessed on 25.10.2022).

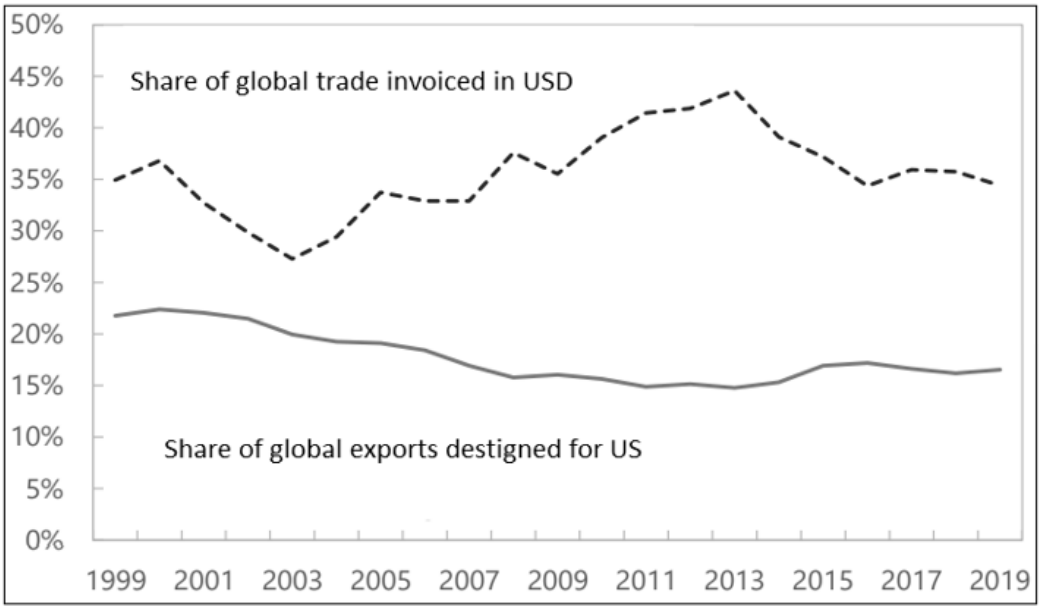

Fig. 2. **Share of the US Dollar in World Trade**

Source: Compiled by the author according to [20].

economy, two distinct patterns are forming. The US dollar is slowly but steadily losing its positions in the reserves of world central banks (*Fig. 1*). But its share in world trade has recently grown from 36.4% in 2013 to 41.1% currently (*Fig. 2*).

ANALYSIS OF THE IMPACT OF THE BANK OF RUSSIA'S GOLD AND FOREIGN EXCHANGE RATE ON THE RUBLE RATE

Based on the data of the Ministry of Finance and the Central Bank of the Russian Federation, we made calculations that allow us to determine the impact of the dynamics of the country's money supply by gold and currency reserves on the dynamics of the exchange rate of the ruble against the dollar. The calculation is as follows.

1. Compilation of statistics for the first of January of each year (1994–2022):

- gold and foreign exchange reserves of the Central Bank of the Russian Federation, mln US dollars;
- foreign currency assets of the National Welfare Fund and the Reserve Fund of the Russian Federation, mln US dollars;
- volume of monetary aggregate M2 in the economy of the Russian Federation, bln rubles;
- value of the exchange rate of the Central Bank of the Russian Federation, ruble/ US dollar.

2. Calculation of the supply of money in the economy of the Russian Federation with gold and foreign exchange reserves according to the formulas:

$$GFR' = GFR - RF, \quad (1)$$

where GFR' — adjusted gold and foreign exchange reserves of the Russian Federation, mln US dollars;

GFR — gold and foreign exchange reserves of the Russian Federation, mln US dollars;

RF — total amount of reserve fund and National Welfare Fund of the Russian Federation (NWF), mln US dollars.

Deduction of NWF and reserve fund (from 2018 — NWF volume) is necessary due to the certain non-transparency composition of these funds, resulting from their placement in low-liquid assets, as well as — insufficiency of current NWF reporting to assess the fund's performance [21].[2].

[2] Savatugin A.L. The Accounting Chamber requests that the Government rethink the terms of the NWF fund placement. Russian Federation Accounting Chamber. URL: https://ach.

$$ER = \frac{M2}{GFR'} \times 1000, \quad (2)$$

where ER — estimated exchange rate of the national currency, ruble/US dollars;

M2 — volume of monetary aggregate M2, bln rubles

$$AR = \frac{R}{ER} \times 100\%, \quad (3)$$

where AR — availability of the country's money supply with gold and foreign exchange reserves, %;

R — exchange rate, ruble/US dollars.

By means of formulas (1) — (3) we derive the calculation formula used to determine the availability of the money supply of the country by gold and foreign exchange reserves:

$$AR = \frac{GFR' \times R}{M2} \times 100\%. \quad (4)$$

3. Analysis of the dependence of the ruble exchange rate on the dynamics of the AR indicator values.

Since the value of the ruble is used to calculate the AR indicator according to formulas (3) or (4), the question arises: will AR as the leading indicator of the exchange rate dynamics be distorted by the influence of the correlation?

To address this issue, when should the exchange rate begin to respond to a change in the value of the indicator AR? No delay or a time lag? In the last case, the AR indicator will include the exchange rate for the period t, while the AR will compare the exchange rate for the period $t + i$, where i — is the value of the time lag. Will there be a correlation between these indicators? In order to obtain the answers, it is necessary to calculate the values of the indicator AR and graphical analysis of its dynamics in connection with the exchange rate dynamics, supplemented by calculation of correlation coefficients.

Original information and calculation results are shown in *Table 1*.

To determine the dependence (including its parameters) of the ruble's exchange rate against the US dollar on the supply of the Russian money supply with gold and foreign exchange reserves, we will perform a graphical analysis of the data presented in line 1 and line 2 in *Table 1*. To reduce visual load, the time period of analysis is divided into overlapping sub-periods.

Analysis of data for 1994–2000 presented at *Fig. 3*.

The analysis of the graph leads to the conclusion that the extremely low (below 37%) endowment of the money supply with international reserves led to a stable, with a significant rate of devaluation of the ruble in 1994–1998. A significant decline in money supply in 1997 and 1998 preceded the devaluation of the ruble exchange rate in 4 times in 1999 (note the similar situation 1994–1995)

Data analysis for 1999–2010 presented at *Fig. 4*.

The decline in GFR's money supply below 50% in 2000 and 2009 led to a devaluation of the ruble. In the first case, the devaluation started in 2000 and continued until 2002, while in the second case the devaluation began in 2010. The opposite situation was observed in 2006, when the growth of the money supply of GFR to 86.95% led to the strengthening of the ruble in 2007–2008.

GFR stable high money supply in 2001–2006 stabilized ruble exchange rate. Its value at the beginning of 2006 is almost equal to its value at the beginning of 2001.

Data analysis for 2010–2015 presented at *Fig. 5*.

The decline in Russia's currency reserves in 2000 below 50% led to a decrease of the ruble, which began in 2000. It continued until 2002. The situation is similar in 2009–2010.

In 2010–2012 a high percentage of Russia's money supply with gold and foreign

gov.ru/checks/schetnaya-palata-predlagaet-pravitelstvu-peresmotret-usloviya-razmeshcheniya-sredstv-fnb (accessed on 25.10.2022).

Table 1

Calculation of the Security of the Russian Money Supply with Gold and Foreign Exchange Reserves

No.	Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3), %	33.69	23.57	36.14	29.59	28.34	55.6	47.04	68.43	68.59	71.27
2	Exchange rate of the Central Bank RUB/USD	1.25	3.55	4.64	5.56	5.96	20.65	27	28.16	30.14	31.78
3	RUB/USD calculated rate (line 4 / line 5)	3.71	15.06	12.84	18.79	21.03	37.14	57.4	41.15	43.94	44.59
4	Monetary aggregate M2, bln rubles	33	98	221	288	374	454	715	1151	1609	2131
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	8894	6506	17207	15324	17784	12223	12456	27972	36622	47793
6	The volume of reserves of the Central Bank, mln USD	8894	6506	17207	15324	17784	12223	12456	27972	36622	47793
7	The volume of the NWF and the reserve fund, mln USD	0	0	0	0	0	0	0	0	0	0
No.	Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3),%	70.69	79.38	86.95	62.99	61.42	48.69	59.97	59.25	54.23	45.7
2	Exchange rate of the Central Bank RUB/USD	29.45	27.75	28.78	26.33	24.55	29.39	30.19	30.35	32.2	30.37
3	RUB/USD calculated rate (line 4 / line 5)	41.66	34.96	33.1	41.8	39.97	60.36	50.34	51.22	59.38	66.45
4	Monetary aggregate M2, bln rubles	3205	4354	6032	8971	12869	12976	15268	20012	24205	27165
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	76938	124541	182240	214601	321951	214978	303286	390677	407608	408809

Table 1 (continued)

No.	Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
6	The volume of reserves of the Central Bank, million USD	76 938	124 541	182 240	303 732	478 762	426 281	439 450	479 379	498 649	537 618
7	The volume of the NWF and the reserve fund, mln USD	0	0	0	89 131	156 811	211 303	136 164	88 702	91 041	128 809
No.	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	
1	Security of money supply with gold and foreign exchange reserves (line 2 / line 3), %	34.97	39.06	51.15	45.76	49.89	60.52	51.38	51.95	50.24	
2	Exchange rate of the Central Bank RUB/USD	32.66	56.24	72.93	60.66	57.6	69.47	61.9	73.88	74.29	
3	RUB/USD calculated rate (line 4 / line 5)	93.4	144	142.59	132.55	115.46	114.79	120.48	142.22	147.87	
4	Monetary aggregate M2, billion rubles	31 156	31 616	35 180	38 418	42 442	47 109	51 660	58 652	66 252	
5	The volume of gold and foreign exchange reserves excluding the funds of the NWF and the reserve fund, mln USD (line 6 / line 7)	333 585	219 550	246 729	289 841	367 592	410 395	428 799	412 414	448 037	
6	The volume of reserves of the Central Bank, million USD	509 595	385 460	368 399	377 741	432 742	468 495	554 359	595 774	630 627	
7	The volume of the NWF and the reserve fund, mln USD	176 010	165 910	121 670	87 900	65 150	58 100	125 560	183 360	182 590	

Source: Bank of Russia. URL: https://www.cbr.ru/statistics/macro_itm/dkfs/; Ministry of Finance of the Russian Federation. URL: https://www.minfin.ru/ru/perfomance/nationalwealthfund/ (accessed on 25.10.2022).

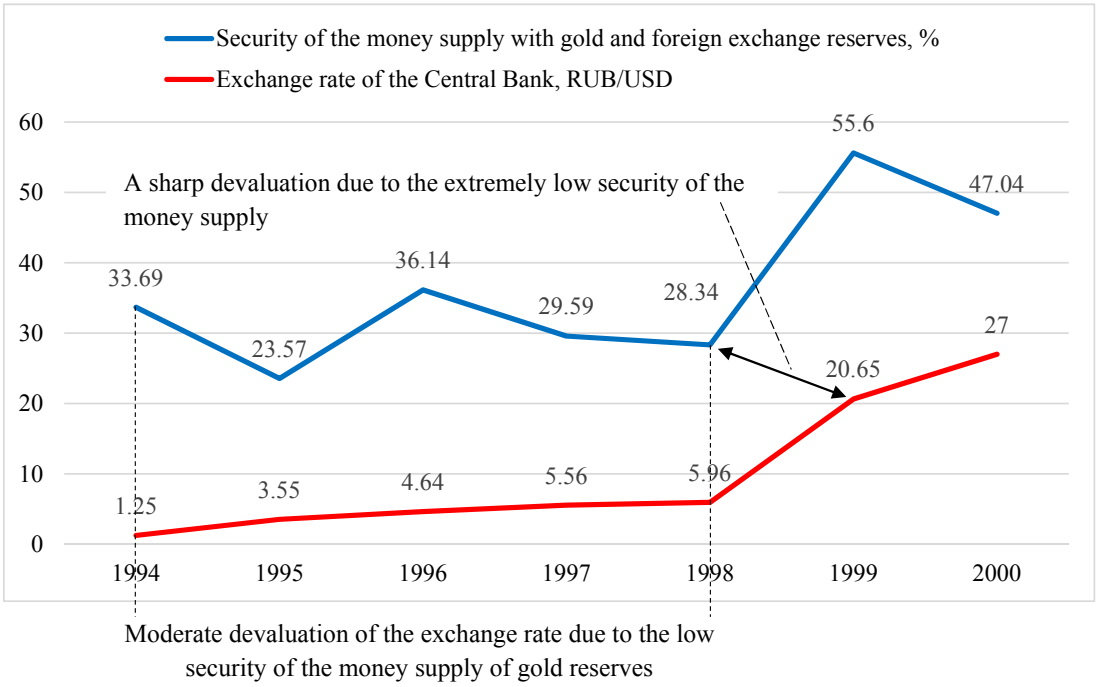

Fig. 3. **Analysis of Data for 1994–2000**

Source: Compiled by the author according to *Table 1*.

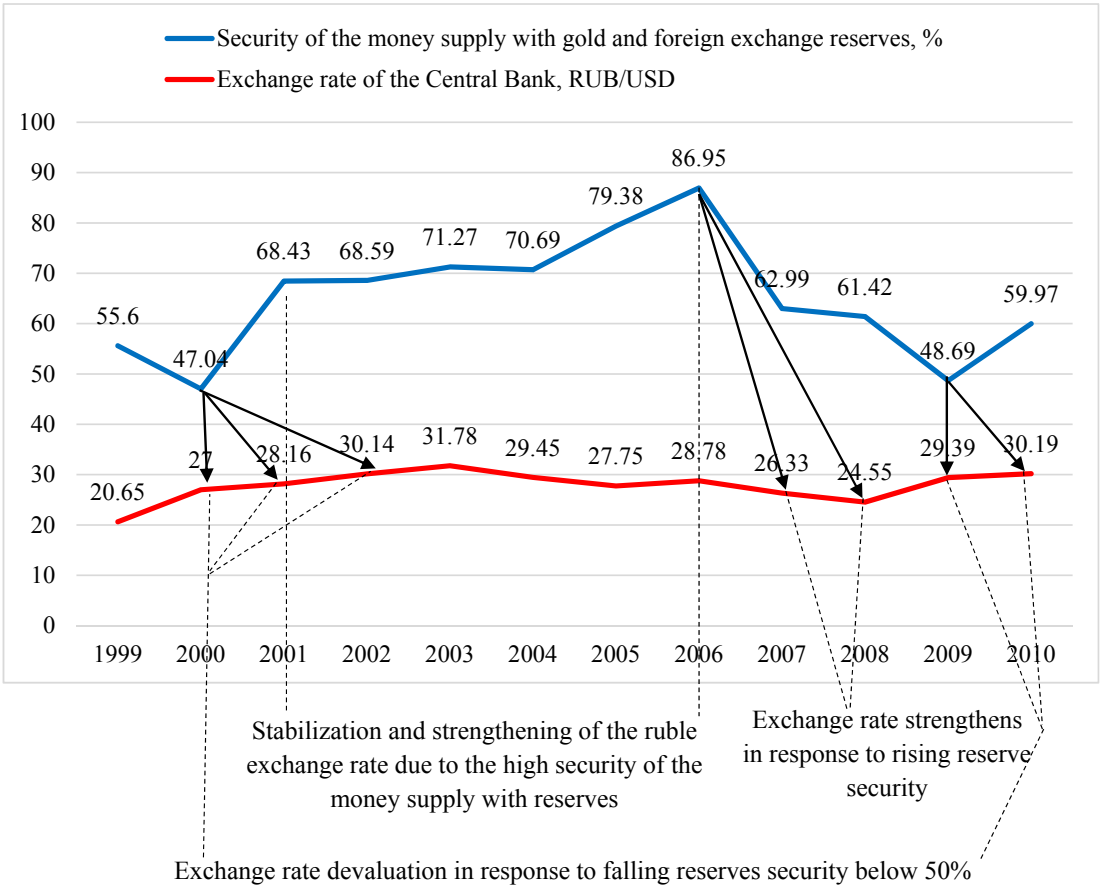

Fig. 4. **Analysis of Data for 1999–2010**

Source: Compiled by the author according to *Table 1*.

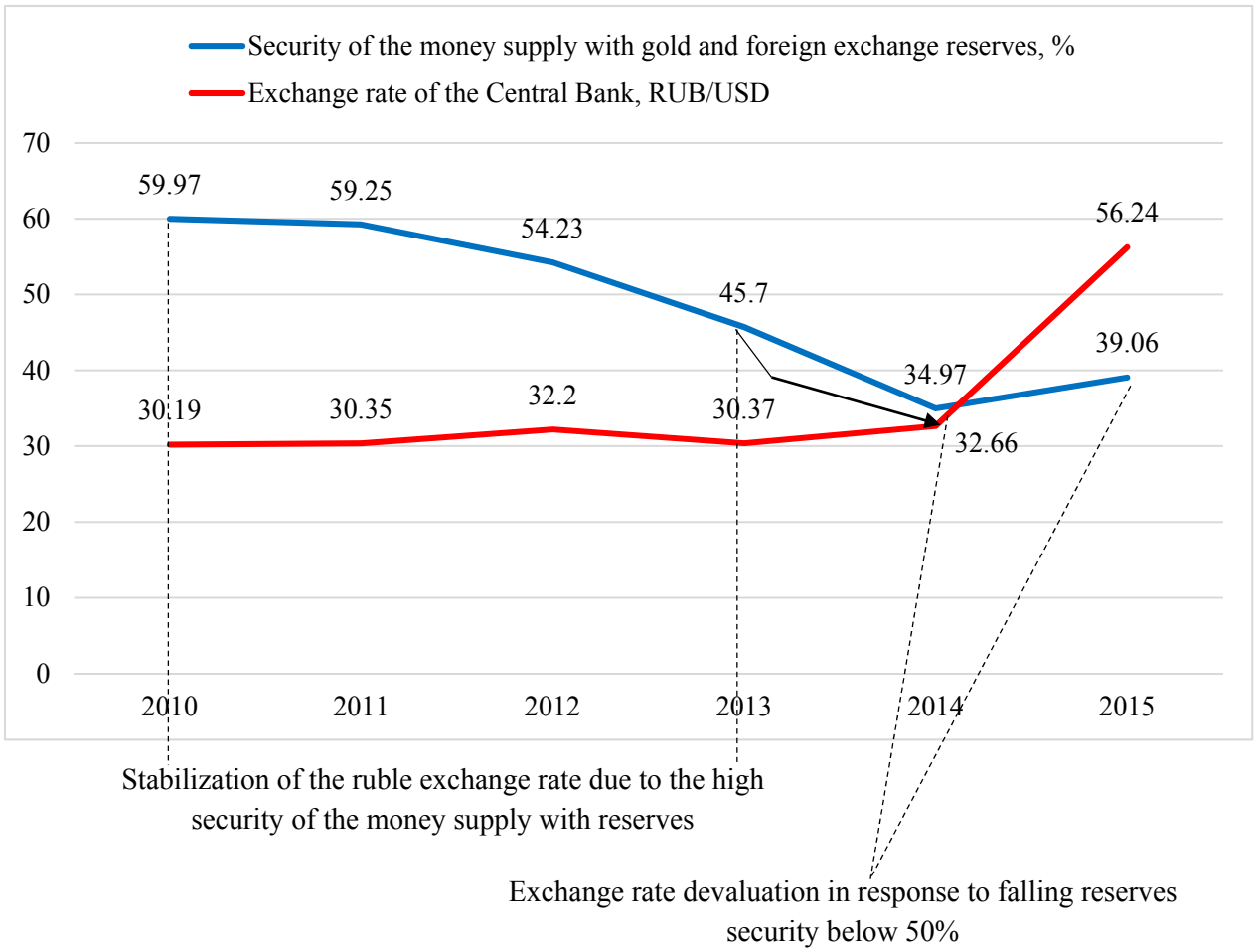

Fig. 5. **Analysis of Data for 2010–2015**

Source: Compiled by the author according to *Table 1*.

exchange reserves led to the stabilization of the ruble exchange rate in 2010–2013. At the same time, the decline in the money supply ratio below 50% in 2013 led to the devaluation of the ruble in 2014. The situation continued in 2014, when a further decline in security indicators preceded a nearly double devaluation of the ruble in 2015.

Data analysis for 2015 — early 2022 presented at *Fig. 6*.

Dynamics of analyzed values during 2015 — early 2022 illustrates the theoretical assumptions of analysis formed above. Decline in the country's money supply with gold and foreign exchange reserves below 50% in 2015, 2017 led to a sharp devaluation of the ruble. The situation was similar when the money supply was reduced to 50–51% (2016, 2020, 2021 years).

At the same time, the growth of the money supply reserves from 39.06% in 2015 to 51.15% in 2016 strengthened the exchange rate from 72.93 rubles per US dollar in 2016 to 60.66 rubles per US dollar in 2017. A similar situation was observed in 2019–2020.

The presented data of graphical analysis allow to conclude that, as a rule, the exchange rate responds to the change in the availability of the Russian money supply by gold and foreign exchange reserves (AR_t) with a time lag, usually equal to a year, less often — two years (R_{t+1}, R_{t+2}). This confirms the formed theoretical assumptions about the dynamics of the AR indicator as the leading indicator of the ruble exchange rate, but does not remove

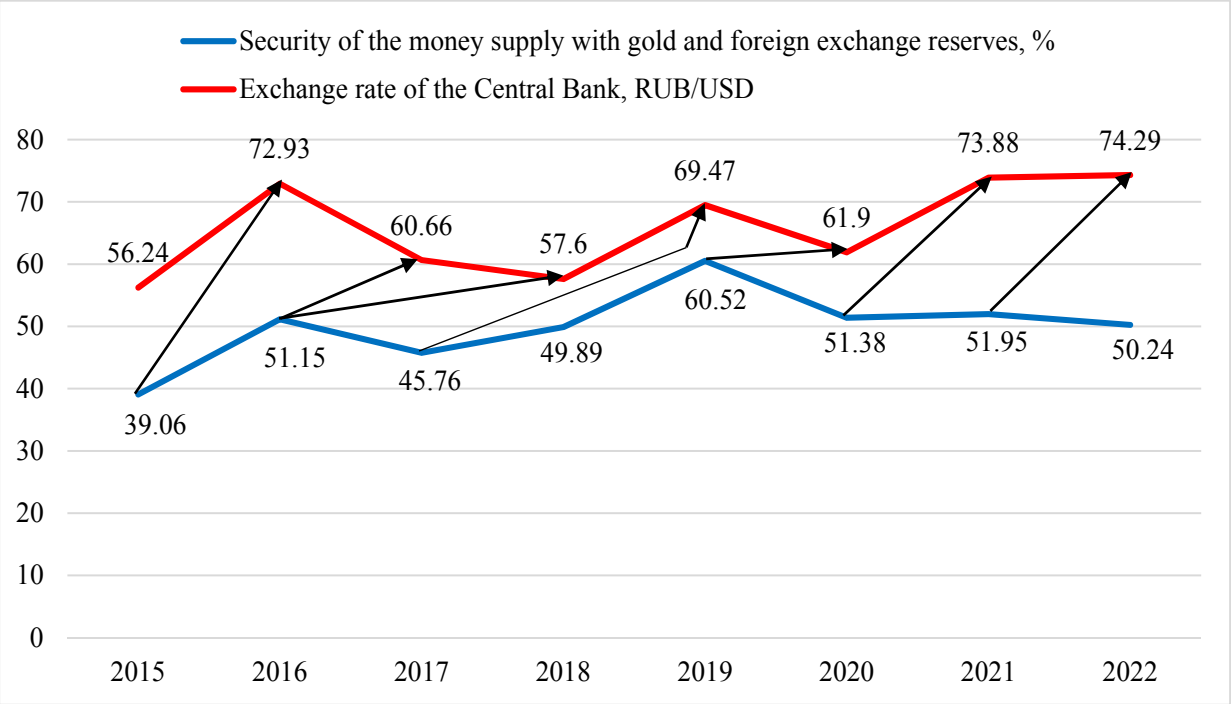

Fig. 6. **Analysis of Data for 2015 — Early 2022**

Source: compiled by the author according to *Table 1*.

the question of a possible correlation between these indicators.

Correlation coefficients between two data series from *Table 1* are analyzed to get a response: AR_t and R_{t+1}; AR_t and R_{t+2}.

The correlation ratio was 0.10377 for AR_t and R_{t+1}, for AR_t and R_{t+2} –0.00785. The acquired results answer the issue of whether there is a correlation between the investigated parameters.

In this situation, the exchange rate R_t, used in the period *t* to calculate the AR_t value, becomes a kind of technical indicator, which is necessary only for the transfer of the gold and foreign currency reserves, the reserve fund and the National Welfare Fund, in US dollars, in rubles.

The suggested method's practical application will enable the end user to foresee changes in the ruble exchange rate trend for the purpose of adjusting operational activity to reduce foreign currency risks or to earn more money in the form of exchange rate difference. And at the level of the state — for a purposeful impact on the volume of the money supply or gold and foreign exchange reserves of the country to influence the dynamics of the ruble exchange rate.

CONCLUSION

The change in the exchange rate of the ruble under conditions of its convertibility reacts to the change of the country's money supply with gold and foreign exchange reserves with some lag. It is usually the year (*Fig. 6*), but there are cases where the exchange rate response starts in the same year as the change in international reserves (2000, 2009), indicating the need for further analysis in shorter time periods (quarterly, monthly).

The decline of the country's money supply with gold and foreign exchange reserves below 50% (which allows to distinguish this value as a threshold) causes a fairly sharp devaluation of the national currency (2000, 2009, 2013, 2014, 2017 years).

Significant increase in money supply leads to a sharp strengthening of the ruble (2003–2006, 2016, 2019 years).

The persistence of the same trends over 27 years (1994–2022) indicates that the trends are not accidental, confirming the assumptions made in the theoretical part of the paper.

The scientific novelty presented by the study is that it is based on the introduction into the scientific sphere (mid-term and long-term analysis) of the method of graphical indicator analysis used in exchange trading for short-term analysis. Given that, in similar scientific publications [22, 23], graphical analysis is frequently utilized as an additional tool rather than as the primary tool. Novelty is scale of analysis — 27 years including data as of early 2022.

The results of the study are clearly implemented, allowing for the use of the quantity of Russian money supply with gold and currency reserves in the event of economic normalization:

1. As a leading indicator of the exchange rate change of the convertible ruble for investors and financiers to make decisions aimed at reducing the foreign currency risks of their activities, as well as — to obtain additional income.

2. As an active instrument in the management of the national currency.

The obtained result can be used by private and corporate investors in the Forex market (after the easing of sanctions pressure and normalization of the political and economic situation), companies whose activities involve large volumes of exports and imports, and Russian Federation authorities in the development and implementation of monetary policy as an integral part of the country's economic and foreign economic policy.

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