# Dutch Disease and Monetary Policy in an Oil-Exporting Economy: the Case of Russia

by

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# Abstract

In this work I broadly investigated the phenomenon of Dutch Disease. I found empirical evidence of vulnerability to DD of Russian economy. The symptoms are: real exchange rate appreciation caused by oil windfall, higher services growth, slower manufacturing growth and overall wages increase. However, these may be caused by other processes taking place in the economy, such as transition. Also I built a DSGE model of the economy sick with Dutch Disease in order to investigate impact of oil price shocks on such economy. In this work I concentrated mostly on incomplete asset market case, since it turned out that agents can totally hedge themselves from stochastic shocks of oil price under complete markets case. Taken several specifications of welfare function I ranked types of monetary policies based on their contribution to welfare loss. It turned out that targeting domestic inflation with Taylor-based rule (DITR) produces poor results. Meanwhile, CPI inflation targeting and exchange rate peg were found optimal under different specifications. Then two extensions were carried out: I introduce stabilization fund and assume that tradable-producing firms have exposure to oil price fluctuation. Overall, the best performance with respect to welfare loss demonstrates CPI inflation targeting as consistent with findings of Sosunov and Zamulin (2007).

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# 1 Introduction

It is common knowledge that in general resource-rich countries demonstrate much slower economic growth than those without natural resources. This is confirmed by empirical findings of Sachs and Warner (1995), and is known as "natural resource curse". There exist mainly three possible and not mutually exclusive theories which explain this phenomenon. The first explanation, and which is the main subject of this work, is known as "Dutch Disease". The basic concern here is real exchange rate appreciation following large windfalls coming from resource export, which makes domestic manufacturing less competitive and even unprofitable. The second possible reason for the "resource curse" is historically high volatility of commodity prices which transfer these fluctuations into resource-addict economy bringing injurious effect on growth. For instance, during the period of low oil prices in the 1990s the Russian government experienced budget deficit and had to cut spending and run into enormous international borrowings. The third popular explanation is associated with institutional inefficiency: windfall revenues induce rentseeking behavior, corruption and low quality of resource management. After commodity market turned into favorable direction for Russia corruption schemes became very popular among officials. The most popular is a "feedback" scheme in government contract auctions when after a firm has received a highly profitable government contract (which is usually overpriced) the firm has to pay a bribe to government officials organizing the auction. Recently activists have started to monitor government auctions and for a couple of years they detected machinations in amount of 15mln USD<sup>1</sup>.As for inefficient resource management, the stabilization fund was not invested/managed in former years of its existence and as a result made loses due to inflation and

<sup>&</sup>lt;sup>1</sup> www.rospil.ru

missed profit. Moreover, after the ministry of finance allowed investing fund resources, the losses received from such unsuccessful managing turned out to be even higher<sup>2</sup>.

Dutch Disease was named after the experience of Dutch economy during the 1960s, just after large amount of natural gas was discovered in the North Sea. This discovery gave a start to active development of gas fields, and Holland rapidly turned into a powerful resource-exporting country. Processing industries on the contrary started to experience a fall in foreign demand due to a loss of relative competitiveness, which in turn led to a decrease of non-gas exports and a fall in tradable sector output and employment. Interestingly, Holland recovered from the disease very soon as we can observe return to normal level of tradables export in the beginning of the 1970s, but other countries cannot give up resource addiction for decades.

It turns out that to diagnose a Dutch Disease is not a trivial task. The reasons for decline in domestic manufacturing and for exchange rate movements are not always clear. Particularly, when examining post-Soviet countries we need to determine whether the observed dynamics are due to vulnerability to Dutch Disease of just a part of transition process.

Symptoms of Dutch Disease in Russia and other post-soviet countries were found by several researchers such as Oomes and Kalcheva (2005) and Kuralbayeva et al(2001). Major evidence of these papers is devoted to real exchange rate volatility explained by terms of trade shocks or simply oil prices. REER's and oil price's time series have unit root, that's why cointegrating vector estimation should be used for detecting oil price effect. A variety of real exchange models exists and most of them are discussed in Driver and Westaway (2004). The symptoms of Dutch Disease which were pointed out by Oomes and Kalcheva (2005):

- 1. Appreciation of real exchange rate;
- 2. Slower manufacturing growth caused by this appreciation;

<sup>&</sup>lt;sup>2</sup> http://www.gazeta.ru/2006/05/16/last199727.shtml

- 3. Faster service growth (non-tradable sector) due to higher income;
- 4. Higher overall wages.

This paper will show that Russia has almost all of these symptoms and is still vulnerable to Dutch Disease, though a fall in manufacturing is not observed. Besides, in this work I investigate the framework for analyzing monetary policy performance in diseased small open economy.

The classical papers denoted to Dutch Disease are Corden and Neary (1982) and Corden (1984). In Corden and Neary (1982) there exist three sectors in the economy: booming sector, manufacturing sector and sector of non-tradable goods which are usually services. Resource abundance has two different effects on the economy and especially on production of tradables. In the general case a highly profitable booming sector attracts labor and capital which flow away from manufacturing and nontradable sector. This is referred to as "Resource movement effect". In oil- or gas-abundant countries this effect is negligible because labor movement to the booming sector is not significant as the oil industry is not labor-intensive. Besides, it is unlikely to observe labor movement in case of Russia with its wide territory, as oil extraction is located in Siberia known for its unfavorable climate conditions and remoteness. The second effect which takes place during a resource boom is known as "Spending effect". It implies that revenue windfall induce surplus demand for nontradables and causing real appreciation, the rise of their price relative to tradables. Referring to a fall in output of manufacturing Corden and Neary (1982) distinguished between a direct de-industrialization which, is a result of lower labor input in tradable sector, and indirect de-industrialization, which is a flow of labor to nontradable sector associated with spending effect.

Originally, tradable/non-tradable framework which I use in the DSGE model was developed by Salter (1959) and Swan (1960,1963), where the authors investigated how terms of

trade shocks affect small open economies. Suescun (1997) developed and calibrated dynamic stochastic growth model of an economy with booming sector which integrates the real business cycle approach. He considered Colombia as an economy sick with Dutch Disease since its wellbeing depends significantly on coffee exports. It would be also very useful to build a similar model for Russian economy, but as the economy is in transition the model would be uneasy to calibrate and it possibly would not fit the stylized facts.

The phenomenon was also previously considered in DSGE small open economy framework by Sosunov and Zamulin(2007). They developed a simplified model for monetary policy implications in Russia. In benchmark case it was assumed that an oil-dependent economy has no tradable production at all. More complicated models containing Dutch Disease were developed by IMF institute, such as Dagher et al.(2010), where they used Learning-by-Doing externality to capture DD effect in African countries.

This work is organized as follows. In Section 2 I evaluate the symptoms of DD and try to find empirical evidence of such symptoms in Russia. These include: 1. Estimation of oil price elasticity of Real Exchange rate using cointegration technique. 2. Analysis of manufacturing dynamic compared to other sectors. 3. Analysis of non-tradable sector and its improvement since oil price jump. 4. Wages overview. In Section 3 I present a DSGE model for a small open economy with booming sector, compute impulse responses and perform welfare analysis. In Section 4 I extend the previous model by adding a stabilization fund and the rest of world economy.

# 2 Symptoms of Dutch Disease: Russian Evidence

#### 2.1 Real Exchange Rate

There is no doubt that for the last decade key indicators of Russian economy were highly connected with or, I would say, were driven by the price of raw materials. I followed the methodology used in Edwards (1988) or Sosunov and Shumilov (2005) in order to determine a long-run relationship between Real effective exchange rate and crude oil price.

Long-run equation of equilibrium can be written as:

$$\ln(e_t^*) = \beta \ln(F_t) + u_t , \qquad u_t \sim l(0) \ error$$

where  $e_t^*$  is equilibrium level of real effective exchange rate,  $F_t$  is vector of fundamental variables discussed later,  $u_t$  is residual from regression. Since all these variables are integrated of order 1, we need to test groups of variables for cointegration. I use Johansen Cointegration Test procedure which is prebuilt in Eviews. The summary of these tests are presented in Appendix A.3.

Short-run dynamics of REER is expressed through equation:

$$\Delta ln(e_t) = \alpha u_{t-1} + \sum_{i=1}^k \beta_i \Delta ln e_{t-i} + \sum_{i=1}^k \gamma_i \Delta ln F_{t-i} + \sum_{i=1}^k \delta_i \Delta ln T_{t-i} + \epsilon_t$$

where  $\Delta$  means first difference,  $T_t$  is a vector of fiscal and monetary policy variables,  $u_{t-1}$  stands for error correction term which is simply lagged residuals from long-run equation. It is worth to mention that according to error correction mechanism the coefficient on  $u_{t-1}$  must be significant, negative and between 0 and 1 is absolute value. This coefficient characterizes the speed of convergence back to equilibrium level after short-run shocks had been received.

#### 2.1.1 Data and Variables

Data was taken from IFS-statistic database and from Goskomstat (Russian Government Statistics Centre). Some variables required for productivity differential between Russia and Germany, such as industrial employment and production index of Germany, were taken from Eurostat. All variables are seasonally-adjusted using X-12 Census, except for one regression where I account for seasonality by including 4 lags in the equation. Descriptive statistics and graphs of all variables are presented in Appendix A.1.

The dependent variable is Real Effective Exchange Rate CPI based (REER). It is computed as a geometrical average of real exchange rates indices between Russian Federation and its major trade partners, weighted by trade volume. There also exist other specifications of exchange rate, for instance, it could be computed as difference in price levels between Russia and the rest of the world and in practice can be estimated as a ratio: GDP deflator over imports deflator. In this regression I stick only to REER provided by IMF-statistics.

The fundamental variables, which explain long-run behavior of REER, were taken term of trade and productivity differential. Term of trade is an essential and the most frequently used variable in exchange rate analysis. Terms of trade is defined as a ratio of price of exports to price of imports. Its improvement leads to an increase in aggregate demand through the welfare effect. As a result, the price level of nontradables also grows and, therefore, real exchange rate appreciates. In empirical studies it is common practice to use a commodity price as a proxy for terms of trade in cases when commodity makes up a significant share of a country's export. In our case oil revenues amount to more than a half of Russian export cash flow, so oil price is used as an approximation for terms of trade. As it was already mentioned, theoretically the effect on REER must be positive. Plots of these two variables are presented in Figure 1.



Figure 1. Real Exchange Rate vs. Oil prices

Another variable which is frequently used as fundamental in exchange rate analysis is productivity differential. Adding this variable into the regression allows me to account for Balassa-Samuelson effect. This theory tells us that real exchange rate appreciates under two conditions hold: 1. higher productivity growth in tradable sector vs. nontradable within a country. Rising wages in tradable sector associated with higher productivity have a spillover effect into another sector. It causes relative increase of price for domestic nontradables and thus forcing up total price level in the economy; 2. relative productivity grows faster than those of countries-trade partners.

Due to unavailable data for Russian nontradable sector I computed only differential of productivity growth between Russian and German manufacturing, which I used as a variable which must account for Balassa-Samuelson effect. The graph of this and further variables are presented in the Appendix.A.2. In this work I used two different specifications of productivity differential: 1. Difference in ratios: output to employment; 2. Methodology provided by Nienke Oomes and Katerina Kalcheva.

After trying different variables of fiscal policy I chose the following three. The first is Government consumption as a share of GDP (GOV). Consuming domestically produced goods and service the government drives up domestic inflation, especially for non-tradables. Other things being equal, the more government spends, the higher is real exchange rate appreciation. The second is Reserves to Import (RIM) and the third is Net international Reserves (NIR). I tried two different indicators which are commonly used in the literature to control for reserves accumulation. Theoretically, accumulation of reserves is inversely related to REER in the shortrun only. Central bank interventions will induce higher inflation in the medium-run period, which will drive exchange rate back to equilibrium.

#### 2.1.2 Estimation Output

The results are presented in Table 1 and Table 2, and were obtained from VEC estimation using EViews 6.1. The estimates highlighted in bold are statistically significant. Being mostly interested in the period of the 2000s rather than in unstable and volatile transmission period of the 1990s the reesults suffer from a small sample size problem. The key variable of interest is oil price elasticity. It ranges from 0.3 to 0.5 and is statistically significant in each specification. My findings are consistent with those of Oomes and Kalcheva (2007) who find it around **0.5**, Sosunov and Shumilov (2005) who get the long-run elasticity of **0.64** and Spatafora and Stavrev (2003) whose estimate is **0.31**. Under such specification of productivity differential I do not observe Balassa-Samuelson effect in Russia in the 2000s. The government expenditure is proportional to REER appreciation, since this consumption is biased towards domestic producers.

Thus, increase in consumption brings up domestic prices, especially relative prices for nontradable goods. However, this connection also implies that government can offset the effect of oil price shocks through decrease in spending (if shock is positive).

#### **Dependent Variable: REER** (1)(2) (3) Seasonality removed with: X-12 X-12 non-SA Lags included 4 2 2 BEGIN 1998Q2 1997Q4 2000Q3 2009Q3 END 2010Q4 2010Q3 **OBSERV** 50 48 41 -0.07 Productivity [-0.79] 0.34 0.29 0.5 Oil price [21.52] [5.11] [5.99] Government Cons 0.62 1.18 0.71 [4.27] [6.32] [2.83] RIM ( \* for Short Run) 0.05\* [5.17] NIR (\* for Short Run) -0.09 [2.07] ECM term -0.82 -0.75 -0.17 [-6.10] [-9.09] [-2.29] Crisis Dummy yes yes no **R**-squared 0.7912 0.8128 0.7308 LM test for serial correlation (the smallest p-statistic) 0.0784 0.35 0.0621 Akaike criteria -3.35 -3.76 -4.8 102.29 Log Likelihood 98.85 108.39

#### **Table 1. Cointegrating Vector Estimation**

Dependent Variable: REER	(4)	(5)
Seasonality removed with:	X-12	X-12
Lags included	2	2
BEGIN	1997Q4	1997Q4
END	2010Q3	2010Q3
OBSERV	52	52
Productivity	<b>0.34</b> [2.20]	<b>0.4</b> [2.38]
Oil price	<b>0.4</b> [8.84]	<b>0.16</b> [4.90]
Government Cons	<b>1.23</b> [8.52]	<b>0.5</b> [4.21]
RIM ( * for Short Run)		<b>0.27</b> * [9.28]
NIR (* for Short Run)		
ECM term	<b>-0.52</b> [-6.51]	<b>-0.84</b> [-9.20]
Crisis Dummy	no	yes
R-squared	0.72	0.81
LM test for serial correlation		
(the smallest p-statistic)	0.12	0.15
Akaike criteria	-3.55	-3.63
Log Likelihood	102.32	364.29

#### Table 2. Cointegating Vector Estimation (cont.)

Using alternative specification for relative productivity I find similar result to oil price elasticity. Moreover, we can observe partially Balassa-Samuelson effect: productivity differential is positive and statistically significant. It means that real exchange rate get 3-4% appreciation from 10% productivity shock in Russia. However, B-S effect was found to be much higher for Russia by other researchers: Spatafora and Stavrev (2003), Egert (2005).

## 2.2 Other symptoms of Dutch Disease

The second sign of Dutch Disease is slower manufacturing growth caused by real appreciation. Production indices of oil industry versus manufacturing are presented in Figure 2.





The results seem to contradict the Dutch Disease hypothesis as we can observe high growth rates in manufacturing for the past decade. At the same time manufacturing is more volatile than the resource sector: its growth rate ranging from -15 to +13% a year. We observe a great decline of 15% following the crisis of 2008, though the resource sector was stable. However, it was pointed out by Russian economists<sup>3</sup> that manufacturing growth is mostly driven by increased domestic demand and higher government consumption, the latter biased towards domestic producers. The former is due to the fact that imported tradable goods are not perfect substitutes to domestic ones. Thus, increased income of domestic agents positively affects

<sup>&</sup>lt;sup>3</sup> e.g. see http://www.finam.ru/analysis/newsitem5816B/default.asp

production, at least for the period under review. Also we should keep in mind that some industries are still recovering from substantial downswing caused by economic reforms during the 1990s. For example, it was reported in 2002 that manufacturing in Moscow (one of the rapidly growing regions) had just exceeded the volume of 1990<sup>4</sup>.

The second symptom is faster non-tradable industries growth, especially growth in services. These growth rates are presented in Figure 3. The absolute champion of the past decade is construction industry which is not surprising: real estate prices grew even faster during that period. Having pattern similar to manufacturing, retail trade grew at 10% per year on average. Service growth was rather stable approximately at 13% per year, though the same as other industries (except for natural resources) it was affected by the crisis of 2008.





<sup>&</sup>lt;sup>4</sup> Rosstat, 2002. Website: www.gks.ru

The next symptom of the disease pointed out by Oomes and Kalcheva (2007) is overall real wage increase which we can observe in Figure 4. Data was taken from electronic versions of yearbooks "Labor and Employment in Russia" published by Goskomstat.



Figure 4. Real Wage Dynamics across Regions and Industries, in RUB of 2005; Rosstat









As it is shown in the graphs wages in all industries have upward trends. Except for Central Federal Region, the highest wages earn employees of resource sector followed by far behind services and manufacturing. Agricultural workers, who are rural area residents, are traditionally least rewarded.

## 2.4 Summary

My brief analysis of Dutch Disease symptoms indicates that Russia has almost all of them. First, using cointegrating vector estimation positive oil price elasticity of real exchange rate was estimated, ranging from 0.3 to 0.5. This finding represents the most evident proof of vulnerability to Dutch Disease of Russian economy. Second, production growth in manufacturing during the past decade was found high which contradicts the Dutch Disease hypothesis. There are two possible driving forces for this process: first, the economy is in transition and is recovering from substantial downturn; second, increased income of domestic agents and government consumption. It is worth to mention that manufacturing grew slower than services, which is consistent with weaker version of DD. Third, growth in services turn out to be slightly higher (3-4%) than in manufacturing; growth in construction was significantly higher but mostly driven by real estate prices. Forth, higher overall real wages across industries were discovered in all regions.

However, these symptoms may be caused by other factors. We should keep in mind that Russian economy is still in the transition. Crisis of 1998 caused significant real exchange rate depreciation resulting in favorable conditions for growth in manufacturing sector.

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## **3 DSGE model of Dutch Disease Economy**

This model was inspired by Sosunov and Zamulin (2007) who considered and calibrated Russian economy as one with Dutch Disease and analyzed monetary policy rules with respect to welfare losses. I built similar model in New Small Open Economy framework, such as Gali and Monacelli (2005) using some features of De Paoli (2009) and Jung (2010). Complete market assumption made the model easier for derivation and analysis, but, unfortunately, is not very realistic. Besides, it turned out that under such specification domestic agents would be totally ensured against oil price shocks. For that reason incomplete asset market case was considered.

#### 3.1 Households

Optimizing Households have value function of following type:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

where the one-period utility function is given by

$$U(C_{t}, N_{t}) = \frac{C_{t}^{1-\sigma}}{1-\sigma} - \frac{N_{t}^{1+\phi}}{1+\phi}$$

Consumption and price indices are determined through aggregators:

$$C_{t} = \left( (1 - \alpha)^{\frac{1}{\eta}} \cdot C_{H,t}^{\frac{\eta - 1}{\eta}} + (\alpha)^{\frac{1}{\eta}} \cdot C_{F,t}^{\frac{\eta - 1}{\eta}} \right)^{\frac{\eta}{\eta - 1}}$$
(1)

$$P_{t} = \left( (1 - \alpha) \cdot P_{H,t}^{1 - \eta} + (\alpha) \cdot P_{F,t}^{1 - \eta} \right)^{\frac{1}{1 - \eta}}$$
(2)

where  $\alpha$  refers to as "degree of openness",  $C_{H,t}$  and  $C_{F,t}$  are consumption of nontradable and tradable goods respectively,  $P_t$  is Consumer Price Index,  $P_{H,t}$  and  $P_{F,t}$  are price indices for nontradable and tradable goods respectively (subscripts H and F were chosen to be consistent with usual SOE notation);  $\eta$  is the elasticity of substitution between tradables and nontradables. Variables  $C_{H,t}$  and  $C_{F,t}$  are also indices presented as:

$$C_{H,t} = \left(\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}} \qquad C_{F,t} = \left(\int_0^1 C_{i,t}(j)^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}}$$

The expenditure minimization problem gives the following results:

$$C_{H,t} = (1 - \alpha) \left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \qquad \qquad C_{F,t} = \alpha \left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \qquad (3)$$

#### 3.1.1 Exchange rate, Terms of Trade and Inflation: Definitions

Following Gali and Monacelli (2005) the following identities will hold whatever asset market type is assumed. Approximated up to first order effective terms of trade will take the form:

$$s_t = p_{F,t} - p_{H,t}$$
 (4)

Price index (CPI) can be log-linearized around symmetric steady state ( $P_{H,t} = P_{F,t}$ ):

$$p_{t} = (1 - \alpha) p_{H,t} + \alpha p_{F,t}$$
  
=  $p_{H,t} + \alpha s_{t}$  (5)

Assuming law of one price (import and export price) holds for individual goods it is straightforward to derive:

$$p_{F,t} = e_t + p_t^* \tag{6}$$

where  $e_t = \int_0^1 e_{i,t} di$  is the (log) nominal effective exchange rate and  $p_t^*$  is world price index. Also I denoted real effective exchange rate (REER) as  $Q_t = \frac{\xi_t P_t^*}{P_t}$ , and get log-linear expression:

$$q_{t} = e_{t} + p_{t}^{*} - p_{t} = (1 - \alpha)s_{t}$$
(7)

#### 3.1.2 Asset Markets

Complete Markets. Budget constraint of domestic households will be the following:

$$P_{t}C_{t} + \frac{B_{H,t}}{(1+i_{t})} \le B_{H,t-1} + W_{t}N_{t} + T_{t} + \xi_{t}(P_{t}^{oil}X)$$
(8)

where  $T_t$  is transfer from the government,  $W_t N_t$  is the nominal wage income,  $B_{H,t}$  is domestic bonds,  $\xi_t (P_t^{oil} X)$  is the oil income valuated in domestic currency. Real price of natural resource (in logs) follow AR(1) exogenous process:

$$p_{t+1}^{oil} = \rho_{oil} p_t^{oil} + \varepsilon_t^{oil} \tag{9}$$

where  $\varepsilon_t^{oil}$  is IID(0, $\sigma$ ) oil price shock.

It turned out that under complete market assumption domestic consumers are totally hedged against oil price fluctuations. Besides, this assumption is to unrealistic known that financial markets in Russia are relatively undeveloped. Further I investigate the case of incomplete markets only.

Incomplete Markets. Budget constraint of domestic households will take the form:

$$P_{t}C_{t} + \frac{\xi_{t}B_{F,t}}{(1+i_{t}^{*})\psi\left(\frac{B_{F,t}\xi_{t}}{P_{t}}\right)} + \frac{B_{H,t}}{(1+i_{t})} \leq \xi_{t}B_{F,t-1} + B_{H,t-1} + W_{t}N_{t} + T_{t} + \xi_{t}(P_{t}^{oil}X)$$
(10)

where  $B_{F,t}$  and  $B_{H,t}$  denote domestic and foreign bonds, denominated in currency of their country. The incomplete markets are introduced in the model using the function  $\psi(.)$ , which represents the cost from international debt holding. This intermediation cost function ensures stationarity of steady state in the model. This function is increasing in foreign debt and is equal to unity in the steady state:  $\psi(\overline{B_{F,t}}) = 1$ . Following De Paoli (2009) it is assumed that foreign households trade only foreign-currency bonds. Under such framework in equilibrium domestic-currency bonds will be of zero net supply and thus only foreign-currency bonds are traded.

We can write the same budget constraint for households from the rest of the world:

$$P_t^* C_t^* + \frac{B_{F,t}}{(1+i_t^*)} \le B_{F,t-1} + W_t^* N_t^* + T_t^* + \Gamma_t$$
(11)

where  $\Gamma_t$  is the intermediation profits which receive foreign agents from small open economy. So, given these budget constraints I can find intertemporal conditions to the households' problem:

$$U_{C}(C_{t}) = (1+i_{t})\beta E_{t} \left[ U_{C}(C_{t+1}) \frac{P_{t}}{P_{t+1}} \right]$$
(12)

$$U_{C}(C_{t}^{*}) = (1 + i_{t}^{*})\beta E_{t} \left[ U_{C}(C_{t+1}^{*}) \frac{P_{t}^{*}}{P_{t+1}^{*}} \right]$$
(13)

$$U_{C}(C_{t}) = (1 + i_{t}^{*})\psi\left(\frac{B_{F,t}\xi_{t}}{P_{t}}\right)\beta E_{t}\left[U_{C}(C_{t+1})\frac{\xi_{t+1}P_{t}}{\xi_{t}P_{t+1}}\right]$$
(14)

where the last equation comes from the decision of domestic households regarding foreign bonds.

Equations (13) and (14) imply that equilibrium real exchange rate is determined by:

$$E_{t}\left[\frac{U_{C}(C_{t+1}^{*})}{U_{C}(C_{t}^{*})}\frac{P_{t}^{*}}{P_{t+1}^{*}}\right] = \psi\left(\frac{B_{F,t}\xi_{t}}{P_{t}}\right)E_{t}\left[\frac{U_{C}(C_{t+1})}{U_{C}(C_{t})}\frac{\xi_{t+1}P_{t}}{\xi_{t}P_{t+1}}\right]$$
(15)

## 3.1.3 Log-linearized conditions of Household problem

Condition (15) can be log-linearized into:

$$\sigma E_t (c_{t+1} - c_t) = \sigma E_t (c_{t+1}^* - c_t^*) + E_t \Delta q_{t+1} - \delta b_t$$
(16)

where  $b_t = \frac{B_{F,t}\xi_t}{P_t}$  is linearized in levels and  $\delta$  is the sensitivity of intermediation cost with

respect to the net foreign asset. Besides, I can write a log-linearized version of domestic budget constraint, assuming that oil income is spent only on imported tradables:

$$\beta b_t = b_{t-1} - c_{F,t} + (p_t^{oil}) \tag{17}$$

In this transformation without loss of generality I assumed that:

$$\overline{C}_{F,t} = 1$$
,  $\overline{Q} = 1$ 

Under any type of asset markets the following first-order condition will hold:

$$C_t^{\sigma} N_t^{\phi} = \frac{W_t}{P_t}$$

After log-linearization labour supply equation takes the form of:

$$\sigma c_t + \phi n_t = w_t - p_t \tag{18}$$

Recall that from expenditure minimization problem (3) it can be easily derived log-linear expression for intratemporal choice between domestic and foreign-good consumption:

$$c_{H,t} - c_{F,t} = -\eta (p_{H,t} - p_{F,t})$$
(19)

#### 3.1.4 Uncovered interest rate parity condition

Putting together equations (13) and (14) I get:

$$(1+i_t^*)\psi\left(\frac{B_{F,t}\xi_t}{P_t}\right)\frac{\xi_{t+1}}{\xi_t} = (1+i_t)$$

Log-linearization gives the following Uncovered Interest Rate Parity (UIP) condition for incomplete market case:

$$r_{t} - r_{t}^{*} = e_{t+1} - e_{t} + \delta b_{t}$$
(20)

where I denote  $R_t^j = (1 + i_t^j)$  for  $j \in [domestic, ROW]$ . The only difference from complete market UIP condition is that difference in interest rates now also affected by net asset position due to intermediation premium.

#### 3.2 Firms

#### 3.2.1 Technology

Domestic production of nontradable goods is presented by differentiated firms and assumed to have production function in form of:

$$Y_t(j) = A_t N_t(j)$$

Index for domestic output is given by  $Y_t = \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$ . Equation () can be log-linearized up to first order: y = a + n (21)

$$y_t \quad \alpha_t + \alpha_t$$
 (21)

I assume that government transfers employment subsidy thereby offsetting the distortion caused by monopolistic competition. The real marginal cost will take the form:

$$MC_t = \left(1 - \frac{1}{\varepsilon}\right) \frac{W_t}{P_{H,t}A_t}$$

(22)

which can be log-linearized as:  $mc_t = w_t - p_{H,t} - a_t$ 

One can argue that oil should be considered as a production factor, besides oil price has primary effect on domestic inflation and should be included in the marginal cost. In reality, oil price in Russia (based on petrol price) is twice less than world price. In other oil-exporting countries oil prices could be even lower. Second, the share of oil costs in nontradable industries (except for transportation and utilities) is low as well. So, based on these facts I leave the production function in AN-form. However, later in this work I extend the model in a way that the rest of the world which is oil-importing and tradables-producing reacts to the fluctuation of oil prices through marginal cost and inflation increase. As for now, I assume the identical production function to the rest of the world:

$$y_t^* = a_t^* + n_t^*$$
(23)

$$mc_t^* = w_t^* - p_t^* - a_t^* \tag{24}$$

#### 3.2.2 Price Setting Mechanism

As in most of SOE literature I assume Calvo(1983)-type price setting, where only a fraction  $\theta$  of domestic firms can adjust their prices in current period. Firm's maximization problem takes the form:

$$\max_{(\overline{P_{H,t}})} \sum_{k=0}^{\infty} (\beta\theta)^k \left\{ Q_{t,t+k} [Y_{t+k}(j)(\overline{P_{H,t}} - MC_{t+k})] \right\}$$

After some algebra it might be derived (for derivations see e.g. Gali and Monacelli (2005)):

$$\overline{p}_{H,t} = (1 - \beta \theta) \sum_{k=0}^{\infty} (\beta \theta)^{k} E_{t} \{ mc_{t+k} + p_{H,t} \}$$

where  $\overline{p}_{H,t}$  denotes newly adjusted (log) price set by domestic firm. Thus, it is observed from this equation that current price decisions incorporate expectations about dynamics of marginal cost.

Under this framework New Keynesian Phillips Curve (NKPC) links current and anticipated domestic inflation with deviation of real marginal cost from its steady-state:

$$\pi_{H,t} = \beta E_t \{ \pi_{H,t+1} \} + \lambda (mc_t - mc)$$
(25)

Inflation dynamics for the rest of world is described by the same shape of NKPC:

$$\pi_t^* = \beta E_t \{\pi_{t+1}^*\} + \lambda (mc_t^* - \overline{mc}^*)$$
(26)

#### 3.3 Equilibrium

In the marginal case of economy sick with Dutch Disease it is assumed that all tradables are imported and the economy produces only nontradables and exports natural resources.

$$Y_t(j) = C_{H,t}(j)$$
 in log-linear terms:  $y_t = c_{H,t}$  (27)

Of course, this assumption can be easily relaxed, allowing the economy to produce, but not to export, some amount of tradables, which are imperfect substitutes to imported manufactured goods. That is demand for domestic tradables is only inner.

Foreign demand and supply side is unaffected by small open economy and takes the form:

$$y_{t}^{*} \equiv \int_{0}^{1} y_{t}^{i} di = \int_{0}^{1} c_{t}^{i} di \equiv c_{t}^{*}$$
(28)

# 3.4 Calibration

In the benchmark model I assume following parameters widely used in the literature:

Parameter	Description	Value	Source
α	Degree of openness	0.7	Sosunov and Zamulin (2007)
η	Elasticity of substitution between tradable and nontradable goods	1	Cobb-Douglas aggregator is assumed
$ ho_{\scriptscriptstyle oil}$	Persistence of oil price shock	0.91	Sosunov and Zamulin (2007)
δ	Sensitivity of intermediation cost with respect to the net foreign asset	0.01	De Paoli (2009)
σ	Coefficient on C in Utility function	1	Log-utility is assumed
φ	Inverse labour supply elasticity	3	Gali and Monacelli (2005)
β	Discount factor	0.98	Implies riskless return 8%
θ	Fraction of optimizing firms	0.25	usual
Е	Elasticity of substitution between varieties produced within given country	6	Gali and Monacelli (2005)

<b>Table</b>	3.	Mod	el Pa	rame	ters
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# 3.5 Impulse responses

The system of equations described in sections above is closed by monetary policy rule, set by a monetary authority of the country. First, I analyze impulse responses from monetary policy rules presented by targeting one-variable. These are:

- The domestic inflation targeting (DIT) :  $\pi_{H_{t}} = 0$
- The CPI inflation targeting (CIT):  $\pi_t = 0$
- The exchange rate peg (PEG):  $e_t = 0$

Impulse response graphs are presented in the Appendix A.4. Those variables, which are not plotted under a certain rule, are zero. The world economy is assumed to be unaffected by oil price fluctuations.

Also I investigate impulse responses for Taylor-type rules:

- The domestic inflation Taylor-rule (DITR):  $r_t = \phi_{\pi} \pi_{H,t}$
- The CPI inflation Taylor-rule (CITR):  $r_t = \phi_{\pi} \pi_t$

where parameter  $\phi_{\pi}$  is set to 1.5 as standard practice. The responses to oil price shock under Taylor-type rules may be found in Appendix A.5 and in Figure 5. The patterns of key variables of a small open economy have common features. In response to jump in oil price the consumption of imported tradables increases, so does the consumption of nontradables ( $C_{H,i}$ ), but to a lower extent. In real world this can be observed due to the fact that consumers benefic not only from additional income received but also from exchange rate appreciation. Real exchange rate, defined here as a difference between price indices of SOE and ROW, appreciates roughly at 0.2% maximum after the 1% oil shock, which is marginally consistent with finding from section 1 of this work. Wages also grow as was predicted by the Dutch Disease hypothesis. An increase in oil windfall induces rise in both domestic and CPI inflation, however if monetary policy is aimed at domestic inflation we observe a kink down in CPI inflation in the first quarter.



Figure 5. Impulse Responses to Oil Price Shock

The key difference between suboptimal policies is the reaction of terms of trade and real exchange rate. Under DITR we observe immediate response of term of trade (same as in the optimal DIT policy) while other policies produce smoother and more gradual response of term of trade. This can be explained by the fact that CPI inflation positively depends on the first difference of terms of trade and domestic inflation. Thus, CPI stabilization is partially implemented by smoothing response of terms of trade and by lowering domestic inflation. Output remains rather stable under DITR, whereas PEG and CITR allow for jump in this variable. The behaviour of variables is roughly similar under CITR and PEG. However under PEG case we observe higher output and domestic inflation deviations due to the inability to lower nominal exchange rate and to allow depreciation of SOE currency as in DITR and CITR cases.

Second moments of the key variables of a small open economy are presented in Table 4. Although DITR policy succeeds in stabilizing output, it demonstrates comparative disadvantage compare to CITR and PEG in lowering variance of its target. As it is shown in impulse response graph, the deviation of domestic inflation much lower under DITR, but it has long period of convergence back to steady state, and as a consequence higher simulated variance.

Holding nominal exchange rate fixed (PEG) and assuming inflation in ROW to be zero we get the lowest value for CPI inflation volatility due to the fact that most of products are imported from abroad, however domestic inflation and output are more volatile than under other regimes.

	Optimal			
	(DIT)	DITR	CITR	PEG
Output	0.000	0.006	0.029	0.040
Domestic Inflation	0.000	0.034	0.029	0.030
CPI inflation	0.041	0.059	0.019	0.009
Terms of Trade	0.205	0.237	0.178	0.189
Nominal exch.rate (1st diff)	0.057	0.025	0.067	0.000
REER	0.062	0.071	0.054	0.057
1				

#### **Table 4. Standard Deviations of Key Variables**

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#### .6 Welfare cost analysis

For welfare analysis of monetary policy I used welfare loss function derived in Gali and Monacelli (2005) based on the second-order approximation of utility function of household problem. The function takes the following form:

$$V = -\frac{(1-\alpha)}{2} \cdot \left[\frac{\varepsilon}{\lambda} \operatorname{var}(\pi_{H,t}) + (1+\phi) \operatorname{var}(x_t)\right]$$
(29)

where  $x_t$  is output gap. It is seen from this expression that the optimal monetary policy must constitute:  $var(\pi_{H,t}) = 0$   $var(x_t) = 0$ 

Obviously, this condition can be reached under perfect implementation of domestic inflation targeting (DIT):  $\pi_{H,t} = x_t = 0$ .

After all, to check results for robustness I used alternative welfare function which is not derived directly from utility approximation, but was used by several researches (Sosunov and Zamulin (2007), Williams (2003)). The function takes the form:

$$L = \omega_1 \operatorname{var}(\pi_t) + \omega_2 \operatorname{var}(y_t)$$
(30)

The intuition is the following: since the economy does not produce tradables, but imports them instead, it is crucial for consumers and the government to be concerned about CPI inflation rather that domestic one. Besides, tradables are not substitutes to nontradables, thus it is also worth to try different values of elasticity of substitution higher that one. Previously I adhered to a special case of Cobb-Douglas aggregator in consumption because this framework allows deriving welfare analytically. It was pointed out by Agnion and Banerjee (2003) that high volatility of domestic output negatively affects economic growth in economy with undeveloped financial markets. Therefore, the government and agents would suffer from excess volatility in GDP, so, the second term in welfare function was chosen to be the output variance.

The weights  $\omega_1$  and  $\omega_2$  put on inflation and output volatilities should be comparable to those from loss function (29). For instance, using calibration provided by Gali and Monacelli (2005) these are:

$$\omega_1 = \frac{(1-\alpha)}{2} \frac{\varepsilon}{\lambda} = 10.48 \qquad \qquad \omega_2 = \frac{(1-\alpha)}{2} (1+\phi) = 0.6$$

So, the exposure to inflation should be much higher than one to output.

The results from model simulations under different rules are presented in Table 5.

Loss Function	DITR	CITR	PEG
V (Gali and Monacelli)	1.2065	<u>0.8848</u>	1.0088
L1 ( $\omega_1 = 10, \omega_2 = 1$ )	2.9614	0.5434	<u>0.2351</u>
L2 ( $\omega_1 = 8, \omega_2 = 2$ )	2.3730	0.5379	<u>0.3730</u>
L3 ( $\omega_1 = 1, \omega_2 = 1$ )	0.2991	<u>0.1317</u>	0.1622

**Table 5. Welfare Contribution under Suboptimal Rules** 

DITR rule performs significantly worse than others due to very sharp kink in CPI inflation, which was observed in impulse response graph, this DITR policy fails to demonstrate optimality under alternative specifications since they highly depend on CPI volatility rather than one of domestic inflation. It is not surprising that DITR policy implies higher welfare loss even under baseline loss specification (29) as soon as volatility of domestic inflation was found high.

Due to a large share of import in consumption the exchange rate peg regime succeed in stabilizing CPI inflation; but this result is questionable, since PEG is implemented by one-variable rule and not by Taylor-type expression. In the same way, simple one-variable CIT provides better results in terms of welfare losses (not presented in the table), that means given coefficient  $\phi_{\pi}$  in CPI Taylor rule is set high enough the latter will outperform PEG. Besides, it shows the best result under specifications of Gali and Monacelli (2005) and Sosunov and Zamulin (2007).

In order to check the previous results I performed grid point search of the parameters minimizing welfare loss under following rule:

$$r_t = \phi_1 \pi_{H,t} + \phi_2 \pi_t + \phi_3 e_t$$

The range for those coefficients is [0;6]. The results are presented in the Table 6. As it is observed in the first specification, allowing higher exposure to domestic inflation monetary authorities can significantly reduce its volatility and, thus, welfare loss. High coefficient on inflation is also found in the last specification. This outcome is not surprising since the DITR rule perfectly stabilizes domestic output, which in L3 has the weight equal to unity.

	F	Parameter o	n	
Specification	Loss	Domestic inflation	CPI inflation	Exchange Rate
V (Gali and Monacelli)	0.0663	6	0.4	0
L1 ( $\omega_1 = 10, \omega_2 = 1$ )	0.1138	0.4	6	0
L2 ( $\omega_1 = 8, \omega_2 = 2$ )	0.2017	1.6	6	0
L3 ( $\omega_1 = 1, \omega_2 = 1$ )	0.0665	6	3.2	1.4

#### **Table 6. Grid Point Loss Minimization**

Under Taylor-type rule the share of exchange rate is either zero or minor. Of course, this is not an appropriate way to deal with PEG regime, since the latter is implemented by a simple rule. The main finding in this procedure is relative outperforming of DITR. Stabilization of inflation is achieved under DITR given that coefficient in Taylor rule is high enough. This finding indicates that rules' performance depends on the calibration used.

## 4 Extensions

#### 4.1 Stabilization Fund

Another important feature of an oil-exporting economy is an existence of Stabilization Fund. This policy is used for muting an effect on the key variables from large oil price shocks. The Stabilization Fund of Russian Federation amounted at 156.81 billion USD on Jan,1 2008<sup>5</sup>. If oil price is higher than the threshold price which is constituted by law, then the difference between actual and threshold price is transferred to Stabilization fund. Formally, this is a 100% tax on the price difference, but this tax does not induce distortion as soon as only windfall income is affected. Since July 2006 it was allowed to invest the means of the fund into low-risk assets. In this work I assume that the fund earns each period risk-free rate. The fund is introduced in the system similar to Batte et al. (2009).

$$F_t^* = R^* (1 - \zeta_2) F_{t-1}^* + (1 - \zeta_1) (P_t^{oil,N} - P_{thresh}^*) X_t$$
(31)

where  $F_t^*$  stands for fund's assets,  $R^*$  is equal to risk-free rate,  $\varsigma_2$  is the share of oil funds each period transferred to households,  $\varsigma_1$  is the share of excess income left to households.  $(P_t^{oil,N} - P_{thresh}^*)$  is the difference between actual and threshold price. I assume this expression to be constant and equal to  $(1 - \mu)$ , and  $\mu$  can be interpreted as average threshold price.

The equation (31) which characterize law of motion of fund assets can be log-linearized:

$$Ff_{t} = R^{*}(1 - \varsigma_{2})Ff_{t-1} + (1 - \varsigma_{1})(1 - \mu)p_{t}^{oil}$$
(32)

where the steady state of the fund is simply:

$$\overline{F} = \frac{(1 - \zeta_1)(1 - \mu)}{(1 - R^*(1 - \zeta_2))}$$
(33)

<sup>&</sup>lt;sup>5</sup> Ministry of Finance of Russian Federation, website: http://www.minfin.ru/en/

Now the budget constraint of a representative household in SOE will take the form:

$$P_{t}C_{t} + \frac{\xi_{t}B_{F,t}}{(1+i_{t}^{*})\psi\left(\frac{B_{F,t}\xi_{t}}{P_{t}}\right)} \leq \xi_{t}B_{F,t-1} + W_{t}N_{t} + T_{t} + \xi_{t}\left[\mu(P_{t}^{oil,N}X) + \zeta_{1}(1-\mu)P_{t}^{oil,N}X + R^{*}\zeta_{2}F_{t-1}^{*}\right]$$
(34)

where amount of  $\zeta_1(1-\mu)P_t^{oil,N}$  is transferred instantly back to households and  $R^*\zeta_2F_{t-1}^*$  is the part of stabilization fund transferred each period. The following parameters were assumed and steady state values were computed:

$$\overline{C_F} = 1.09;$$
  $\mu = 0.4;$   $\zeta_1 = 0.1;$   $\zeta_2 = 0.14;$   $\overline{F} = 4.41$ 

The material balance condition takes the form:

$$\overline{C_F}c_{F,t} + \beta b_t = b_{t-1} + \left[\mu + \zeta_1(1-\mu)\right]p_t^{oil} + \zeta_2 R^* \overline{F} f_{t-1}$$
(35)

Impulse responses from the economy with stabilization fund will have almost the same shape as without it, the only difference that now oil price shock has muted and prolonged effect. Simulated second moments under three different suboptimal rules are presented in the Table 7. The results indicate that improvement of welfare is possible by means of stabilization fund whatever monetary policy is implemented. Using the current parameters of the fund I find the volatilities to be roughly half of benchmark values. Besides, the performance of different monetary rules with respect to welfare losses is unaffected by introduction of stabilization fund.

	DITR		CITR		PEG	
Variable	Without SF	With SF	Without SF	With SF	Without SF	With SF
Domestic Inflation	0.033	0.016	0.027	0.014	0.028	0.015
CPI Inflation	0.051	0.027	0.020	0.010	0.008	0.005
Output	0.006	0.003	0.027	0.015	0.037	0.019

Table 7. Effect of Stabilization Fund (SF) on Second Moments

A perfect stabilization fund which entirely removes oil price concern is impossible in reality because oil price may remain lower than average for longer period that it have been previously expected, thus the means of the fund could be totally spent at a certain point of time implying imperfect consumption smoothing.

### 4.2 World Economy

Taking into account the fact that the rest of the world (ROW) economy produces tradables and imports oil, I can specify the production function in form of Cobb-Douglas the following way:

$$Y_t^*(f) = [A_t^* N_t^*(f)]^{\chi} \cdot O_t^{1-\chi}(f)$$
(36)

where  $O_t(f)$  is demand for oil by foreign firm f. Without loss of generality, I normalize oil demand to unity, which is equal to supply of oil-exporting economy. Again the nominal marginal cost (expressed in foreign currency) will be identical for each foreign firm:

$$MC_{t}^{N} = \frac{1}{\chi} \left[ \frac{\chi}{1-\chi} \right]^{1-\chi} \left[ \frac{W_{t}^{*}}{A_{t}^{*}} \right]^{\chi} P_{oil,t}^{1-\chi}$$
(37)

In order to get real marginal cost I divide this expression by world price index.

The coefficient on labor in production function is taken  $\chi = 0.8$ ; thus, the effect of oil price fluctuation has minor effect on the marginal cost of a ROW-firm. However, given that in a small oil-exporting economy exists well-behaved stabilization fund, for instance, which was calibrated in previous subsection, and assuming that world economy fails to hedge all the risks associated with oil price fluctuations, then the impact of a shock on CPI inflation of the rest of the world will transmit to a small economy as well (given nominal exchange rate fixed).

Therefore, further analysis is needed to determine which monetary policy rule performs better with offsetting external oil price exposure.

Monetary policy of the rest of world is assumed to be of inflation targeting form (note that for ROW economy there is no difference between CPI and domestic inflation):

$$r_t^* = \phi_\pi^* \cdot \pi_t^* \tag{38}$$

Log-linear version of ROW Euler Equation (15) will take the form:

$$c_t^* = E_t c_{t+1}^* - \frac{1}{\sigma} (r_t^* - \pi_{t+1}^*)$$
(39)

The comparative results are presented in Table 8. In order to investigate the effect of both stabilization fund and exposure world's inflation to oil price shocks, I tried both high and low value of labour elasticity. The value of  $\chi = 0.5$  is unrealistic, but this calibration allows us to account for the case of superior stabilization fund, which reduces impulse responses by three or more times.

<b>Table 8. Welfare Contributio</b>	n with Stabilization	<b>Fund and ROW</b>
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Loss Function ( $\chi = 0.8$ )	DITR	CITR	PEG
V (Gali and Monacelli)	0.2211	0.1509	0.2770
L1 ( $\omega_1 = 10, \omega_2 = 1$ )	0.7045	0.1021	<u>0.0683</u>
L2 ( $\omega_1 = 8, \omega_2 = 2$ )	0.5645	0.1058	<u>0.1007</u>
L3 ( $\omega_1 = 1, \omega_2 = 1$ )	0.0712	<u>0.0284</u>	0.0414

Loss Function ( $\chi = 0.5$ )	DITR	CITR	PEG
V (Gali and Monacelli)	0.1463	<u>0.0802</u>	0.3416
L1 ( $\omega_1 = 10, \omega_2 = 1$ )	0.7098	<u>0.0856</u>	0.1034
L2 ( $\omega_1 = 8, \omega_2 = 2$ )	0.5695	<u>0.0910</u>	0.1308
L3 ( $\omega_1 = 1, \omega_2 = 1$ )	0.0722	<u>0.0254</u>	0.0464

Table 8. Welfare Contribution with Stabilization Fund and ROW (cont.)

The upper table reproduce the same results as were found in benchmark case and presented in the Table 5. However, if there exists a stabilization fund which successfully stifles responsiveness of variables and/or high share of oil price in real marginal cost of tradable-producing firms, the CPI inflation targeting invariably outperforms other monetary regimes under four alternative specifications of loss function. The intuition is simple: fixing nominal exchange rate does not allow currency to appreciate in order to mitigate the transmission of foreign inflation into domestic economy.

# 5 Conclusion

In this work I broadly investigated the phenomenon of Dutch Disease. In the second section I found empirical evidence of vulnerability to DD of Russian economy. In order to find long-run exchange rate elasticity of oil price cointegrating vectors were estimated. Elasticity was found in the range from 0.2 to 0.5 which is consistent with findings of other researches. During the 2000s Russian economy experienced rapid economic growth induced also by both favourable oil prices and low real exchange rate caused by recent crisis. Service industry was growing at 12% rate annually, manufacturing averaged at 8%. Although the latter contradicts usual DD hypothesis, the possible reasons were discussed. These are: transitory process including recovery from large downturn; increased government expenditure which is biased towards domestic producers; rising demand from domestic consumers and imperfect substitutability with imported tradables. Finally, real wages were also found growing across different industries and regions. However, having investigated basically all symptoms of Dutch Disease I cannot diagnose it with high level of confidence, since the processes typical for DD may be caused by other reasons, mainly by transition process.

In the third section I built a dynamic stochastic general equilibrium model of the economy sick with Dutch Disease assuming exogenous AR(1) process for real oil price. The model was designed in a standard SOE fashion such as price-staggering, AN production function. A small oil-exporting economy is assumed to be in its steady state characterized by the absence of manufacturing and a large share of imports in consumption. In this work I concentrated mostly on incomplete asset market case, since it turned out that agents can totally hedge themselves from stochastic shocks of oil price under complete markets case. Impulse responses to a positive oil price shock were found consistent with Dutch Disease behaviour pointed out in Section Two.

Taken several specifications of welfare function I ranked types of monetary policies based on their contribution to welfare loss. It turned out that targeting domestic inflation with Taylor-based rule (DITR) produces poor results. Meanwhile, CPI inflation targeting and exchange rate peg were found optimal under different specifications. On the contrary, grid-point search of coefficients minimizing welfare loss indicated that targeting domestic inflation may be optimal in specifications of welfare V and L3, given the coefficient in DITR is high enough.

In the forth section two extensions to the benchmark model were introduced. First, I include stabilization fund in the system as a common experience for oil-exporting economies. This fund takes a form of a non-distortionary tax on the price difference (actual price minus threshold value), thus muting response of variables and leading to more efficient (under certain calibration) consumption smoothing. Reduction in welfare loss was proportional and did not change monetary policy ranking. It is worth to mention that the welfare effect from stabilization fund would be higher if I introduced rule-of-thumb households in the model, since they do not have an opportunity to allocate their consumption intertemporally. The second extension of mine was to allow oil price to affect the world economy through introducing oil in production function as a production factor. Oil price shock induces inflation in the rest of the world; this inflation is transmitted into small open economy with imported goods given that nominal exchange rate remain constant. Under baseline calibration results are the same as without extensions. However, given well-behaved stabilization fund and/or high share of oil in production cost, CITR becomes in the lead of ranking. PEG demonstrated lower performance due to inability of domestic currency appreciate and mitigate the effect of higher world prices. to

					Net	
Variable	REER	Relative Productivity	Oil price	Government Consumption	International Reserves	Reserves to Import
Mean	95.43	0.47	41.82	0.18	162199.1	3.89
Std Dev	20.34	0.23	29.26	0.02	185285	2.47
Unit Root	yes	yes	yes	yes	yes	yes
P-value for ADF test in levels	0.89	0.95	0.74	0.53	0.97	0.97
P-value for ADF test in 1st difference	0.00	0.05	0.00	0.00	0.01	0.01

# Appendix A.1. Descriptive Statistics of Key Variables

\*Augmented Dickey-Fuller unit-root test statistics are presented





Figure A.1. Government Consumption as a share of GDP, seasonally-adjusted and versus Real Exchange Rate



Figure A.2. Net International Reserves (NIR) and Reserves to Import ratio (RIM)

# **Appendix A.3. Johansen Cointegration Test Summary**

Sample: 1996Q4 2010Q4 Included observations: 53 Series: LRERSA LURALSSA LNIR2 LPROD\_NEW LGOV

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	3	3	2	1	1
Max-Eig	1	3	1	1	1

Selected (0.05 level\*) Number of Cointegrating Relations by Model

\*Critical values based on MacKinnon-Haug-Michelis (1999)

Sample: 1996Q4 2010Q4 Included observations: 52 Series: LRERSA LURALSSA LNIR2 LPROD\_NEW

Selected (0.05 level\*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	3	3	1	1	1
Max-Eig	3	1	1	0	1

\*Critical values based on MacKinnon-Haug-Michelis (1999)

#### Sample: 1996Q4 2010Q4 Series: LRERSA LURALSSA LNIRSA LPRODUCTIVITY

Selected (0.05 level\*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	2	1	1	1
Max-Eig	2	1	1	1	1

\*Critical values based on MacKinnon-Haug-Michelis (1999)

#### Series: LRERSA LURALSSA LGOV

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	2	2	2	3
Max-Eig	1	2	2	2	3

\*Critical values based on MacKinnon-Haug-Michelis (1999)



Appendix A.4. Impulse Responses of Oil Price Shock (DIT, CIT, PEG)\*

\*note: "rer" is the inverse of terms of trade in these graphs



\*note: "rer" is the inverse of terms of trade in these graphs

PEG

# Appendix A.5. Impulse Responses of Oil Price Shock (Taylor-type rules: DITR and CITR)





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