THE RESPONSE OF MANUFACTURING INDUSTRY TO OIL AND GAS SECTOR: EVIDENCES FROM RUSSIA

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Abstract: This study empirically examines the relationship between Russia's manufacturing industry and the oil and gas sectors through analyzing quarterly data from 2005:Q1 to 2014:Q3 using the Vector Error Correction model. The main findings of the paper are following: i) Russia's manufacturing industry is negatively influenced by the booms in oil and gas complex represented by oil price and oil exports, ii) government expenditures crowd out the share of manufacturing industry while the net inflows of foreign currency slightly enlarge the manufacturing industry, iii) appreciation of the exchange rate is negatively associated with the development of manufacturing production, although the level of coefficient's significance is low, iv) manufacturing needs slightly more than 2 quarters to return to the equilibrium after the structural changes.

Keywords: Russia, Manufacturing industry, Oil and gas sector, VECM.

1 Introduction

National oil and gas sectors serve as a driving force and a foundation of the Russia's economy. In total, they provide about 55% of total export revenues and constitute almost 40% of the Federal budget[1].

In 2000s high oil prices and stable large volumes of crude oil and gas exports provided rapid economic growth in Russia (about 7% per year) before the world financial crisis in 2008 and quite moderate economic development after the 2008-2009 shock till the autumn 2014. On the contrary to the general economic growth mainly caused by the favorable oil prices (apart from the crisis time), the manufacturing industry[2] of Russia was gradually shrinking at the same period. From the Figure 1 below, it is clear that the share of manufacturing industry in GDP reduced by almost 2.70% from 16% in 2005:Q1 to 13.30% in 2014:Q3, while the share of mining in GDP increased by about 3%.[3]

In this respect, the general theory suggests that countries with the large reserves of oil and gas suffer from the problem of manufacturing slowdown (Ito, 2017). The first intuition behind this statement is that resource boom (e.g. increase in oil prices) leads to the labor migration from the manufacturing and service sectors to more profitable mining sector. Subsequently, in order to return to the equilibrium labor market the real wages increase. And, as long as labor is a factor of production and the real wage is a one of the production costs, the manufacturing industry is expected to experience reduction during the favorable conditions in oil and gas sectors (Mironov,2015). Another intuition suggests that resource boom (e.g. increase in the volume of crude oil exports) brings considerable amount of exports revenue, which in turn positively influence the real exchange rate. As a result of the real exchange rate appreciation, the competitiveness of the finished manufacturing goods in the international market decreases, exports go down and imports rise, hence the share of the manufacturing industry shrinks.

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[1] Sources: Ministry of Finance of Russian Federation, Central Bank of Russian Federation.
[2] The sectors of Russian industry (e.g. metalworking, ferrous and non-ferrous metallurgy, light industry) except mining and utilities
[3] Source: Rosstat.

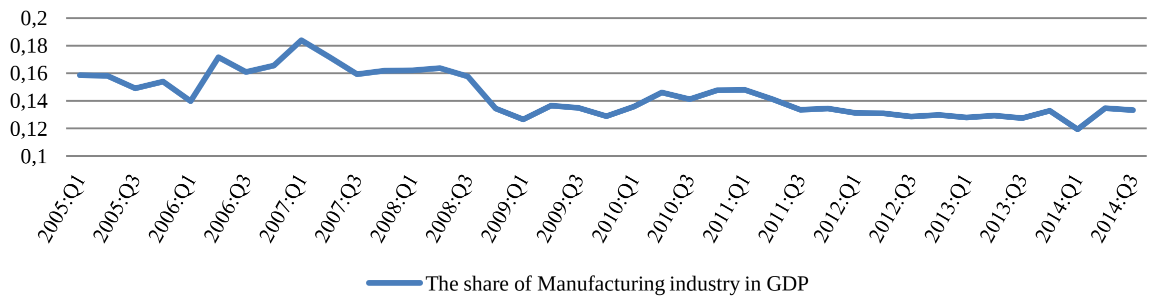

Figure 1. The share of manufacturing industry in GDP.
Source: Rosstat.

Over the past 15 years, the range of empirical studies has been held in Russia to examine the nexus of fundamental macroeconomics variables and oil and gas sectors. The most of them indicates positive relation between general economic growth and the oil and gas complex. In contrast, there is a lack of empirical works that are focused on the investigation of response of Russia's manufacturing industry to the shifts in national oil and gas sectors, although it is quite debatable issue for resource rich countries.

Therefore, the aim of this paper is to empirically determine the effect of oil and gas industry on the Russia's manufacturing production, employing the Vector Error Correction model (VECM). The hypothesis underlying our empirical research is that, Russia's manufacturing production is negatively associated with the shifts in the oil and gas sectors.

2 Data and methodology

Table 1. Description of variables used in econometric analysis

Variable	Name	Source	Period	Description
Manufacturing industry.	***MI***	Rosstat	2005:Q1 – 2014Q3	The share of manufacturing industry in GDP of Russian Federation (% of GDP).
Price of crude oil.	***OILP***	Reuters		Price of Brent oil, $/bbl.
Exports of crude oil.	***OILQ***	Central Bank of Russian Federation.		The volume of crude oil exports (mln. tons).
Government expenditures.	***GE***	Ministry of Finance of Russian Federation.		Expenditures of Federal budget of Russian Federation (% of GDP).
Current account surplus.	***CAS***	Central Bank of Russian Federation.		Proxy for net inflows of the foreign currency (% of GDP).
Real effective exchange rate.	***REER***	Bank for International Settlements		Based on CPI of Russia and on CPI of its major trading partners. 2005=100 (base year).
Dummy variable.	***D***	-	-	2008-2009 crisis dummy variable.

The model analyzed in the study includes six variables. The dependent variable is manufacturing industry (MI), which is represented by almost all sectors of Russian industry (e.g. metalworking, metallurgy, engineering, timber industry, chemical and petrochemical industry, etc.) except for mining and utilities. The explanatory variables are presented in Table 1 with corresponding description and sources. All series are seasonally adjusted by dummy variable (D) (taking into consideration the sharp shifts during the financial crisis in 2008-2009) and converted to logarithmic form.

Before proceeding to the identification of the estimation model, Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) unit root tests were conducted for each variable in order to determine the order of integration of the series (Table 2). The ADF test fails to reject the null hypothesis of the presence of unit root for each series and both specifications (intercept/intercept and trend). PP test in most cases also gives the results in accordance with the ADF test's outcomes, namely that series suffer from the non-stationarity, apart from lg (OILQ) and lg (CAS) statistics which are significant at 1% level. After transforming the series into the first difference, the null hypothesis of the both tests is rejected for each variable at 1%, 5% and 10% significance level, respectively. Therefore, it can be concluded that each series is integrated of order one I (1) and we can proceed to the determination of cointegrating relation.

Table 2. Unit root tests

ADF test (H0: Unit root)				
	Level.		First difference.	
Variables	**Intercept**	**Intercept and trend.**	**Intercept**	**Intercept and trend.**
lgMI	-1.2	-2.7	-2.9**	-3.9**
lgOILP	-1.9	-3.1	-3.9*	-3.8**
lgOILQ	-0.03	-1.6	-3.1**	-3.3***
lgGE	-2.07	-1.9	-3.1**	-3.2***
lgCAS	-1.2	-2.8	-3.4**	-3.2***

lgREER	-2.5	-2.5	-3.0**	-3.3***
№ obs.	34	34	33	33
Critical values.				
1%	-3.6	-4.2	-3.6	-4.3
5%	-2.9	-3.5	-2.9	-3.5
10%	-2.6	-3.2	-2.6	-3.2
PP test (H0: Unit root)				
lgMI	-1.9	-3.2	-7.9*	-7.7*
lgOILP	-2.1	-2.8	-4.3*	-4.2**
lgOILQ	-4.5*	-6.8*	-16.0*	-16.4*
lgGE	-1.9	-1.8	-5.8*	-5.8*
lgCAS	-2.9	-4.5*	-8.5*	-8.3*
lgREER	-2.7	-2.7	-6.8*	-7.2*
№ obs.	37	37	36	36
Critical values.				
1%	-3.6	-4.2	-3.6	-4.2
5%	-2.9	-3.5	-2.9	-3.5
10%	-2.6	-3.2	-2.6	-3.2
Notes: The symbols *, ** and *** refer to the rejection of the null hypothesis at the 1%, 5% and 10% significance levels, correspondingly.				

In our analysis, in order to capture the long run relationship between the oil and gas sector and manufacturing industry of Russia, VECM which is developed by Johansen (1988, 1995) is employed (Johansen,1988; Johansen,1995). The model used in the analysis has the following form:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} \ldots + \Gamma_{k-1} \Delta Z_{t-k-1} + \alpha\beta' Z_{t-1} + e_t \quad (1)$$

where Δ is the difference operator, Z_t is an (n × 1) vector of variables= (MI_t $OILP_t$ $OILQ_t$ GE_t CAS_t $REER_t$ D), k is the number of lags, e_t is an (n × 1) the vector of error terms. Γ refers to an (n × n) matrix of parameters, providing the information about the short run relationship between variables. α and β' are (n × r) adjustment and cointegration matrices, respectively, which contains information regarding the long-run relationships of series. Cointegration trace test and Max-Eig test based on Johansen's method are applied to verify the existence of the cointegration and determine the number of cointegration equations in the estimated model.

Finally, the Lagrange Multiplier test, proposed by Breusch and Godfrey (1981), which permits to check the estimated model for accuracy, is adopted (Breusch et al, 1981).

3 Results

The outcomes of the unit root tests which proved the integration of order one I (1) of each series, permits us to conduct the investigation for cointegration using Johansen's methodology in a multivariate framework. To capture the effect which is not explained by the dependent variables, constant is included in cointegration equation. Optimal lag length of 3 was determined by using the sequential likelihood-ratio (LR) test, Akaike's information criterion (AIC) method and Schwarz Bayesian information criterion (SBIC) method. The results of the Trace test and Max-Eig test presented in Table 3 confirm the presence of cointegration, namely our model cannot reject the null hypothesis of at least one equilibrium cointegrating relation at the 5% significance level. Based upon the results, it can be concluded that the stable long run relationship between the manufacturing industry (MI) and its explanatory variables exists and it is time to proceed to the model estimation.

Table 3. Johansen cointegration test

Panel A. Trace test.			
No. of cointegrating equations, r.		Trace statistic	5% critical value.
H_0	H_1		
r = 0	r = 1	135.0*	104.9
r = 1	r = 2	76.9	77.7
r = 2	r = 3	40.2	54.6
Panel B. Maximum eigenvalue test.			
No. of cointegrating equations, r.		Max-eigenvalue statistic	5% critical value.
H_0	H_1		
r = 0	r = 1	58.1*	42.4
r = 1	r = 2	35.6	36.4
r = 2	r = 3	17.5	30.3
Notes: The symbol * denotes rejection of null hypothesis at 5% significance level.			

Table 4 presents the outcomes of the VECM estimation, where the coefficient of manufacturing industry (MI) is normalized to 1. The parameters of explanatory variables are all statistically significant and their values are reasonable with expected signs. Generally, the cointegrating vector implies that MI depends negatively on the OILP, OILQ, GE and REER, while CAS has a positive effect on the development of manufacturing industry. More specifically, 1% growth in oil price results in about 0.41% decline of the manufacturing production, while the elasticity of oil exports is considerably higher, namely 1% increase in the volume of export decreases manufacturing production by more than 2%. These findings support our expectations and can be explained by the following postulates. Firstly, rise in oil price and volume of crude oil export strengthens the real effective exchange rate, which in turn negatively influences the competitiveness of the Russia's manufacturing products in the international market, and as a result the total production goes down. Another intuition that stays behind the obtained outcomes is that growth in both variables (OILP and OILQ) has negative impact on the domestic prices of raw materials used in manufacturing industry. Subsequently, the price of finished manufacturing goods goes up which further declines the demand for them and the share of manufacturing industry. Thirdly, in accordance with Mironov and Petronevich, (2015) the rise of oil price shifts the labor (mobile resource) to the more profitable mining sector, as a result the labor scarce in manufacturing and service sectors occurs (Mironov et al, 2015). Consequently, in order to fill the loss of labor resources it is necessary to manipulate the labor force through increasing the real wages, which in turn shrinks the share of manufacturing industry, or in other words brings to de-industrialization.

Table 4. Results of the VECM estimation.

Variables	Long run coefficients	t-statistic
lgOILP	- 0.413*	-3.76
lgOILQ	-2.112*	-4.58
lgGE	-0.528*	-4.87
lgCAS	0.135*	5.61
lgREER	-0.568***	-1.78
Constant	14.08883	
Error correction	-0.42044**	-2.39
Notes: The symbols *, ** and *** refer to statistical significance at 1%, 5% and 10%, respectively.		

Moreover, Table 4 suggests that 1% increase in government expenditures pushes down the portion of manufacturing industry by more than 0.50%.This outcome can be explained by the fact the rise in government expenditures leads to growth in inflation and interest rate which in turn crowds out the private investments causing manufacturing industry to diminish. In addition, the net inflow of foreign currency represented by the current account surplus has comparatively low, but significant effect on manufacturing industry, specifically 1% rise in the net inflow of foreign currency leads to growth in manufacturing production by nearly 0.14%. Despite the low significance level (10%) of the real exchange rate coefficient, the direction of relationship is in the line with expectations, namely appreciation of real exchange rate by 1%, decreases manufacturing production by about 0.57%.

The error correction term parameter is not only negative and statistically significant but also has quite large absolute value less than one, indicating that manufacturing industry adjusts to its long run equilibrium at a comparatively rapid rate after the shock.

Finally, Table 5 shows the outcomes of Lagrange – multiplier test that is employed to check the estimated model for possible misspecifications. It is found that there is no serial correlation in the system due to the fact that all p-values are larger than the 5% level of significance. Therefore it can be claimed that the results obtained through the model estimation is accurate and can be used for further implementation.

Table 5. Lagrange – multiplier test.

Lags	LM-Stat	p values.
1	30.5	0.7
2	35.0	0.5
3	27.9	0.8
Notes: H_0 is no autocorrelation. Degrees of freedom are 36.		

4 Disscusions

The manufacturing industry is considered as a substantial economic force, which not only provides massive number of work places, but also promotes productivity growth, development of innovations and technologies, and expansion of international trade, which further extends to other sectors of the economy (Kondratyev,2013). In the developing countries (e.g. China, India) the manufacturing industry serves as lever which transforms poor nations to the momentous players of the global economy. In turn, the contraction of the manufacturing production, others sectors being constant, is estimated as a sign of economic decline and results in the reduction of the country's attractiveness in the international markets (Rubtsov et al, 2012; ,11). There is a range of issues and challenges that theoretically may inhibit the development of manufacturing industry, among which the dependency on natural resources occupies the leading position.

Turning to the Russia, it is known that raw materials constitute about 80% of total value of goods export, out of which fourth fifth represented by two products: oil and natural gas (Mironov et al, 2015). This excessive concentration of Russia's export on mining industry as compared with manufacturing production causes the range of destructive consequences as follows: i) the significant structural unemployment and low wages rate among highly qualified labor force as result of de-industrialization, ii) the absence of the considerable competitive advantages in science, education and high-tech iii) substantial macroeconomic instability iv) accelerated depletion of non-renewable resources.

The results of our investigation empirically confirmed the negative impact of mining industry represented by oil and gas sectors on the manufacturing industry of Russia, thereby providing the important insights for researchers as well as policymakers. In any case the obtained outcomes do not mean that Russia needs to cease or limit the mining and exports of crude oil and gas, as long as this is the natural competitive advantage of our country (Rubtzov et al, 2015). However, regardless of the price of oil government have to stably and permanently support the modernization and development of the manufacturing sectors in order to achieve the maximum efficiency in processing the raw materials and as a result to produce the goods mostly with high added value. Subsequently, this strategy which is believed to successfully function due to the competent and rational using of taxes' and exports' revenues as well as using the strict legislation would substantially elevate the manufacturing industry and minimize the dependence of Russia's economy on the international markets conjuncture.

5 Conslusions

This paper investigates the response of the manufacturing industry of Russian Federation to changes in oil and gas industry, additionally controlling for the range of variables and taking into account the economics shock in 2008-2009. The VECM method with quarterly data from 2005:Q1 to 2014:Q3 was employed to detect the long run causalities. The main findings of the study are as follows:

1. Russia's manufacturing industry is negatively influenced by the booms in oil and gas complex represented by oil price and oil exports.

2. Government expenditures crowd out the share of manufacturing industry while the net inflows of foreign currency slightly enlarge the manufacturing industry.
3. Appreciation of the exchange rate is negatively associated with the development of manufacturing production, although the level of coefficient's significance is low.
4. Manufacturing industry needs slightly more than 2 quarters to return to the equilibrium after the structural changes.

Therefore, it is reasonable to conclude that the gradual decline in the Russia's manufacturing industry is directly related to the natural resources' dependency of the Russian economy, thereby supporting the findings of Oomes and Kalcheva (2007), Mironov and Petronevich (2015) (2,8).

The future direction of the research is to examine how separate sectors of manufacturing industry behave during the shifts in the mining industry. This would permit us to identify the most pressed sectors and to make more precise policy recommendations.

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