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RTSI volaility: impact of oil price volatility and sanctions

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Motivation

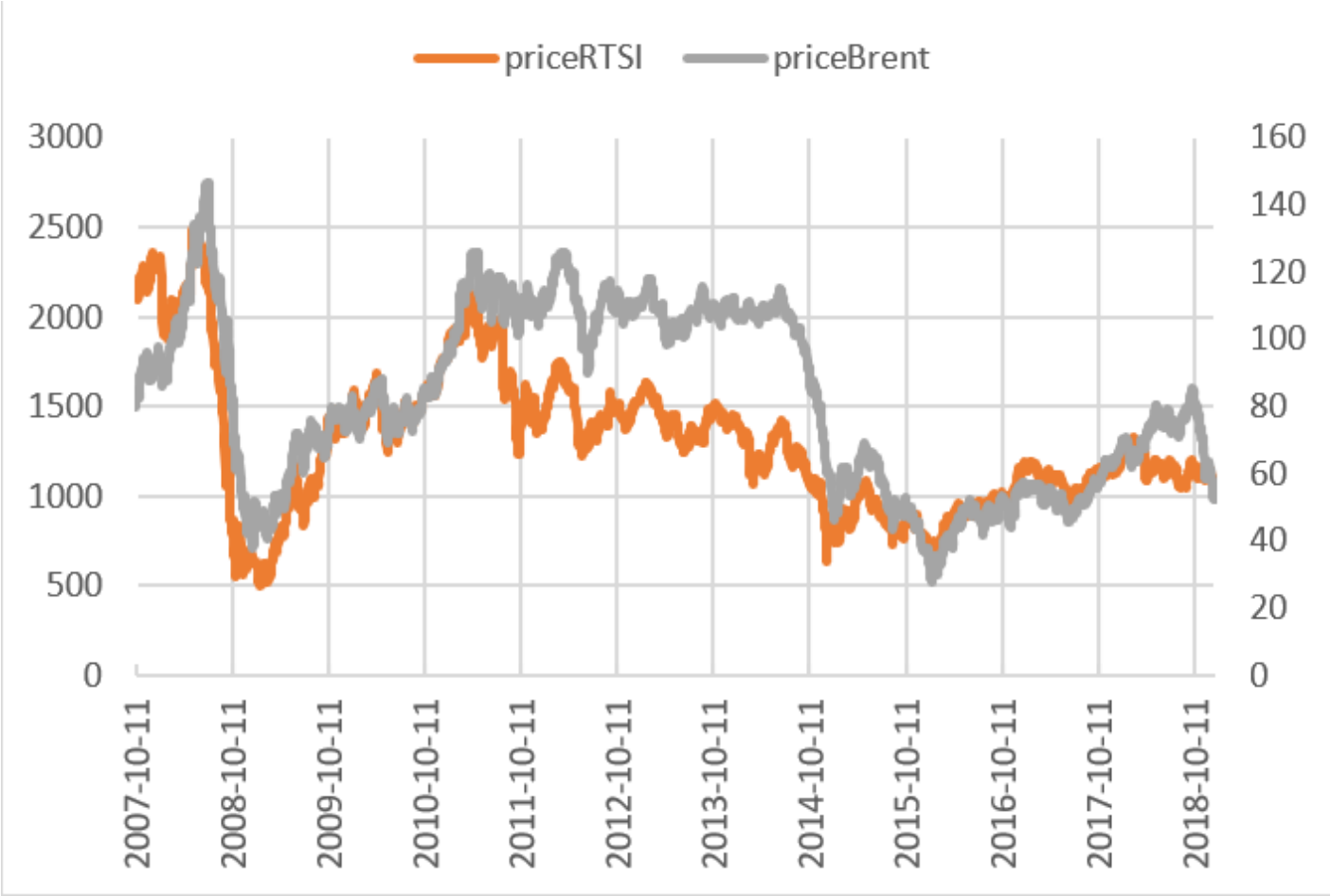
RTSI is a main index of Russian stock market and therefore an important indicator of Russian economy.
A number of papers have found influence of oil price volatility on volatility of stock market indicators in oil-exporting countries, including Russia. But very little was said about such effect since 2014 and Ukranian crysis.

- How much RTSI volatility is defined by the oil price volatility?
- Do sanctions impact RTSI volatility?
- To what extent?

Literature

- Dependence of MICEX index on oil prices was found in (Bein,Aga 2016)
- In (Degiannakis, et. al 2018) authors tried to summarize conclusions of many papers, dedicated to oil price and oil price volatility effect on stock market indicies.
- Kholodilin, Netšunajev (2019) analyzed impact of sanctions on Russian GDP. They discover little evidence of GDP decrease due to sanctions.
- Factors, influencing Russian stock market during 2008-2017 were analyzed in (Rubtsov, Annenskaya, 2018). Authors came to conclusion that during 2014-2017 sanctions were the main driver of Russian stock market.

Exchange rate & Brent



Daily quotes of RTSI (left axis) and Brent oil prices (right axe) on interval 10.10.2007-31.12.2018

How can we model volatility?

1. Data frequency:
   - intraday
   - daily
   - weekly;
2. Model dimensionality:
   - One-dimensional models - GARCH family
   - Multidimensional models - BEKK(1,1), DCC(1,1), GHAR(1,1);
3. In-sample data size;
4. Macroeconomic factors selection.

AR(1)-TGARCH(1,1)

(Zakoian, 1994) and (Glosten, Jaganathan, Runkle, 1993)

$$r_t = \mu + \rho r_{t-1} + \varepsilon_t,$$

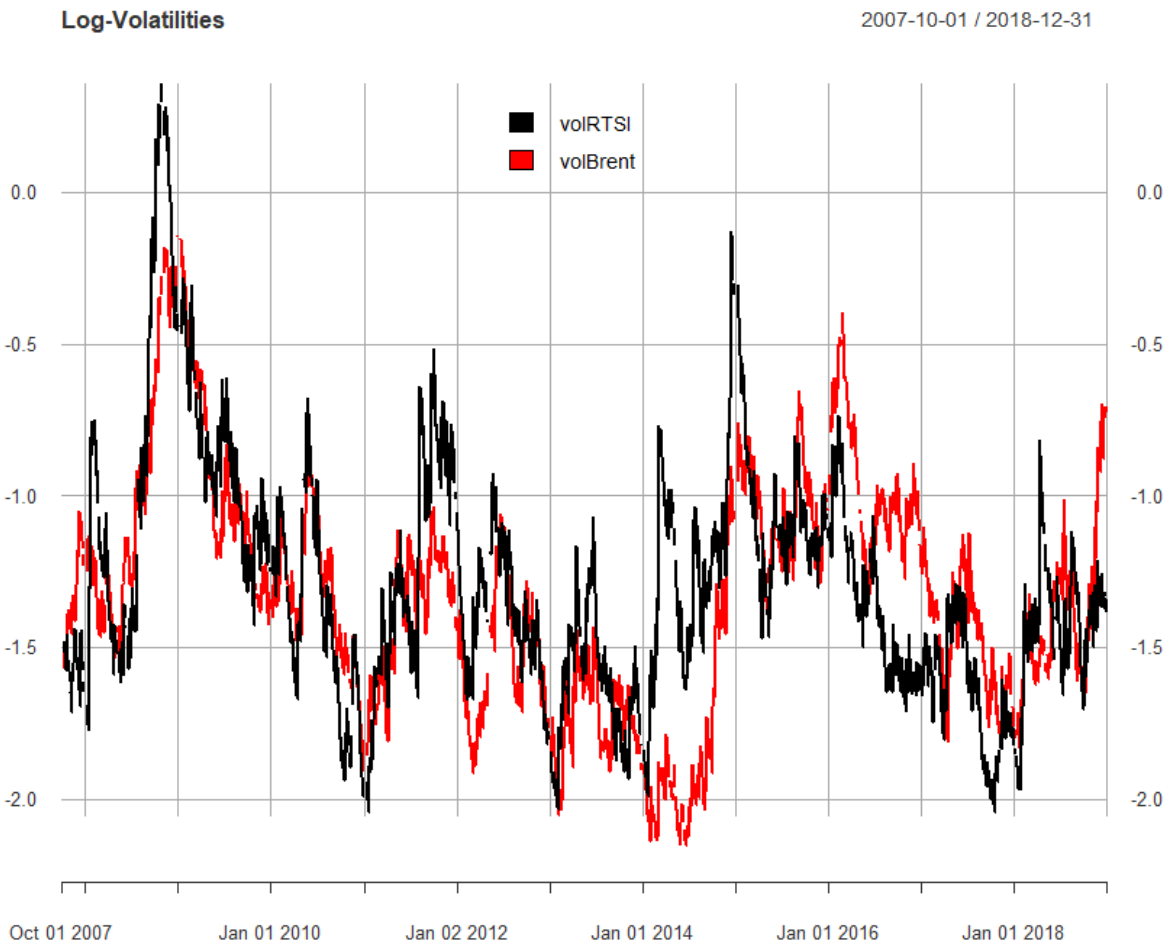
$$\sigma_t = \omega + \alpha\varepsilon_{t-1}^{+} - \gamma\varepsilon_{t-1}^{-} + \beta\sigma_{t-1}.$$

$$\varepsilon_t = \sigma_t u_t, u_t \sim i.i.d.\ \mathcal{N}(0,1),$$

$$\varepsilon_t^{+} = max(\varepsilon_t, 0), \varepsilon_t^{-} = min(\varepsilon_t, 0);$$

$$\alpha > 0, \gamma > 0, \beta > 0, \omega > 0.$$

Volatility estimates



Here volRTSI and volBrent are logarithms of RTSI and Brent volatility, calculated by one-dimensional TGARCH model

AR(1)-GARCH-BEKK

(Engle, Kroner, 1995)

$$\begin{bmatrix} r_{brent,t} \\ r_{RTSI,t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \beta_{11} & 0 \\ \beta_{21} & \beta_{22} \end{bmatrix} * \begin{bmatrix} r_{brent,t-1} \\ r_{RTSI,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix},$$

$$\begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} = H_t^{1/2} \begin{bmatrix} \eta_{1,t} \\ \eta_{2,t} \end{bmatrix}, \eta_t = \begin{bmatrix} \eta_{1,t} \\ \nu_{2,t} \end{bmatrix} \sim i.i.d.\ \mathcal{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right)$$

$H_t -$ Conditional covariance of $\begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix}$

$$H_t = CC^T + A^T \varepsilon_{t-1} \varepsilon_{t-1}^T A + B^T H_{t-1} B$$

Volatility estimates

Non-parametric approach

Instead of using volatility models we can estimate realized volatility - observed proxy for unobserved volatility:

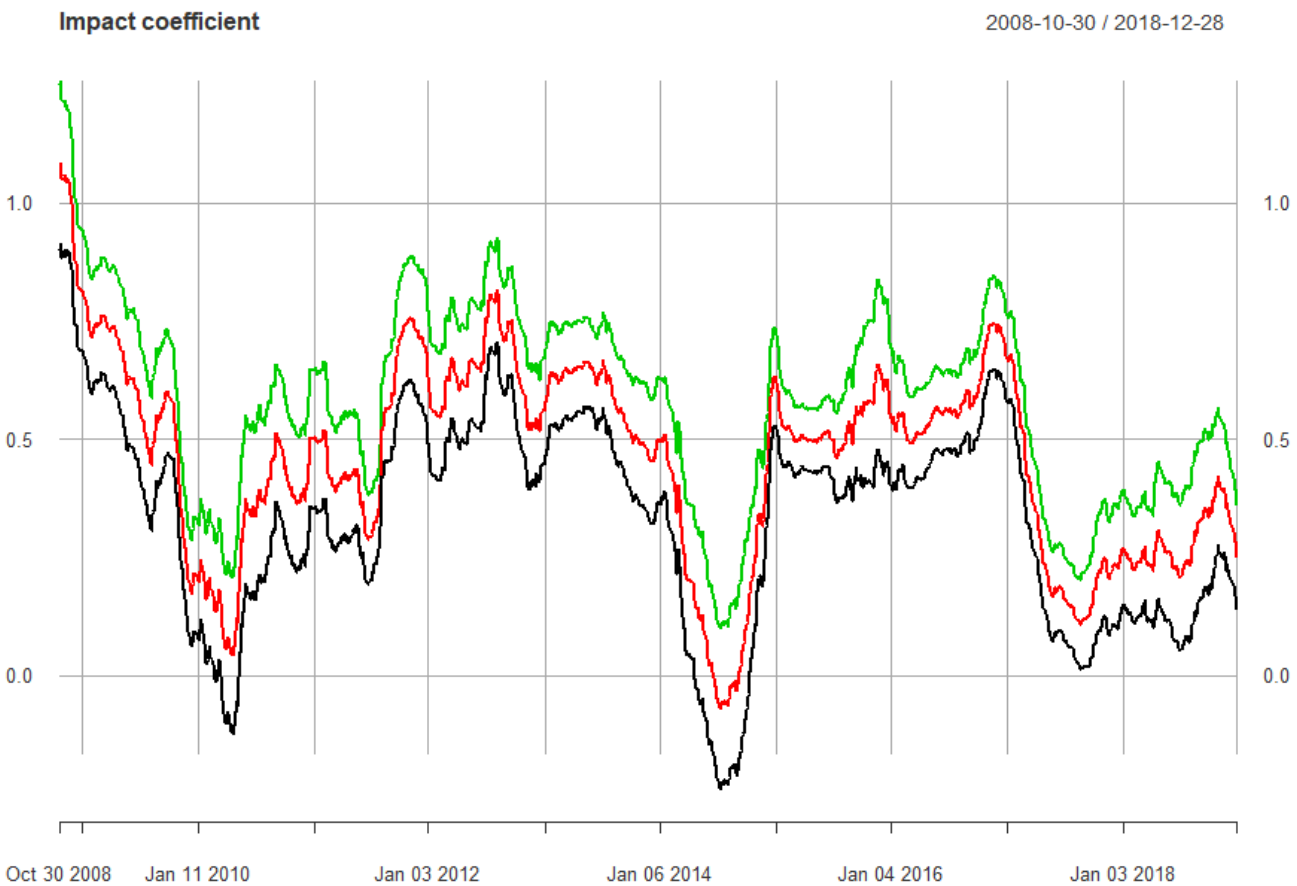
$$RV_t = \sum_{i=1}^{N} r_{i,t}^2$$

$r_{i,t}$ - return in day t at the interval $[t_i, t_i + \Delta_t], i \in [1, N]$.
Here $\Delta_t = 5$ minutes.

Impact coefficient

Dynamics of impact coefficient β

$$\ln(\sigma^2_{RTSI,t}) = c + \beta \ln(\sigma^2_{brent_t}) + \varepsilon_t.$$



Searching for other factors

Possible factors

1. Periods of high/low oil prices:
   - Highoil, if higher than 110$
   - Lowoil, if lower than 45$
2. VIX - American stock market's expectation of volatility implied by S&P 500 index options
3. Volatility of emerging markets
4. Sanctions - dummy or categorical variable

Macroeconomic factors

Sanctions

№	Dates	Description
1	17.03.2014	The EU, NATO and a number of countries have announced the suspension of cooperation with Russia on individual projects and the imposition of sanctions against a number of Russian politicians
2	12.09.2014	The EU announced introduction of new sanctions against Russia, in particular against Sberbank and oil companies.
3	16.02.2015	The EU announced introduction of new sanctions. At this point, the sanctions list began to contain 151 individuals and 37 legal entities.
4	22.12.2015	Expansion of US sanctions against Russia - sanctions imposed on 34 individuals and legal entities.
5	29.12.2016	The US President signed an order to expel 35 Russian diplomats and expand sanctions against Russia due to interference in the US presidential election
6	06.04.2018	International sanctions against Russia in response to the poisoning of Skripal and his daughter on March 4 in the UK, which has been blamed on Russia.
Other important date		
	22.08.2014	Start of significant decrease in oil prices

Macroeconomic factors

Modelling

- Volailities were calculated by TGARCH(1,1) model
- Volatilities from TGARCH estimation on whole 11 year interval were used
- Volatilities are in fact nonstationary, so that introduces a problem for estimation
- But in fact RTSI and oil volailities were found to be cointegrated, so we can use special methods

Dynamic ols regressions of next form were used:

$$\ln(\sigma^2_{RTSI,t}) = \ln(\sigma^2_{brent,t}) + d_t + d_t \cdot \ln(\sigma^2_{brent,t}) + \epsilon_t$$

Results (1)

	Dependent variable: ln(volRTSI)		
	1	2	3
ln(volB)	0.419***	0.451***	0.524***
ln(VIX(-1))	0.467***	0.559***	0.538***
lowoil	0.200		0.008
highoil	−0.937*		−0.729
ln(volB)×lowoil	0.061		0.010
ln(volB)×highoil	−0.198*		−0.173*
sanctions=1		−1.038**	−1.116***
ln(volB)×(sanctions=1)		−0.287**	−0.307***
Constant	−0.228	0.237	0.441
Observations	2.560	2.560	2.560
Adjusted R^2	0.608	0.648	0.650
Note:		*p<0.1; **p<0.05; ***p<0.01	

Results (2)

	4	5
ln(volB)	0.548***	0.574***
ln(VIX(-1))	0.444***	0.441***
sanc=1	0.571***	1.817
sanc=2	0.458***	1.348**
sanc=3	0.115***	−1.545**
sanc=4	−0.136***	−0.194
sanc=5	−0.032	0.173
sanc=6	0.037	−2.993***
ln(volB)×(sanc=1)		0.259
ln(volB)×(sanc=2)		0.220*
ln(volB)×(sanc=3)		−0.432**
ln(volB)×(sanc=4)		−0.012
ln(volB)×(sanc=5)		0.048
ln(volB)×(sanc=6)		−0.740***
Constant	0.138	0.253
R^2	0.735	0.753
Adjusted R^2	0.734	0.751
Note:	*p<0.1; **p<0.05; ***p<0.01	

Conclusions

- RTSI volatility depends on oil price volatility.
- GARCH, BEKK and RV volatility estimates showed similar behavior and all confirm found connection.
- This dependence varies in time
- Sanctions increased RTSI volaility for a short period of time.
- Impact of sanctions deteriorates with time.
- Russian stock market quickly adapts to the sanctions

Literature

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