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

O.V. Zolotarev¹, A.Kh. Khakimova², M.A. Berberova¹,²,³, V.P. Zolotareva⁴

¹ANO «Russian New University», Moscow, Russia
²ANO «Scientific and Research Center for Information in Physics and Technique», Nizhny Novgorod, Russia
³ANO International Nuclear Safety Center, Moscow, Russia
⁴Moscow Polytechnic University, Moscow, Russia

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 coronavirus 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.
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 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):

\[
\text{RelRub}(t) = \frac{\text{rub}(i)}{\text{rub}(i+1)}
\]  

(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:

\[
\text{RelOil}(t) = \frac{\text{oil}(i)}{\text{oil}(i+1)}
\]  

(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:

\[
\text{RelPercRub}(t) = 100 \times \frac{\text{Rub}(i) - \min\{\text{Rub}(i)\}}{\min\{\text{Rub}(i)\}}
\]  

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:

\[
\text{RelPercOil}(t) = 100 \times \frac{\max\{\text{Oil}(i)\} - \text{Oil}(i)}{\max\{\text{Oil}(i)\}}
\]

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:

$\text{DepRubOil}(i) = 100 \times \frac{\text{RetRubOil}(i)}{\text{RetPercOil}(i)}$ (5)

Next, we calculate the average value among the set of values of the series DepRubOil. It is equal to

$\text{DepRubOilAvrg} = 42.2932996060693$.

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](image)

At the same time, with the depreciation of the ruble and lower oil prices (Oil), 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.

Acknowledgment

The reported study was funded by RFBR according to the research projects № 18-07-00225, 18-07-00909, 18-07-01111, 19-07-00455 and 20-04-60185.

References


About the authors

Zolotarev Oleg V., Ph.D., Docent, ANO HE «Russian New University» (Moscow, Russia), E-mail: ol-zolot@yandex.ru
Khakimova Aida Kh., PhD, docent, Kama Institute (Naberezhnye Chelny, Russia), ANO «Scientific and Research Center for Information in Physics and Technique» (Nizhny Novgorod, Russia), E-mail: aida_khatif@mail.ru

Berberova Maria A., PhD, docent, ANO HE «Russian New University» (Moscow, Russia), ANO International Nuclear Safety Center (Moscow, Russia), ANO «Scientific and Research Center for Information in Physics and Technique» (Nizhny Novgorod, Russia), E-mail: maria_berberova@gmail.com
Zolotareva Vera P., Ph.D., Moscow Polytechnic University (Moscow, Russia), E-mail: zolotareva2005@mail.ru