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Is Groningen Effect Still Present in Russia: A Vector Error Correction Approach

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ABSTRACT

In this article we aim to test the Groningen effect on the example of Russia. According to the Groningen effect, a boom in the resource sector leads to deterioration in other sectors of the national economy due to appreciation of the national currency. This leads to, given the openness of the economy and elasticity of global markets' prices, to a decline in manufacturing sector and a rise in the services sector. The hypothesis is tested on the example of Russia. To test the hypothesis, we examine the impact of oil prices' dynamics (Brent) on different sectors of Russian economy, including manufacturing, real estate services, transport and communication services over the period 1990–2016. To test the hypothesis, we use vector error correction approach and Granger causality test. The results of the study show that all the sampled variables are cointegrated in the long-run, detecting dependence of the Russian economy on oil. Short-run effects estimation show that the Groningen effect is absent in the Russian economy. Pairwise Granger causality test confirms absence of the Dutch disease as well.

Keywords: Oil Prices, Gross Domestic Product Sectors, Groningen Effect, Cointegration, Causality, Dutch Disease
JEL Classifications: E01, O11, O13, Q41, Q43

1. INTRODUCTION

The rationale behind the Dutch disease states that an oil boom leads to a negative effect, stemming from appreciation of the national currency, affecting economic development. Dutch disease or the Groningen effect states that a fast growth of oil/gas (or other mineral resources) export leads to an increase in inflation and unemployment, a decline in manufacturing and pace of economic growth. So, the rise of oil prices in 1970s and 1980s led to the similar result in Saudi Arabia, Nigeria and Mexico. The negative effect and its negative externalities are achieved through different channels. A sudden burst of export revenues in oil sector leads to an additional inflow of foreign currency, which in turn leads to appreciation of the national currency. The last diminishes competitive position of the goods, produced in the manufacturing sector, which leads to a decline in output and export of the goods. Another possible consequence of a surge in the manufacturing sector may be rising unemployment. Herewith a rise in import may be observed, which leads to declining gross domestic product (GDP).

Moreover, a rise of income creates additional demand on both tradable goods and non-tradable goods. As tradable goods are under international competitive pressure, additional demand doesn't significantly affect their price in case of a small open economy, while non-tradable goods, that doesn't participate on global markets suffer rising prices on them, which increases inflation pressure in the national economy.

A rise in revenues of the services sector, which doesn't participate in the global competition, stimulates the growth. This effect may maintain the level of GDP growth, masking a decline in output of the manufacturing sector. Hence, one of the main symptoms of the Dutch disease is rising services sector, while manufacturing is in decline. In the long-run, a shift of investments and resources takes place, migrating from manufacturing sector to resources and services sector, showing returns above average. Moreover, dependency on resources rent affects incentives and willingness to invest in manufacturing.

Russia, being one of the largest oil producers and exporters, may be subject to the Dutch disease. One of the main symptoms of the

Dutch disease is steadily declining output of the manufacturing sector and growing services sector. As can be seen from Figure 1, the symptoms are present in case of Russia. During 2003–2016 the share of manufacturing sector in Russian GDP has shrunk from 17% of total value added to 13.5%. On the other hand, the share of services sector (e.g., real estate operations) has risen up to 18% of total value added from 10.5%. Another disturbing aspect of the Dutch disease is pronounced through declining share of wholesale and retail trade, which indicates total economic activity for tradable goods.

Therefore, we aim to test the Dutch disease presence in Russian economy through examining causal and cointegration relationship between oil prices (Brent) dynamics and value added by sampled economic sectors in Russia.

The remainder of the paper is organized as follows: Section 2 provides an overview of relevant literature; Section 3 describes econometric modeling techniques and data used; Section 4 presents an analysis of empirical results; Section 5 presents the conclusion of the study.

2. LITERATURE REVIEW

To test the stated hypothesis, we refer to the relevant literature on the issue. As can be seen from Table 1, "resource curse" hypothesis is well tested on different examples, including both developed and developing countries, resources-rich and resources poor countries, transition economies and so on. Dutch disease, being a main tested subject in this paper, presents itself a specific case of resource curse problem, aimed at pointing out causes and consequences of oil boom in the national economy and its effects on economic development and economic growth in various sectors of the national economy. A brilliant overview of different approached to the Dutch disease, its consequences and validity of the hypothesis is presented in papers by Corden (1984) and Wright and Czelusta (2004). Evolution of approaches and conventional views on the Dutch disease is closely linked with the empirical observations. Double oil hike in the 1970-s showed that in some cases a boom in the energy sector (in our case, oil sector) leads to extremely abnormal level of extracted rent in the oil segment of the national economy at the cost of declines and deterioration in other sectors of economy, especially in manufacturing sector. Another effect of the Dutch disease manifests itself in rising services sector. All these empirical observations found themselves best captured in the Dutch disease hypothesis.

Table 2 presents overview of main empirical and theoretical findings, concerning the Dutch disease hypothesis. As can be seen form Table 2, relevant literature source may be divided in several groups. One group emphasizes and advocates importance and existence of the Dutch disease or natural abundance disease in this or that way. The results of empirical investigations, presented in the second group show that Dutch disease is absent in the sampled states. Ambiguity of results and reasons to explain absence or presence of the Dutch disease in the sampled countries is explained by institutional and political factors, which lies at heart of the papers in the third group.

Concerning Russian case, Perifanis and Dagoumas (2017) find strong evidence on the oil dependence of the Russian economy; however, they do not find firm established proof of the Dutch disease. Ito (2017) also found no strong evidence of rising oil prices affecting decline in manufacturing output.

Despite these results, we use a vector error correction (VEC) approach on the data for the period 1990–2016, using data for sampled sectors of the national economy.

3. MATERIALS AND METHODS

3.1. Research Methods

To test the hypothesis about relationship between shocks in oil prices and different economic sectors of Russian economy, we use econometric techniques to analyze time series. The algorithm of the ongoing study is determined by several key stages. First and foremost, one should test sampled variables on stationarity or order of cointegration, since the time series must have the same order, as can be seen from equation (1). Secondly, it is necessary to determine presence/absence of correlation in long term between the variables in the equation. To check this assumption, we use a Johansen cointegration test. In a case of a long-term relationship on the one hand and condition of stationarity of sampled time series in the first order I (1) on the other, it is possible to use VEC model.

Figure 1: Russian gross domestic product sectoral decomposition

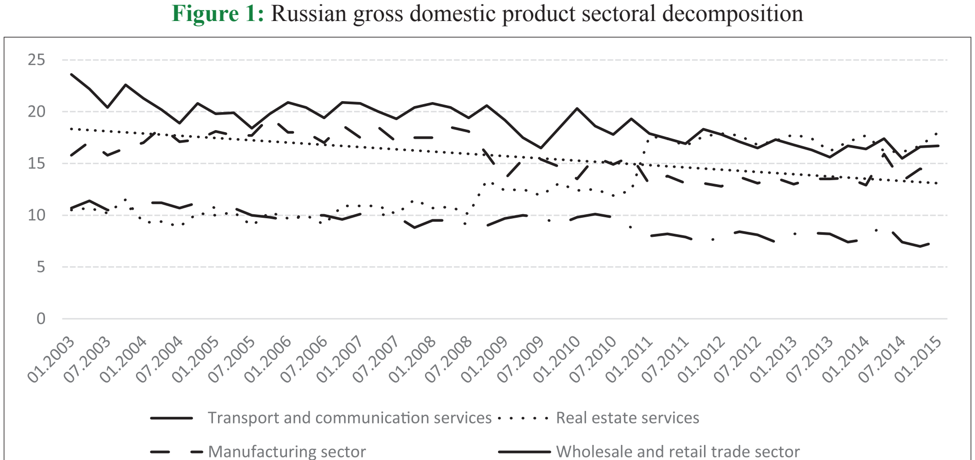

Table 1: Literature review

Author	Sample	Methodology	Results of the study
Alexeev and Conrad (2009)	Large endowment of oil - long-term economic growth	Regression analysis	The claims of a negative effect of oil and mineral wealth on the countries' institutions as well as on some other factors potentially affecting economic growth do not appear to be valid
Alexeev and Conrad (2010)	Relationship between "point-source" resource abundance and economic growth, quality of institutions, investment in human and physical capital, and social welfare, transition economies	Cross-country regression analysis	Author find little evidence of a natural resource curse for all countries. Only the "voice and accountability" measure of institutional quality is negatively and significantly affected by oil wealth. In the economies in transition, there is some evidence that natural resource wealth is associated with lower primary school enrollment and life expectancy and higher infant mortality compared to other resource rich countries
Bjornland (1998)	Norway, the UK, energy booms (oil, gas) – manufacturing output	Restrictred VAR analysis	There is only weak evidence of a Dutch disease in the UK, whereas manufacturing output in Norway has actually benefited from energy discoveries and higher oil prices
Bjorvatn et al.(2012)	Political fractionalization -"resource curse" nexus, 30 oil-rich countries	Regression analysis	Authors find that the income effect of resource rents is moderated by the political power balance. With a strong government, resource wealth can generate growth even in an environment of poorly developed institutions, while adding oil revenues to a weak government may have damaging effects on the economy
Boschini et al. (2007)	Resource curse – institutional quality nexus, Resources-rich countries	Regression analysis	Countries rich in minerals are cursed only if they have low-quality institutions, while the curse is reversed if institutions are sufficiently good. Furthermore, if countries are rich in diamonds and precious metals, these effects - both positive and negative - are larger
Brunnschweiler (2008)	Natural resource curse hypothesis testing	OLS, 2 SLS regression analysis	In both OLS and 2 SLS regressions, the positive resource effects are particularly strong for subsoil wealth. Results also show no evidence of negative indirect effects of natural resources through the institutional channel
Brunnschweiler and Bulte (2008)	Resource abundance hypothesis testing	Regression analysis	In multiple estimations that combine resource abundance and dependence, institutional and constitutional variables, authors find that resource abundance, constitutions and institutions determine resource dependence, resource dependence does not affect growth, and resource abundance positively affects growth and institutional quality
Cotet and Tsui (2010)	Cross-country analysis, oil rent - development nexus	Panel regression analysis	Exploiting cross-country variations in the timing of oil discoveries and the size of initial oil in place, authors find that, contrary to the oil-curse hypothesis, there is little robust evidence of a negative relationship between oil endowment and economic performance, even after controlling for initial income
Eggoh et al. (2011)	Relationship between energy consumption and economic growth, 21	Cointegration and causality analysis	There exists a long-run equilibrium relationship between energy consumption, real GDP, prices, labor and capital for each group of countries as well as for the whole set of countries. Decreasing energy consumption decreases growth and vice versa, and that increasing energy consumption increases growth, and vice versa, and that this applies for both energy exporters and importers
Gokmenoglu et al. (2015)	Turkey, Industrial production, GDP, Inflation and Oil Prices nexus, 1961–2012	Cointegration, causality analysis	Johansen co-integration results confirm a long-run relationship among these variables and Granger causality test illustrates the unidirectional relationship from oil price to industrial production
Hutchison (1984)	The United Kingdom, the Netherlands, Norway	Cointegration and VEC modeling	Results do not provide much support for the hypothesis, either for the short - or longer-term horizons. Only for Norway do impulse response functions indicate a short-run adverse effect on manufacturing arising from the energy boom

(*Contd..*)

Table 1: (*Continued*)

Author	Sample	Methodology	Results of the study
Larsen (2006)	Denmark, Sweden. Dutch disease hypothesis testing	Structural break techniques	Norway was in a favorable position to find oil. An educated populace could start an intensely technological extraction that also gave birth to expertise build-up and innovative research. To the extent that developed countries share these qualities, it may be possible that developed countries are less likely to contract the curse. However, Norway is a special case in its fervently egalitarian society that cultivates strong social norms. This may have prevented pressure from vested interests in rent seeking and allowed a centralized second, Norway's oil policy was patient, realistic, and modest
Prasad et al. (2007)	Fiji Islands, 1970-2005, relationship between real GDP and oil prices	Time series analysis	Main finding is that an increase in oil has a positive, albeit inelastic, impact on real GDP, inconsistent with the bulk of the literature
van Wijenbergen (1984)	Gulf countries	Disequilibrium analysis	Higher oil revenues can be likened to a transfer putting pressure on non-oil traded goods prices and drawing resources out of the T sector. The slope of the wage indexation line determines whether classical unemployment or repressed inflation results
Wright and Czelusta (2004)	Developed and developing countries, resource production - economic growth	Description, correlation analysis	The resource-curse hypothesis seems anomalous as development economics, since on the surface it has noclear policy implication but stands as a wistful prophecy: Countries afflicted with the "original sin" of resource endowments have poor growth prospects. The danger of such ostensibly neutral ruminations, however, is that in practice they may influence sectoral policies. Min-erals themselves are not to blame for problems of rent-seeking and corruption. Instead, it is largely the manner in which policymakers and businesses view minerals that determines the outcome
Yaduma (2017)	OECD and non-OECD oil-exporting countries, share of oil rents in GDP/per capita oil reserves - aggregate/per capita income	Arellano–Bond difference GMM method	Results provide evidence of the curse in non-OECD countries employing aggregate and per-capita measures of genuine income
Perifanis and Dagoumas (2017)	Russian federation, oil prices - GDP, industrial production index, unemployment, government expenditure, oil production	VAR analysis, impulse response analysis	Authors find strong evidence on the oil dependence of the Russian economy; however, they do not find firm established proof of the Dutch disease
Rivero et al. (2017)	Bolivia, resource dependence - economic growth, real exchange rate, 2000–2015	Production function analysis, VAR/SVAR analysis	Results show empirical support that a positive shock in natural resource dependence increases the boom sector in natural resources and generates positive innovations in domestic demand. Positive shocks in dependence on natural resources generate positive effects on real growth of economic activity
Ito (2017)	Russian federation, testing Dutch disease	Regression analysis	Manufacturing output in Russia is positively associated with the price of oil, though the response following an oil-price shock is marginal in the short run; manufacturing output rises slightly even in case of the appreciation of real effective exchange rate; FDI inflows contribute to the growth of manufacturing output, but not significant; an increase in government expenditures crowds out the manufacturing sector; and the government has a tight fiscal policy in response to a rise in manufacturing output

FDI: Foreign direct investment, GDP: Gross domestic product

Table 2: Results of individual unit root test

Variables	ADF		P-P	
	Statistic	Prob.**	Statistic	Prob.**
Levels				
Intercept	12.545	0.792	9.142	0.6743
Intercept and trend	16.343	0.376	18.895	0.1434
First-difference				
Intercept	42.991	0.0000**	51.483	0.0000**
Intercept and trend	33.116	0.0010**	63.435	0.0000**

**Denotes statistical significance at the 5% level of significance. ADF: Augmented Dickey and Fuller, P-P: Phillips-Perron

In case of confirmation of presence of cointegration between the variables of the sample, residuals of the equilibrium regression can be used to estimate error correction model. Also based on VEC model it is possible to identify short-term relationships between sampled variables. For this purpose, we would use the Wald test. The final stage of constructing a model is to conduct diagnostic tests to determine validity of the model. These include testing for heteroscedasticity and serial correlation, normality and stability of the model. Another tool for detecting presence or absence of the Dutch disease in Russian economy is Pairwise Granger causality test.

3.1.1. Unit root test

For the analysis of long-term relationships between the variables, Johansen and Juselieus (1990) admit that this form of testing is only possible after fulfilling the requirements of stationarity of the time series. In other words, if two series are co-integrated in order d (i.e., $I(d)$) then each series has to be differenced d times to restore stationarity. For $d = 0$, each series would be stationary in levels, while for $d = 1$, first differencing is needed to obtain stationarity. A series is said to be non-stationary if it has non-constant mean, variance, and auto-covariance over time (Johansen and Juselius, 1990). It is important to cover non-stationary variables into stationary process. Otherwise, they do not drift toward a long-term equilibrium. There are two approaches to test the stationarity: Augmented Dickey and Fuller (ADF) test (1979) and the Phillips-Perron (P-P) test (1988). Here, test is referred to as unit-root tests as they test for the presence of unit roots in the series. The use of these tests allows to eliminate serial correlation between the variables by adding the lagged changes in the residuals of regression. The equation for ADF test is presented below:

$$\Delta Y_t=\beta_1+\beta_2 t+ aY_{t-1}+\delta 3\sum\Delta Y_{t-1}+\varepsilon_t \quad (1)$$

Where ε_t is an error term, β_1 is a drift term and $\beta_2 t$ is the time trend and is the differencing operator. In ADF test, it tests whether a = 0, therefore the null and alternative hypothesis of unit root tests can be written as follows:

Ho: a = 0 (Y_t is non-stationary or there is a unit root).
H1: a < 0 (Y_t is stationary or there is no unit root).

The null hypothesis can be rejected if the calculated t value (ADF statistics) lies to the left of the relevant critical value. The alternate hypothesis is that a < 0. This means that the variable to be estimated is stationary. Conversely, we cannot reject the null hypothesis if null hypothesis is that a = 0, and this means that the variables are non-stationary time series and have unit roots in level. However, normally after taking first differences, the variable will be stationary (Johansen and Juselius, 1990). On the other hand, the specification of P-P test is the same as ADF test, except that the P-P test uses nonparametric statistical method to take care of the serial correlation in the error terms without adding lagged differences (Gujarati, 2003). In this research, we use both ADF and P-P test to examine the stationarity of the sampled time series.

3.1.2. Johansen co-integration test

To test for presence of cointegration we apply the Johansen test using non-stationary time series (values in levels). If between variables does exist a cointegration, the first-best solution would be using VEC methodology (VECM) model. An optimal number of lags according to Akaike information criterion for providing Johansen test is determined in VAR space. To conduct Johansen test, we estimate a VAR model of the following type:

$$y_t=A_1 y_{t-1}+.+A_p y_{t-p}+Bx_t+\epsilon t \quad (2)$$

In which each component of y_t is non-reposeful series and it is integrated of order 1. x_t is a fixed exogenous vector, indicating the constant term, trend term and other certain terms. ε_t is a disturbance vector of k dimension.

We can rewrite this model as:

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} V_i \Delta y_{t-1} + Bx_t + \epsilon_t \quad (3)$$

Where,

$$\prod = \sum_{i=1}^{p} A_i - I, \quad \Delta_i = -\sum_{j=i+1}^{p} A_j \quad (4)$$

If the coefficient matrix $\prod$ has reduced rank $r < k$, then there exist $k \times r$ matrices α and β each with rank r such that $\prod = \alpha\beta'$ and $\beta' y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate $\prod$ matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of $\prod$ (Johansen, 1991).

3.1.3. VECM

Granger (1988) suggested the application of VECM in case if the variables are cointegrated in order to find short-run causal relationships. VECM, therefore, enables to discriminate between long-run equilibrium and short-run dynamics. In this sense, we employ following VECMs to estimate causal linkages among the variables:

$$\Delta lnl = a_0 + \sum_{i=1}^{k} a_1 \Delta lnl_{t-i} + \sum_{i=1}^{n} a_2 \Delta lnm_{t-i} + \sum_{i=1}^{m} a_3 \Delta lnr_{t-i} + \sum_{i=1}^{s} a_4 \Delta lnt_{t-i} + \lambda ECT_{t-1} + v_1$$

$$\Delta \ln m = \beta_0 + \sum_{i=1}^{k}\beta_1 \Delta lnm_{t-i} + \sum_{i=1}^{n}\beta_2 \Delta lnl_{t-i} + \sum_{i=1}^{m}\beta_3 \Delta lnr_{t-i} +$$

$$\sum_{i=1}^{s}\beta_3 \Delta lnt_{t-i} + \phi ECT_{t-1} + v_2$$

$$\Delta \ln r = \eta_0 + \sum_{i=1}^{k}\eta_1 \Delta lnr_{t-i} + \sum_{i=1}^{n}\eta_2 \Delta lnl_{t-i} + \sum_{i=1}^{m}\eta_3 \Delta lnm_{t-i} +$$

$$\sum_{i=1}^{s}\eta_3 \Delta lnt_{t-i} + \chi ECT_{t-1} + v_3$$

$$\Delta \ln t = \theta_0 + \sum_{i=1}^{k}\theta_1 \Delta\, lnt_{t-i} + \sum_{i=1}^{n}\theta_2 \Delta lnl_{t-i} + \sum_{i=1}^{m}\theta_3 \Delta lnm_{t-i}$$

$$+ \sum_{i=1}^{s}\theta_3 \Delta lnr_{t-i} + ECT_{t-1} + v_4$$

Where l - international oil prices (Brent), m - value added by manufacturing sector, r - value added by real estate services sector, t - value added by transportation and communication services sector (Granger, 1988).

Providing regression analysis of the sampled variables by modeling VECM allows us to determine the existence of substantial and statistically significant dependence not only on the values of other variables in the sample, but also dependence on previous values of the variable.

However, VEC model must meet the requirements of serial correlation's absence, homoscedasticity of the residuals and to meet the requirement of stability and normality. Only in this case the results can be considered valid.

3.2. Materials and Data Processing

We test a hypothesis of relationship between oil prices shocks and value added by various economic sectors of an economy on example of Russian data for the period 1990–2016. The base period is one quarter. Using VECM, we set ourselves a task to determine sensitivity of different economic sectors in Russia to shocks in international oil prices.

Data on value added by sampled economic sectors is obtained from Federal Service of State Statistics (www.gks.ru). Data on world prices of oil is obtained from the statistical database of NASDAQ (www.nasdaq.com).

To conduct time-series analysis, all variables were transformed into logarithms. To study sensitivity and causal linkages between the variables in the sample in short-and long-run, we turn to regression analysis, which involves the construction of VEC model of certain type based on stationary time series, testing the model for heteroscedasticity of the residuals, autocorrelation. To test casual linkages between the sampled variables we use pairwise Granger causality test.

4. RESULTS AND DISCUSSION

The first step in testing hypotheses is to test variables for the presence of unit root. For this purpose, we use standard tests - ADF and P-P test. Results of unit root testing are presented in Table 2.

As can be seen from the test results of the variables for the presence of unit root in their differentiation to the first order, we can reject the null hypothesis of unit root in each of the variables. Thus, the condition of stationarity at I(1) is performed, which gives us reason to test variables for cointegration. However, it is necessary to determine the optimal time lag.

Building a VAR model involves determining the optimal number of lags. In our case, the Akaike information criterion equals 1. Consequently, we built a model based using time lag of 4 quarters to determine the relationship in the short run. The results of the diagnostic testing of VAR model for heteroscedasticity of residuals, autocorrelation, serial cross-correlation, and stability are presented in Table 3. As can be seen from Table 4, the model is stable, heteroscedasticity and serial correlation of residuals in the model are absent.

The model is used to determine the level of sensitivity of control variables to shocks in oil prices in the short run and we use it to test for stable long-run relationship, applying Johansen cointegration test. Results of Johansen co-integration test are presented in Table 4.

Johansen test results show the presence of cointegration between a number of equations, which allows presuming the existence of a long-term relationship between them. Starting from the results of the cointegration test, we can proceed to the construction of VEC model to reveal presence or absence of long-term and short-term relations between variables.

The results of the model, showing the relationship between the sampled variables are presented in Table 5.

Table 3: Results of unrestricted VAR model diagnostic testing

Type of test	Results		
VAR residual serial correlation LM test	Lags	LM-Stat	P-value
	1	9.2543	0.3954
	2	6.4531	0.9437
	3	5.5973	0.8593
	4	11.3483	0.4392
Stability condition test	All roots lie within the circle. VAR satisfies stability condition		
Heteroscedasticity (white test)	0.6703*		
VAR residual cross correlation test	No autocorrelation in the residuals		

**Denotes acceptance of null hypothesis (Ho: There is no serial correlation). *Denotes acceptance of null hypothesis of homoscedasticity

As can be seen from the Table 5, the value of error correction term C(1) is negative in sign and statistically significant. This suggests the existence of long-run relationship between the variables of the sample. In other words, we obtained evidence that Brent oil prices and sampled economic sectors of Russia are cointegrated, so that they have similar trends of movement in the long term.

The C(1) shows speed of long run adjustment. In other words, this coefficient shows how fast the system of interrelated variables would be restored back to equilibrium in the long run or the disequilibrium would be corrected. Given statistical significance at 5% level (p-value being <5%) and negative meaning, the system of variables corrects its previous period disequilibrium at a speed of 39.53% in four quarters (given optimal lag meaning of four quarters for ECM). It implies that the model identifies the sizeable speed of adjustment by 39.53% of disequilibrium correction in four quarters for reaching long run equilibrium steady state position.

Yet, we find no evidence of existence of the short-run effects coming from world oil prices to manufacturing, trade and services sector. On the one hand, long-run trends of economic sectors and oil prices are cointegrated. And dependency in the long-run exist between them, given the fact that Russian economy is heavily dependent on oil revenue. Yet, short-run effects on sampled sectors are absent due to the fact that Russian is not a small open economy, as stated in neoliberal economic models for different states, and also due to the fact that natural currency appreciation/depreciation effects are softened by trade tariffs and protectionist policies, as well as Central Bank's monetary policy.

Overall, the obtained results are consistent with existing empirical and theoretical results of the previous studies (e.g., Ito, 2017; Perifanis and Dagoumas, 2017), finding no statistical or significant evidence on the presence of the Dutch disease in Russia.

The final stage of the analysis of the model is to determine the extent of its validity. For this, it is necessary to conduct some diagnostic tests, including tests for heteroscedasticity of the residuals and serial correlation in the model. The results of these tests show that residuals are homoscedastic and serial correlation is absent.

Another test to check for the presence of the Dutch disease is Pairwise Granger causality test. The results of the test are presented in Table 6.

As can be seen from Table 6, results of pairwise Granger causality test also reject the hypothesis of manufacturing sector being affected by oil prices dynamics in Russia.

5. CONCLUSION

In this paper we aim to test the Dutch disease presence in Russian economy through examining causal and cointegration relationship between oil prices (Brent) dynamics and value added by sampled economic sectors in Russia. Dutch disease or the Groningen effect states that a fast growth of oil/gas (or other mineral resources) export leads to an increase in inflation and unemployment, a decline in manufacturing and pace of economic growth.

Table 4: Results of Johansen co-integration test

Hypothesized number of CE(s)	Eigenvalue	Trace statistics	0.05 critical value	Prob.*
None*	0.9912	78.6345	29.7970	0.0002*
At most 1	0.3864	12.8531	15.4947	0.5324
At most 2	0.0536	2.4345	3.8414	0.1934
At most 3	0.0312	0.9453	2.1253	0.1124

Trace statistics indicate 1 cointegrating equation at the 0.05 level. *Denotes statistical significance at the 5% level of significance

Table 5: Results of ECM

Coefficient number	Coefficient meaning	Standard error	t-statistic	Prob.
C(1)	−0.3953	434.254	3.8922	0.0009*
C(2)	−0.3523	0.435	7.5742	0.4509
C(3)	−0. 0114	3.194	9.2471	0.8167
C(4)	0.0272	5.367	8.2149	0.7582
C(5)	0.7823	2.158	9.9134	0.9544
C(6)	574.3213	413.475	2.0166	0.0021

*Denotes statistical significance. VECM: Vector error correction model

Table 6: Results of pairwise granger causality test

Null hypothesis	Observations	F-statistic	*P*-value
Oil prices dynamics does not Granger cause manufacturing's value added	108	0.42153	0.6608
Manufacturing's value added does not Granger cause oil prices dynamics	108	2.14166	0.6020
Oil prices dynamics does not Granger real estate services sector's value added	108	0.47790	0.9467
Real estate services sector's value added does not Granger cause oil prices dynamics	108	0.56583	0.5296
Oil prices dynamics does not Granger cause trade sector's value added	108	1.06645	0.2225
Trade sector's value added does not Granger cause oil prices dynamics	108	0.51841	0.6259
Oil prices dynamics does not Granger cause T and C's value added	108	1.58988	0.3600
T and C'S value added does not Granger cause oil prices dynamics	108	0.65272	0.3392

*Denotes acceptance of null hypothesis

Concerning Russian case, Perifanis and Dagoumas (2017) find strong evidence on the oil dependence of the Russian economy; however, they do not find firm established proof of the Dutch disease. Ito (2017) also found no strong evidence of rising oil prices affecting decline in manufacturing output. Despite these results, we use a VEC approach on the data for the period 1990–2016, using data for sampled sectors of the national economy. To test the hypothesis about relationship between shocks in oil prices and different economic sectors of Russian economy, we use econometric techniques to analyze time series. It is necessary to determine presence/absence of cointegration in long term between the variables in the equation. To check this assumption, we use a Johansen cointegration test. In a case of a long-term relationship on the one hand and condition of stationarity of sampled time series in the first order I(1) on the other, it is possible to use VEC model. In case of confirmation of presence of cointegration between the variables of the sample, residuals of the equilibrium regression can be used to estimate error correction model. The final stage of constructing a model is to conduct diagnostic tests to determine validity of the model. These include testing for heteroscedasticity and serial correlation, normality and stability of the model. Another tool for detecting presence or absence of the Dutch disease in Russian economy is Pairwise Granger causality test.

Johansen test results show the presence of cointegration between a number of equations, which allows presuming the existence of a long-term relationship between them.

Based on these results we construct a VEC model, where the value of error correction term C(1) is negative in sign and statistically significant. This suggests the existence of long-run relationship between the variables of the sample. In other words, we obtained evidence that Brent oil prices and sampled economic sectors of Russia are cointegrated, so that they have similar trends of movement in the long term. Yet, we find no evidence of existence of the short-run effects coming from world oil prices to manufacturing, trade and services sector. Results of pairwise Granger causality test also reject the hypothesis of manufacturing sector being affected by oil prices dynamics in Russia.

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