The Role of Oil Prices, Real Effective Exchange Rate and Inflation in Economic Activity of Russia: An Empirical Investigation

Izatov, Asset

University of Exeter

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Asset Izatov
University Of Exeter,
Streatham Court, Exeter, Devon, EX4 4ST, United Kingdom
0077014045753
ai252@exeter.ac.uk

Abstract
In this study we employ an empirical analysis to observe the impact of changes in inflation rate, real exchange rate instability and oil price fluctuations on the level of real economic activity of Russia. Vector Autoregressive Model (VAR) was represented and estimated along with Vector Error Correction Model (VECM). There was revealed the existence of long-run cointegration between the economic activity, the real effective exchange rate and oil prices over the 01/1995-03/2015 period. In addition, the effect of these factors on the economic output is positive. However, the cointegration with the inflation was not present in the long-run over the sample period. While, in the short-run only real effective exchange rate had an effect on the economy of Russia. The important feature of this research is that there was revealed an automatic adjustment mechanism in the model, which helps the economy of Russia to reach its equilibrium after the shock. The paper insists on implementation of the relevant reforms to the fiscal policy to diversify and strengthen the economy.

Keywords: macroeconomics empirical oil exchange inflation economy Russia monetary fiscal policy

Chapter 1 - Introduction

Russian Federation is one of the leading hydrocarbon producers around the world. Its economy was always associated with strong reliance on exports of crude oil. Russia exports 5 million barrels of crude oil and nearly 2 million barrels of refined products every day. Its exports constitute 28 percent of country's nominal GDP, while 39 percent of its total exports are occupied by oil exports. In addition, the country exports a substantial share of natural gas, along with petrochemical products. However, the impact from gas and petrochemical exports on the economy is expected to be equal to crude oil prices, as they are being indexed by oil prices.

The economy of Russia, already suspending growth because of pre-existing structural bottlenecks, has been further damaged by geopolitical uncertainties arising from the notorious conflict with Ukraine (IMF, 2014). Although its oil production power was weakened by the relative decrease in the value of Russian rouble to the U.S. dollar, the global sanctions initially imposed in March 2014 and augmented subsequently may cause the reduction of the future oil, gas and refinery products exports to countries that have forced trade restrictions. A decrease in the price of oil from $108.66 (The average price for Brent crude oil in 2013) to $45 (the current price), with the increase of European sanctions has led to the deterioration of growth rate of economy of Russia. A few years ago, Russian Federation has extensively upgraded its macroeconomic structure, with the acceptance of a fiscal rule, in particular the enactment of enlarged exchange rate flexibility, and the planning policy for inflation targeting (IMF, 2014).

According to new forecasts, inflation would not ease in the near future and would be at 12 percent level by the end of 2015, compared to 11.4 percent in 2014. Capital investment is likely to fall by 8 percent. At the same time net capital expenditures, prompted by sinking rouble and increased grappling between Russia and Ukraine, are projected to reach $155 billion (Thomson Reuters). It was estimated that the immediate effect of sanctions and counter-sanctions had been the reason for GDP to decrease between 1 and 1.5 percent, rising to the loss of 9 percent over the next several years. Present prognoses on wellbeing of the economy are dependent on a gradual perseverance in resolution of the geopolitical issues, as continuous tensions could lead to additional sanctions and worsen development. However, even in the absence of escalation of the conflict, continuous uncertainty can lead to the reduction of confidence for investors, which may reduce investment and consumption. Nevertheless, Russian public finances and economy in general seem to stay sensitive to changes in oil prices. On the other hand, the influence of these risks on outdoor sustainability of the economy is diminished by ample buffers, in particular low headline budget deficits, international reserves and low net public debt.

Despite improvement in legislation, future reform implementation and sharply changing business climate, the primary question is the same: To what extent does Russian economic situation depend on changes in

prices for energy on the international market, exchange rate fluctuations and the inflation rate?

There are several important contributions of this research to the topic of oil price effect on the economic performance of developing countries. Firstly, it is a well-known fact that Russia is a relatively emerging economy. Over the last 15 years economic activity of the country has grown rapidly. Even though, Russia is generally recognised to be significantly dependent on exports of oil, little empirical evidence exists on the influence of oil prices on its macroeconomic development. The majority of analyses are based on straightforward calculations; in particular how much a dollar change in the price of crude oil will change the export and fiscal revenues. Therefore, classically the valuation by international financial institutions and the Russian government itself centre their attention on the ability of Russia to pay its debts, i.e. fiscal and external vulnerability. Our study includes the examination of the causation between oil prices and economic activity with inflation and the real effective exchange rate included into the model, which will have direct importance for policy. How and to what extent chosen variables affect the economic activity of an emerging economy will give a new food for thought, as well as it will fund already known facts in regards of performance of transition economy in response to changes in macroeconomic factors.

In addition, we decided to use Industrial Production Index, as an economic indicator, because it can give a perfect picture about the wellbeing of the cluster of different production sectors in the economy, including energy industry, which is wanted for our empirical research. In addition, it is generally implemented to examine growth and structural developments in industrial sectors, as well as it measures variations in real output from manufacturing, public utilities over business cycle. Industrial Production Index is universal, as it is affected by both external and internal factors in an economy. Even though, the sectors, included into Industrial Production Index contribute a small part of GDP, they are extremely sensitive to consumer demand and interest rates. These features, give industrial production index the power of forecasting future economic performance and GDP growth. The increasing value of Industrial Production Index indicates that firms are performing well, while sinking value of Industrial Production Index signals to contraction in different sectors of the economy.

Chapter - 2 Literature review

Historical question on what has the most effect on economic development of different countries has been a core interest for a large number of economists, hence took a lot of time to find their explanations on this topic. In this section of our research, some of the important pieces of literature in the history of researches, in particular some empirical studies on this issue are going to be reviewed, which are related to the elucidation of disputes.

2.1 The Theory of Economic Dependence on Oil Price, Exchange Rate and Inflation

2.1.1 An influence of oil price on economic performance

Throughout two previous decades a substantial number of studies aiming at analysis of the relationship between the hydrocarbon sector and economic growth have been released. Oil price variations are paid essential attention for their acknowledged impact on macroeconomic variables. The growth of oil prices can diminish economic progress, produce inflation, and cause panics on stock exchange market, which in the long run leads to financial and monetary uncertainty. In addition, according to McKillop (2004), in the short-run period an upsurge in oil value can produce the upsurge in domestic price and reduction in the output, as well as it can lead to growth in interest rates and fall into recession. Edelstein and Kilian (2007) in their research of the oil effect on the macroeconomic variables came out with the result of the weakening of the impact of oil shocks using the vector autoregression model. Jin (2008) in his paper claims that the rapid increase in the international prices for oil has adverse influence on the economy. The important feature of these papers is that oil prices have strong influence on both net oil export and import countries. There can be found a number of reasons for oil prices to influence the macroeconomic indicators in the theory. Firstly, the oil price shock could decrease the aggregate demand, as the growing price reallocates income among oil importing and oil exporting countries. Oil price fluctuations can reduce the economic activity as a large share of customers' domestic earnings will be unfocused on discretionary expenditures and diverted toward energy consumption. In addition to that, increased costs of production in the majority of cases are converted into increased prices for services

and goods. Furthermore, the supply side effects are associated with the circumstance that energy resources are counted as an input to production procedure in the economy. Therefore, a jump in the prices for crude oil reduces total supply, since higher prices on energy leads to the situation, when firms purchase less. In the end of the chain the productivity of the amount of labour and capital declines and prospective output falls.

Some empirical papers' outcomes recommend that the response of net oil exporters to variations in prices for energy can be different from the reaction of the oil importing countries. The positive effect on the economy of oil exporting countries was conducted by Rautava (2002) for Russia, where he established that in the long-run a 10% immediate growth or fall in international oil prices was associated with 2.2 % increase or decrease in the level of Gross Domestic Product, and Aliyu (2009) for Nigeria, where the researcher investigated the influence of oil and real effective exchange rate on the economic performance, proxied by real GDP, where positive relationship between them was found. Du et al. (2010) produced the research, where he used monthly observations for oil prices and macroeconomic indicators to find possible link between them. The academic employed the vector autoregression model, which was useful to reveal the significant causality running from oil prices to economy of China. Jin (2008) conducted the paper, where he investigated the effect of oil prices on macroeconomic indicators for three countries, which are: Russia, Japan and China. He found that prices on energy exerts a harmful influence on oil importing in China and Japan, while the influence was positive for Russian Federation, which is mostly an oil-exporter.

Other researchers found evidence of some Asian countries economic dependence from oil prices. Cunado and Gracia (2005) established that economic activity and price indexes are strongly influenced by the fluctuations in international prices on oil. The countries that were included into the research are: Thailand, Philippines, Malaysia, Japan, Singapore and South Korea. No significant long-run impact was revealed, however in the short-run the influence of oil price dynamics was clear and noteworthy, when the oil shocks were in domestic currencies. Furthermore, the only oil importing country in the research was Malaysia, where the effect of oil price fluctuations was less noteworthy, apart from the rest countries from this region.

2.1.2 An influence of inflation on economic performance

The problematic question on the impact of inflation on economic progress has created a persistent debate among scientists. Researchers from one side (structuralists) have faith in the view that inflation is vital for the good economic performance, while others (monetarists) state that inflation is destructive for the economy. The indecisive nature of the connection between inflation and economic performance was represented by Friedman (1973). His conclusion was that historically there were examples, when inflation improved and deteriorated the development, as well as the situations when the inflation was not present and there were still improvement and deterioration of the development.

Nowadays the concept of inflation is considered to have adverse influence on the economic progress. Nevertheless, this destructive impact was not found in the analysis of data in the period from the 1950 to 1960. Economic studies based on those data all have the same inference, such that the influence of inflation on the output was not significant. Until the seventies, some of the studies revealed that the inflation impact on economic growth was not important; in addition some authors concluded that the effect of the inflation on the economy was found to be positive (Bhatia, 1960; Wai, 1959, Dorrance, 1963; Galbis, 1979). The view on the positive impact of the inflation changed after severe crises of high inflation happened in many countries around the world between 1970 and 1980. These crises were associated with drop in macroeconomic indicators and with balance of payments crisis. After this period, the more data arose from these incidents; therefore the effect of the inflation was associated with negative impact on the economic performance, and was confirmed by many empirical research papers (Barro, 1996; De Grigorio, 1991; Fischer, 1993).

Furthermore, some of the papers proposed that inflation was not a robust factor of economic development. When there were added another set of conditioning variables, the economic significance of the inflation decreased (Levine and Zervos, 1993). Nevertheless, in one of the works by Mallik and Chowdhury (2001) the existence of long-run positive link between inflation and Gross Domestic Product growth rate was established for four countries, in praticular Sri Lanka, Bangladesh,

India and Pakistan. Paul et al. (1997) explored the causality among economic growth and inflation for the period from 1960 to 1989 in seventy countries, from which forty eight were developing economies. He concluded that there was no causality running from inflation to the economic performance in forty percent of the countries, nevertheless, it was found that twenty percent of the countries had bidirectional link between economic development and inflation, and the rest had unidirectional causation. The noteworthy feature of the analysis is that in some cases the relationship among the variables was positive for some countries, but negative for the others. The majority of other cross-country research papers mainly focused on the nonlinearities and threshold effects of inflation on output. In one of these papers threshold rate of inflation was estimated by implementation of the balanced panel, which made time-series data to be an average over non inflicting half decades (Khan and Senhadji, 2001). Researches figured out the threshold rate of inflation to stay in the middle of 0.89 percent and 1.11 percent for industrially advanced countries, and in the middle of 10.62 percent and 11.38 percent in case of transition economies. Above these levels inflation slows down its growth.

2.1.3 An influence of exchange rate on economic performance

Common assessments like an absorption, elasticity and the Keynesian method generally proclaim that the devaluation is helpful for an output. Absorption methodology states that, through the expenditure reducing effects and expenditure substituting effects, devaluation will positively influence the output for the economy (Guitian, 1976). According to the elasticity method, devaluation will recover the trading balance as long as Marshall Lerner statement is fulfilled. In the Keynesian approach the demand is supposed to control the output and the economy operates beneath its potential. There is supposed to be the full employment condition, which assumes that devaluation's influence is positive on economic performance and employment rate. However, Jin (2008) in his research argues that fierce instability in the level of exchange rate is usually supposed to be negative factor for the economic development. In addition, Domac (1997) states, that in terms of the monetary approach, exchange rate upsets real magnitudes mostly with the real balance effect in the short-run horizon, however in the long term does not influence macroeconomic variables. Even though some of the views

state that decrease of the currency rate is expansionary, other theoretical beliefs suggest that there exist a number of negative effects, including capital account problems, flagging reliance in terms of economic policies and the difference in the marginal propensity to save from revenue and salaries (Krugman and Taylor, 1978; Berument and Pasaogullari, 2003). Kandil (2004) represented the model, which combined the exchange rate fluctuations. This model reveals that the influence of real depreciation is conflicting in theory through the impact of the supply side effect.

For the purpose of investigation of the influence of the variations in the real exchange rate on real economic activity of a country, writers used a conditional error correction model. One of these researches is paper by Terence and Pantecost (2001) for four central and eastern European emerging market economies, where the reduced form of estimation represented the result of devaluation doesn't affect Gross Domestic Product in the long-run in case of Hungary and Czech Republic. However, a violent increase in the level of real exchange rate drives to a dramatic reduction in the level of economic progress for Poland, at the same time a significant growth of GDP in Slovakia. Others employed a VAR model with five variables representing the economic activity of Mexico, such as GDP, government budget spending, real effective exchange rate, money growth and inflation (Rogers & Wang, 1995, Copelman & Werner, 1996). In the first research authors concluded that rise in exchange rate lead the level of output of the economy to decline, while in the second one researchers stated that positive shocks to the exchange rate depreciation considerably decrease the credit availability, causing adverse influence on the economy of Mexico. However, when they investigated the shock to the level of real exchange rate, they found that surprisingly, it does not have any impact on the output of the economy.

The latest study by Rautava (2002), where he used VAR model to check, if oil prices and real effective exchange rate had any effect on economic activity of Russia, proxied by GDP and government revenues, or not. The data was quarterly for the period from 1995 to 2001. His results suggested that a 10% permanent appreciation or depreciation in the level of home currency was linked to 2.4% drop or growth of output. To study the short-run link among the variables, he employed an error correction model. Aliyu (2009) discovered that the 10 % escalation in the level of real exchange rate affects Gross

Domestic Product to rise by 0.35% in Nigeria. Jin (2008) found that an increase of the real exchange rate drives to an appreciation in the level of Gross Domestic Product, whereas in case of Japan and China growing real exchange rate leads to depreciation in level of economic growth.

Chapter – 3 Data and Methodology

3.1 Data description

A vast range of macroeconomic variables, which have an effect on economic activity are worth to be included into our empirical model, such as government revenue, government expenditure, trade, investment and consumption. However, insertion of the big amount of variables into the research, will increase the volume, and will lessen the degrees of freedom. To avoid this situation, we are restricting our model with only three dependent variables, which are: inflation, exchange rate and oil price. Economic activity is reflected, using the Industrial Production Index, and regressed against international oil price for crude oil, consumer price index, and the real effective exchange rate.

The set of data chosen for our analysis is monthly and includes 243 observations for the period from January of 1995 to March of 2015 for each variable. The data on Russian industrial production index was downloaded from International Financial Statistics dataset (IFS) of the IMF. The data on the international crude oil prices is based on dollar index, and was obtained from the IMF, International Financial Statistics (IFS), as an average of two spot oil price indices: United Kingdom Brent and Dubai Brent. Consumer price index on Russian economy for the exact period of time was taken from IMF, International Financial Statistics. The real effective exchange rate data was obtained and adjusted from Central Bank of Russia (CBR).

The real effective exchange rate is defined in terms of foreign currency and is estimated using the following formula:

$$reer_t = \prod_{j=1}^{n} \left(e_{jt} \frac{P_t}{P_{jt}}\right)^{w_{jt}} \text{ ----- (1)}$$

Where $reer_t$ is the real effective exchange rate of the Russian Federation; n is the number of trading partner countries' currencies in the trade basket; e_{jt} – is the nominal exchange rate relative to currency j, calculated as the number of currency j per unit of the domestic

currency; w_{jt} – is the weight of currency j at time t; P_t – is the domestic price index of the currency at time t; P_{jt} – is the price of trade partner countries price index of foreign country j at time t. The foreign currencies included into the estimation belong to the top thirty six partners, which are: China, Netherlands, Germany, Italy, Ukraine, Belarus, Japan, Turkey, Poland, United States of America, Korean Republic, United Kingdom, Kazakhstan, France, Finland, Switzerland, Belgium, Czech Republic, Spain, India, Slovak Republic, Hungary, Sweden, Latvia, Lithuania, Greece, Brazil, Austria, Estonia, Malta, Bulgaria, Cyprus, Ireland, Slovenia, Portugal, Luxembourg. The share of 36 primary Russian trade partners is 87.9% from the total foreign trade turnover. The indices of the variables are created with the base index being equal to 100 in 2010.

The graphs attached (Figure 1) represent the plot of data on Industrial production index, CPI, real effective exchange rate and oil prices, which reinforce the view of existence of strong links among the relevant variables.

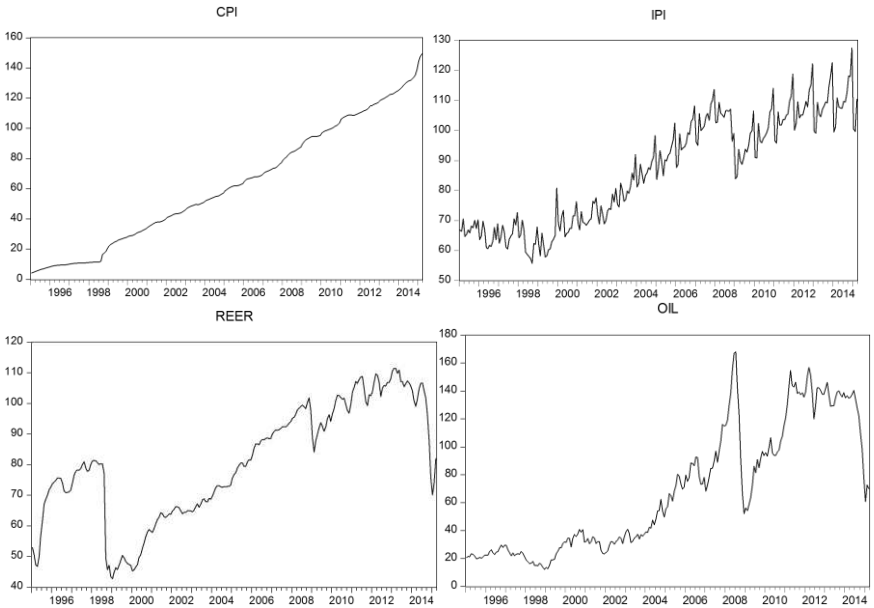

Fig. 1: *the deployment of raw data on Russian Industrial Production Index, Consumer Price Index, Real Effective Exchange Rate and Oil Price Index*

The raw data seems to be non-stationary at the level, as we can observe the upward growth between the variables during the time. Apart from that, the possibility for cointegration seems to be high.

3.2 Methodology

To conduct an empirical part of our research, we used the "Eviews 8" package and "Stata SE 13" software. For the convenience of the analysis, we convert all the variables into the logarithmic form, which also helps to avoid the heteroskedasticity.

Firstly, we will employ the tests to check for stationarity and unit root in the variables individually. In the second step, we will implement the cointegration testing for the variables as a group to discover, if the long-run dynamic behaviour exists amongst them. Lastly, we will test for the possible short-run interlink among the variables.

Chapter - 4 Empirical analysis

We first start the empirical analysis with converting our data into the logarithmic form, and plotting the logs of the variables.

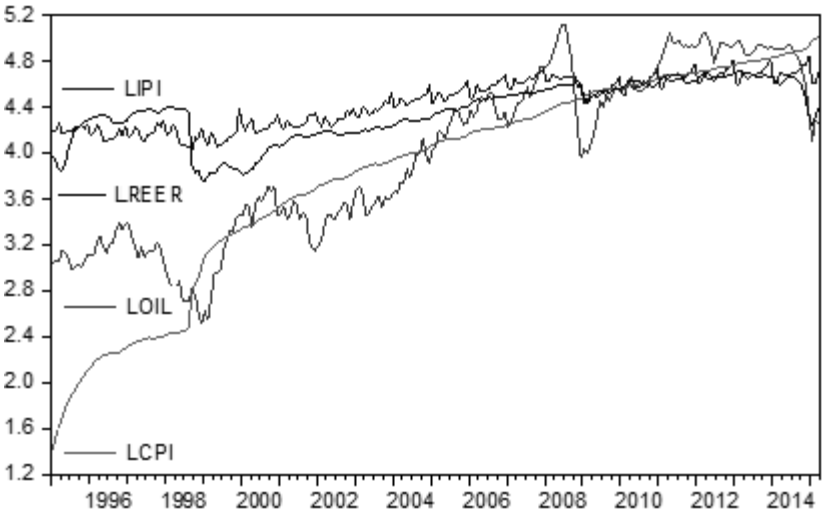

Fig. 2: log of industrial production index, log of oil price index, log of consumer price index and log of real effective exchange rate index

From the first look at the data, interpreted as the graph in the Figure 2, we get the rough idea, that our variables are not stationary at their levels, since the trend of variables is mounting with the time. In addition, our variables can be stationary at the first difference. If the outcome of the assessment is that all the series are integrated of order I(1), we will move to the cointegration tests. In addition, we can roughly say that our variables are cointegrated in the long run and can be cointegrated in the short run, since they move together through the time.

4.1 Stationarity and Unit root tests

As was described in the methodology, we need to implement stationarity and unit root tests to confirm the integrational properties of the data series for each variable: industrial production index, oil prices, real effective exchange rate and consumer price index. According to Chris Brooks (2014), financial variables are usually not stationary in their levels. We employ three well known approaches to test our variables for the existence of the unit root. The Augmented Dickey-Fuller test is generally the extended version of the Dickey-Fuller test, with the difference that we need to include lags into the model.

The number of lags included into the model will be determined by Akaike Information Criterion (AIC). The following approach can be employed without a constant, or without a constant and a trend.

The null hypothesis of the following statistic assumes that $\hat{\varphi} = 0$, while the alternative hypothesis is that $\hat{\varphi} < 0$. The last step of the test, which goal is to reveal the stationarity of the series, is to compare the absolute value obtained from the t-statistic with critical values of the Dickey-Fuller test. If the absolute value is less than the critical value, then the null hypothesis of $\hat{\varphi} = 0$ is true and the variable has a unit root.

The Phillips-Perron test is constructed on the basis of the Dickey-Fuller test and has the following formula:

$$\Delta y_t = \varphi y_{t-1} + U_t \text{ ----- (2)}$$

The null hypothesis is that φ=0, where Δ denotes the first difference of the variable at the moment of time t. The PP test is dealing with the data for y_t, like the ADF test. The Phillips-Perron test makes an adjustment for any correlation between the series and heteroskedastisity in the error terms, using a non-parametric correction technique. The

following test is robust in terms of serial correlation by using the Newey-West estimator. Given that, the PP test can be called a modified version of the DF test.

Kwiatkowski-Phillips-Schmidt-Shin test has the following form:

$$y_t = \beta' Dt + \mu_t + U_t \text{ ----- (3)}$$

Where Dt includes components, such as constant or constant and time trend, u_t is I(0) and may probably be heteroskedastic and μ_t is the random walk. Unlike the PP and the DF, the H_0 of the Kwiatkowski-Phillips-Schmidt-Shin test is that the series is stationary. The problems that can possibly arise during the estimation of the t-statistic, is that the results might show that the series suffers from the unit root, even though it does not (C. Brooks, 2014).

	Augmented Dickey-Fuller test		**Phillips-Perron test**		**KPSS test**	
Variable	**Constant**	**Const.+Trend**	**Constant**	**Const.+Trend**	**Constant**	**Const.+Trend**
Loil	-1.258	-2.051	-1.487	-2.268	1.797**	0.145
Dloil	-4.811**	-4.836**	-12.707**	-12.710**	0.109	0.073
Lipi	-1.007	-2.735	-1.528	-6.552**	1.842**	0.213*
Dlipi	-3.247*	-3.221	-27.830**	-27.745**	0.068	0.068
Lreer	-2.410	-2.811	-1.970	-2.225	1.525**	0.164*
Dlreer	-7.451**	-7.497**	-10.182**	-10.009**	0.093	0.064
Lcpi	-2.478	-2.121	-4.404**	-3.318	1.830**	0.472**
Dlcpi	-5.704**	-5.978**	-10.790**	-11.427**	0.835**	0.113
Null Hypothesis: Variable is not stationary or has a unit root						

1st simple of table: Unit root tests

Notes: ** and * show the significance at the 1% and 5% level

Since, the H_0 of the ADF and PP tests is that the series is non-stationary or it has a unit root; the results of these methods for the series, which are available from Table 1, suggest that we cannot reject it for the four variables in their levels. However, we have two exceptions in the PP test, where we can discard H_0 for the industrial production index, with 1% level of significance with constant and trend included into the formula, and for the consumer price index variable, where we can reject the null with the 1% of significance as well. When we compare the results of the tests between each other, we find that we can miss out the exceptions, as PP and ADF tests supplement each other's results. We accept the fact that all the variables are not stationary or have a unit root in their levels. The reverse situation we have, when we check the stationarity of the variables in their first differences. In the majority of cases we reject the H_0 of non-stationarity, hence acquire the statement

of the stationarity of our data with the 1% level of significance in the most cases. Nevertheless, we have the industrial production index with the 5% level of significance in the first difference with the constant included, which is still enough to reject the null hypothesis, and insignificant t-statistic to reject the null in the form of the first difference where we include the constant and trend. As the PP test complements the results of the ADF, in particular for both cases the PP test shows that the series in the first difference is at the 1% level of significance, we conclude that the all of the series are integrated of order I(1).

The KPSS test, which has the converse assumption for the null hypothesis, suggests that we reject the null hypothesis of stationarity for the most of the series in their levels with 1% of significance. We have the one exclusion in the oil prices at the level with included constant and trend, where we cannot reject the null. The industrial production index and the real effective exchange rate at their levels, where we include the constant and trend, give us the opportunity to reject the null hypothesis with the 5% level of significance, which is still enough. In the first differenced series we see, that almost in all of the cases we accept the null hypothesis except the consumer price index, where we have to reject the null hypothesis with 1% level of significance.

The results of the tests allow us to conclude, that the majority of the variables are non-stationary at their levels under all tests. When we include the variables in their first differences, the outcome suggests, that the majority of the series are I(0) at the 1% level of significance, as well as some of the series are I(0) at the 5% of significance. Thus, we conclude that oil prices, industrial production index, real exchange rate and consumer price index are integrated variables of order one. The following variables were differenced once to become stationary. The logical conclusion of three tests allows us to proceed to examination of the possible long-run link between the variables.

4.2 Cointegration tests

4.2.1 Lag selection criteria

It is a well-known fact that the first instance task, when applying the vector autoregressive model (VAR), is to estimate the autoregressive lag length p . The autoregressive process of lag length is included into the economic model of time series, in which its current value depends

on its first p lagged values. For this purpose, we employ four lag length selection criteria in our empirical research to determine the number of lags in time series variables, which are the Akaike information criterion (AIC) (Akaike 1973), Schwarz Information criterion (SIC) (Schwarz 1978), Hannan-Quinn criterion (HQC) (Hannan and Quinn, 1979) and Final Error Prediction. In Table 2 we represent these approaches

Final Error Prediction	$FPE_p = \delta_p^2(T-p)^{-1}(T+p)$
Akaike information criterion	$AIC_p = -2T\left[\ln\left(\delta_p^2\right)\right] + 2p$
Schwarz information criterion	$SIC_p = \ln\left(\delta_p^2\right) + \frac{pln(T)}{T}$
Hannan-Quinn criterion	$HQC_p = \ln\left(\delta_p^2\right) + 2T^{-1}pln[\ln(T)]$

2nd simple of table: Lag length selection criterion tests

The criteria have following form due to Sims (1980). In the formulas above T represents the size of the sample, $\delta_p^2 -$ represents the finite variance, $p -$ is the number of lags. We note, that the Akaike information criterion and final error prediction are considered biased towards high order of lags, while Schwarz information criterion and Hannan-Quinn criterion are considered to be the most relevant criteria, as they give more weight to less lags.

Lags	FPE_p	AIC_p	SIC_p	HQC_p
0	5.40e-06	-0.778	-0.718	-0.754
1	8.38e-12	-14.153	-13.855	-14.033
2	6.00e-12	-14.488	-13.951	-14.271
3	4.68e-12	-14.738	-13.963*	-14.425*
4	4.43e-12	-14.793	-13.780	-14.384
5	4.62e-12	-14.752	-13.500	-14.247
6	4.89e-12	-14.696	-13.206	-14.095
7	5.14e-12	-14.648	-12.920	-13.9510
8	5.07e-12	-14.663	-12.696	-13.870
9	5.35e-12	-14.613	-12.408	-13.724
10	5.84e-12	-14.530	-12.086	-13.544
11	5.21e-12	-14.650	-11.967	-13.568
12	3.03e-12*	-15.197*	-12.277	-14.019

3rd simple of table: Lag order selection criteria according to vector autoregressive (VAR) model

Notes: * denotes the number of lags suggested by each criterion

In Table 3 we represent the results on estimation of the lag order selection techniques. We have started the assessment by including

twelve lags, as the data included is monthly. We have obtained the contradicting results, because conclusions of final error prediction and Akaike information criterion suggest, that the optimal number of lags for the VAR should be twelve, while Schwarz information criterion and Hannan-Quinn criterion recommend to decrease the model to a third order VAR. According to Lutkepohl (1991) the HQ and SIC are the preferred ones to determine the lag quantity for the vector autoregression model. Hence we select three lags for both the Johansen and Juselius cointegration test and vector error correction model.

4.2.2 Johansen and Juselius cointegration test

The next approach is the Johansen cointegration test, based on the VAR model. The test has the following formula:

$$\Delta y_t = \phi_0 + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \text{ ----- (4)}$$

Where y_t is a (4×1) vector, which includes the logs of the variables and ϕ_0 is the (4×1) interception vector. Π is the matrix, which contains the long-run information of the data, with the rank r. What we expect to find is, whether the depending variable industrial production index, which reveals the economic activity of Russia has the cointegrating equilibria with the regressors or not. The result will tell us, whether the production index of the country reacts on the changes in consumer price index, real effective exchange rate and oil prices.

Table 4 characterizes the test results for the quantity of cointegrating β-vectors.

Rank	Trace test	Max Eigenvalue test
None	68.513**	32.523*
At most 1	35.990**	25.020*
At most 2	10.970	6.980
At most 3	3.990*	3.990*

4th simple of table: Testing for the number of cointegrating β- vectors

Notes: The number of lags included was determined by lag selection criteria in the previous part.

MacKinnon-Haug-Michelis (1999) p-values

** and * denote the statistical significance at 1% and 5% level.

Results, obtained from both trace and maximum eigenvalue tests suggest, that there exists at most 2 cointegrating vectors between the variables, as we cannot reject the null statement, which suggests that the model has at most two cointegrating relationships. In the situation

where the null hypothesis tells us, that there is no β- vector among the variables, is rejected at 1% level of significance in trace statistic and at 5% in maximum eigenvalue test. The null hypothesis, which suggests at most one cointegrating equation in the model, is rejected at 1% and 5% levels of significance in the trace and eigenvalue tests. Our variables do not have three long-run cointegrations in the model, since we can reject this assumption with 5% of significance for both tests.

β −coefficient	Equation 1	Equation 2
LIPI	1.000	0.000
LCPI	0.000	1.000
LREER	-0.048	2.596
LOIL	-0.279	-1.726
intercept	-3.116	-8.291

5th simple of table: Johansen cointegration estimation: long-run equations.

In Table 5 we represent estimated values of the β - coefficients, which constitute the cointegrating vectors. Therefore, now we have an opportunity to derive two cointegrating equations from these results. The derivation of cointegrating vectors looks as following:

$$Lipi = 3.116 + 0.048 * Lreer + 0.279 * Loil \text{ ----- (5)}$$

$$Lcpi = 8.291 - 2.596 * Lreer + 1.726 * Loil \text{ ----- (6)}$$

Due to small amount of variables in the vector autoregression system, it was relatively easy to detect two cointegrating equations, which reveal the long-run relationships. Cointegrating vector in regards of industrial production index, where we restrict the consumer price index to zero, demonstrates that there is a stationary long-run relationship, so that the economic activity in Russia depends on the level of real effective exchange rate and oil prices. For instance, if the rate of real effective exchange rate increases on 10%, it will cause the rate of industrial production index to appreciate on 0.5%. In addition, with the rise of the prices for oil on 10%, the industrial production index appreciates on 2.7%. We obtain the second equation by restricting the industrial production index to zero, which shows the long-run relationship between the consumer price index as the dependent variable and its regressors, such as the real effective exchange rate and oil prices. For example, if the level of real effective exchange rate

increases on 10%, the consumer price index depreciates on 25.96%. However, if the oil prices appreciate on 10%, it leads the consumer price index to escalate on 17.3%. The set of variables is found to have more than one cointegrating vector, thus the suitable estimation technique is vector error correction model (VECM), which adjusts to both short run changes and deviations from equilibrium.

4.3 Vector Error Correction Model

The difference of the vector error correction model from the error correction model is that VECM has many equations that can be solved at a time, while ECM has only one equation, or one way causation. Generally, error correction models exhibiting the short-run adjustment of the system in the direction of equilibrium are interesting, as error correction model shows a dynamic rather than static relationship between the economic activity and the regressors, which could be helpful in revealing more information.

Breusch-Godfrey Serial Correlation LM Test:		
VECM	**F-statistic**	**p-value**
LIPI	0.812	0.488
LCPI	0.361	0.781

6th simple of table: Serial correlation test

Notes: The number of lags included was determined by lag selection criteria

Table 6 represents results of the autocorrelation LM test, aiming to check the model for the presence of serial correlation. It is clear, that the null hypothesis cannot be rejected in both equations, hence our system does not suffer from serial correlation and VECM makes sense. Now we employ the VECM, where we check whether short-run dynamics are affected by the estimated long-run equilibrium circumstances. In practice, we test if coefficients of the error correction terms implied by cointegrating vectors for economic activity in the individual equations are negative and significant.

	Coefficient	Std. Error	Prob.
Error correction term 1	-0.308	(0.070)	0.000
Error correction term 2	0.011	(0.010)	0.299
$\Delta Lipi(-1)$	-0.251	(0.083)	0.003

$\Delta Lipi(-2)$	-0.283	(0.074)	0.000
$\Delta Lipi(-3)$	-0.032	(0.068)	0.639
$\Delta Lcpi(-1)$	0.057	(0.268)	0.831
$\Delta Lcpi(-2)$	0.203	(0.287)	0.480
$\Delta Lcpi(-3)$	-0.098	(0.237)	0.679
$\Delta Lreer(-1)$	-0.051	(0.165)	0.756
$\Delta Lreer(-2)$	0.100	(0.184)	0.587
$\Delta Lreer(-3)$	-0.374	(0.150)	0.013
$\Delta Loil(-1)$	0.022	(0.041)	0.591
$\Delta Loil(-2)$	0.037	(0.043)	0.395
$\Delta Loil(-3)$	0.052	(0.043)	0.229
$constant$	0.001	(0.005)	0.863
R^2	0.346		
Adjusted R^2	0.305		
F-statistic	8.444		
Durbin-Watson stat	1.958		

7th simple of table: VECM

Notes: The number of lags included was determined by lag selection criteria

$coefficient/(std.error) = [t - value]$

Table 7 represents the results of the VECM model. Both R-squared and its adjusted value are less than Durbin-Watson statistic, which means that the model is not spurious. F-statistic is equal to 8.45 being at 1% level of significance, thus we assume that our data is fitted well. Given all that, we can construct the following equation for the economic activity of Russia, which is proxied by industrial production index, under the vector error correction model

One period lagged first error correction term, which shows the speed of adjustment of economic activity to its equilibrium level, is negative and statistically significant being at the 1% level of significance. A value of -0.308 for the coefficient of error correction term suggests that Russian economy will foregather in the direction of its equilibrium level with a relatively high speed after an oil price shock or fluctuation in the exchange rate. Following the approach of Aliyu (2009) and Trung and Vinh (2011), we find that eliminating 95% of an oil shock would take approximately eight months in our model, where we used the following formula:

$$(1-\alpha)^t = (1-x) \text{ ----- (7)}$$

Where t is the time, α is the absolute value of the speed of adjustment parameter, while x determines the percentage of a shock.

However, one period lagged second error correction term is neither negative, nor statistically significant, being equal to 0.011. Therefore, we assume that there exists a long-run causality between the Industrial

production index of Russia, real effective exchange rate and oil prices, while in the second equation, when we include the consumer price index, its regressors do not have long-run relationship with the economic activity of Russia. Now we need to check the model for the existence of the short-run causality between the variables. The results of the tests are conveyed in the Table 8.

	LCPI		LREER		LOIL	
test	**Value**	**p-value**	**value**	**p-value**	**value**	**p-value**
F-statistic	0.350	0.789	2.919	0.035	0.877	0.454
Chi-square	1.050	0.789	8.758	0.033	2.632	0.452
Null hypothesis	$\Delta Lcpi(-1) = \Delta Lcpi(-2) = \Delta Lcpi(-3)=0$		$\Delta Lreer(-1) = \Delta Lreer(-2) = \Delta Lreer(-3)=0$		$\Delta Loil(-1) = \Delta Loil(-2) = \Delta Loil(-3)=0$	

8th simple of table: Short-run causality
Source: Author's calculations using the data**.**

The outcome of the tests proposes the existence of short-run causality running from real effective exchange rate to industrial production index of Russia with 5% level of significance in both F-statistic and chi-square. However, the null hypothesis of the existence of the short-run causality running from consumer price index and real effective exchange rate to economic activity of Russian Federation is rejected. This test proves results, represented in the Table 7, where all three lagged coefficients of the consumer price index were insignificant to explain the industrial production index, as well as oil prices. Only three lagged coefficient of the real effective exchange rate was at 5% level of significance. Thus we can conclude that only real effective exchange rate affects the industrial production index in the short-run, while neither oil prices, nor consumer price index have an influence on the economy of Russia.

Chapter – 6 Conclusion

The results obtained from the empirical part of the study suggest that prices for oil and devaluation have substantial supportive effect on the economic activity of Russia. For instance, a stable 10 percent increase (decrease) in international oil prices is associated with 2.7 percent growth (decline) of economic activity over the long run. In the same way, a stable 10 percent increase (decrease) of Russian rouble is related

to 0.5 percent appreciation (depreciation) of the economic activity in the long run. The effect of inflation was not present for the economic activity of Russia in the long-run. This relationship shows that Russian industrial production appreciates more, when the oil price increases than in the situation, when the growth of exchange rate takes place. Lastly, the outcomes from the vector error correction model presented that the error term for the first equation, which includes oil price and real effective exchange rate as regressors and Industrial Production Index as a regressand, are accurately signed and statistically significant, proving that the first equation is true. Even though, the second error term for the second equation from the Johansen procedure is correctly signed, it is not statistically significant, proving the second cointegration equation for the Consumer Price Index being wrong. These results imply that long-run equilibrium condition only in the case of the variables from the first equation influences the long-run dynamics.

Furthermore, while this research does not report much about the factors, which define the exchange rate, it was found that in the short-run economic development play a major role in the determination of the real exchange rate. In addition, known the important role of real exchange rate, the results of the research supports the anti-inflation policy, through which Russia controlled the growth of the rouble and, which led to positive output from the production sector. In addition, we found that the economy of Russia has an automatic adjustment mechanism and that the economy replies to deviations from equilibrium in balancing manner.

To conclude, theory and evidence have shown that oil price shock has both income and output effect on the economy of Russia. On the other side, exchange rate fluctuations have significant effect on output through investment. The precedent, which happened recently with an oil price depreciation to its historical minimum, the government should be careful, as it looks much alike the accident experienced by the USSR in 1980s. For the United Soviet Union hard currency linked to oil income was the only remedy against systematic flaws, which made communist economy extremely faint. Apart from this, Russian government does not practice a solid rule for the symmetry between revenues, obtained from energy industry, that are to be spent. Given the reliance of the nowadays Russian economy on crude oil, it will be logical to recommend making a greater diversification of the economy

through cautious investment in the productive sectors of the economy using the money earned from oil industry.

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