The Impact of the Global Stock Market on the Russian Oil and Gas Sector before and during the Pandemic

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Annotation: The statistical dependencies of the RTS stock indicators and the oil and gas sector of the Russian stock market on the dynamics of the indicators of the global stock market and its oil and gas sector are studied. The experimental calculations were carried out and the main factors influencing the dynamics of this market in 2006-2019 (before the pandemic) and in 2020-2021 (during the pandemic) were identified. Calculations were carried out both on the dynamics of the RTS index and on the stock quotes of the largest companies of PJSC LUKOIL, NK Rosneft and PJSC Gazprom.
Key words: Stock Markets, Global Stock Indexes, Stock Indicftors, Global Oil Sector, RTS Index, Russian Oil and Gas Companies, Statistical Dependence, Pandemic, Statistical Analysis, PJSC LUKOIL, NK Rosneft, PJSC Gazprom.

Влияние глобального фондового рынка на российский нефтегазовый сектор до и во время пандемии

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Аннотация: Исследованы зависимости фондовых индикаторов РТС и нефтегазового сектора российского фондового рынка от динамики индикаторов глобального фондового рынка и его нефтегазового сектора. Поведены экспериментальные расчеты и выявлены

основные факторы, влиявшие на динамику этого рынка в 2006-2019 гг. (до пандемии) и в 2020-2021 гг. (во время пандемии). Расчеты проведены как в целом по динамике индекса РТС, так и по котировкам акций крупнейших компаний ПАО «ЛУКОЙЛ», НК «Роснефть» и ПАО «Газпром».

Ключевые слова: фондовые рынки, фондовые индексы, фондовые индикаторы, индекс РТС, глобальный нефтяной сектор, российские нефтегазовые компании, статистическая зависимость, пандемия, статистический анализ, ПАО «ЛУКОЙЛ», НК «Роснефть», ПАО «Газпром».

Introduction

In recent decades, due to the globalization of the world economy, it has become almost axiomatic to say that the global stock market has an increasing influence on national stock markets. However, in our previous works [1-3] based on the study of economic and statistical methods of macroeconomic trends and benchmarks of investors in the stock markets of the BRIC countries and Germany in the years 2006-2019, and the impact on these markets global resource and technology sectors in complex with oil prices and other factors, it was shown that this influence is not always single-valued in the different periods of its role changes significantly, especially in the years of political crises and trade wars. In addition, the process of globalization and the presence of close links between stock market indicators affects the preferences of investors when purchasing securities of certain companies. One of the first studies of such preferences was performed by De Bondt Werner F.M. & Thaler Richard [4], later by T. Odean [5], Wermers Russ [6], Nofsinger John R. & Sias Richard W. [7].

What has changed in the context of the new type of coronavirus pandemic in this regard? How did the temporary partial separation of economies affect these processes and the market position of Russian companies, especially large companies in the oil and gas sector, whose share in Russian stock indices totals more than a third?

Methodology

Based on the economic and statistical tools [8] described in the works cited above [1-3], statistical dependences of stock indices of the oil and gas sector of the Russian stock market on the dynamics of indicators of the global stock market and its oil and gas sector are studied. Analysis of sufficiently long time series of daily quotes and meanings for the presence of stationarity using an extended test of the Dickey-Fuller [9] and autocorrelation by building the VAR model (testing linear combinations of the rows on the long-term stability [10]) gave negative results [1], which is absolutely legitimate, given the practically absence of the long-term trends in the stock market. This makes it possible to evaluate the mutual influence of indicators by using a series of linear correlation equations and selecting time intervals during which each of them is valid.

The experimental calculations are performed and the main factors influencing the dynamics of this market in 2006-2019 (before the pandemic) and in 2020-2021 (during the pandemic) are identified. Calculations were made both for the RTS index and for quotes of the largest companies of PJSC LUKOIL, NK Rosneft and PJSC Gazprom [11].

Results and discussion

The dynamics of daily stock quotes of these companies in comparison with the dynamics of the complex indicator of the USO oil futures price and the S&P500 index is shown in Fig. 1. We can see the growth of indicators before the pandemic, their sharp decline at the beginning of the pandemic, and then a new growth, but with a local short-term collapse in October 2020 of PJSC LUKOIL shares: apparently, a sharp rise in the previous period was played out, but then everything returned to the usual trajectory.
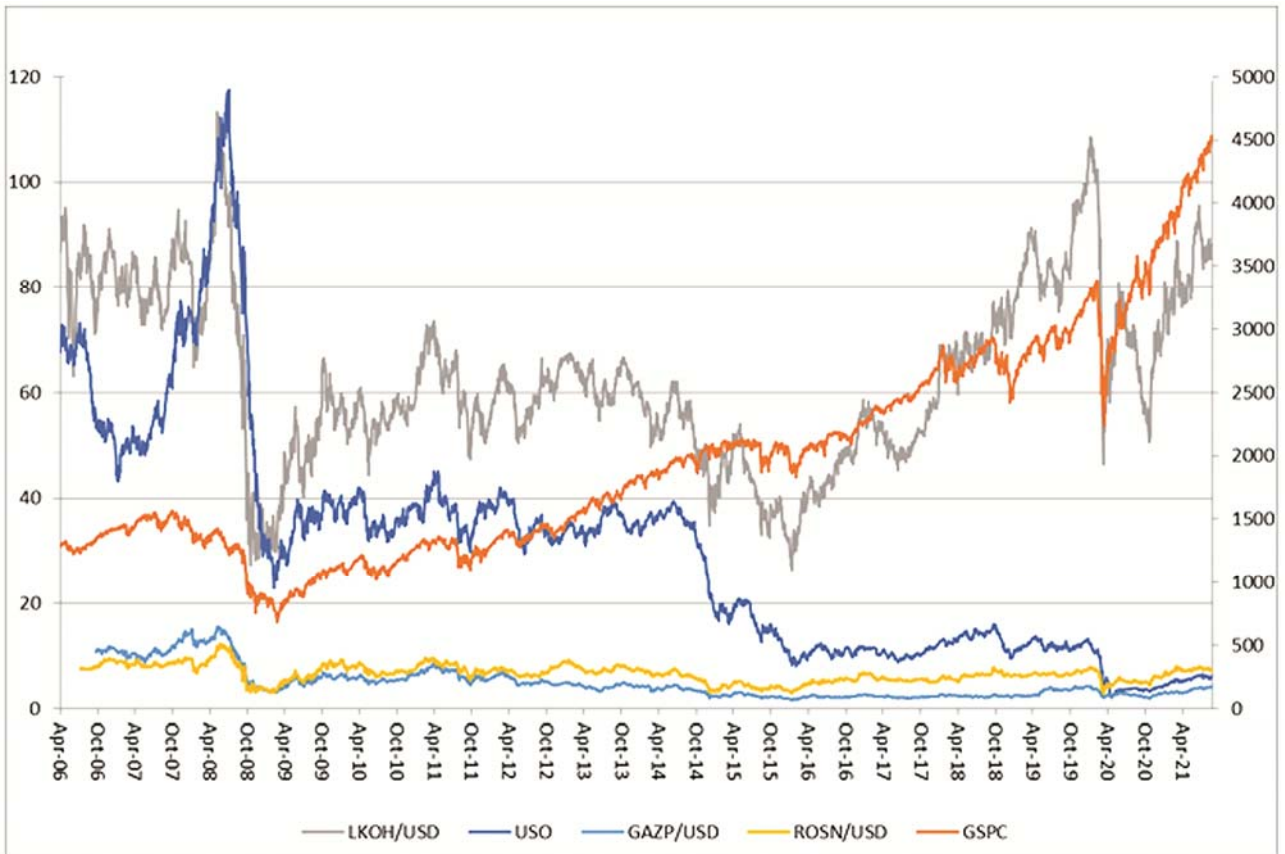
Fig. 1. Dynamics of USO indicator, stock prices of NK Rosneft, PJSC LUKOIL, PJSC Gazprom and the S&P500 index in 2006–2021

Dependence of the RTS index on the USO oil futures price indicator

First, we will analyze the relationship between the RTS dynamics and the USO dynamics [12], that is, we will evaluate the impact of the latter indicator on the dynamics of the Russian stock index as a whole. The results of calculating their mutual correlation over the time periods established in the course of calculations are presented in Diagram 1, where periods of statistically significant dependence are highlighted in bold, as in all subsequent tables. In Figure 1, the results for the most important period from September 2012 to August 2021 are shown as straight regression lines.

As can be seen from Table 1, the dynamics of the RTS index throughout the entire period is largely determined by the dynamics of the composite indicator USO (of the oil futures price), but there are periods when the correlation temporarily disappears, usually before and during crises with a sharp collapse or increase in the volatility of the USO. Thus, before the crisis of 2014, the link that had been close and very close for many years noticeably weakened (lines 10-13 and 15 in Diagram 1), and then it was restored again (lines 16-18).

Table 1

Dependence of the RTS index (*y*) on the USO oil futures price indicator (*x*)

No of dependencies in diagram 1	Validity period	Regression equation	Coefficient of determination (R^2)
1	25.04.2006 — 13.12.2006	y = − 7.12x + 2028.85	0.1847
2	**14.12.2006 — 18.01.2008**	**y = 15.82x + 1082.85**	**0.8459**
3	**22.01.2008 — 23.06.2008**	**y = 12.63x + 1024.22**	**0.8471**
4	**24.06.2008 — 17.12.2008**	**y = 22.53x – 411.07**	**0.9206**
5	**18.12.2008 — 14.05.2010**	**y = 68.73x – 1300.75**	**0.7841**
6	**17.95.2010 — 28.10.2011**	**y = 62.35x – 596.18**	**0.7380**
7	**31.10.2011 — 13.09.2012**	**y = 37.37x + 110.47**	**0.7098**
8	**14.09.2012 — 04.12.2012**	**y = 34.89x + 310.59**	**0.7706**
9	**05.12.2012 — 13.03.2013**	**y = 35.55x + 359.86**	**0.9150**
10	14.03.2013 — 23.04.2013	y = 41.00x + 66.83	0.5366
11	24.04.2013 — 30.12.2013	y = − 3.45x + 1508.40	0.0083
12	06.01.2014 — 28.02.2014	y = − 24.76x + 2209.05	0.5848
13	03.03.2014 — 04.08.2014	y = 71.11x –1397.94	0.6385
14	**05.08.2014 — 16.12.2014**	**y = 30.23x + 139.33**	**0.8852**
15	17.12.2014 — 17.03.2015	y = 0.70x + 805.46	0.0003
16	**18.03.2015 — 90.10.2015**	**y = 50.86x + 22.17**	**0.8475**
17	**12.10.2015 — 17.02.2016**	**y = 30.18x + 435.07**	**0.7410**
18	**18.02.2016 — 10.05.2016**	**y = 73.82x + 122.05**	**0.8182**
19	11.05.2016 — 06.07.2016	y = 28.07x + 587.40	0.1757
20	07.07.2016 — 01.11.2016	y = 31.50x + 632.86	0.4659
21	**02.11.2016 — 31.01.2017**	**y = 116.07 + 192.05**	**0.7976**
22	**01.02.2017 — 05.04.2018**	**y = 65.06x + 421.57**	**0.8291**
23	06.04.2018 — 13.11.2018	y = 11.29x + 974.52	0.0436
24	**14.11.2018 — 28.05.2019**	**y = 46.53x + 638.02**	**0.7609**
25	29.05.2019 — 06.01.2020	y = 103.46x + 160.27	0.5486
26	**08.01.2020 — 06.03.2020**	**y = 94.67x + 476.25**	**0.7951**
27	10.03.2020 — 16.04.2020	y = 11.92x + 951.18	0.0152
28	**17.40.2020 — 31.08.2021**	**y = 164.16x + 644.47**	**0.9136**

Since May 2019, before the pandemic, the statistical link between indicators weakened (line 25), followed by its strengthening in January — February 2020 (line 26), after which the link was completely broken with the onset of turbulence in the stock market at the beginning of the pandemic (line 26) in March — mid-April, when the indicators fell sharply, but not synchronously. However, then a very close statistical relationship was established, which remained in 2021, and with a very high coefficient of determination of 0.91 and the maximum regression coefficient for the entire period (the "steepest" line is 28). This means that the RTS index is very sensitive to changes in the USO indicator.

It is significant that qualitatively similar results were obtained by a group of Turkish scientists who studied of the dynamics of the Turkish stock index RBIST100 and indicators of the financial, industrial and service sectors at the beginning of the pandemic (February-October 2020) using economic and mathematical methods. A sharply negative short-term reaction of these indicators to the contraction of the economy was revealed, with subsequent compensation in the medium term [13].
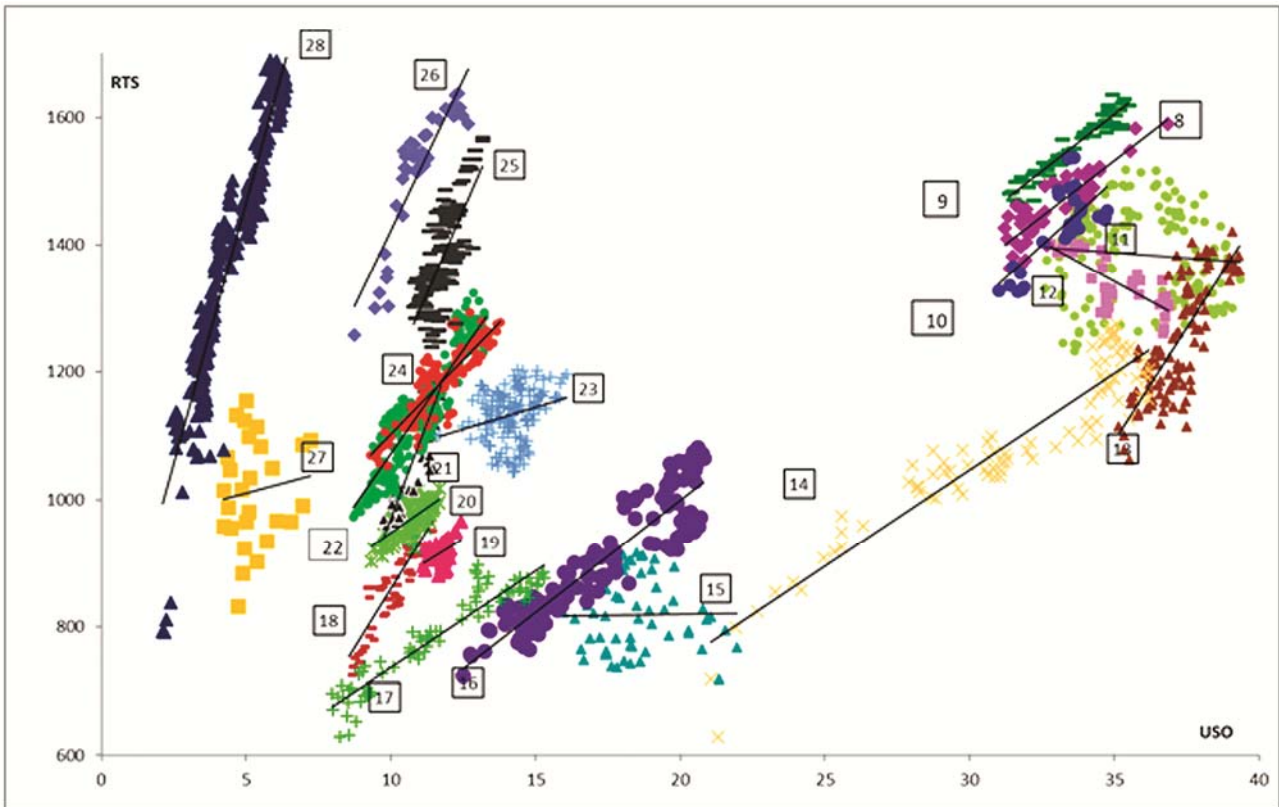
Diagram 1. Changes in the nature of the dependence of the RTS index on USO in 2012-2021

Dependence of PJSC LUKOIL's share prices
from the USO oil futures price Indicator

A similar but not quite identical situation was observed in relation to the share prices of PJSC LUKOIL (LKOH indicator). Table 2 shows the equations of the dependence of LKOH on the USO indicator calculated by us for different periods and the corresponding diagram 2.

As we can see, the share prices of the LUKOIL company in comparison with the RTS index depend statistically significantly on the USO indicator for a shorter period of time. At the same time, changes in the periods before and during the pandemic are very similar.

Table 2

Dependence of PJSC LUKOIL's share prices (y) on the USO indicator (x)

No of dependencies in diagram 2	Validity period	Regression equation	Coefficient of determination (R^2)
1	10.04.2006 — 13.06.2007	y = 2.79x − 109.54	0.466
2	**02.08.2006 — 17.10.2006**	**y = 0.89x + 27.01**	**0.888**
3	18.10.2006 — 02.02.2007	y = 0.85x + 40.70	0.558
4	05.02.2007 — 27.06.2007	y = 1.22x + 18.14	0.208
5	28.06.2007 — 22.08.2007	y = 1.40x + 2.23	0.355
6	23.08.2007 — 15.01.2008	y = 0.65x + 40.80	0.606
7	**16.01.2008 — 07.05.2008**	**y = 0.84x + 9.64**	**0.779**
8	08.05.2008 — 20.06.2008	y = − 0.18x + 125.91	0.044
9	**23.06.2008 — 17.11.2008**	**y = 1.07x − 24.31**	**0.948**
10	18.11.2008 — 11.02.2009	y = − 0.14x + 37.35	0.072

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11	12.02.2009 — 06.04.2009	y = 1.42x – 3.66	0.799
12	07.04.2009 — 11.06.2009	y = 1.02x + 15.81	0.893
13	15.06.2009 — 29.12.2009	y = 2.19x – 28.55	0.489
14	30.12.2009 — 05.07.2016	y = 0.86x + 27.94	0.756
15	06.07.2016 — 26.10.2018	y = 4.85x + 0.14	0.855
16	29.10.2018 — 03.12.2018	y = 1.29x + 57.94	0.387
17	04.12.2018 — 05.04.2019	y = 6.26x + 10.15	0.912
18	08.04.2019 — 19.11.2019	y = 1.92x + 60.17	0.237
19	20.11.2019 — 06.03.2020	y = 2.04x + 74.81	0.101
20	08.01.2020 — 06.03.2020	y = 6.70x + 26.82	0.742
21	10.03.2020 — 21.04.2020	y = 1.37x + 53.92	0.057
22	22.04.2020 — 08.07.2020	y = 11.91x + 35.87	0.889
23	09.07.2020 — 31.08.2021	y = 10.03x + 27.78	0.876
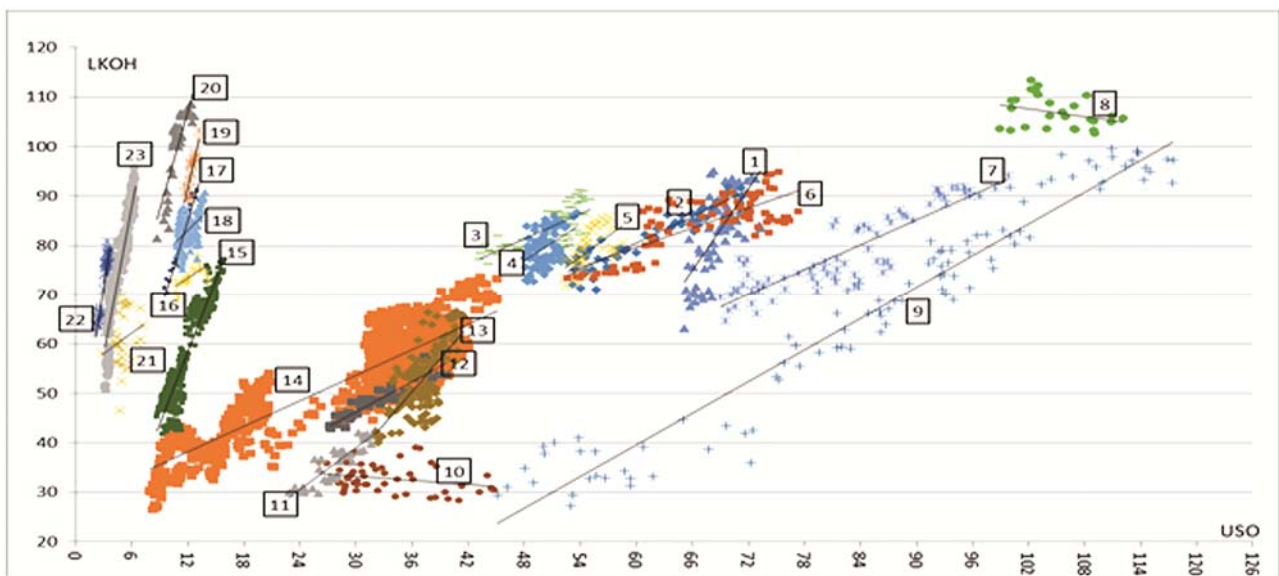
Diagram 2. Change in the dependence of PJSC LUKOIL shares on USO in 2006-2021

In the Table 2 and particularly evident in Diagram 2 are not visible very close relationship between the studied parameters before the pandemic (line 20). We can see the practical absence (a large scatter of points) at the beginning of the pandemic (line 21) and a sharp increase in statistical significance in times of pandemic (22 and 23), when the points are densely as if "stuck" straight regression lines, which are more "cool" than other. It means that the growth or decline USO leads to a much more significant growth or decline in shares of PJSC "LUKOIL" than before the pandemic.

Dependence of Rosneft's share prices
from the USO oil futures price indicator

As can be seen from Table 3 and Diagram 3, a statistically significant dependence of Rosneft's share prices on USO is observed in fewer periods than LUKOIL's shares, and these periods do not always coincide.

Table 3

Dependence of Rosneft's share prices (y) on USO (x)

No of dependencies in diagram 3	Validity period	Regression equation	Coefficient of determination (R^2)
1	20.07.2006 — 04.10.2006	y = − 0.02x + 8.74	0.476
2	05.10.2006 — 19.07.2007	y = 0.01x + 8.02	0.004
3	**20.07.2007 — 18.01.2008**	**y = 0.05x + 5.51**	**0.710**
4	**22.01.2008 — 03.10.2008**	**y = 0.12x – 1.54**	**0.786**
5	06.10.2008 — 05.03.2009	y = 0.01x + 3.06	0.207
6	06.03.2009 — 14.09.2009	y = 0.15x + 0.61	0.606
7	15.09.2009 — 23.11.2011	y = 0.25x – 1.46	0.636
8	**25.11.2011 — 21.09.2012**	**y = 0.14x + 1.52**	**0.707**
9	24.09.2012 — 07.12.2012	y = − 0.41x + 20.88	0.672
10	10.12.2012 — 21.02.2014	y = 0.01x + 7.25	0.001
11	**24.02.2014 — 03.02.2015**	**y = 0.18x – 0.02**	**0.948**
12	04.02.2015 — 03.03.2016	y = 0.11x + 2.34	0.655
13	04.03.2016 — 06.03.2020	y = 0.26x + 2.92	0.270
14	10.03.2020 — 20.04.2020	y = 0.01x + 3.96	0.001
15	**21.04.2020 — 31.08.2021**	**y = 0.96x + 1.88**	**0.905**

In the Table 3 the periods 3, 4, 8, and 11 are highlighted in bold. The relationship between LKOH and USO was significant during these periods. However, before and at the beginning of a pandemic, the coefficient of determination drops to almost zero in March — April 2020, and then rises to 0.9, thereby showing a very significant positive relationship with the highest regression coefficient for the entire study period.
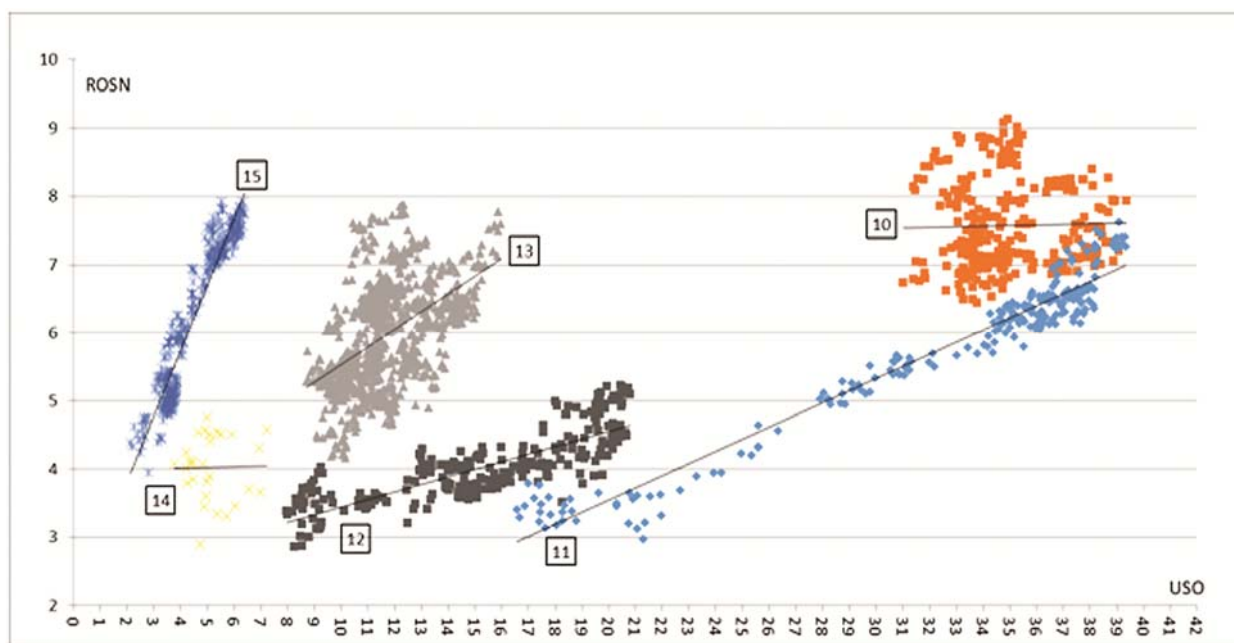

Diagram 3. Change in the dependence of Rosneft shares on USO in 2012-2021.

Dependence of Gazprom's share prices
from the USO oil futures price indicator, the UNG gas futures composite, and the "The Henry Hub pipeline" indicator

Calculation data presented in Table 4 and in Diagram 4 shows a similar dependence on the dynamics of USO stock prices of PJSC LUKOIL, Rosneft and PJSC Gazprom, with the non-fundamental difference during the pandemic period that in April — July 2020, when the coefficient of determination in Table 4 is 0.7 (line 16). This is lower than for the same period in Tables 2 and 3 (about 0.9). Diagram 4 also shows a sharp increase in the steepness of regression lines between the end of April 2020 and the end of August 2021. This indicates that Gazprom's share prices are becoming more sensitive to the growth of the global oil sector.

Next, we investigated the dependence of shares of PJSC "Gazprom" on the following indicators: composite futures UNG [14] (basket of futures contracts on natural gas traded on exchanges in the U.S., Europe and other countries) and the indicator of "The Henry Hub pipeline" (indicator futures prices on the New York Mercantile Exchange [15]).

As shown by the calculations (Tables 5 and 6 and diagrams 5 and 6), Gazprom's share prices are more dependent on the oil futures price than on the composite indicators of gas futures prices: the coefficients of determination during the pandemic period for the indicator are about 0.9 and 0.6, respectively. The insignificance of the relationship is clearly visible in Diagrams 5 and 6, where the spread of points from regression lines 9-13 is similar to amorphous clouds.

Table 4

Dependence of Gazprom's share prices (y)
from the USO oil futures price indicator (x)

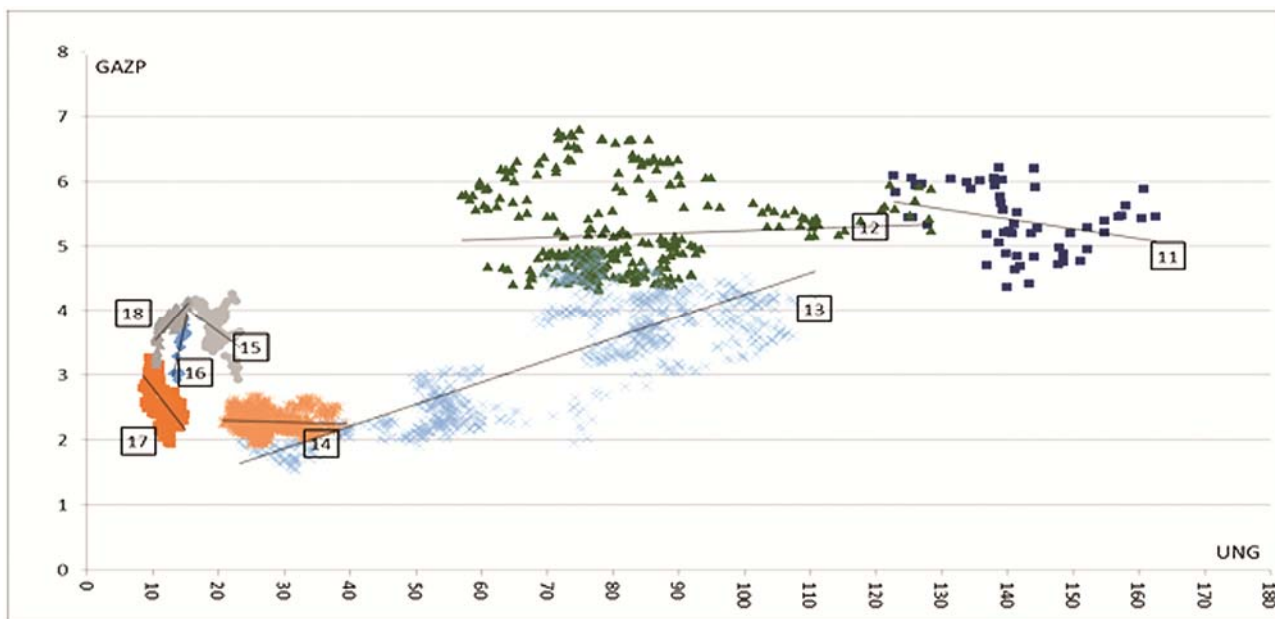| No of dependencies in diagram 4	Validity period	Regression equation	Coefficient of determination (R^2)
1	04.10.2006 — 21.05.2007	y = 0.09x + 6.06	0.167
2	**22.05.2007 — 29.11.2007**	**y = 0.12x + 3.72**	**0.845**
3	30.11.2007 — 18.01.2008	y = 0.08x + 8.04	0.153
4	**22.01.2008 — 25.06.2008**	**y = 0.07x + 6.80**	**0.807**
5	**26.06.2008 — 29.10.2008**	**y = 0.18x – 6.77**	**0.963**
6	30.10.2008 — 19.03.2009	y = 0.05x + 1.98	0.676
7	20.03.2009 — 12.10.2010	y = 0.15x – 0.08	0.631
8	**13.10.2010 — 02.11.2011**	**y = 0.27x – 3.51**	**0.771**
9	**03.11.2011 — 17.01.2013**	**y = 0.19x – 1.51**	**0.805**
10	18.01.2013 — 12.08.2014	y = – 0.01x + 4.52	0.003
11	**13.08.2014 — 26.03.2015**	**y = 0.08x + 0.88**	**0.936**
12	**27.03.2015 — 22.02.2016**	**y = 0.10x + 0.76**	**0.902**
13	24.02.2016 — 13.05.2019	y = 0.05x + 1.68	0.246
14	14.05.2019 — 26.02.2020	y = 0.13x + 2.16	0.095
15	27.02.2020 — 20.04.2020	y = 0.12x + 1.76	0.605
16	**21.04.2020 — 13.07.2020**	**y = 0.30x + 1.77**	**0.700**
17	**14.07.2020 — 31.08.2021**	**y = 0.57x + 0.30**	**0.901**
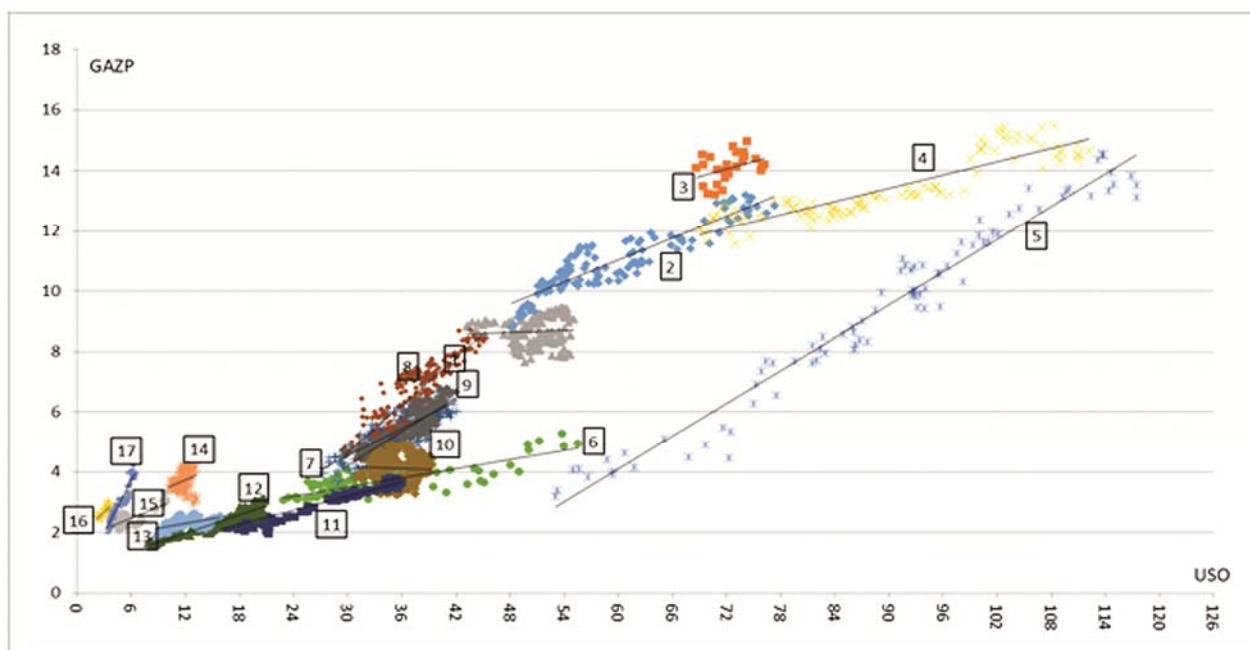
Diagram 4. Changes in the nature of dependence of PJSC Gazprom shares of the USO oil futures price in 2006-2021

<div align="right">Table 5</div>

**Dependence of Gazprom's share prices (y)
from the UNG (x) gas futures composite**

| No of dependencies in diagram 5	Validity period	Regression equation	Coefficient of determination (R^2)
1	**18.04.2007 — 09.08.2007**	**y = − 0.004x + 15.57**	**0.736**
2	10.08.2007 — 03.10.2007	y = 0.001x + 9.307	0.070
3	04.10.2007 — 28.12.2007	y = − 0.01x + 23.54	0.532
4	09.01.2008 — 11.02.2008	y = 0.004x + 7.520	0.018
5	**12.02.2008 — 03.10.2008**	**y = 0.01x + 1.45**	**0.812**
6	06.10.2008 — 06.03.2009	y = 0.003x + 1.439	0.640
7	11.03.2009 — 05.05.2009	y = − 0.004x + 6.214	0.309
8	06.05.2009 — 26.08.2009	y = 0.005x + 2.991	0.258
9	27.08.2009 — 29.10.2010	y = 0.005x + 4.391	0.295
10	01.11.2010 — 07.09.2011	y = 0.002x + 6.637	0.000
11	08.09.2011 — 23.11.2011	y = − 0.02x + 7.60	0.098
12	25.11.2011 — 05.03.2013	y = 0.003x + 4.911	0.005
13	06.03.2013 — 14.03.2016	y = 0.03x + 0.85	0.656
14	15.03.2016 — 13.05.2019	y = − 0.003x + 2.374	0.007
15	14.05.2019 — 17.01.2020	y = − 0.08x + 5.18	0.203
16	21.01.2020 — 05.03.2020	y = 0.44x − 2.75	0.581
17	06.03.2020 — 04.05.2021	y = − 0.13x + 4.08	0.379
18	05.05.2021 — 31.08.2021	y = 0.12x + 2.32	0.608

Diagram 5. Changes in the nature of the dependence of the quotations of PJSC Gazprom shares from gas composite UNG in 2009-2021

<div align="right">Table 6</div>

**Dependence of Gazprom's share prices (y) on the futures market
gas composite "The Henry Hub pipeline" (x)**

No of dependencies in diagram 6	Validity period	Regression equation	Coefficient of determination (R^2)
1	04.10.2006 — 11.01.2008	$y = -0.029x + 11.24$	0.0003
2	14.01.2008 — 03.10.2008	$y = 0.933x + 3.27$	0.589
3	23.05.2008 — 25.02.2009	$y = 0.486x + 1.032$	0.531
4	26.02.2009 — 04.05.2009	$y = -1.05x + 7.85$	0.552
5	05.05.2009 — 15.12.2010	$y = 0.192x + 4.768$	0.088
6	16.12.2010 — 15.12.2011	$y = 0.27x + 2.27$	0.392
7	16.12.2011 — 17.12.2013	$y = -0.962x + 7.859$	0.604
8	**18.12.2013 — 27.09.2016**	**$y = 0.027x + 1.154$**	**0.804**
9	28.09.2016 — 13.05.2019	$y = 0.062x + 2.112$	0.026
10	14.05.2019 — 27.02.2020	$y = -0.098x + 3.911$	0.008
11	28.02.2020 — 10.12.2020	$y = -0.280x + 3.049$	0.215
12	11.12.2020 — 10.05.2021	$y = 0.020x + 2.933$	0.035
13	11.05.2021 — 31.08.2021	$y = 0.317x + 2.675$	0.613
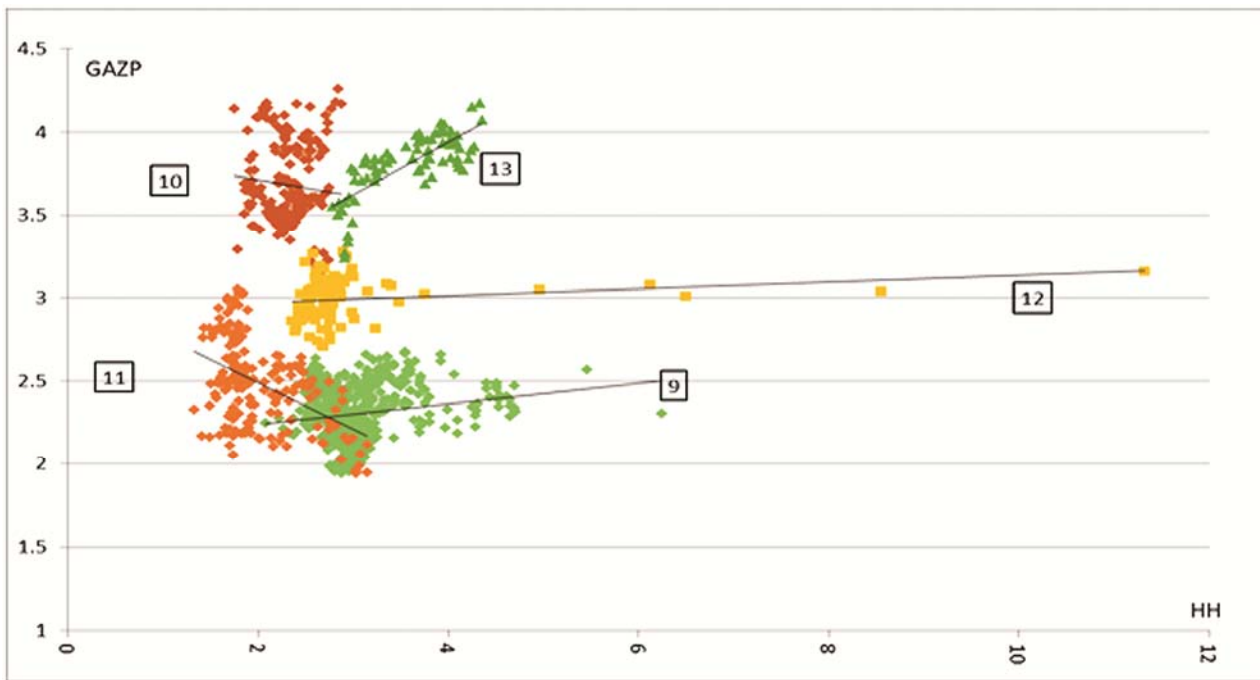
Diagram 6. Changes in the nature of the dependence of the quotations of PJSC Gazprom shares from the gas composite "The Henry Hub pipeline" in 2009-2021.

Inferences

The calculations showed that during the period 2006 – early 2020, the dynamics of the RTS index and stock prices PJSC LUKOIL and NK Rosneft were largely determined by the dynamics of the composite indicator of the USO oil futures price, but there were periods when the correlation temporarily disappeared, usually before and during crises with a rapid collapse or high volatility of the indices, as during the 2014 crisis.

Before the pandemic and the beginning of it the determination coefficient of a statistical link between futures composite USO and index RTS, as well as between USO and quotations of the shares of PJSC LUKOIL and Rosneft fell to almost zero in March and April 2020, and then increased to 0.9, thereby demonstrating a highly significant positive correlation with the highest regression coefficient for the entire period of the study.

The statistical relationship between Gazprom's share prices and the global gas sector indices of the stock market is generally not significant. Although there is an increase in statistical dependence here, but only from May 2021 and with relatively low values of the coefficient of determination (about 0.6). There are two reasons for this: PJSC Gazprom primarily sells gas under long-term contracts, and the company's shares are considered by investors primarily as part of the overall package of company shares in the Russian oil and gas sector.

Conclusion

Thus, the COVID-19 pandemic contributed to a sharp increase in the positive dependence of the oil and gas sector of the Russian stock market and large Russian companies on the global stock *indicator*s of the oil (but not gas) sector of the world stock market. The sensitivity of the RTS index and stock prices of major oil and gas companies to changes in the composite oil futures price has also increased. Investors who buy shares of these Russian companies are largely guided by the performance of the oil sector of the global stock market. It means that the pandemic has significantly increased the processes of globalization in the Russian stock market.

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