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Original Research Article

Macroeconomic Implications of Oil Price Fluctuations: A Simultaneous Equation Analysis of Russia's Economic Performance and Policy Responses

Anthony Nyangarika[1*]
[1]The Nelson Mandela African Institution of Science and Technology, P.O. Box 447 Arusha, Tanzania

***Corresponding Author**
Anthony Nyangarika
The Nelson Mandela African Institution of Science and Technology, P.O. Box 447 Arusha, Tanzania

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Abstract: This study uses a simultaneous equation model (SEM) to examine the relationship between oil price fluctuations and Russia's macroeconomic performance. It uses a comprehensive set of variables, including GDP growth, investment, export and consumption rates, exchange rates, and oil prices, to estimate the interactions between these variables. The study reveals significant findings on the macroeconomic impact of oil price fluctuations on Russia's economies, including short-term and long-term effects on GDP growth, inflation, and unemployment rates. It also examines the role of monetary policy in mitigating the adverse effects of oil price shocks on the economy. The study highlights Russia's vulnerability to oil price fluctuations, especially due to its heavy reliance on oil exports. It also examines the effectiveness of policy responses, such as fiscal measures and exchange rate interventions, in mitigating the impact of oil price shocks on Russia's macroeconomic stability. The findings provide valuable insights for policymakers and stakeholders, aiming to enhance economic resilience and stability in the face of oil market fluctuations.

Keywords: Investments Export, Gross National Product, Normality of Distribution, Oil Price Forecasting, Budget Revenues, Oil and Gas Impact.
JEL classification: E37, F20, G15.

1. INTRODUCTION

The volatility of oil prices has long been recognized as a significant driver of economic fluctuations worldwide. This phenomenon is particularly salient for major oil-producing and consuming nations such as the United States and Russia, where fluctuations in oil prices can have profound macroeconomic implications (Hamilton, 2009). Understanding the complex relationship between oil price volatilities and economic variables in these countries is essential for policymakers, investors, and other stakeholders (Fattouh *et al.,* 2016). This study employs a simultaneous equations model approach to investigate the macroeconomic impact of oil price volatilities in Russian economy.

Oil prices are subject to a multitude of factors, including geopolitical tensions, supply disruptions, technological advancements, and changes in global demand (Fattouh *et al.,* 2016). The resulting volatility in oil prices can have ripple effects across various sectors of the economy, influencing inflation, employment, investment, trade balances, and overall economic growth (Hamilton, 2009).

In recent years, the United States has undergone a transformative shift in its energy landscape, driven primarily by advancements in hydraulic fracturing and horizontal drilling techniques (Apergis & Miller, 2009). This shade revolution has propelled the United States into becoming a net exporter of oil and gas, reducing its dependence on foreign oil and reshaping global energy markets (Fattouh *et al.,* 2016). However, despite this newfound energy independence, the U.S. economy remains interconnected with the global energy market, and fluctuations in oil prices can still impact domestic economic variables.

Similarly, Russia, as one of the world's largest oil producers, is heavily reliant on oil revenues to support its economy. Oil and gas exports constitute a substantial portion of the country's GDP and government revenues, making it particularly vulnerable to swings in oil prices (Apergis & Miller, 2009). Moreover, geopolitical tensions, such as conflicts with neighboring countries and international sanctions, further compound the economic significance of oil price volatilities for Russia.

The simultaneous equations model approach offers a powerful analytical framework for examining the relationship between oil prices and macroeconomic variables in the In Russia. By simultaneously estimating equations for multiple endogenous variables, such as GDP growth, inflation, exchange rates, and oil prices, these models allow for a comprehensive understanding of how oil price volatilities propagate through the economy (Pesaran & Smith, 1995).

The impact of oil price volatilities on key macroeconomic variables, including GDP growth, inflation, unemployment rates, and exchange rates, in Russia; the transmission mechanisms through which oil price shocks affect the domestic economies of Russia; and the policy implications of oil price volatilities for policymakers in both countries are assessed, and potential strategies for mitigating the adverse effects of oil price fluctuations are explored (Apergis & Miller, 2009). This study contributes to the literature on the macroeconomic implications of oil price volatilities and provides valuable insights for policymakers and market participants.

The macroeconomic impact of oil price volatilities in Russian economy is of paramount importance for several reasons: economic stability fluctuations in oil prices can destabilize economies, leading to inflationary pressures, currency fluctuations, and uncertainty in financial markets; policy formulation the insights gained from this study can inform policymakers in both countries about the potential effects of oil price volatilities and help formulate appropriate policy responses; investment decisions investors and businesses rely on accurate economic forecasts to make informed decisions about resource allocation, expansion plans, and risk management strategies; and global energy dynamics the Russia are major players in global energy markets, and understanding how oil price volatilities affect their economies can provide valuable insights into broader energy dynamics.

Given this structure of the economy and the raw material export potential, one of the most important external factors for the majority of macroeconomic indicators for the United States is world oil prices.

Despite the several slowing economic growth events caused by the controversial foreign and domestic policies of the current leadership of the country, an increase in world oil prices and associated prices for natural gas and mineral fertilizers positively influence the dynamics of the U.S.A economy both due to the growing demand for the results of its current functioning and at the expense of increased investment activity. U.S. crude oil production was first reported in 1983 by the U.S. Energy Information Administration (EIA). The values shown are in thousands of barrels produced per day. The current level of U.S. crude oil production as of February 2022 is **11,600.00** thousand barrels per day.

In contrast, falling prices for crude oil, as history shows, almost inevitably lead to a decrease in real GDP growth and in investment and exports. In addition, although a sharp decline in oil prices in 2014 was supposed to provide an incentive for the growth of the U.S. economy, according to the U.S. Federal Reserve, the average family with fuel costs can decrease by $700 (Apergis,2009). The report notes that higher net household income due to lower oil prices led to an increase in consumer spending of 0.61%, while a decrease in drilling volumes reduced the inflow of investments by 0.62%, almost negating all the advantages of the low oil price period. At the same time, as reported in the report, non-oil-producing sectors of the economy are not able to attract a large amount of new investments. These equations are quite economical in terms of the number of parameters used and reflect the dependence of the main macroeconomic parameters GDP, investment, consumption, and net exports on the dynamics of world oil prices. Shale oil production is still crucial for the U.S. economy (Fattouh *et al.,* 2016). This again underscores the important role that the oil industry plays in the U.S.A. economy and what benefits the country has received from the Slate Revolution. Interactive Brent (Europe) crude oil prices over the last ten years. The current price of Brent crude oil as of February 26, 2024, is $84.01 per barrel as shown in Figure 2.

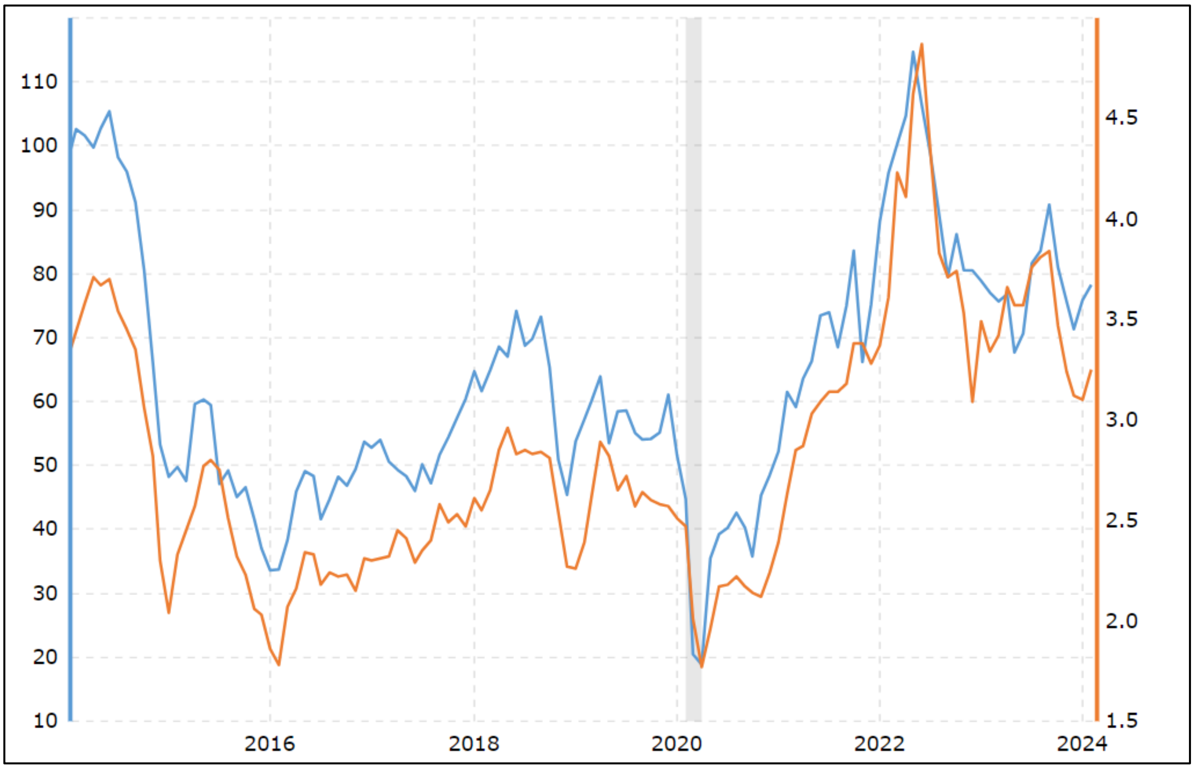

Figure 1: U.S. crude oil production 2016-2024

Figure 2: Brent Crude Oil Prices 2016-2024

Source: Brent crude oil prices

It is obvious that without the slate revolution, the U.S.A economy's reaction to the recent decline in oil prices would have been different, had it not been for the low level of oil and gas production for GDP. The real interest to the authorities shows the growth of investments in the oil sector help offset the negative impact on private consumption in the future recovery of real oil prices (Fattouh *et al.,* 2016).

A substantial part of Federal budget revenues are revenues from taxes and duties collected from oil and gas companies. Revenues depend on the dynamics of asset prices in commodity markets. In 2023, there was a sharp devaluation of the national currency, which peaked in December and began to have a positive effect on the current balance of payments of Russia.

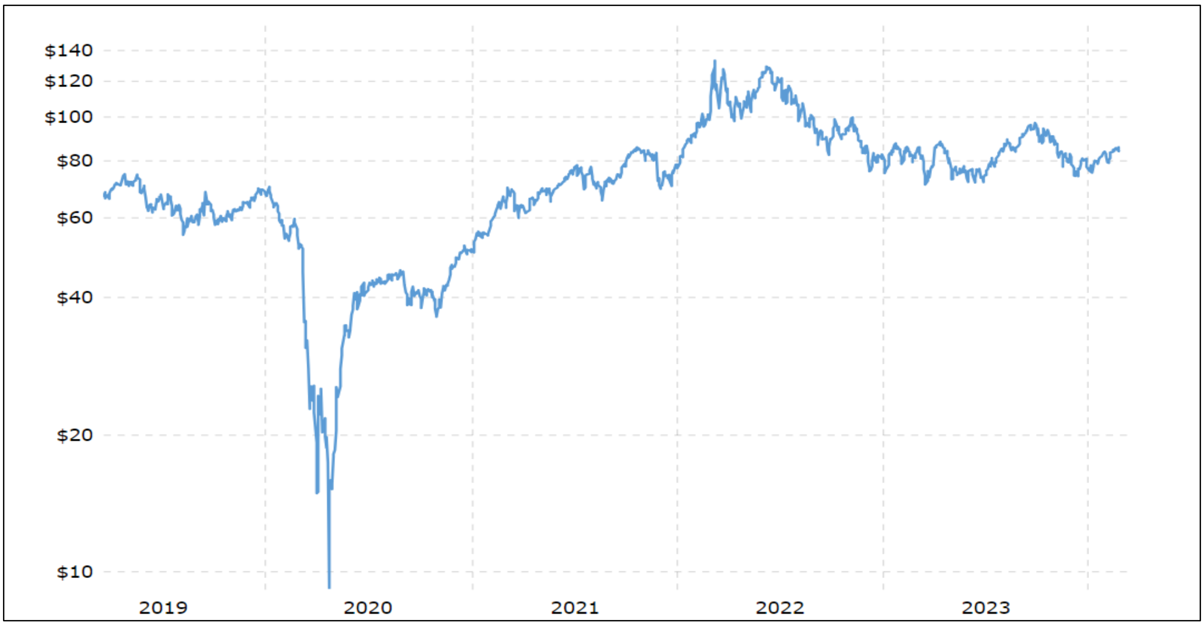

Figure 3: Price Dynamics of Brent Oil in 2019-2023
Source: Brent crude oil prices

To assess Federal budget revenues, we need to understand how the volume of ruble-denominated tax revenues from the oil and gas sector has changed. By comparing the depth of the fall of the Russian ruble against the depth of the fall in the price of oil brands, it is clear that the rate of decline of the ruble is ahead of the rate of fall of oil prices as shown in Figure 4.

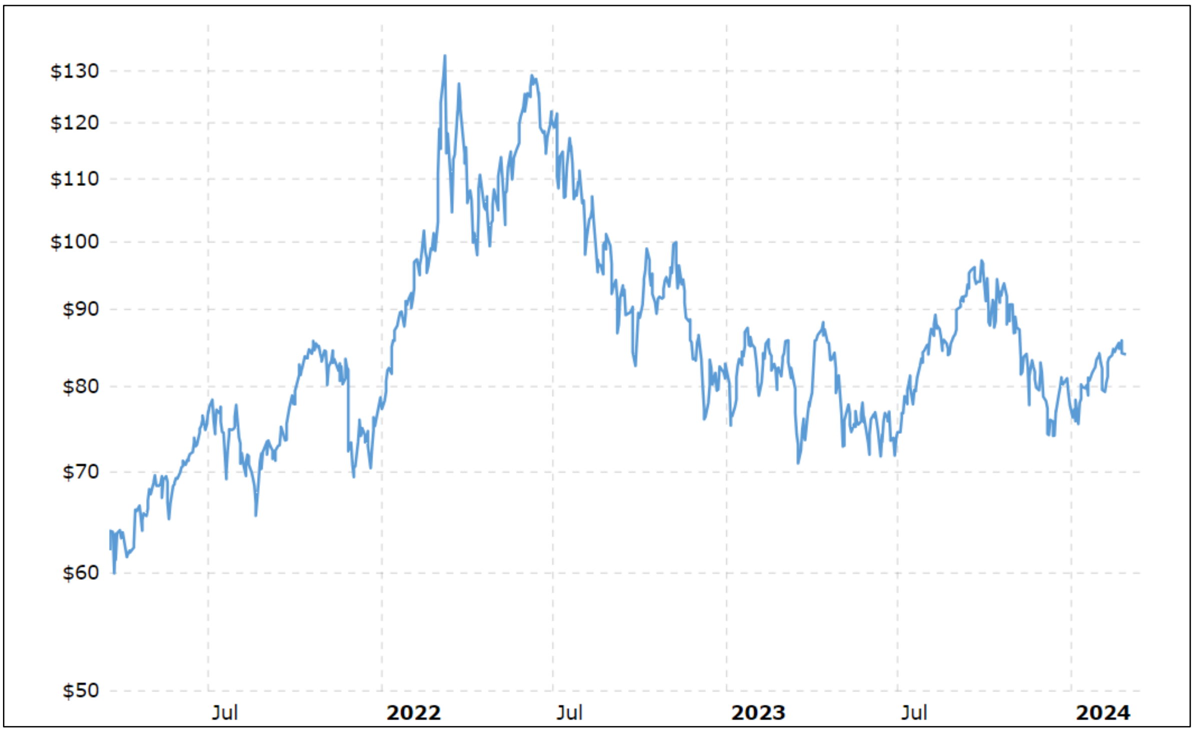

Figure 4: Prices for oil-grade Ural blend 2023-2024
Source: Central Bank of Russia, Thomson Reuters.

Figure 4 shows that the ruble export price of Urals oil even increased compared to that in 2022 that is, the ruble tax base for income should not suffer much as a result of such sharp changes in asset prices. However, considering that the rates of duties and taxes largely depend on the dollar value of exported oil, the Federal budget revenues should be significantly reduced compared to the forecast values of the previous year. Moreover, a sharp change in commodity markets can lead to a decrease in exports of petroleum products and gas to countries outside of Russia. Likely, the stability of the physical volumes of Russian oil and gas exports will be the main factor influencing budget revenues. Both an increase in exports and a sharp decline may pose risks to Russia's fiscal policy (Figure 5). In accordance with the budget for 2015, the total budget revenues are planned at the level of 14,564 bln. Russian rubles, of which a significant share (46.8%) are oil and gas revenues 6818 bln. Russian rubles.

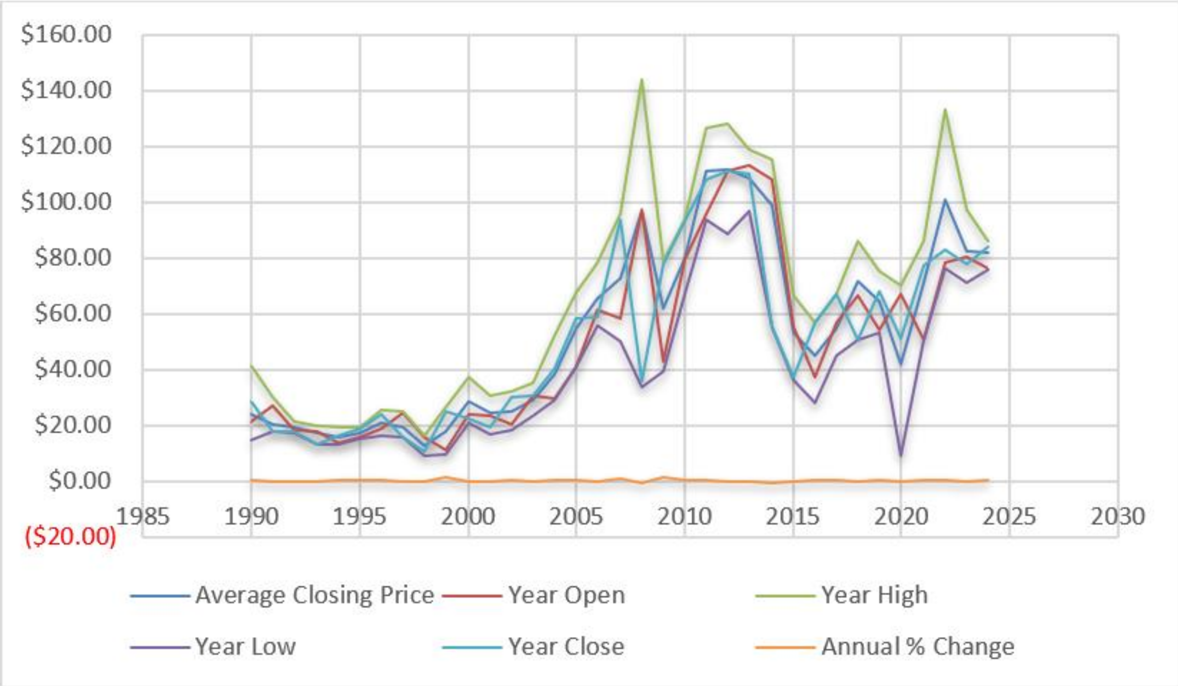

Figure 5: Forecast of Crude Oil Price 1985- 2030
Source: Data Brent crude oil prices

2. MATERIAL AND METHODS

The macroeconomic impact of oil price volatilities and the use of simultaneous equation models in economic research provide valuable insights into the complex relationship between oil prices and economic variables. Numerous studies have investigated the macroeconomic consequences of oil price volatilities, highlighting their significant impact on key economic indicators. For instance, Apergis and Miller (2009) examine the effects of structural oil-market shocks on stock prices and find evidence of a significant relationship between oil price fluctuations and stock market performance. Similarly, Hamilton (2009) provides a comprehensive analysis of crude oil prices, emphasizing their importance in understanding economic fluctuations and inflation dynamics.

Moreover, Fattouh, Mahadeva, and Sen (2016) explore demand and supply shocks in the oil market, emphasizing the role of oil price volatilities in shaping global economic outcomes. Their study underscores the interconnectedness of oil markets with broader economic trends, highlighting the need for rigorous empirical analysis to disentangle the underlying mechanisms.

Simultaneous equation models have emerged as powerful tools for analyzing the complex interactions between oil prices and macroeconomic variables. Pesaran and Smith (1995) propose a methodology for estimating long-run relationships from dynamic heterogeneous panels, which allows for a more comprehensive understanding of the transmission channels of oil price shocks. By simultaneously estimating equations for multiple endogenous variables, such as GDP growth, inflation, and exchange rates, simultaneous equation models enable researchers to capture the interdependencies among these variables and assess their responses to oil price volatilities.

Furthermore, recent advancements in econometric techniques have expanded the applicability of simultaneous equation models in economic research. For example, dynamic stochastic general equilibrium (DSGE) models incorporate stochastic shocks and intertemporal optimization to analyze the dynamic effects of oil price volatilities on macroeconomic variables (Kilian, 2009). These models provide a framework for assessing the effectiveness of monetary and fiscal policies in mitigating the adverse effects of oil price fluctuations on the economy.

The macroeconomic impact of oil price volatilities and the use of simultaneous equation models in economic research highlight the importance of understanding the transmission mechanisms and policy implications of oil price shocks. By incorporating empirical evidence from various studies, researchers can contribute to a better understanding of the complex relationship between oil prices and economic variables and inform policymakers about potential strategies for managing the macroeconomic effects of oil price volatilities.

Research examining the impact of oil price volatilities on key macroeconomic variables, including GDP growth, inflation, unemployment rates, and exchange rates, in both the USA and Russia is abundant in the literature and provides valuable insights into the interconnectedness of oil markets and broader economic trends.

In the context of the United States, numerous studies have investigated the relationship between oil price volatilities and macroeconomic variables. Kilian (2009) examines the dynamic effects of oil price shocks on the US economy and finds that both demand and supply shocks in the oil market have significant implications for GDP growth, inflation, and employment levels. Similarly, Hamilton (2009) provides a comprehensive analysis of the effects of oil price fluctuations on economic activity in the USA, highlighting the importance of oil prices in driving inflationary pressures and economic uncertainty.

In Russia, research on the impact of oil price volatilities on macroeconomic variables has also been extensive. Arbatli *et al.,* (2016) analyze the transmission channels of oil price shocks to the Russian economy and find that fluctuations in oil prices significantly affect GDP growth, inflation, and exchange rates. Moreover, Lomivorotov and Ponomarenko (2018) explore the effects of oil price volatility on unemployment rates in Russia, highlighting the role of oil revenues in shaping labor market dynamics.

Overall, empirical studies examining the impact of oil price volatilities on key macroeconomic variables in both the USA and Russia underscore the importance of understanding the transmission mechanisms and policy implications of oil price shocks. By incorporating evidence from these studies, policymakers can make informed decisions about managing the macroeconomic effects of oil price volatilities and mitigating their adverse consequences on economic stability and growth.

Insights from empirical research on the impact of oil price volatilities on key macroeconomic variables can provide valuable guidance for policymakers in formulating appropriate policy responses to mitigate the potential effects of oil price fluctuations.

In the United States, policymakers have long been concerned about the economic consequences of oil price volatilities. Studies such as those by Hooker (1996) and Kilian (2009) have highlighted the importance of understanding the relationships between oil prices and inflation, GDP growth, and employment levels. This understanding can inform policymakers about the potential effects of oil price volatilities on the US economy and guide the design of monetary and fiscal policies to mitigate adverse consequences.

Similarly, in Russia, where the economy is heavily dependent on oil revenues, policymakers face significant challenges in managing the macroeconomic effects of oil price fluctuations. Research by Arbatli *et al.,* (2016) and Lomivorotov and Ponomarenko (2018) has demonstrated the substantial impact of oil price volatilities on GDP growth, inflation, and unemployment rates in Russia. These findings can provide policymakers with valuable insights into the transmission mechanisms of oil price shocks and help formulate appropriate policy responses to stabilize the economy during periods of oil price volatility.

Overall, empirical research on the macroeconomic impact of oil price volatilities can serve as a valuable tool for policymakers in both the USA and Russia to anticipate the potential effects of oil price fluctuations and design effective policy responses to mitigate their adverse consequences.

Accurate economic forecasts are crucial for investors and businesses to make informed decisions about resource allocation, expansion plans, and risk management strategies. Research in the field of macroeconomics provides valuable insights into the relationship between oil price volatilities and key economic indicators, which can inform investment decisions.

Kilian (2009) and Hamilton (2009) examined the dynamic effects of oil price shocks on GDP growth, inflation, and employment levels. Understanding these relationships can help investors assess the potential impact of oil price volatilities on the overall economic environment and adjust their investment strategies accordingly.

Furthermore, research by Hooker (1996) has highlighted the importance of oil prices in driving inflationary pressures, which can have significant implications for businesses' cost structures and pricing strategies. By incorporating information about the relationship between oil prices and inflation into their forecasting models, businesses can better anticipate changes in input costs and adjust their pricing strategies accordingly.

In addition, studies such as those by Arbatli *et al.,* (2016) and Lomivorotov and Ponomarenko (2018) have examined the effects of oil price volatilities on GDP growth and unemployment rates in countries heavily reliant on oil revenues, such as Russia. This research can provide valuable insights for investors considering investments in industries or regions that are particularly sensitive to oil price fluctuations.

Overall, empirical research on the macroeconomic impact of oil price volatilities can help investors and businesses make more informed decisions about resource allocation, expansion plans, and risk management strategies by providing insights into the potential effects of oil price fluctuations on key economic indicators.

Understanding the dynamics of global energy markets, particularly the roles played by the United States and Russia, is essential for comprehending the broader implications of oil price volatilities. Research in this area sheds light on how fluctuations in oil prices can affect the economies of these two major players and, consequently, impact global energy dynamics.

The United States has undergone a remarkable transformation in its energy landscape in recent years, largely due to advancements in shale oil and gas extraction technologies. This has propelled the country into a leading position in global energy markets, significantly altering the dynamics of supply and demand (Fattouh *et al.,* 2016). As such, understanding how oil price volatilities influence the US economy is crucial for gauging the overall stability and direction of global energy markets.

Similarly, Russia holds a significant position in global energy markets as one of the world's largest oil producers and exporters. The Russian economy is heavily dependent on oil revenues, making it particularly sensitive to fluctuations in oil prices (Apergis & Miller, 2009). Research on the macroeconomic impact of oil price volatilities in Russia provides insights into how changes in oil prices can reverberate throughout global energy markets, affecting supply, demand, and pricing dynamics. These insights can inform decision-making processes for policymakers, industry stakeholders, and investors, helping them anticipate and navigate shifts in global energy markets.

3. METHODOLOGY

This study seeks to contribute macroeconomic implications of oil price volatilities by employing a simultaneous equations model approach to analyze the specific case of the Russia economy. The study use rigorous empirical analysis and robust econometric techniques aims to enhance the complex relationship between oil prices and macroeconomic variables. We deployed the system of econometric equations, which consists of 3 equations. The regression model is presented in a log-linear form.

$$GDP = C_1 + C_2\, ln(consu_t) + C_3\, ln(inv_t) + C_4\, ln(exp_t) \quad (1)$$

$$INV = C_5 + C_6\, ln(inv_{t-1}) + C_7\, ln(oil_t) + C_8\, ln(gdp_t - gdp_{-1}) \quad (2)$$

$$Exp = C_9 + C_{10}\, ln(oil_{t-1}) + C_{11}\, ln(consu_t) + C_{12}\, ln(inv_t - inv_{t-1}) \quad (3)$$

where GDP – GDP in real terms, INV – investment in real terms, C – constant, $consu$ – consumption in real terms, EXP – export in real terms, oil – price of crude oil, t – index of year.

The main exogenous variable that determines the dynamics of an open economic system is the fluctuations in the price of crude oil. The endogenous variables defined within the system are real GDP and its main structural components.

4. RESULTS AND DISCUSSION

The first equation (1) specifies the value of real GDP, the size of which consists of three basic pillars: domestic consumption, export value, and investment. The variables depend on many exogenous factors, in particular, oil prices. The system evaluated using the least squares method in the statistical package. When estimating the parameters of the model, as already mentioned above, the annual values of macroeconomic indicators were used in the period from 1991-2016. As a result, estimates of the parameters of the behavioral equations obtained in Figures 1-3 were obtained.

The values of all model variables were obtained using public sources of information. Annual data on GDP and its components for the period beginning from 1991-2016 are posted on the official website of the Federal Reserve (Apergis & Miller, 2009). Data on the price of oil are taken from the analytical portal of the NASDAQ exchange as shown in Table 1.

Table 1: Estimation of the parameters of the GDP function

Dependent Variable: LOG(GDP)				
Method: Least Squares				
Date: 01/24/18 Time: 20:19				
Sample: 1991 2016				
Included observations: 26				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.950497	0.032206	29.51314	0.0000
LOG(CONSUMPTION)	0.910081	0.012235	74.38433	0.0000
LOG(INVESTMENT)	0.033946	0.013406	2.532192	0.0190
LOG(EXPORT)	0.000255	0.001068	0.238850	0.8134
R-squared	0.999693	Mean dependent var		9.344900
Adjusted R-squared	0.999652	S.D. dependent var		0.340423
S.E. of regression	0.006354	Akaike info criterion		-7.138966
Sum squared resid	0.000888	Schwarz criterion		-6.945413
Log likelihood	96.80656	Hannan-Quinn criter.		-7.083230
F-statistic	23916.00	Durbin-Watson stat		0.538938
Prob(F-statistic)	0.000000			

Source: Research Panel Data

The study result revealed that the verification of significance, we can say with confidence that the real values of the significance level of the consumption factor and investment are less than 0.05. This means that we cannot discard these factors in the equation under consideration. The impact of these factors on GDP is significant. Coefficients under the factors are positive, i.e. the relationship of indicators is direct. At the same time, the factor of domestic consumption is of overwhelming importance as shown in Table 1.

The equation (2) reflects the correlation of investment activity in the US economy from the level of oil prices and real GDP growth (accelerator effect). The specification of the partial adjustment model is also used when the actual consumption is gradually "adjusted" to the variation of the previous value. It is based on the hypothesis that the level of oil prices affects investment activity as follows:

First, the high oil prices directly expand the investment opportunities of the budget and the backbone oil companies; Secondly, because one of the main sources of monetary base formation in the economy is raw materials export earnings, therefore, high oil prices lead to a softening of monetary policy, including an increase in the money supply and a reduction in the discount rate, which, of course, positively affects investment activity; Third, the forecast for oil prices is largely formed based on the current price level, and accordingly when oil prices rise, they change into larger forecast estimates of the prospects for generating operating cash flows from projects not only sold in the commodity sector and oriented to external demand, but and focused on satisfying domestic demand in connection with the expected growth of the purchasing power of the population and mitigating financial constraints for business and the public sector (Fattouh *et al.,* 2016).

Table 2: Estimation of the parameters of the investment function

Dependent Variable: LOG(INVESTMENT)				
Method: Least Squares				
Date: 01/24/18 Time: 20:18				
Sample (adjusted): 1992 2016				
Included observations: 25 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.237557	0.225225	1.054754	0.3035
LOG(INVESTMENT(-1))	0.924512	0.033642	27.48120	0.0000
LOG(OILPRICE)	0.052804	0.015356	3.438762	0.0025
LOG(GDP)-LOG(GDP(-1))	4.202839	0.441456	9.520414	0.0000
R-squared	0.988742	Mean dependent var		7.601753
Adjusted R-squared	0.987134	S.D. dependent var		0.311320
S.E. of regression	0.035313	Akaike info criterion		-3.703505
Sum squared resid	0.026187	Schwarz criterion		-3.508485
Log likelihood	50.29381	Hannan-Quinn criter.		-3.649415
F-statistic	614.7918	Durbin-Watson stat		0.994360
Prob(F-statistic)	0.000000			

Based on the results of verification of significance, we can say with confidence that the real significance level of the significance of all factors is less than 0.05. This means that we cannot discard any of the factors in the equation under consideration. And the impact of these factors on investment is significant. Coefficients under the factors are positive, i.e. the relationship of indicators is direct. We draw attention to the fact that the price of oil has a direct impact on investment, which confirms our hypothesis. In particular, when the price of crude oil is increased by 1%, the investment will grow by 5.2%. as shown in Table 2.

The inverse processes can take place with a drop in oil prices this will lead the investments to be squeezed as a result of a reduction in the current financial capacity of the budget and large companies, pessimistic expectations about the prospects for implementing new investment projects and tightening monetary policy.

To take into account seasonality, the annual dummy variables were not introduced into the equation, in order to obtain the most realistic results. In addition, the nature of the adaptation of economic agents to a new level of oil prices determines the need to include in the equation a lagged level of investment in real terms as shown in Figure 6.

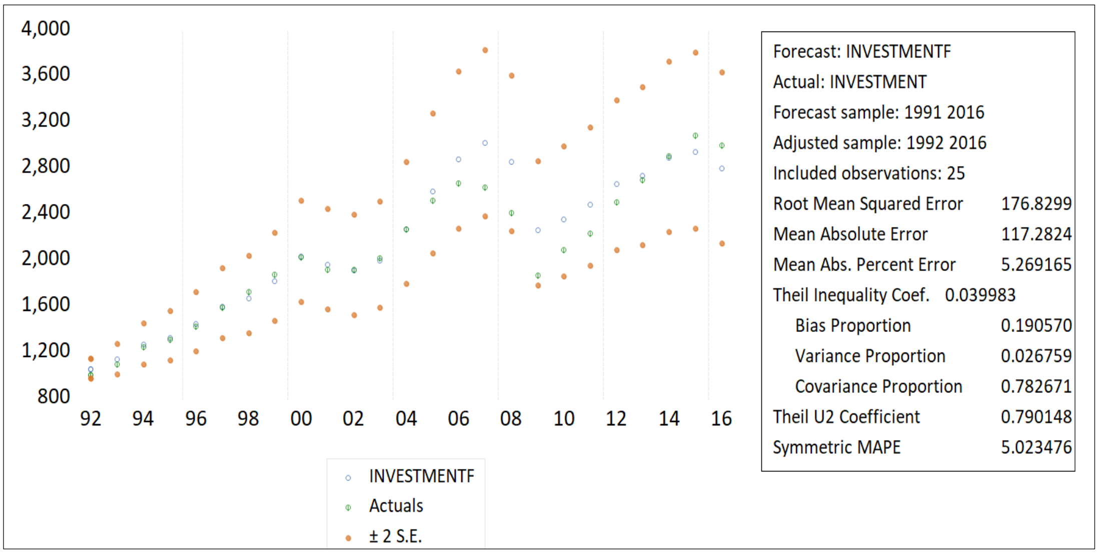

Figure 6: Check for normality by the Jarque-Bera method

The Equation (3) determines the export volumes in real terms. As the main factors of formation of the volume of exports, the level of oil prices and the exchange rate of the ruble against the US dollar are considered (assuming that the weakening of the ruble stimulates exports). To take into account, the seasonality of export deliveries, quarterly dummy variables are introduced into equation (3) as shown in Table 3.

Table 3: Evaluation of export function parameters

Dependent Variable: LOG(EXPORT)				
Method: Least Squares				
Date: 01/23/18 Time: 21:43				
Sample (adjusted): 1992 2016				
Included observations: 25 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-5.258959	7.667770	-0.685852	0.5003
LOG(OILPRICE)	-0.046484	0.467293	-0.099475	0.9217
LOG(CONSUMPTION)	1.206727	1.014502	1.189477	0.2475
LOG(INVESTMENT)-LOG(INVESTMENT(-1))	14.65926	2.034241	7.206256	0.0000
R-squared	0.713816	Mean dependent var		6.069766
Adjusted R-squared	0.672932	S.D. dependent var		1.391255
S.E. of regression	0.795657	Akaike info criterion		2.526349
Sum squared resid	13.29446	Schwarz criterion		2.721369
Log likelihood	-27.57936	Hannan-Quinn criter.		2.580439
F-statistic	17.45976	Durbin-Watson stat		1.869251
Prob(F-statistic)	0.000006			

The obtained results confirm the hypotheses put forward on the dependence of the export level on the oil price level. On the example of the consumption function, we check the consistency of the conclusions we have drawn, for which we will check the quality of the model. To do this, we first check the function for normality. The study conducts the heteroscedasticity test. (Apergis & Miller, 2009) the results are shown in figure 5. Based on the results, we can conclude that the distribution of model errors is really slightly different from normal. The next step is to check for heteroscedasticity. To do this, we plot the calculated, actual and residual values (Fig. 7).

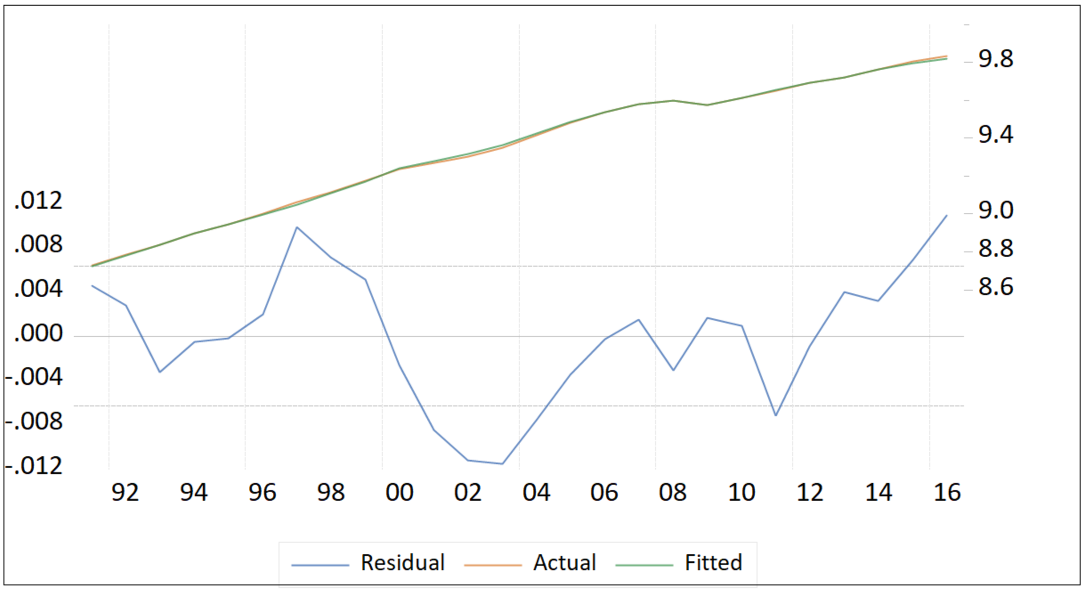

Figure 7: Check for heteroscedasticity in the E-views package

Having made a visual analysis of the graph of the residues, we concluded heteroscedasticity because there are groups of observations with a small dispersion of values and with a large spread. In addition to visual analysis, we analyze the test results see Table 4.

Table 4: Trace Test for Cointegrating equation

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.** Critical Value**
None *	0.180644	4.582438	3.841465	0.0323
Trace test indicates 1 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Max-eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.** Critical Value**
None *	0.180644	4.582438	3.841465	0.0323
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Data: Research Panel Data (2024)

The findings show that, the probability of heteroscedasticity is quite large, which confirms our earlier conclusions. Having carried out these tests, we can confidently state the sufficient accuracy of our model.

The main exogenous variable that determines the dynamics of an open economic system is the fluctuations in the price of crude oil. The endogenous variables defined within the system are real GDP and its main structural components see Table 5.

Table 5: Cross-sectional ADF unit root test

Null hypothesis: Unit root for specified cross-section					
Lag selection: AIC with maxlag = 6					
Test results:					
		CADF		**Truncated CADF**	
Cross-section	**ADF lags**	**t-stat**	**p-value**	**t-stat**	**p-value**
CPI	6	-2.93270	>=.10	-2.93270	>=0.10
EXCHANGERATE	6	-73.67889	<0.01	-6.42000	<0.01
EXPORT	6	-2.29124	>=.10	-2.29124	>=0.10
GDP	6	-4.64208	<0.05	-4.64208	<0.05
LGEXCHANGERATE	6	-10.47865	<0.01	-6.42000	<0.01
LGCPI	4	-4.25536	<0.05	-4.25536	<0.05
LGEXPORT	6	-1.69921	>=.10	-1.69921	>=0.10
LGGDP	6	-4.28039	<0.05	-4.28039	<0.05
LGOILPRICE	6	-1.38168	>=.10	-1.38168	>=0.10
OILPRICE	6	-0.50892	>=.10	-0.50892	>=0.10

Data: Research Panel Data (2024)

Furthermore, because one of the main sources of monetary base formation in the economy is raw materials export earnings, therefore, high oil prices lead to a softening of monetary policy, including an increase in the money supply and a reduction in the discount rate, which, of course, positively affects investment activity.

Thus the third, the forecast for oil prices is largely formed based on the current price level, and accordingly, when oil prices rise, they change into larger forecast estimates of the prospects for generating operating cash flows from projects not only sold in the commodity sector and oriented to external demand (Kilian and Pack, 2009).It is focused on satisfying domestic demand in connection with the expected growth of the purchasing power of the population and mitigating financial constraints for businesses and the public sector. As the main factors of formation of the volume of exports, the level of oil prices and the exchange rate of the ruble against the US dollar are considered (assuming that the weakening of the ruble stimulates exports) as show in Table 5.

To take into account, the seasonality of export deliveries, quarterly dummy variables are introduced into equation (3). The values of all model variables were obtained using public sources of information. Annual data on GDP and its components for the period beginning from 1991-2016. Data on the price of oil are taken from the analytical portal of the NASDAQ exchange (Morana,2001). The changes in the factors listed above determine the changes in revenues from gas production and exports (Ferraro *et al.,* 2015).

We used the following formula to estimate the change in oil and gas revenues compared to the forecast values:

$$\delta D = a\sum D_o + b\sum D_g - \sum D_b \qquad (4)$$

where is the change in revenues compared to budget 2015, a – correction factor for oil revenues, - amount of planned revenues from production and export of petroleum products in 2015, b – correction factor for gas revenues, D_o- amount of planned oil revenues in 2015, D_g- amount of planned gas revenues in 2015, D_b – amount of oil and gas revenues, which is equal to $\Phi\left(D_o + D_g\right)$.

Thus, the problem boils down to finding correction factors a and b on the basis of the above-mentioned factors of influence on revenues from the production and sale of petroleum products and gas. The formula for calculating the correction factor a is as follows:

$$a = \frac{\sum\left(R_n * P_n * S_n * E_n * T_n\right)}{12}, n = [1,L\ ,12] \qquad (5)$$

where R is the coefficient of change in the average monthly exchange rate of the us dollar to the Russian ruble, P is the coefficient of change in the average monthly prices of Urals oil, E is the coefficient of change in the average monthly volumes of oil exports, S is the coefficient of change in the average monthly oil production, T is the coefficient of change in the average monthly tax rates, n is the number of months.

Since the factor of the export duty on oil has a significant weight in the structure of oil and gas revenues of the Federal budget.

$$\sum(S_n * T_n) = \sum\left[\frac{M_n + 2}{3}\right] \quad (6)$$

where M is coefficient of change of export duty on oil products.

$$a = \frac{\sum\left(R_n * P_n * E_n * \frac{M_n + 2}{3}\right)}{12}, n = [1, \ldots, 12] \quad (7)$$

Gas prices are strongly correlated with oil prices. Most long-term contracts of Russian gas exporters imply that gas export prices are directly dependent on natural gas stock prices with a time lag of about 6-9 months. While European and Asian exporters (Norway, Netherlands, Qatar) sell gas mainly at stock quotes (Morana,2001). Taking into account the peculiarities of taxation of gas revenues (rates of export duties and taxes on gas production are not significantly affected by the dynamics of exchange gas prices), the formula for calculating the coefficient b is as follows:

$$b = \frac{\sum\left(R_n * P_{n-6} * N_p\right)}{12}, n = [1, \ldots, 12] \quad (8)$$

where is coefficient of change in the average monthly exchange rate of us dollar to the Russian ruble, P is the coefficient of change in the average monthly prices for URALS oil price, N is the coefficient of change in the average monthly volumes of gas exports, n is the number of months (Narayan,2011).

5. RESULTS

Our system was evaluated using the least squares method in the statistical package E-views. When estimating the parameters of the model, as already mentioned above, the annual values of macroeconomic indicators were used in the period from 1991-2016. As a result, estimates of the parameters of the behavioral equations were obtained.

Based on the results of the verification of significance, we can say with confidence that the real values of the significance level of the consumption factor and investment are less than 0.05. This means that we cannot discard these factors in the equation under consideration.

The impact of these factors on GDP is significant. Coefficients under the factors are positive, i.e. the relationship of indicators is direct. At the same time, the factor of domestic consumption is of overwhelming importance.

Based on the results of the verification of significance, we can say with confidence that the real significance level of the significance of all factors is less than 0.05. This means that we cannot discard any of the factors in the equation under consideration. And the impact of these factors on investment is significant. Coefficients under the factors are positive, i.e. the relationship of indicators is direct. We draw attention to the fact that the price of oil has a direct impact on investment, which confirms our hypothesis. In particular, when the price of crude oil is increased by 1%, the investment will grow by 5.2%.

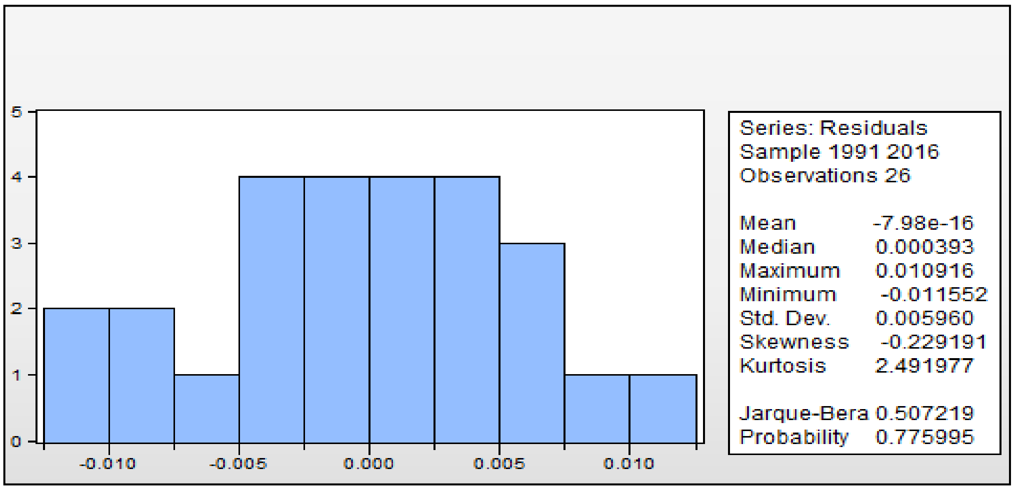

Figure 8: Check for normality by the Jarque-Bera method

The obtained results confirm the hypotheses put forward on the dependence of the export level on the oil price level. On the example of the consumption function, we check the consistency of the conclusions we have drawn, for which we will check the quality of the model. We analyzed the function for normality in the E-views package we will conduct the Jarque-Bera test. Based on the results, the distribution of model errors is really slightly different from normal. We tested heteroscedasticity and we plot the calculated, actual and residual values (Fig. 8). Having made a visual analysis of the graph of the residues, we concluded heteroscedasticity because there are groups of observations with a small dispersion of values, and with a large spread. Therefore, the probability of heteroscedasticity is quite large, which confirms our earlier conclusions. Having carried out these tests, we can confidently state the sufficient accuracy of our model.

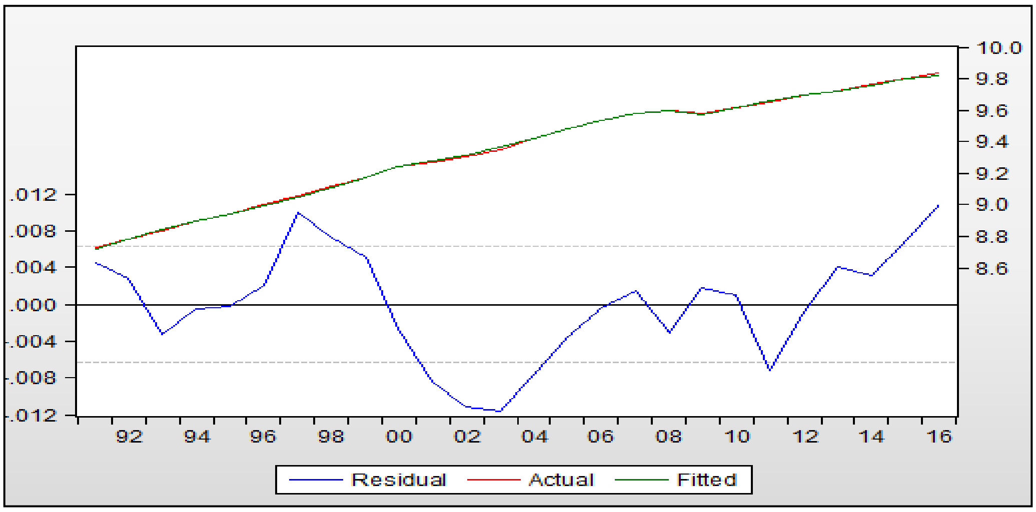

Figure 9: Check for heteroscedasticity

To use the above model, we will use data from the economic development Ministry forecast for 2015. (Figure 9) provides the initial data for modelling. In accordance with the main directions of the budget policy of the Russian Ministry of Finance the budget for 2015 includes the following forecast values:1. Average annual price for Urals oil is 96 dollars per barrel. 2. Average rate of the dollar to 37 rubles to US dollar.3. Oil and gas revenues at the level of 6818 bln. Russian rubles. Taking into account the preservation of structural proportions, revenues from the production and export of petroleum products were projected at 5420 bln. Russian rubles and revenues from gas production and export - at 1398 bln. Russian rubles.

The Federal budget losses in 2015 from the export and production of oil products in the amount of 967 bln. Russian rubles and the positive effect of gas exports in the amount of 94 bln. Russian rubles, which indicates the positive impact of the current situation on the revenues from gas production and export in 2015. Taking into account the lag described above, the negative impact on budget revenues in the decline in gas prices will take place mainly in 2016 (see figure 10).

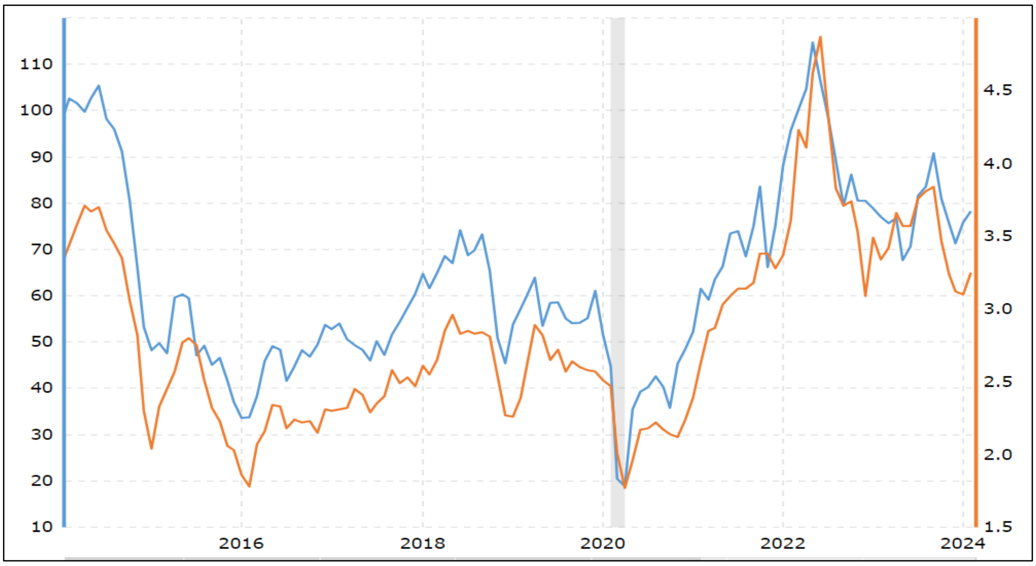

Figure 10: Revenues Projection 2016 - 2024, bln. Russian rubles 10yrs
Source: Brent Crude Oil

In accordance with the described model, under current assumptions and factors of influence, the study reveal that a reduction in Federal budget revenues by 874 bln. Russian rubles. Since the Federal budget for 2015 includes a forecast for oil and gas revenues at the level of 6818 bln. Russian rubles, the decline will not exceed 13% of all oil and gas revenues, which will change the income structure and can benefit the Russian economy in the future.

We investigated the effect of oil prices in oil exporting crude oil price and it was found that positive shocks in oil prices negatively affect macroeconomic indicators.

6. CONCLUSION

In conclusion, this study seeks to shed light on the macroeconomic impact of oil price volatilities on the USA and Russian economies using a simultaneous equations model approach. By examining the transmission mechanisms and policy implications of oil price shocks, this research aims to provide valuable insights for policymakers, investors, and other stakeholders. Through rigorous empirical analysis and robust econometric techniques, this study contributes to our understanding of the complex relationship between oil prices and macroeconomic variables in two of the world's largest economies. The result of this work can be considered confirmation of the hypothesis of the sensitivity of US macroeconomic indicators on the dynamics of oil prices. The US economy is currently diversified, so we can assume stable growth even in the period of shock prices for oil, which is confirmed by the statistics that were used in the model. But Russian economy not so diversified from energy markets. The reason for this is the innovative-oriented model of economic development, and one cannot ignore the slate revolution that has allowed the United States to become one of the world export leaders in the commodity sector. By the way, the key question is whether the growth of investments in the oil industry will help to cope with the negative consequences for the economy at higher oil prices. Under current conditions, higher, ever-predicted oil prices are not required for investment in shale oil production, given the speed with which shale can react to price changes compared to conventional oil production. High oil prices can stimulate investment, and, consequently, job creation, which in general contributes to GDP growth. Given the unstable conditions in the commodity markets, this has a positive impact on the strengthening of the stability of budget revenues in the future (Segal, 2011) and (Singer 2011). Taking into account the peculiarities of Russia's institutional development, it is the crisis that can be an appropriate moment for restructuring the economy towards increasing the share of innovative goods and technologies in the structure of production and exports (Tuzova, *et al.,* 2016).

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