Analysis of the Impact of Sanctions on Systemic Risks for Russian Companies

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***Abstract*—Governments of the United States and European Union countries as well as some international organizations enforce economic sanctions on some Russian companies and banks in 2014. The sanctions resulted in the weakening of the Russian ruble and led to the ongoing recession of the Russian economy. In this paper we examine the impact of sanctions on systemic risks for some Russian companies using CoVaR, one of the most popular systemic risk measures proposed by M. Brunnermeier and T.Adriany in 2011. The measure provides an opportunity to estimate the mutual influence of certain institutions or the mutual influence of the financial system and a particular institution. The analysis is focused on the static and dynamic models of the CoVaR estimation. The results show that the sanctions has brought some negative effects of an disintegration of financial intermediation both for banks and some companies.**

***Index Terms*—systemic risks, risk measures, Value-at-Risk, quantile regressions, financial risk.**

I. Introduction

Nowadays the entire world economy is a complex system. First of all, that means high degree of interdependence not only between the economies of different countries but also between separate sectors of national economies. Insufficient identification of these links and their influence on the institutions of these sectors lead to the increasing systemic risk. The crisis of 2008 showed that systemic risk threatens financial economic system as a whole. The possible consequences include the deepest depression due to the so-called knock-on effect of the separate institutions and sectors falling into distress one after another [1], [2], [3]. Thus, problems of early detection, prediction and prevention of the factors contributing to the appearance and developing of systemic risk are the priorities of the modern science. One of the most widely spread measures of risk nowadays is the value at risk (VaR) [4] that focuses on the risk of an individual institution in isolation. It shows that with the certain rate of probability potential losses would not exceed the VaR value calculated for the specified period. However, this value does not evaluate risks for the entire financial system.

The aim of the paper is to examine the effect of sanctions on some Russian companies using static and dynamic models of the systemic risk measure CoVaR. This value was proposed by American economists Tobias Adriany and Markus K. Brunnermeierz in [5], [6]. To emphasize the systemic nature of the risk measure, its name contains prefix 'Co', which stands for conditional, contagion, or comovement.

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Our analysis includes the following four biggest Russian companies from different sectors:

- Gazprom (LSE:OGZD), the largest Russian company in the field of extraction, production, transportation, and sale of natural gas;
- Cherkizovo Group (LSE:CHE), the largest meat manufacturer in Russia;
- Magnit PAO (MGNT:LSE), a Russia-based holding company engaged in the food retail industry;
- Sberbank (SBER:LSE), the largest state-owned Russian banking and financial services company.

The first analysis of systemic risks for Russian companies using CoVaR was presented in the paper [7]. As it is pointed out in [7], CoVaR and its derived values are extremely promising from the point of view of financial risk-management, especially for the detection of potential danger for the economic system and companies inside it under systemic risks. The work [7] also demonstrates the capabilities of CoVaR to analyze of the Russian market and shows the adequacy of the obtained values of CoVaR to the real state of economy.

In the empirical part of the paper we use the method of quantile regressions to estimate CoVaR and its derived values.

II. Definitions

Given a confidence level $q \in (0,1)$, Value-at-Risk (VaR) of a random variable $r_{i,t}$ is defined as the solution of the equation

$$\Pr\left(r_{i,t} \leq \mathrm{VaR}^{i}_{q,t}\right) = q.$$

In other words, $\mathrm{VaR}^{i}_{q,t}$ is implicitly defined through the q-quantile of the conditional distribution of $r_{i,t}$. Usually (as well as in this paper), $r_{i,t}$ refers to the log return of the financial institution i at time t. Theoretical properties and practical applications of VaR can be found in the book [4]. Nowadays, VaR is one of the most well-known risk measures and is widely used by regulators and banks all over the world.

To start with, CoVaR calculated for the specific institution conditional on the whole system is defined as the Value at Risk of the whole financial sector conditional on that institution being under distress.

Let us now give the formal definition of CoVaR measure as it was proposed in [5] or [6].

$\mathrm{CoVaR}^{j|C(r_{i,t})}_{q}$ is the value equal to the $\mathrm{VaR}^{j}_{q,t}$ of institution j (with log return $r_{j,t}$) conditional on some event $C(r_{i,t})$ of institution i. That is, $\mathrm{CoVaR}^{j|C(r_{i,t})}_{q,t}$ is implicitly defined by the q-quantile of the conditional probability distribution:

$$\Pr\left(r_{j,t} \leq \mathrm{CoVaR}^{j|C(r_{i,t})}_{q,t} | C(r_{i,t})\right) = q.$$

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In the papers [5] and [6], $C(r_{i,t})$ refers to distress of institution i and that event of distress occurs when the return of institution i is equal to its VaR, i.e $r_{i,t} = \mathrm{VaR}^i_{q,t}$. In addition to that, works [5] and [6] define the event of median state of an institution as the event when an institution's return is equal to its median, i.e. $r_{i,t} = \mathrm{VaR}^i_{0.5,t}$.

Then we have a legitimate question about the difference between the CoVaR value estimated for institution j conditional on institution i being under distress and in its normal state. That kind of difference is the measure of the contribution of institution i to the risk of institution j and is denoted as $\Delta\mathrm{CoVaR}^{j|i}$.

Thus, $\Delta\mathrm{CoVaR}^{j|i}_{q,t}$ measures the influence of the institution i on the institution j and is defined as follows:

$$\Delta\mathrm{CoVaR}^{j|i}_{q,t} = \mathrm{CoVaR}^{j|r_{i,t}=\mathrm{VaR}^i_{q,t}}_{q,t} - \mathrm{CoVaR}^{j|r_{i,t}=\mathrm{VaR}^i_{0.5,t}}_{q,t}.$$

The rest of the paper focuses on the conditioning distress event of $r_{i,t} = \mathrm{VaR}^i_{q,t}$.

The definition of the $\mathrm{CoVaR}^{j|i}_{q,t}$, namely the VaR of the institution j conditional on the institution i being at its VaR level, allows the study of the spillover effects of the whole process on the financial network. Furthermore, we can obtain value $\mathrm{CoVaR}^{j|\mathrm{system}}_{q,t}$, which can give an answer to the following question: which institutions are most at risk during financial crises due to the fact that it reports the increase of VaR of the institution in the case of a financial crisis in the system.

Papers [5], [6] note that CoVaR is directional, i.e. CoVaR of the system conditional on institution does not equal the CoVaR of institution conditional on the system.

III. CoVaR estimation methods

Estimation of the described value is a nontrivial task, and it can be handled with the help of a great variety of methods, particularly the method of quantile regressions, which has been chosen for the empirical part of the study. It is the method of the regression analysis commonly used in statistics and econometric theory [8], [9]. While ordinary least squares (frequently used in Russian studies) are focused on getting estimators approximating conditional mean value of the variable in the case of the defined incoming values, the quantile regression is directed to getting estimation either for 50% or for any other quantile. One more profit of this method is connected with the fact that it is more stable in case of getting the outlying values among incoming data. The case is that this kind of outlying values can be frequently met in practice, especially during the study of financial economic system.

It is also the case that there are two models of the CoVaR estimation the static model and the dynamic model.

A. The static model

The static model provides an opportunity to calculate CoVaR and ΔCoVaR values that are constant over time and independent of other exogenous factors. According to this model, CoVaR and ΔCoVaR estimation starts with the construction of the quantile regression to find estimated coefficients for institutions i and j.

The q-quantile regression describes the dependance of the predicted value of institution j for q-quantile $\hat{X}^{j,i}_q$ conditional on institution i:

$$\hat{X}^{j,i}_q = \hat{\alpha}^i_q + \hat{\beta}^i_q X^i, \tag{1}$$

where $\hat{X}^{j,i}_q$ presents the predicted value on the specified quantile and returns of the institution i. We concentrate on the case when $X^i = \mathrm{VaR}^i_q$, which means that the institution i is at its VaR level [5], [6].

Then, after getting the coefficients, we can find the CoVaR and ΔCoVaR values using the following equations:

$$\mathrm{CoVaR}^{j|r_i=\mathrm{VaR}^i_q}_q = \mathrm{VaR}^{j|\mathrm{VaR}^i_q}_q = \hat{\alpha}^i_q + \hat{\beta}^i_q \mathrm{VaR}^i_q, \tag{2}$$

The value of $\Delta\mathrm{CoVaR}^{j|i}$ is the difference between CoVaR of institution j conditional on the institution i being in distress and CoVaR of institution j conditional on median state of the institution i:

$$\Delta\mathrm{CoVaR}^{j|i}_q = \mathrm{CoVaR}^{j|r_i=\mathrm{VaR}^i_q}_q - \mathrm{CoVaR}^{j|r_i=\mathrm{Median}_i}_q = \\ = \hat{\beta}^i_q(\mathrm{VaR}^i_q - \mathrm{VaR}^i_{0.5}). \tag{3}$$

However, under the conditions of a real economy not only separate sectors should to be taken into consideration but also macroeconomic indicators which have a strong influence on the estimation results in case of dynamic pattern study. Dynamic model includes this kind of factors and provides an opportunity to capture time variation.

B. The dynamic model

Let M_{t-1} denote a vector of state variables included into the model. To capture time variation in the joint distribution of $r_{i,t}$ and $r_{j,t}$, the conditional distribution is estimated as a function of state variables [6]. Then to estimate time-varying CoVaR_t and VaR_t conditional on a vector of lagged state variables M_{t-1} we run the following quintile regressions in the weekly data:

$$r^i_{i,t} = \alpha^i + \gamma^i M_{t-1} + \epsilon^i_t \tag{4}$$

$$X^j_t = \alpha^{j|i} + \beta^{j|i} X^i_t + \gamma^{j|i} M_{t-1} + \epsilon^i_t \tag{5}$$

We then generate the predicted values from these regressions to get VaR_t, CoVaR_t and $\Delta\mathrm{CoVaR}_t$:

$$\mathrm{VaR}^i_{q,t} = \hat{\alpha}^i + \hat{\gamma}^i M_{t-1}, \tag{6}$$

$$\mathrm{CoVaR}^{j|r_i=\mathrm{VaR}^i_{q,t}}_{q,t} = \hat{\alpha}^{j|i} + \hat{\beta}^{j|i}\mathrm{VaR}^i_{q,t} + \hat{\gamma}^{j|i} M_{t-1}, \tag{7}$$

$$\Delta\mathrm{CoVaR}^{j|i}_{q,t} = \hat{\beta}^{j|i}(\mathrm{VaR}^i_{q,t} - \mathrm{VaR}^i_{0.5,t}). \tag{8}$$

As a result we obtain panels of weekly $\mathrm{CoVaR}^{j|\mathrm{VaR}^i_{q,t}}_{q,t}$ and $\Delta\mathrm{CoVaR}^{j|i}_{q,t}$. The systematic state variables M_{t-1} should not be interpreted as systematic risk factors, but rather as conditioning variables that are shifting the conditional mean and the conditional volatility of the risk measures [6].

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IV. Empirical Results

This part of the paper presents empirical results. Our analysis is based on the original observations of the weekly prices of four Russian companies being the part of the RTS index: Gazprom (LSE:OGZD), Cherkizovo Group (LSE:CHE), Magnit PAO (MGNT:LSE), Sberbank (SBER:LSE). The data was taken from January 09, 2011 to April 03, 2016. We used the RTS index as state variable and took 5% and 1% quantiles for the estimation.

We examine the mutual influence of the Russian companies. Moreover, the main question of interest is how did it changed after western countries had imposed sanctions. The first wave of sanctions against some Russian companies was introduced in April 2014 by the United States and Canada. Of course, the negative impact of sanctions appeared not immediately but quickly enough. Some companies have lost sources of cheap fast loans, some lost their purchases sources or markets. Later the Russian authorities have also introduced counter sanctions, which concerned mostly food producers.

Based on analysis of the Russian economica data, many researchers conclude that Russia economy is in a recession. Data show that GDP of the first quarter of 2015 is negative with -2.2% with comparison to the first quarter of 2014. Moreover, the cumulative effect of the sanctions and the sharp decline in oil prices in 2014 and 2015 has led to serious downward pressure on the ruble value. The process of flight of capital out of Russia has been enhanced. The sanctions on access to foreign financing have urged Russian government to use part of its fund and reserves to boost the Russian economy. In 2014 the Central Bank of Russian Federation ceased to support the value of the ruble and harshly increased interest rates. On the other hand, the impact of anti-Russian sanctions on the eurozone economy proved to be negligible. Average economic growth in the eurozone declined slightly. In 2014 negative euro-zone trade balance with Russia decreased only by $3.6 billion.

Accumulated losses from the sanctions of the Russian GDP amounted to 6 percentage points in 2014-2017 compared to the GDP in 2013. Capital flight triggered by sanctions is estimated at $160-170 billion over the same period.

Counter sanctions imposed by Russia in response to Western sanctions affected the inflation rate in the country. Based on the 2014 year data, the Ministry of Economic Development of Russian Federation estimated that the contribution of the counter sanctions to the annual inflation rate (11.4%) was about 1.5 percentage points. At the same time, the food price inflation in 2014 was equal to 15.4%, and 3.8 percentage points of it were due to sanctions.

In this paper we consider how the new economic situation affects on relations between the leading Russian companies in different sectors of economy. Descriptive statistics shows that log returns quantile for all probabilities and all companies become larger after the introduction of sanctions. In some sense it was the consequence of inflation processes. No one of the considered companies was in primary sanction list, but these sanctions, one way or another, touched all these companies. All of them are the leaders in their economy sectors. Cherkizovo is the leader in poultry and pork production, has a unique position in this list due to the absence of universal producers in food industry.

Let us note some facts connected with the relationships between these companies and some evident consequences of the sanctions. Sberbank credits Gazprom. Sberbank and Gazprombank credits several companies, including Magnit and Cherkizovo. Creditors are forced to increase credit rates. 56% of large and medium agrarian firms are Sberbank clients. Cherkizovo is oriented on its own production. In 2014 after introduction of the sanctions in view of prohibition for some food products import there was an upturn of Cherkizovo returns connected with meat production. But rouble devaluation can stop that rise because grain and forage are mainly bought abroad. Agrarians do not plan to invest cash in new infrastructures, because their managers do not believe that sanctions will be long-term.

Magnit has the following problem: it cannot supply all popular products. The largest Russian retailer changes the product line. It attempts to exclude foreign goods from its list. On the other hand, Magnit, which is interested in product quality, sometimes buys such products by nonstandard ways and pays fines. Some companies suffer the sanctions indirectly, through their affiliated companies. Such structures in Sberbank lose their opportunity for placing their assets long-term period. Gazprom as resource company has difficulties in equipment procurement.

TABLE I
Summary statistics of log returns for four Russian companies before sanctions (before 13.04.2014, 170 weeks), %

	Gazprom	Cherkizovo	Magnit	Sberbank
Mean	-0.26	-0.26	0.27	-0.25
Std.Dev	3.98	4.12	4.35	4.20
Min	-12.49	-19.01	-12.99	-15.22
Max	10.83	18.14	13.17	16.82
1% VaR	-11.56	-12.2	-12.17	-15.21
5% VaR	-7.01	-6.43	-7.51	-6.92
50% VaR	-0.29	-0.23	0.56	-0.03

TABLE II
Summary statistics of log returns for four Russian companies after sanctions (after 13.04.2014, 102 weeks), %

	Gazprom	Cherkizovo	Magnit	Sberbank
Mean	0.13	0.49	0.41	0.43
Std.Dev	3.57	3.83	4.77	4.87
Min	-8.31	- 7.70	-16.06	-10.42
Max	8.95	11.49	15.61	15.03
1% VaR	-7.03	-7.59	-10.39	-9.38
5% VaR	-5.14	-6.48	-6.66	-6.84
50% VaR	-0.50	0	0.73	0.04

Some results for the static model with ΔCoVaR values are given in the following tables. According to 1% estimates, critical situation (distress) in Sberbank has the most significant influence before sanctions on Gazprom and Cherkizovo (-13.21 against -0.09 and 0.03 for Gazprom, -0.14 against 0.02 and 0.0095 for Cherkizovo). Gazprom has insignificant advantage in its influence on Gazprom (-0.04 against -0.038), and we can ignore this fact. Magnit most strongly affects Sberbank, maybe significant credits can explain this

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fact. After the imposition of sanctions, prioritization of the effects has not changed. But modules of maximal values become (excluding Magnit), and we can explain these facts with decreasing economic activity and the level of mutual influence.

TABLE III
THE VALUES OF $\Delta\text{CoVaR}^{j|i}_{0.01}$ FOR STATIC MODEL, %

$j \setminus i$	Gazprom	Cherkizovo	Magnit	Sberbank
before sanctions				
Gazprom		-3.09	-8.78	-13.21
Cherkizovo	0.95		2.01	-14.43
Magnit	-4.04	-1.03		-3.79
Sberbank	-8.87	0.00	-11.05	
after sanctions				
Gazprom		-0.98	-2.94	-5.59
Cherkizovo	0.14		0.28	0.09
Magnit	-6.56	-3.37		-6.42
Sberbank	-7.94	-2.12	-0.66	

TABLE IV
THE VALUES OF $\Delta\text{CoVaR}^{j|i}_{0.05}$ FOR STATIC MODEL, %

	Gazprom	Cherkizovo	Magnit	Sberbank
before sanctions				
Gazprom		-3.62	-4.03	-4.78
Cherkizovo	-1.88		-2.77	-2.48
Magnit	-2.20	-1,31		-3.92
Sberbank	-4.89	-3.04	-6.26	
after sanctions				
Gazprom		0.03	-2.29	-3.29
Cherkizovo	0.82		-0.33	-0.29
Magnit	-4.90	-2.18		-3.46
Sberbank	-3.07	-1.93	-3.10	

We should note special situation connected with Cherkizovo. Almost all characteristics of influence on agrarians have positive sign, although they are very little. We can see opposite directions of movements for this company and three others during abrupt changes in economy, or about incipient "indifference" of company towards the businesses of three others. The company tries to find its own way. Producers, although slowly, stands on way of import substitution, but such decision would not be acceptable neither for banks, nor for retailers. 5% ΔCoVaR are not full copies of 1% ΔCoVaR, but we see not many significant changes. In this table we more distinctly see "indifference" for practically all companies on P/E ratios of other companies fluctuations from 50% level to 5% level. Therefore, 5% level, as opposed to 1% is not stressful.

The dynamic model shows (Fig. 1 and 2) approximately the same results, but it provides us not with a single precise value but with a panel of weekly values to capture time variation. That is why these results are presented in the form of graphics.

Let us comment values of ΔCoVaR for the analysis of influence of Sberbank on Cherkizovo shown in Fig. 1. We can see the jump of ΔCoVaR_t values (from -0.1 to -0.4)

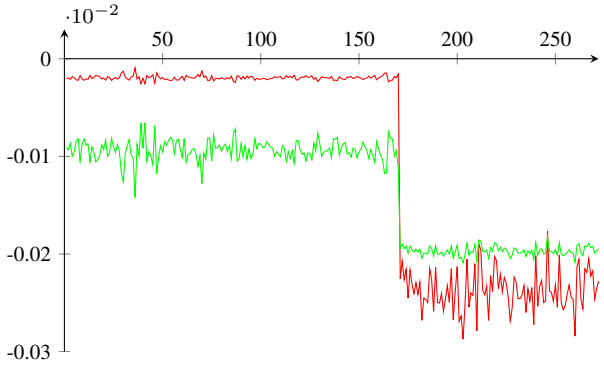

Fig. 1. Dynamics of $\Delta\text{CoVaR}_{0.01,t}$ (the red line) and $\Delta\text{CoVaR}_{0.05,t}$ (the green line) of Cherkizovo group conditional on Sberbank being under distress

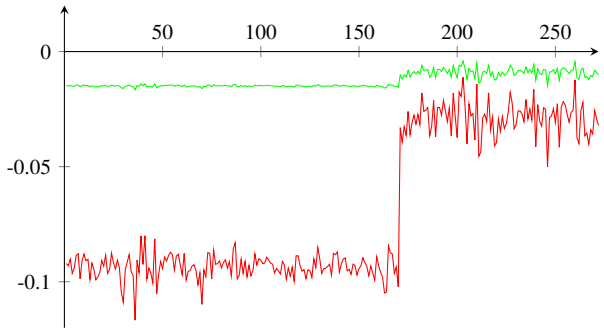

Fig. 2. Dynamics of $\Delta\text{CoVaR}_{0.01,t}$ (the red line) and $\Delta\text{CoVaR}_{0.05,t}$ (the green line) of Cherkizovo group conditional on Sberbank being under distress

for 1% level after imposing of the sanctions. As for 5% ΔCoVaR we can say that it preserve some stability during all the period, however in second period we can see certain fluctuations and the weakening the influence of Sberbank.

As for Cherkizovo influence on Sberbank we can observe (Fig. 1) the opposite dynamics but all ΔCoVaR values are very unsignificant.

V. CONCLUSION

We can make the following conclusions on the functioning of the Russian economy and its companies.

The Russian economy has been mostly focused on the B2B (business-to-business) model and this resulted (following the fall of the Russian ruble and oil prices) in decreasing of key sectors of the economy. It should be noted that energy and mining sectors give 80% of the total income of the Russian economy. The income of businesses working for the Russian government have sank for at least 30 % in 2014. As the result of the ruble weakening, the funding of many government programs was suspended. The B2B company lost a huge part of their orders. This, in turn, this led to falling consumer demand due to the cuts of real incomes.

Before sanctions many Russian companies took loans in the EU banks at 2-3% per annum. Loans in the Russian banks (17-19% per annum) were not profitable. The sanctions have forced the companies to lend in Russian banks, which can be clearly seen from the data of $\Delta\text{CoVaR}_{0.05}$ in Table IV. For example, the impact of Gazprom on Sberbank has changed from -4.89 to -0.04. This indicates that after the sanctions Gazprom began to borrow from Russian banks and increased

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profitability of Sberbank. This positive effect is also observed in other pairs of companies.

The main problem in the development of Russian economy is the weak government support of the B2C (business-to-customer) market. The prices of consumer products depend strongly on the US dollar/ Ruble rate. As the result of the dollar rate growth and reducing real incomes, the Russian consumer market significantly dipped. Moreover, companies that produce the products, the component parts for which are bought in dollars, were forced to reduce production. Therefore, sanctions have led to the necessity to create its own production of the component parts and goods for end consumers. The table IV shows that the Sberbank effect on some B2C companies became more significant (for example, $\Delta\mathrm{CoVaR}$ of the pair Sberbank—Magnit has changed from -3.79% to -6.42%).

On the other hand, the counter sanctions and the weak Ruble have led to a sharp rise of the agricultural industry, since agricultural products of Russian companies became competitive in the Russian market. The results in Table IV confirm this. For example, before sanctions the impact of Cherkizovo on Magnit is equal to

$$\Delta\mathrm{CoVaR}_{0.05}^{\mathrm{Magnit}|\mathrm{Cherkizovo}} = -1,31\%,$$

while after the sanctions it is equal to -2,18%.

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