Analysis of the dependence of the ruble exchange rate volatility on the oil market in a pandemic

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The article attempts to analyze the degree of impact of changes in the ruble exchange rate on the oil market in the conditions of economic instability caused by the coronavirus pandemic. The statistical data for the calculation cover the time from January to May 2020. The importance of the further development of theoretical and methodological approaches to the study of the dependence of the country's economy on external shocks is substantiated. The approach described in the article is considered by the authors based on the analysis of non-stationary time series. The transformation of the post-industrial economy indicates the duality of this process, which manifested itself both in expanding opportunities for the development of the world economic system and in the emergence of new factors of its instability. The main factors complicating its development include the volatility of world prices, the growth of protectionism, the spread of trade wars, the coronavirus pandemic.

***Keywords**: world economic system, Russia, external shocks, volatility, ruble exchange rate, conjuncture, oil market, pandemic, coronavirus.*

1. Introduction

The involvement of the Russian economy in world processes a priori implies its dependence on external shocks, the most important of which are the sanctions policy, the volatility of oil prices and the coronavirus pandemic, which dramatically changed the world economic space. The projected slowdown in the global economy poses a serious threat to Russia's GDP growth rates, which are critically dependent on external factors, primarily the situation on world energy markets [1]. A negative influence is exerted on the development of foreign trade. So, even the relatively high growth rates of physical volumes of export could not compensate for the losses from the deterioration of the terms of trade [2,3].

In addition, a large-scale collapse in global financial markets generates crisis processes in the global economy. National states are again forced to urgently develop and implement anti-crisis programs [4]. An important role in these programs in Russia should be played by measures to counter external shocks aimed at strengthening the national currency and reducing losses of the state budget from lower oil prices.

The purpose of this study is to identify the dependence of changes in the ruble exchange rate on the oil market in the conditions of economic instability caused by a pandemic. The most important task facing the scientific community is to identify priority drivers for the development and functioning of the Russian economic system.

The role of the world oil market in the volatility of the ruble exchange rate is very important for development of Russia. We used hypothetical method in stating the problems and contradictions that arise in the era of a pandemic and in the sustainable economic development of Russia.

The study of the problem of the mutual influence of the ruble exchange rate and the oil market conditions in the conditions of economic instability caused by the pandemic allows to introduce adjustments to the theory of global imbalances [5,6], putting forward new requirements for rethinking established ideas. The results also contribute to the development of institutional theory.

2. Materials and methods

A lot of attention is paid to the transformation of the contours of the world economic system in modern domestic science, which is associated with global changes in the conditions of reproduction. The aggravation of the global systemic crisis, complicated by the coronovirus pandemic, necessitates the search for new forms of existence of the system of international economic relations and its sustainable development [7].

A number of researchers draw an analogy of the current crisis caused by the coronavirus epidemic with the Great Depression, which has hit the global economy on a large scale. Under these conditions, it is very important to understand how much the national currency depends on the dynamics of world energy prices [6].

This problem is particularly significant for states whose income largely depends on export prices for resources, in particular Russia [8]. It is necessary to operate not only with the absolute values of financial indicators, but also to understand the trends in the economic situation in the country. Understanding how dependent the national economy is on external conditions, on the market conditions for energy carriers, allows us to draw appropriate conclusions and make important strategic decisions in terms of sustainable economic development of its economic system.

The article discusses the dynamics of oil prices and the ruble for the period from January 13, 2020 to April 23, 2020. Table 1 shows a fragment of statistical data, and the variables introduced below will be considered in detail.

Table 1. Statistical data on oil prices and the ruble exchange rate (fragment) [9]

Date	Rub	Oil	RelRub	RelOil	RelPercRub	RelPercOil	DepRubOil
23.04.2020	77,0416	21,33	1,010299	1,047128	25,75510257	65,16641082	39,5220517
22.04.2020	76,2562	20,37	1,021302	1,053802	24,47309315	66,73416729	36,67250846
21.04.2020	74,6657	19,33	1,009759	0,755964	21,87691795	68,43257014	31,96857565
20.04.2020	73,9441	25,57	0,989723	0,910613	20,69904935	58,24215305	35,53963627
17.04.2020	74,7119	28,08	1,013531	0,985263	21,95233027	54,1431231	40,54500187
16.04.2020	73,7145	28,5	1,005449	1,017857	20,32427297	53,45722964	38,01968996
15.04.2020	73,315	28	0,997151	0,930542	19,67216861	54,27376947	36,2461808
14.04.2020	73,5245	30,09	0,996922	0,944444	20,01413573	50,86063298	39,35093717
13.04.2020	73,7515	31,86	0,98856	1,014327	20,38466812	47,97008198	42,4945451
10.04.2020	74,605	31,41	0,984886	0,980643	21,77783727	48,70496783	44,71379048
09.04.2020	75,7499	32,03	1,003908	0,95214	23,64665901	47,69245844	49,58154765
08.04.2020	75,455	33,64	0,987535	1,038272	23,16529336	45,06320018	51,40623228
07.04.2020	76,4074	32,4	0,982953	1,224953	24,7198971	47,08821896	52,49698894
30.03.2020	77,7325	26,45	0,987427	0,936283	26,88285953	56,80504295	47,32477635
27.03.2020	78,7223	28,25	1,011948	0,963835	28,49851134	53,86549956	52,90679855
26.03.2020	77,7928	29,31	0,986601	0,975374	26,9812873	52,13443512	51,75329365
25.03.2020	78,8493	30,05	0,974874	1,084446	28,7058136	50,92595617	56,36774597
24.03.2020	80,8815	27,71	1,036354	1,006904	32,02297627	54,74736258	58,49227208
23.03.2020	78,0443	27,52	0,973643	1,011393	27,39181107	55,05764771	49,75114668
20.03.2020	80,157	27,21	1,038127	0,968327	30,84037399	55,56390241	55,50433403
19.03.2020	77,2131	28,1	1,044979	1,063588	26,03504224	54,11046151	48,11461872
18.03.2020	73,8896	26,42	0,996808	0,915771	20,61008893	56,85403534	36,25088141
17.03.2020	74,1262	28,85	1,012816	0,966823	20,99629141	52,88565176	39,70130028
16.03.2020	73,1882	29,84	0,988664	0,853303	19,46519281	51,2689029	37,96686043
13.03.2020	74,0274	34,97	1,035754	1,06746	20,83502004	42,89120423	48,5764399
12.03.2020	71,472	32,76	0,99238	0,914063	16,66383734	46,50031029	35,83597022
11.03.2020	72,0208	35,84	1,066698	0,94865	17,55964429	41,47042493	42,34257141
10.03.2020	67,5175	37,78	1,020127	0,83033	10,20890192	38,30225038	26,65353032
06.03.2020	66,1854	45,5	1,001619	0,906736	8,034513378	25,6948754	31,26893302
05.03.2020	66,0784	50,18	0,994502	0,97418	7,859857141	18,05206258	43,53993958
04.03.2020	66,4437	51,51	1,001753	0,998256	8,4561368	15,88006663	53,25000831
03.03.2020	66,3274	51,6	0,990096	0,972484	8,266300161	15,73308946	52,5408578
02.03.2020	66,9909	53,06	1,021052	1,059293	9,349332062	13,34879315	70,03878144

The study introduced the Rub and Oil variables - these are the sets of ruble exchange rates and oil prices for the specified period, respectively.

The trends in the dependence of the national currency rate on energy prices were analyzed.

An initial assessment was made of the relative impact of incremental changes in the ruble exchange rate, the variable RelRub was introduced, which shows the change in the trend of the ruble exchange rate depending on time (strengthening or weakening of the ruble exchange rate). By analogy with the theory of time series, when the first difference (the difference between adjacent members of the series) is introduced, the concept of the first quotient is introduced. The set of values of the RelRub variable forms the time series RelRub (t). Here Rub (i) and Rub (i + 1) are sequential values of the ruble exchange rate in the reverse order (from a later value to an earlier in time):

$$RelRub(t) = \frac{Rub(i)}{Rub(i+1)} \qquad (1)$$

Similarly, we calculate the trends in oil prices, the first private ones for the RelOil (t) series. A calculation is made for the set of values of the RelOil (t) series:

$$RelOil(t) = \frac{Oil(i)}{Oil(i+1)} \qquad (2)$$

Fig. 1 shows a joint diagram of the relative changes in the ruble and oil prices.

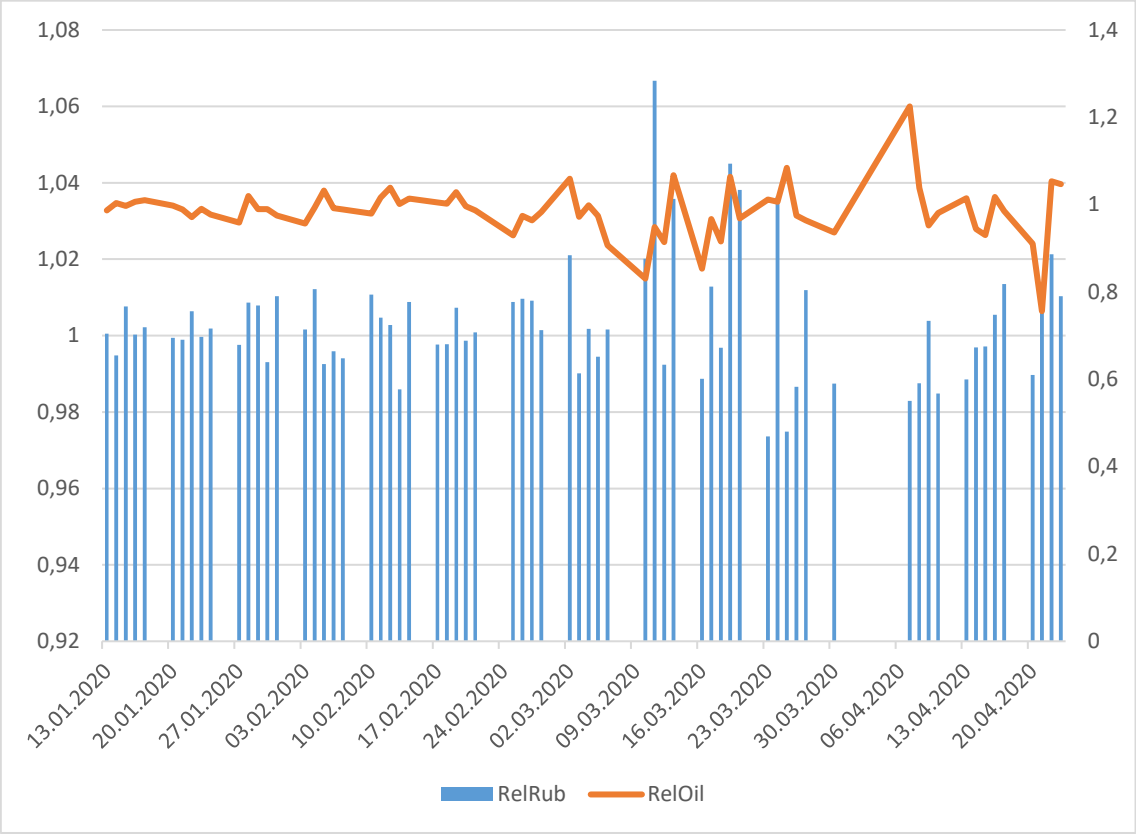

Fig. 1. The joint dynamics of changes in the ruble and oil prices

Based on the diagram in Fig. 1, the relative dynamics of price changes is lower than the relative dynamics of the ruble exchange rate. Obviously, the series RelRub (t) and RelOil (t) are stationary.

The RelPercRub variable shows the relative percentage change in the ruble exchange rate from the beginning of the year to April 23. Next, the set of values for the series RelPercRub (t) is calculated:

$$RelPercRub(t) = 100 * \frac{Rub(i) - \min(Rub(i))}{min\ (Rub(i))} \quad (3)$$

Similarly, the RelPercOil variable is calculated. It is the relative percentage change in oil prices from the beginning of the year to April 23. But instead of a minimum of prices of oil, the maximum value of the series is used. The values of the RelPercOil (t) series are calculated in a similar way:

$$RelPercOil(t) = 100 * \frac{\max\ (Oil(i)) - Oil(i)}{max\ (Oil(i))} \quad (4)$$

Fig. 2 shows the relative changes in oil prices and the ruble exchange rate as a percentage.

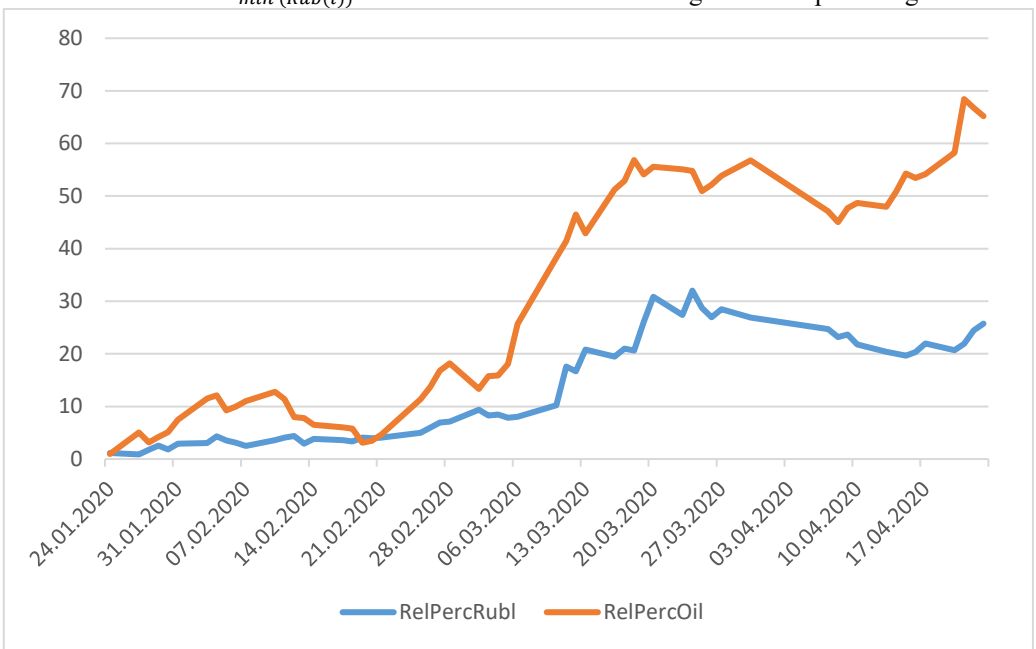

Fig. 2. Joint chart of changes in the ruble exchange rate and oil prices, in %

Based on the presented diagram, the relative changes in the ruble exchange rate are significantly lower than the relative changes in oil prices in percent [10].

Figure 3 shows a joint diagram of the relative changes in the ruble exchange rate and oil prices for this period.

3. Results and discussion

Analysis of the dynamics of price changes shows that significant changes in oil prices cause less significant changes in the ruble exchange rate. At the same time, oil price spikes in early February do not cause equally significant changes in the ruble exchange rate, it is growing gradually. A similar conclusion can be made regarding the period at the end of February. In this situation, the dependence of the ruble rate on oil prices should be calculated.

The following is an assessment of the dependence of changes in oil prices on the ruble exchange rate. This makes it possible to estimate the share of the country's income from the sale of petroleum products. This is the DepRubOil variable. The set of calculated values of this variable is presented in the following formula:

$$DepRubOil(i) = 100 * \frac{RelPercRub(i)}{RelPercOil(i)} \qquad (5)$$

Next, we calculate the average value among the set of values of the series {DepRubOil}. It is equal to DepRubOilAvrg = 42.2932996060693.

An analysis of the many values of the DepRubOil variable shows that despite the emergency in the country due to coronavirus, the indicator of the dependence of the Russian economy on oil prices still fluctuates around 40%. Fig. 3 shows the dependence of the ruble on oil prices. The figure also shows the average value of the indicator of the dependence of the ruble exchange rate on the price of oil, and for comparison, the price of oil for the indicated period.

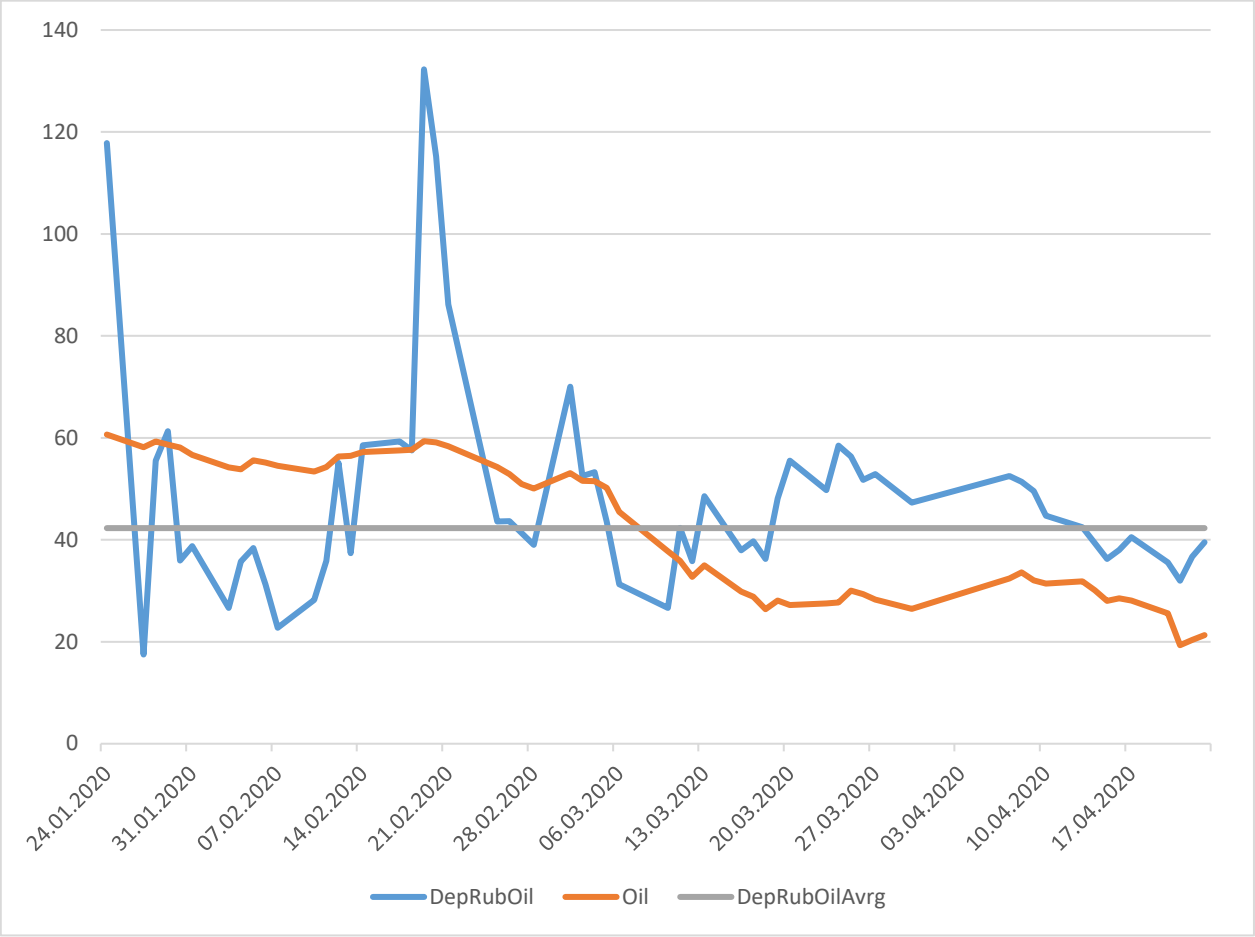

Fig. 3. The dependence of the ruble on oil prices

At the same time, with the depreciation of the ruble and lower oil prices (Oll), the dependence of the Russian economy (DepRubOil) on oil products also falls, which obviously confirms the calculations made.

This is the average dependence of the ruble exchange rate on oil prices, expressed as a percentage.

Agreed indicators of the dynamics of the ruble exchange rate and oil prices suggest that the ratio of these two values depends on objective factors. We can observe it for periods of stability.

4. Conclusion

Currently, there is a large dependence of the economic situation in the country on the foreign exchange market. In addition, the coronavirus pandemic once again showed the dependence of the Russian economy on the volatility of oil prices on the world market.

An analysis of the dynamics of price changes shows that significant changes in oil prices cause less significant changes in the exchange rate of the ruble. At the same

time, oil price spikes in early February 2020 do not cause equally significant changes in the ruble exchange rate but demonstrate gradual growth.

The calculations of the average value of the dependence index and the presented results in the form of graphs clearly indicate that with the fall in world oil prices, the dependence of the Russian economy on the oil market conjuncture falls. However, it should be noted that the coronavirus pandemic will have a residual impact on the global and national economies for a relatively long time manifested in the volatility of exchange rates.

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