Econometric assessment of the world energy market impact on the incomes of the consolidated budget of Russia

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Abstract. The article is devoted to the study of modern trends in energy resources megamarket. The results of the study reveal a system of factors affecting the production and consumption of energy resources in the global economy. The authors make a forecast of the development of traditional and alternative energy in the coming decades. The paper assess the degree of influence of the changing conjuncture of the world energy market on the Russian economy. The study shows the presence of high closeness of communication on the Chaddock scale and the direct linear dependence of Russia’s GDP at current prices on the volume of oil and gas revenues of the consolidated budget of the Russian Federation, confirmed by calculating the Pearson correlation coefficient. The article proposes a set of measures that reduce the dependence of the Russian budget on the world energy market.

1. Introduction
Availability of own energy resources is a significant competitive advantage of national economies of countries. However, countries with significant reserves of natural resources are often the least economically developed than countries with little or no reserves.

The term “resource curse” was first used in 1993 by Richard Auty in his work Sustaining development in mineral economies: The resource curse thesis. In his study, R. Auty concludes that countries endowed with richer natural resources often have lower economic growth, in contrast to countries that have less natural resources [1].

In his study, R. Auty refers to the study of Angus Maddison, a British economist who specializes in quantitative macroeconomic history, an Emeritus professor at the Faculty of Economics at the University of Groningen, which compares GDP per capita and the stock of resources per capita in Australia and Japan. As a result of a comparative analysis, A. Maddison comes to the following conclusion: despite Australia has 150 times more resources per capita than Japan, the latter country’s per capita income level is predominantly higher [2].

A significant research in this area is also a joint article by Giles Atkinson, professor at the London School of Economics and Political Science, and Kirk Hamilton, a leading economist at the World Bank’s research group, entitled “Savings, Growth and the Resource Curse Hypothesis”. In this article, scientists come to a similar conclusion: “the curse of resources” may be a manifestation of the inability of governments to sustainably manage large resource revenues. [3]

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Such results allow scientists to look at this hypothesis from a different angle: countries in which growth rates lag behind are those countries in which the combination of natural resource policies, macroeconomics and government spending led to a low level of real savings (net savings adjusted for depletion of resources).

In particular, Norwegian economist dealing with development economics and economic history, Eric Reinert, in his book “How Rich Countries Got Rich and why Poor Countries Stay Poor”, indicates that the poverty of resource-rich countries is not related to the resources themselves, but to concentration on mono-production in diminishing returns, as well as abuse of the theory of comparative advantage. [4].

The purpose of this article was to study the problem of the “resource curse” in the Russian economy.

2. Materials and methods
To write this article, we relied on the analysis of existing studies of resource endowment impact on the country's economic development model and its effectiveness.

In the course of the study, we used a methodological approach, based on the identification and use of the dialectical method, which determines the system of principles and techniques of the study; general scientific methods (systemic, structural-functional, synergistic, observation, deduction, etc.), allowing to adapt philosophical methods to the fundamental theoretical and methodological provisions of the special sciences; as well as econometric methods, allowing to build an economic-mathematical model of the relationship between the GDP of the Russian Federation and the oil and gas revenues of its budget, with the help of “Gretl” software package. For this purpose, we made an assessment of the relation quality on the Chaddock scale and calculated Pearson correlation coefficient.

To build a time series, we used statistical data for 2005–2018, as well as forecasts of the volume of oil and gas revenues of the consolidated budget of the Russian Federation for 2019–2020.

3. Results
One of the indicators of the stable development of national economies and the world economy as a whole is the energy intensity of GDP, which is expressed in the amount of primary energy needed to create a unit of gross domestic product (GDP). Reducing the energy intensity of GDP is one of the priority areas for intensifying production and resource conservation, which can be achieved by implementing a set of technical, technological, organizational and economic measures aimed at systematically improving the processes of energy production and consumption. [5,6]

In the long run, the increase in oil prices contributes to the transition of consumers to energy-saving technologies, the acquisition of more economical vehicles and equipment. Economic waves and technological orders that are close in length are accompanied by a change in the energy carriers used: from hydropower to alternative energy sources. The explanation of cyclicality is in the delayed influence of the market on the economy. Indeed, in the period of economic growth there is an additional demand for oil, which leads to an increase in its prices. However, the increase in oil supplies occurs gradually, and, gaining strength, it “slips” into a state of equilibrium. As a result - the overproduction of goods and falling prices.

Oil and gas revenues account for a significant proportion of the consolidated budget of the Russian Federation.

Let’s view at its structure, basing on the data on the performance reports of the consolidated budget of the Russian Federation for 2008-2017, from the point of the division of revenues into oil and gas and non-oil in the following histogram (Fig. 1). [7]
Figure 1. Share of oil and gas revenues in the consolidated budget of the Russian Federation for 2006-2017.

This figure shows the following trends:

1. positive growth rates in the share of oil and gas revenues in the total revenue base of the Russian budget in 2009-2010 after the crisis of 2008;
2. a stable share of oil and gas resources in 2011-2013 at the level of 26-27% for the consolidated budget of the Russian Federation;
3. the peak of dependence of budget revenues on oil and gas resources, which falls on 2014, when the share of oil and gas resources of the total consolidated budget revenues was about 37%, which is about 10% more than a year earlier;
4. a decrease in the share of oil and gas revenues in 2015-2016 up to the minimum values for the period under review up to 17-19%;
5. the upward trend of growth in the share of oil and gas revenues in the consolidated budget of the Russian Federation in 2017

The main factor contributing to the above trends, according to experts, is the linking of the Russian economy to the conjuncture of the world market of energy resources and its pricing. We will confirm this thesis by a graph of the dependence of the growth rates of Russia's GDP and the dynamics of world prices for Brent oil according to the data for 1990-2017 (Figure 2). [8]
Figure 2. Dependence of the growth rates of Russia's GDP and the dynamics of world prices for Brent oil 1990-2017.

The almost identical curves of Brent oil price and the growth rates of Russia's GDP clearly demonstrate the fact that the Russian economy is closely linked to the situation on the world energy market, and in particular to price formation in the oil market. A particularly close correlation between these two indicators is observed in the period 2009-2011, when the prices for Brent oil rose after the 2008 crisis, which led to an increase in the Russian GDP growth rates in this period.

Having determined that there is a certain interrelation between GDP growth rates and the level of prices for Brent oil, and that oil and gas revenues constitute a significant part of the Russian budget, we estimate the force and direction of the relationship between GDP at current prices (dependent variable X) and oil and gas revenues of the budget of the Russian Federation (independent variable Y).

Pearson's correlation coefficient is calculated by the formula:

\[
 r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}
\]

where \( x_i \) – values of variable X;
\( y_i \) – values of variable Y;
\( \bar{x} \) – average value of X;
\( \bar{y} \) – average value of Y.

Let’s substitute the calculated values in the original formula and get the value of the Pearson correlation coefficient for the variables X and Y:

\[
 r_{xy} = \frac{362.342.464.47}{5.877.33 \times 75.343.85} = 0.82
\]
Then, let us determine the critical values for the obtained correlation coefficient: $r_{cr} = 0.39$ at the significance level $\alpha = 0.05$ and $r_{cr} = 0.5$ at the significance level $\alpha = 0.01$. Let’s look at the location of the value of the correlation coefficient on the significance axis with respect to critical points (Fig. 3).

![Significance axis](image)

**Figure 3.** Significance axis

As can be seen from Figure 3, the calculated value of the Pearson correlation coefficient falls within the zone of significance, and therefore the relationship between GDP at current prices and the oil and gas revenues of the RF budget is statistically significant at 1% level and positive. Moreover, the calculated value of $r_{xy} = 0.82$ on the scale of the qualitative assessment of Chaddock's connection closeness is estimated as a strong bond (0.7-0.9).

Let’s look at a graph of the correlation field.

![Correlation field](image)

**Figure 4.** Correlation field of dependence of Russia's GDP at current prices on oil and gas revenues of the Russian budget.

Such a close interdependence of the Russian economy and volatility in the oil market is positive only during the stabilization or increase in oil prices. However, as noted earlier, an important regularity in the functioning and development of the world oil market is stable cyclical fluctuations,
which, with such a close correlation, can have a negative impact on the economy of the Russian Federation.

We will construct an economic-mathematical model using the Gretl software package for econometric modeling in order to predict the volume of oil and gas revenues of the consolidated budget of the Russian Federation for 2018-2020 based on the time series of data for 2005-2017.

It is necessary to clarify that the model constructed by ARIMA is significant, because during the construction of this model in the Gretl software package for econometric modeling all tests for significance were successfully passed. Let’s present the forecast values of the model for 2018-2020 in the form of a table.

**Table 1.** Forecast of the volume of oil and gas revenues of the consolidated budget of the Russian Federation for 2018-2020

| Year | Forecast values of oil and gas revenues of the budget of the Russian Federation, billion rubles | Standard error, billion dollars | 95% confidence interval, billion rubles |
|------|---------------------------------------------------------------------------------|-------------------------------|-------------------------------------|
| 2018 | 5 654,50                                                                         | 1 068,81                      | 3 559,7 - 7 749,3                   |
| 2019 | 5 405,80                                                                         | 1 357,88                      | 2 744,4 - 8 067,2                   |
| 2020 | 5 210,90                                                                         | 1 508,17                      | 2 254,9 - 8 166,9                   |

It should be noted that the appropriateness of using this model for forecasting oil and gas revenues is confirmed by U-statistic, which is a relative measure of the accuracy of predicted results by calculating the root-mean-square value of the forecast growth error, denoted by U and calculated using the following formula:

\[
U = \sqrt{\frac{\sum_{t=1}^{n-1} \left( \frac{(Y_{t+1} - \hat{Y}_{t+1})}{Y_t} \right)^2}{\sum_{t=1}^{n-1} \left( \frac{(Y_{t+1} - \hat{Y}_{t+1})}{\hat{Y}_t} \right)^2}},
\]

where \( Y_t \) - the actual value of the point for a given period of time t; 
\( n \) – number of data points; 
\( \hat{Y}_t \) - the predicted value of the point for a given period of time t.

According to the results of the constructed model, the value of U-statistics is 0.84. According to the interpretation of the values of this statistics, it is advisable to use the predictive model only if the value of the U-statistics is less than 1, which indicates the possibility of building a more accurate prediction than using the naive or intuitive forecasting method, in which the predicted value is taken equal to the value of the variable in the last observation. Because U-statistics calculated = 0.84 < critical value of U-statistics = 1, then the constructed model can be considered expedient for forecasting the oil and gas revenues of the RF budget for 2018-2020.

According to the hypothesis, the budget system revenues for the period 2013-2030 for all variants of the long-term forecast will fall from 37.4% of GDP in 2011 to 32.7 - 35.4% of GDP in 2030. This reduction will be associated with a decrease in oil and gas revenues, which will be reduced from 10.1% of GDP in 2011 to 3.4 - 6.0% of GDP in 2030, depending on the type of forecast. The main reason for the fall in the projected volumes of oil and gas revenues of the budget system in the GDP structure is the outrunning growth of the forecast of GDP volumes relative to the growth of the main macroeconomic indicators affecting the forecast volumes of oil and gas revenues: production and export of major energy resources, the dollar rate and oil prices.
The main reason for such a significant discrepancy in the forecast of the volumes of oil and gas revenues of the budget system in the GDP structure for option 3 relative to the two other macroeconomic forecast options is a significant difference in the ruble / dollar forecasts. For option 3, a stronger ruble exchange rate against the US dollar is predicted than scenarios 1 and 2 throughout the forecast horizon. As a result, the positive effect from the growth of such macroeconomic indicators as taxable export and production of oil and gas is completely leveled.

**Conclusion.**

Thus, we can make the following conclusions:

1. Oil and gas revenues in the overall structure of the consolidated budget of the Russian Federation account for a significant share: from 17 to 27% in different years over the past decade;
2. One of the main factors causing the cyclical nature of the share of oil and gas revenues in the budget of the Russian Federation is price volatility in the oil market;
3. The presence of high closeness of communication on the Chaddock scale and direct linear dependence of Russia's GDP in current prices on the volume of oil and gas revenues of the consolidated budget of the Russian Federation, confirmed by calculating the Pearson correlation coefficient;
4. The predicted downward trend in the volume of oil and gas revenues in the consolidated budget of the Russian Federation in the short term (2018-2020), revealed by building an economic-mathematical model using the Gretl application software package for econometric modeling, the feasibility of which was confirmed by U-statistics.

The above conclusions are evidence that despite the efforts being made to remove the Russian economy from the “oil needle”, the effectiveness of its development continues to depend on the situation on the world oil market, and in particular on the pricing on it.

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