BACHELOR THESIS: RUSSIA AND THE EU; A CASE OF OIL, GAS AND EXCHANGE RATES

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1.1. Introduction

It is the year 1991 when Boris Yeltsin, the first President of the Russian Federation, executes shock therapy on the Russian economy. The former Soviet Union had been known worldwide for its planned economic policy including five-year plans and heavily centralized output. After the collapse of the Soviet Union economic reforms seemed imminent and Yeltsin ensued by pressing for instant liberalization and privatization of the big Russian market. It took years for the economy to stabilize and for the Russian Central Bank to get a grip on their Ruble. Having lost up to 70% of its worth despite of a currency redenomination in 1998, the Russian currency still remains sensitive having fluctuated from RUB/EUR = 50 to RUB/EUR = 40 in less than a years' time.

Unlike their currency, the Russian economy seems quite stable and is well known for its industrial oligarchs, a lot of whom back President Putin's political agenda. In 2012, Russia averaged 10.4 million barrels of oil per day in production, only tolerating the United States and Saudi Arabia ahead of them. Obviously, the Russian economy relies heavily on this massive industry as 52% of the 2012 federal budget revenue came from oil and gas exports. In the same year oil and gas made up for 70% of Russia's total exports. With the largest part of the industry being state-controlled, one might say the Russian oil and gas industry is as steady as the Russian exchange rate is sensitive.

Currently Russia and the European Union find themselves in an economic and political stand-off over the Ukraine crisis. With 79% of its crude oil exports going directly to Eurozone countries and no ties to the OPEC (organization of petroleum exporting countries), a drastic price increase of oil and gas does not seem unthinkable. Although such action would definitely hurt the finances of Eurozone countries, it is important to consider the consequences it might have for the Russian economy. For instance, a price increase could very well have a dramatic effect on Russia's currency, which hasn't proven to be to stable, and make Russia's own economy suffer in the long-run.

To project the effect a price increase of oil and gas would have on the Russian Ruble, we can use an exchange rate estimation model. Regression analysis can be applied to get a general view of what any future course of action, regarding Russian oil and gas prices, has in store for the sensitive Russian exchange rate. After this analysis it should be possible to assess the impact and effects of a Russian oil and gas price increase, should President Putin choose to enforce one.

1.2 Review of previous literature

Dornbusch (1976) develops a two-step theory of exchange rate overshooting. Particularly, he shows that the exchange rate will overshoot its long-run equilibrium value after certain events shock the interest rate, assuming commodity prices are slow to adjust on the short-run. Dornbusch theory provides the theoretical grounds of this model that will form the base of the analysis in this paper.

In chapter 7 of Exchange Rates and International Finance (Copeland, 2008), the Dornbusch model is explained and elaborated. Both monetary and fiscal expansions are treated and a case study involving the discovery of oil in the UK and the effects on its economy is included. Formulas and identities regarding exchange rate expectations, demand for money, demand for goods and interest rate parity are explained and graphically displayed.

The elaborated answer to problem 8, as explained in the Seminar group: Economics of exchange rates by Prof. Dr. J.M.A. Viaene, shows how a country's sudden discovery of oil can be included into the Dornbuch analysis regarding exchange rate dynamics. An extended Dornbusch model is developed which portrays how a potential discovery or price increase of oil can cause wealth- and transaction effects on different markets within the economy. Both the described transactions effect on the money market and the wealth effect on the goods market are predicted to hold negative relationships towards price levels and exchange rates.

The phenomenon of overshooting is further theoretically specified in part II of Exchange Rate Dynamics and the Overshooting hypothesis (Frenkel and Rodriguez, 1982). Along with the goods- and money market, the capital account and the balance of payments are taken into account. Special attention is given to the several parameters indicating the sensitivity of the balance of trade to the real exchange rate, the interest elasticity of the demand for money and the speed of adjustment on the goods and asset markets. These parameter values appear to be the key factors determining whether the exchange rate will overshoot its long-run equilibrium value or not. The final extent of any apparent overshooting seems to depend on the magnitude of the expectations adjustment coefficient of the exchange rate which Frenkel and Rodriguez define in their equation for exchange rate expectations.

Frankel (1979) sets out to empirically prove there is overshooting by using an extended monetary version of the Dornbusch model in which he incorporates inflation rates. He begins by formulating the fundamental assumptions of interest rate parity and expected rate of depreciation. He combines these two assumptions in an equation where $\bar{s}$ defines the long-run equilibrium exchange rate, r is defined as the natural log of one plus the domestic rate of interest rate and π represents expected long-run inflation:

$$s - \bar{s} = -\frac{1}{\theta}((r - \pi) - (r^* - \pi^*)) \tag{1.1}$$

Assuming the interest rate differential and the inflation differential are equal on the long-run ($\bar{r} - \bar{r}^* = \pi - \pi^*$), the long-run equilibrium level of exchange rate is expressed as follows:

$$\bar{s} = \bar{m} - \bar{m}^* - \phi(\bar{y} - \bar{y}^*) + \lambda(\pi - \pi^*) \tag{1.2}$$

Combining equation (1.1) and (1.2) leads to the following equation that Frankel tests empirically:

$$s = m - m^* - \phi(y - y^*) + \alpha(r - r^*) + \beta(\pi - \pi^*) + u \tag{1.3}$$

where $\alpha(= -\frac{1}{\theta})$ and $\beta(= \frac{1}{\theta} + \lambda)$.

In terms of equation (1.3), Frankel hypothesizes α to be negative and β to be positive. However, alternative hypotheses are formulated regarding the original Keynesian model (Dornbusch) and the Chicago theory (Bilson-Frenkel). In the Keynesian model α is hypothesized negative and β is hypothesized zero for a rise of the domestic interest rate should cause an appreciation and the inflation differential is always assumed zero. The Chicago model as formed by Bilson agrees with the Keynesian approach of the inflation differential but states an increase in domestic interest rate lowers the demand for domestic currency, thus α is hypothesized positive and β is hypothesized zero. (Bilson, 1978)

In regression, a method of adding lagged values to instrumental variables is used gain significant coefficients for all variables. Coefficient α is found to be significantly less than zero, rejecting the Chicago formed (Bilson) hypothesss. Coefficient β is found to be significantly greater than zero, meaning the Keynesian (Dornbusch) is also rejected.

The empirical results support Frankel's theory and he goes on to calculate the exchange rate's speed of adjustment and amount of overshooting. parameter value α is estimated at -5.4 and known to be that $(\alpha =) -\frac{1}{\theta}$. The θ value is calculated to be 0.185. This implies $(1 - 0.185 =)\ 0.815$ percent of any deviation from purchasing power parity is expected to remain after one quarter. This leaves $(0.815^4 =)\ 44.1$ percent of deviation to remain after one year. The estimate of the speed of adjustment θ on a per cent annum basis is $(-log.44 =)\ .819$. In order to calculate overshooting, Frankel assumes long-run interest semi-elasticity to hold on the short-run. In a hypothetical experiment where the U.S. relative money supply expands with 1.0 percent, Frankel illustrates how liquidity effects cause the currency to appreciate immediately and inherently overshoot its new equilibrium. Accordingly, on the long-run, the equilibrium Mark/Dollar rate decreases with 1% due to the expanding money supply. However, the semi-elasticity of money demand with respect to the interest rate of 6.0 causes the nominal interest rate to drop by ($\frac{1\%}{6.0} =$) 0.17% on the short-run, triggering an immediate capital outflow. Now the currency depreciates further, overshooting its new equilibrium by $(1.35 * 0.17\% =)$ 0.23%. Concluding, total initial depreciation is 1.23%, whereas long-run exchange rate depreciation is estimated to be 1%.

2. Theoretical framework

In order to analyse the movement of the Russian currency, we will be using an extended version of the Dornbusch exchange rate model. This model is also known as the Dornbusch overshooting model for its ability to illustrate how a country's exchange rate overreacts to certain macro-economic events. By applying this model of exchange rate estimation we will be able to foresee both the long-run and the short-run effects of an abrupt increase of the gas and oil prices on Russian behalf.

Several key assumptions are to be made for this model to fit reality and correctly project estimates. First of all, we assume Russia's economy to be small when compared to that of the Eurozone combined. This says that Russian economic fluctuations don't significantly affect the economy of the Eurozone. Moreover, aggregate demand is set using Mundell and Flemings IS-LM mechanism (Copeland, 2008, pp 133-134). This says all equilibriums in goods and money markets are established in relation to the real output and interest rate. In defining the exchange rate we use the foreign exchange rate, i.e. the amount of domestic currency that is needed to acquire one unit of foreign currency. In our case, this will be the RUB1/€1 exchange rate, since we're taking Russia as our domestic country and the Eurozone as foreign. The formal expression of this model leans heavily on the formal explanation given in (Copeland, 2008, p. 201), and the elaborated answers to problem 8 as explained during the seminar; the economics of exchange rates by Prof. Dr. J.M.A. Viaene.

Exchange rate expectations: $\Delta s^e = \theta(\bar{s} - s)$ (2.1)

In theory, the exchange rate is always adjusting towards its long-run value. The equation shows that exchange rate expectations are formed by multiplying the difference between the long term exchange rate and the short exchange term rate with a parameter value. This parameter value indicates how fast the adjustment towards the long term exchange rate is.

Uncovered interest rate parity (UIRP): $r = r^* + \Delta s^e$ (2.2)

In a world in which financial markets are expected to adjust immediately, the UIRP condition represents a no-arbitrage state in which investors are indifferent between investing with domestic banks as opposed to investing at a foreign bank.

Demand for money: $m - p = ky - lr$ (2.3)

This equation is a basic log-linear formulation with the assumption that $m^d = m^s$, therefore both money demand and money supply are written as m.

Demand for Russian non-oil goods: $y^d = h(s - p) = h(q) \qquad q \equiv s - p$ (2.4)

Here we see demand for Russian non-oil goods treated as a function of the real exchange rate. The real exchange rate is set by the difference between price level and the short term exchange rate. At a higher real exchange rate Russian export products are more competitive, thus creating greater demand.

Rate of inflation: $\dot{p} = \pi(y^d - \bar{y})$ (2.5)

If demand deviates from its level in an economy with assumed full employment and fixed income, the result is a drawn-out adjustment in the level of prices in the economy. Inflation increases when the level of demand deviates away from the level of output.

m, s, p and y denote natural logarithms of the respective upper-case variables and all the parameters are assumed positive. Merely natural logarithms are used in this paper.

In order for this model to fit the projected event of a Russian price increase of oil and gas, a few extra assumptions and two slight modifications are to be made. We choose to treat the effects of a price increase as we would treat a sudden discovery of oil. From a macro-economic point of view there is no difference between Russia stumbling upon a new oil or gas field, as opposed to raising its oil and gas prices, regarding the accumulation of wealth it creates. In both situations, Russia sees its own wealth expand; leaving both goods and money markets in shock and eager to react.

Extra assumptions regarding this specific oil-related case are to be made:

- The Russian price increase has not been anticipated and we do not take into account any taxing over extra revenues.
- No costs are made in extracting oil and gas from the ground.
- The contribution to the price index that oil and gas have can be disregarded due to their insignificant weight in the World's and Russia's consumption baskets. Similarly, their input to production is to be ignored.
- Neither fiscal nor monetary policy will be altered by Russian authorities regarding these price changes.

Likely, the accumulation of wealth on Russian behalf will affect its non-oil output as well as the balance on its money market. When processing this occurrence, we perceive a so called 'wealth effect' on the goods market and a 'transactions effect' on the money market. In both cases it is possible to calculate a short-run and a long-run equilibrium, each carrying its own properties.

In order to accurately show these effects, two modifications will be made to the basic Dornbusch equations.

- Permanent income derived from oil production, variable $\bar{V}$, will be added to the aggregate demand function. $\bar{V}$ represents the newly gained wealth in the Russian household sector as a result of greater oil and gas revenues.
- The current value of oil revenues, variable V, will be treated as a temporary addition to the level of economic activity. It is added to the money demand function by treating it as additional national income.

<u>2.2 Wealth effect</u>

To effectively portray the outcome of the wealth effect, we'll assume V to be zero when discussing $\bar{V}$. This way, the different effects both inputs have are displayed most clearly.

2.2.1 Long-run equilibrium

Seeing as both the level of demand and the exchange rate are at their respective long-run values, the following assumptions can be made:

- $\dot{p} = 0$, implying the aggregate demand is at its long-run level.
- $s = \bar{s}$, the exchange rate is at its long-run level.

The demand function for Russian production as shown in equation (2.4) can be rewritten to project the positive change in underlying wealth: $\bar{V}$. Parameter c denotes the average propensity to consume:

$$\bar{y} = h(\bar{s} - \bar{p}) + c\bar{V} \tag{2.6}$$

Rewriting this equation gives us a function for the long-run exchange rate on the goods market:

$$\bar{s} = \frac{1}{h}\bar{y} + \bar{p} - \frac{c}{h}\bar{V} \tag{2.7}$$

The equilibrium on the money market remains unchanged:

$$\bar{m} - \bar{p} = k\bar{y} - lr^{*} \tag{2.8}$$

Rewriting this equation leads to the money markets long-run equilibrium price level:

$$\bar{p} = \bar{m} - k\bar{y} + lr^{*} \tag{2.9}$$

By substituting equation (2.9) into equation (2.7) we find the exchange rates long-run solution for both the goods market and money market in combined equilibrium:

$$\bar{s} = \bar{m} + \left(\frac{1}{h} - k\right)\bar{y} + lr^* - \frac{c}{h}\bar{V} \tag{2.10}$$

Equation (2.10) demonstrates that permanent income $\bar{V}$ does not affect the general price levels. This makes sense seeing as nothing has occurred to affect the money market in equation (2.9). Nonetheless, increased permanent income does lead to an appreciation of the currency in the long-run.

2.2.2 Short-run equilibrium

Note that in the short-run equilibrium; several variables change, indicating that it is their respective short-run values we are working with. However, the level of demand will be at its long-run value for the goods market to be in equilibrium, therefore we assume:

- $\dot{p} = 0$, implying the aggregate demand is at its long-run level.

Again we write the altered demand function for Russian production as follows:

$$\bar{y} = h(s - p) + c\bar{V} \tag{2.11}$$

Rewriting this equation gives us the short-run equilibrium on the goods market:

$$s = p + \frac{1}{h}\bar{y} - \frac{c}{h}\bar{V} \tag{2.12}$$

Exchange rate expectations play a big role in short-run estimations; hence the money market equation is expanded by adding equation (2.1):

$$m - p = ky - lr^* - l\theta(\bar{s} - s) \tag{2.13}$$

Rewriting this equation leads to:

$$s = -\frac{1}{l\theta}p + \frac{1}{l\theta}m - \frac{k}{l\theta}y + \frac{1}{\theta}r^* + \bar{s} \tag{2.14}$$

In order to get an undoubted equation for the exchange rate on the short-run, we substitute the long-run exchange rate from equation (2.10) into equation (2.14). We are now left with the short-run money market equilibrium:

$$s = -\frac{1}{l\theta}p + \left(1 + \frac{1}{l\theta}\right)m + \left(\frac{1}{h} - k - \frac{k}{l\theta}\right)\bar{y} + \left(\frac{1}{\theta} + l\right)r^* - \frac{c}{h}\bar{V} \tag{2.15}$$

Now it is possible to implement both market equations in a graph, illustrating what path the economy follows as a result of this wealth effect on the short run.

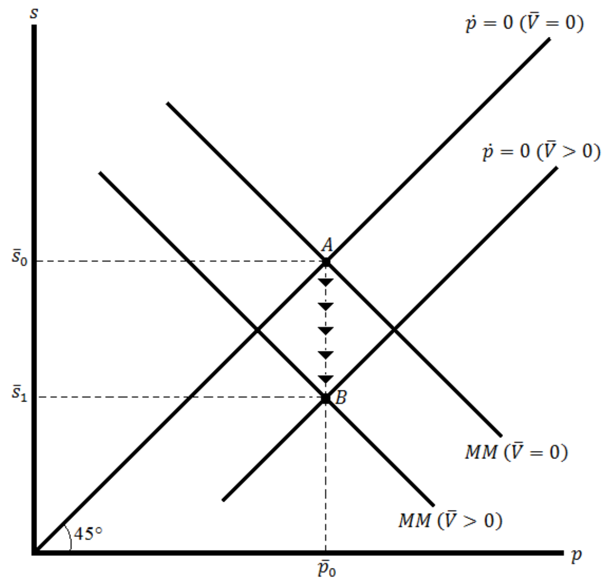

Figure 2.1: Wealth effect

By partially deriving both equation (2.12) and equation (2.15), we can assess the marginal effect $\bar{V}$ has on the exchange rate on each market:

Goods market: $$\frac{\partial s}{\partial \bar{V}} = -\frac{c}{h} \tag{2.12a}$$

Money market: $$\frac{\partial s}{\partial \bar{V}} = -\frac{c}{h} \tag{2.15a}$$

Because the prices of non-oil production have remained unchanged, the real exchange rate must eventually drop, causing the Russian non-oil production to lose competitiveness. This lack of competitiveness sees external demand being pressed out by domestic demand from the newly enriched Russian households, causing an upward pressure on the prices. This implies the $\dot{p} = 0$ line in figure 2.1 will move to the right, even though we know from equation (2.9) that the equilibrium price level cannot move. The solution to this situation is the nominal exchange rate shifting so that the decline in competitiveness is reduced.

Concluding, in both markets the effect of the sudden wealth increase $\bar{V}$ is to move downward towards point B, hence appreciating the currency. It is evident here that the price increase of oil and gas sees the price of foreign currency fall from s_0 to s_1 directly and the economy move smoothly and instantly to its new steady state.

2.3 Transactions effect

To effectively portray the outcome of the transactions effect, we'll assume $\bar{V}$ to be zero when discussing V. This way the different effects both inputs have are displayed most clearly.

2.3.1 Long-run equilibrium

When we analyze the transactions effect in the long-run we again recognize that both the level of demand and the exchange rate are at their respective long-run values, hence the following assumptions can be made:

- $\dot{p} = 0$, implying the aggregate demand is at its long-run level.
- $s = \bar{s}$, the exchange rate is at its long-run level.

The demand function for Russian production here remains unaltered and can be written as follows:

$$\bar{y} = h(\bar{s} - \bar{p}) \tag{2.16}$$

Rewriting this equation leads to:

$$\bar{s} = \frac{1}{h}\bar{y} + \bar{p} \tag{2.17}$$

The equilibrium on the money market is expanded by adding the current value of oil revenues, variable V to the equation:

$$\bar{m} - \bar{p} = k(\bar{y} + V) - lr^* \tag{2.18}$$

Rewriting this equation leads to:

$$\bar{p} = \bar{m} - k\bar{y} + lr^* - kV \tag{2.19}$$

By substituting equation (2.19) into equation (2.17) we find the long term solution for the exchange rate:

$$\bar{s} = \bar{m} + \left(\frac{1}{h} - k\right)\bar{y} + lr^* - kV \tag{2.20}$$

The goods market is not affected by the addition of variable V, therefore the real exchange will not deviate from its long-run value causing the $\dot{p} = 0$ line to remain unmoved. Yet the demand for real balances does change, thus the enlarged national income $\bar{y}$ must be accounted for by a lower equilibrium price level. Maintaining this lower price level and the constant real exchange rate is only possible if the nominal exchange rate appreciates, which it does.

Equation (2.19) and equation (2.20) show that the current value of oil revenues V holds a negative relationship towards both price levels and exchange rate. It causes prices to drop and the exchange rate to appreciate on the long-run.

2.3.2 Short-run equilibrium

Again, in the short-run equilibrium, several variables change. However, the level of demand will be at its long-run value for the goods market to be in equilibrium, therefore we assume:

- $\dot{p} = 0$, implying the aggregate demand is at its long-run level.

The demand function for Russian production is still:

$$\bar{y} = h(s - p) \tag{2.21}$$

Rewriting this equation leads to:

$$s = p + \frac{1}{h}\bar{y} \tag{2.22}$$

The equilibrium on the money market is now expanded by exchange rate expectations from equation (2.1):

$$m - p = ky - lr^* - l\theta(\bar{s} - s) + kV \tag{2.23}$$

Rewriting this equation leads to:

$$s = -\frac{1}{l\theta}p + \frac{1}{l\theta}m - \frac{k}{l\theta}y + \frac{1}{\theta}r^* + \bar{s} + \frac{k}{l\theta}V \tag{2.24}$$

Now we can substitute the long run exchange rate (2.20) into our money market equation (2.24) to find the short run exchange rate:

$$s = -\frac{1}{l\theta}p + \left(1 + \frac{1}{l\theta}\right)m + \left(\frac{1}{h} - k - \frac{k}{l\theta}\right)\bar{y} + \left(\frac{1}{\theta} + l\right)r^* - k(1 + \frac{1}{l\theta})V \tag{2.25}$$

It is possible to present both market equations in a graph, illustrating which path the economy follows as a result of this transactions effect.

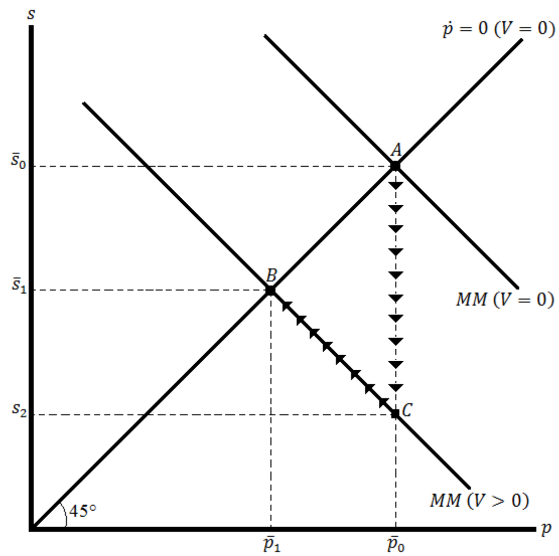

Figure 2.2: Transactions effect

By partially deriving both equation (2.22) and equation (2.25) we can assess the nature of the effect of V on each market:

Goods market: $$\frac{\partial s}{\partial V} = 0 \qquad (2.22a)$$

Money market: $$\frac{\partial s}{\partial V} = -k\left(1 - \frac{1}{l\theta}\right) \quad < 0 \quad if\ l\theta > 1 \qquad (2.25a)$$

We know the goods market is unaffected, yet there is downward pressure on the equilibrium price level due to the increased demand for real balances. The domestic currency appreciates so as to maintain the economy's equilibrium. We now find overshooting on the short-run in point C. The appreciation of the currency has led to an increased demand for money and an excess supply of goods. Logically, interest rates should rise immediately in a situation like this, which they do, for the currency is perceived overvalued and is expected to depreciate in point C. As a result of prices being sticky on the short run, overshooting is clearly a two-step process. In time, prices concede and decrease, causing the economy to move towards the long-run equilibrium at point B.

2.4 Combined effect

After having analyzed both the wealth and the transaction effect in isolated cases, the Dornbusch model predicts indefinite appreciation of the domestic currency as a result of Russia increasing its oil and gas prices. Figure 2.3 sees both effects combined in one graph and shows overshooting on the short-run and real appreciation of the nominal exchange rate on the long run.

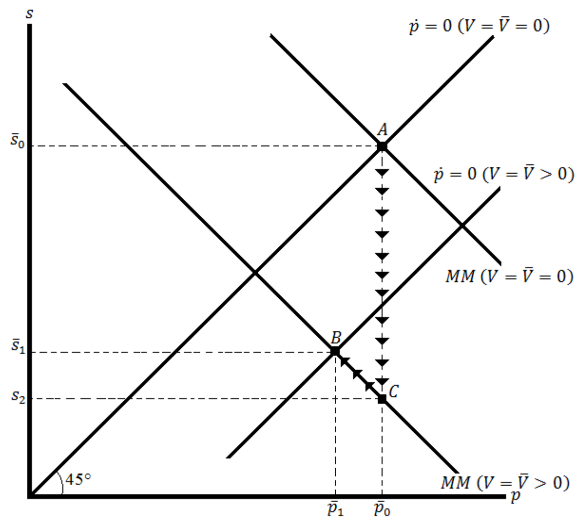

Figure 2.3: Combined effect

Equation (2.25) gives us a short-run solution for the money market. This equation will be tested empirically to gain insights as to what the effect of an oil and gas price increase is regarding the short-run exchange rate. In order to measure the overshooting phenomenon, inherent to the transaction effect, we will use the semi-elasticity of the domestic interest rate with respect to oil and gas prices.

3. Methodology and data

In this section, we take a look at testable hypotheses regarding the effects of an oil and gas price increase on Russian behalf. Furthermore, the variables used in regression are explained and assessed along with the regression technique itself. Our model will follow the Dornbusch theory; equation (2.25) will be estimated.

With a correlation statistic of 0.94, oil (x) and gas (g) show to hold a strong positive relation. It is therefore safe to assume both variables will have a similar effect on the interest rate. Each will be added to our regression separately and from equations (2.15) and (2.25) we are led to believe that the effect they have on the exchange rate will be negative. The price index (p) is also believed to hold a negative relationship with the exchange rate, for prices are sticky and slow to react. If we take a look at figure 2.2, we see the exchange rate overshooting in point C. Hereafter; prices give in and decrease as the exchange rate depreciates towards its long-run value, i.e. p decreases as s increases. Domestic money supply (m) is believed to hold a positive relationship with the exchange rate. Any percentage increase in the money supply is offset by an equal depreciation of the exchange rate on the long-run. The long term aggregate demand (y) is hypothesized to have a negative sign, for a sudden increase in demand would lead to an increased domestic demand for money. A higher interest rate would follow causing an incipient inflow of capital to appreciate the currency even further. The foreign interest rate (r^*) will hold a positive coefficient. By substituting equation (2.1) into equation (2.2) we learn that, in order to satisfy the UIRP condition, an increase in r^* is to be met by an increase of s. Hence, the hypotheses we want to test are as follows:

Main hypothesis – Dornbusch theory		
H_0: *An increase in the price of Russian oil and gas leads to absolute appreciation of the Russian Ruble.* H_a: *An increase in the price of Russian oil and gas does not lead to absolute appreciation of the Russian Ruble.*		
Variable	**H_0- and H_a-hypothesis**	**Expectation**
p	$H_0: \beta_1 < 0$ $H_a: \beta_1 \geq 0$	As price levels decrease, the exchange rate depreciates.
m	$H_0: \beta_2 > 0$ $H_a: \beta_2 \leq 0$	When the money supply grows, the exchange rate will depreciate to the same extent.
y	$H_0: \beta_3 < 0$ $H_a: \beta_3 \geq 0$	As aggregate demand increases, the exchange rate appreciates.
r^*	$H_0: \beta_4 > 0$ $H_a: \beta_4 \leq 0$	When the foreign interest rate grows, the exchange rate will appreciate.
x and g	$H_0: \beta_5 < 0$ $H_a: \beta_5 \geq 0$	When the real prices of oil and gas increase, the exchange rate will appreciate.

The data sample used in this analysis will stretch from January 1999 through January 2013. All values are of the Russian Federation on a monthly basis, except for the foreign interest rate which is that of the Eurozone. Because we want our regression to display linear characteristics, log values are used for all variables.

To gain a function of the exchange rate for regression we alter equation (2.25) by adding an error term. We set up two models, one containing the oil price and the other containing the gas price:

$$s = \varepsilon + \beta_1 p + \beta_2 m + \beta_3 y + \beta_4 r + \beta_5 x \tag{3.1}$$

$$s = \varepsilon + \beta_1 p + \beta_2 m + \beta_3 y + \beta_4 r + \beta_5 g \tag{3.2}$$

The variable m for the domestic money supply is treated as exogenous and is established by taking the narrow money (M1) for the Russian Federation. To gain the value of aggregate demand y on a monthly basis, we use the output approach. This method views the total output of the economy as the sum of outputs of every industry. To avoid counting items that move through several industries twice, the total value produced by the economy is the sum of the values-added by every industry. The foreign interest rate r^* of the Russian Federation is formulated by; $1 +$ the short-term, percent per annum value on a monthly basis. The oil price x is generally expressed in dollars per barrel. We use the average specific gravity of oil to calculate the correct price per barrel. Knowing the exact value and the amount of barrels exported gives way for a steady price/barrel calculation as shown in Appendix 7.1. In order to properly analyze the influence of oil and gas prices, it is important to work with real prices as opposed to absolute values. Because Russian oil is expressed in US dollars, we take the US wholesale price index. Pairing up this index with the absolute values of oil and gas allows us to calculate their real values. Base year is set to 2000. The following graph shows that the real and absolute prices of oil do not progress at the same rate over an extended period.

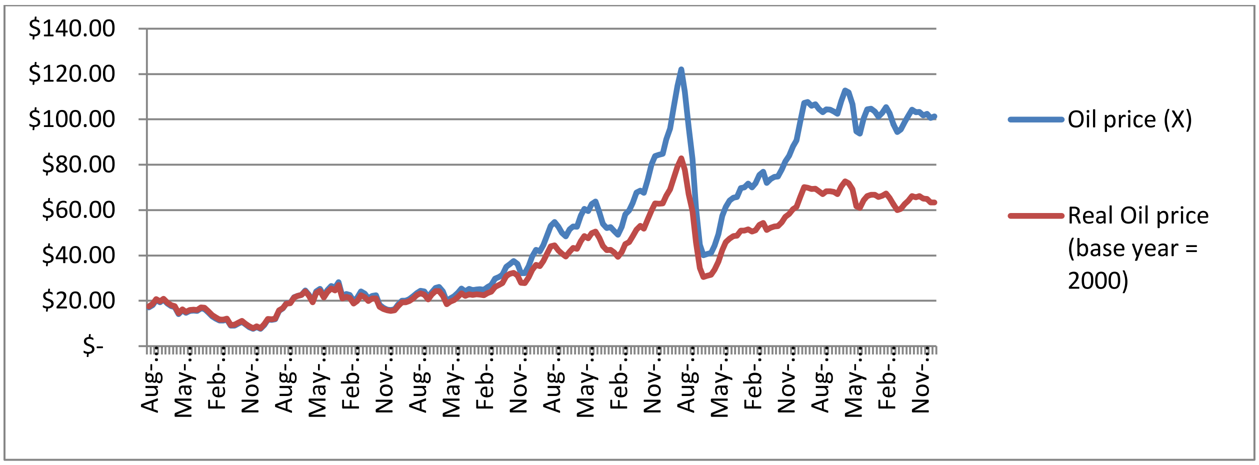

Figure 3.1: Real oil prices

The gas price g is expressed in US dollars per cubic meter times 1000. In order to arrive at these values a small calculation was made which can be found in Appendix 7.2. Like the oil prices in Figure 3.1, the gas prices have been adapted to show of real price movements. Again the US wholesale price index is used and the base year is set to 2000.

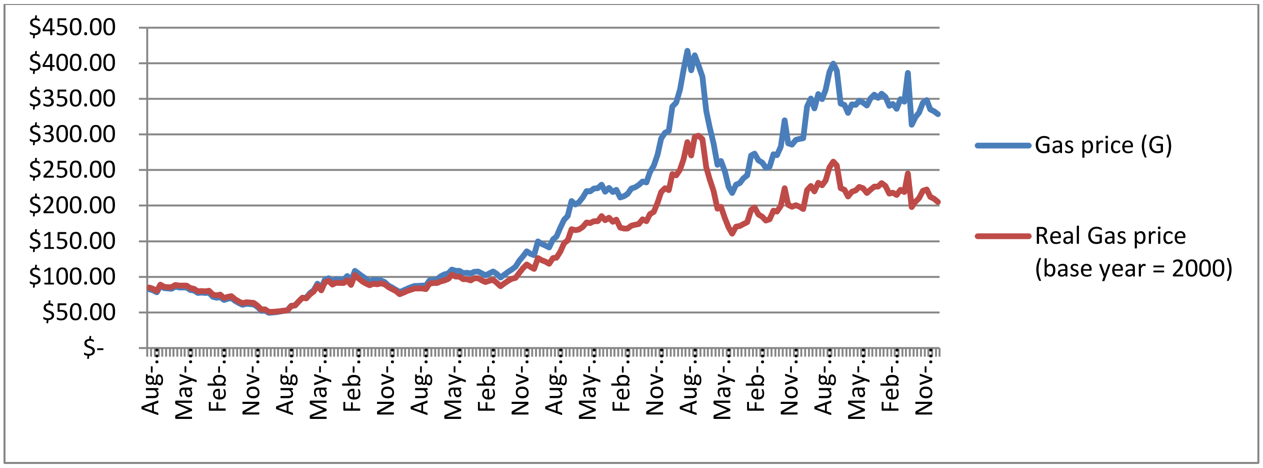

Figure 3.2: Real gas prices

Note that the values for the gas price in the months April, May and June of 2001 and 2002 have been estimated using linear interpolation. Finally, the exchange rate s is extracted and slightly transformed into EUR/RUB, this calculation can be found in Appendix (7.3). We run our regressions through Eviews7 using data retrieved from Thomson Reuters' Datastream and www.stats.oecd.org; this is part of the OECD website. Details of all the data are given in Appendix (7.4).

In order to see if the exchange rate shows the same movements in reality as it does in theory, we will test our equations using the OLS technique. This method should help us estimate the unknown parameters in our model. For an OLS model to produce a good estimate in our next chapter, the following perfect conditions have to be met. Best linear unbiased estimator (BLUE) assumes data to be linear (the model is linear in the coefficients of the predictor with an added error term), unbiased (the error terms are to have a mean of zero), homoskedastic (the conditional variance of the error term is constant) and uncorrelated (the error terms are independently distributed according to normal distribution).

4. Empirical results

In this section we take equation (3.1) and equation (3.2) and fit each into a regression model. The initial results can be found in the top halves of table 4.1 and table 4.2. Before drawing conclusions from our regression, the model is tested and adjusted to satisfy several BLUE (best linear unbiased estimator) assumptions. Unless the data used for the OLS regression is generated by an ideal experiment, there is a big chance it will not perfectly fit the set conditions. However, the more it fits the more stable and trustworthy the model is.

Firstly, equation (3.1) is estimated. Using a Jarques-Bera test for normality, we see the null-hypothesis of normality is rejected. Nonetheless, because the mean is significantly zero and the number of observations exceeds one hundred, we carry on without adjustments. We apply a Breusch-Godfrey test for autocorrelation and see the null-hypothesis of no serial correlation is rejected. After adding a lagged residual term to our equation, we see the Durbin-Watson (D.W.) statistic increase vastly towards the value of 2 (indicating no autocorrelation). Repeating the test still has us rejecting the null-hypothesis of no serial correlation, however we move on, keeping in mind the encouraging D.W. statistic. Finally, a White-test on homoscedasticity of error-terms sees the null-hypothesis being rejected. This unfortunately means the error-terms are heteroskedastic. Consequently we estimate our equation by using the HAC Newey-West method which adjusts the standard deviations of our variables to correct for this heteroskedasticity. The results of this adjusted equation are listed in the bottom half of table 4.1. The model has failed to satisfy all BLUE assumptions, yet a Wald-test of linear constriction confirms our variables play a significant part in predicting s. Both the R^2 and Durbin-Watson statistic reach desirable values and all three information criteria have dropped in value.

Table 4.1: Results of exchange rate estimation regression; $s = \varepsilon + \beta_1 p + \beta_2 m + \beta_3 y + \beta_4 r + \beta_5 x$

Technique: OLS				
Variable	Coefficient	Std. Error	t-Statistic	Probability
ε	2.84	0.527	5.393	0.0000
p	0.02	0.113	0.143	0.8865
m	0.13	0.058	2.273	0.0243
y	0.14	0.144	0.967	0.3348
r^*	-3.40	0.458	-7.434	0.0000
x	-0.09	0.041	-2.104	0.0369
R^2	0.882			
$D.W.$	0.214		Akaike info criterion	-2.77
Log likelihood	239.8277		Schwarz criterion	-2.66
Number of observations	169		Hannan-Quinn criterion	-2.72
Technique: HAC Newey-West, OLS including lagged residual term				
Variable	Coefficient	Std. Error	t-Statistic	Probability
ε	2.95	0.221	12.364	0.0000
p	-0.09	0.052	-1.750	0.0820
m	0.19	0.028	7.004	0.0000
y	0.03	0.065	0.475	0.6358
r^*	-3.29	0.229	-14.356	0.0000
x	-0.06	0.021	-2.854	0.0049
resid01(-1)	0.90	0.034	26.295	0.0000
R^2	0.977			
$D.W.$	1.629		Akaike info criterion	-4.38
Log likelihood	374.9455		Schwarz criterion	-4.25
Number of observations	168		Hannan-Quinn criterion	-4.33

$p = \log of\ Russian\ industrial\ PPI$
m = log *of Russian* $M1$
y = log *of Russian production*, r^* = *Short-term Eurozone interest rate*, x = log *of Russian oil price per barrel*

Secondly, equation (3.2) is estimated. Not surprisingly, due to the high correlation between the oil and gas prices, the results are quite similar to those of equation (3.1). We encounter the same hypothesized test results as before regarding our BLUE assumptions, therefore identical measures are taken. The final results of the adjusted equation are listed in the bottom half of table (4.2). This model also fails to satisfy all BLUE assumptions. Yet again a Wald-test of linear constriction confirms our variables play a significant part in predicting s. Both the R^2 and the Durbin-Watson statistic reach desirable values and the log likelihood has increased.

Table 4.2: Results of exchange rate estimation regression; $s = \varepsilon + \beta_1 p + \beta_2 m + \beta_3 y + \beta_4 r + \beta_5 g$

Technique: OLS				
Variable	Coefficient	Std. Error	t-Statistic	Probability
ε	3.16	0.660	4.786	0.0000
p	-0.14	0.077	-1.861	0.0646
m	0.23	0.046	4.892	0.0000
y	-0.05	0.136	-0.383	0.7022
r^*	-3.23	0.634	-5.092	0.0000
g	-0.04	0.045	-0.881	0.3796
R^2	0.880			
$D.W.$	0.210		Akaike info criterion	-2.75
Log-likelihood	237.9652		Schwarz criterion	-2.63
Number of observations	169		Hannan-Quinn criterion	-2.70
Technique: HAC Newey-West, OLS including lagged residual term				
Variable	Coefficient	Std. Error	t-Statistic	Probability
ε	3.31	0.239	13.843	0.0000
p	-0.19	0.053	-3.596	0.0004
m	0.26	0.025	10.549	0.0000
y	-0.12	0.059	-2.036	0.0434
r^*	-3.02	0.293	-10.282	0.0000
g	-0.04	0.028	-1.514	0.1319
resid01(-1)	0.91	0.037	24.414	0.0000
R^2	0.976			
$D.W.$	1.556		Akaike info criterion	-4.34
Log-likelihood	371.5233		Schwarz criterion	-4.21
Number of observations	168		Hannan-Quinn criterion	-4.29

$p = log\ of\ Russian\ industrial\ PPI$
m = *log of Russian* $M1$
y = *log of Russian production*
r^* = *Short-term Eurozone interest rate*
g = *log of Russian gas price per cubic meter x1000*

When both oil and gas are added to the same equation, a Wald's test confirms both variables' coefficients to be significantly identical. Based on the higher log likelihood attributed to equation (3.1) we will proceed to work with the first model containing the price of oil. The coefficient for x is significantly negative at a 5% confidence level, which means we accept the null-hypothesis of $\beta_5 < 0$, an increase in the price of Russian oil and gas leads to absolute appreciation of the Russian Ruble. Theoretically, it is the combination of wealth- and transactions effect that see th enlarged national income and increased permanent income cause long-run appreciation. The coefficient is -0.06, meaning a 10% increase in oil and gas prices would lead to an appreciation of 0.6%. The coefficient for m is found to be significantly positive, which means we accept the null-hypothesis of $\beta_2 > 0$, an increase in the Russian money supply leads to depreciation of the Russian Ruble.

Apart from the coefficients of variable x and m, none of our other coefficients show their hypothesized signs or values at a 5% confidence level. Both coefficients appointed to p and y do not significantly differ from zero, hence both $H_0: \beta_1 < 0$ and $H_0: \beta_3 < 0$ are to be rejected. Lastly, the foreign interest rate was hypothesized to be greater than zero ($H_0: \beta_4 > 0$), this null-hypothesis is also rejected.

Despite p and y being insignificant, inserting all coefficients into short-run equation (2.25) yields the following equation. Variable V takes on the coefficient attributed to the oil price, for any price increase can be treated as the additional national income V represents:

$$s = -0.09p + 0.19m + 0.03\bar{y} - 3.29r^* - 0.06V \tag{4.1}$$

The coefficient of the interest rate plays a key-role in our overshooting analysis. Unfortunately, our significant coefficient β_4 does not match the positive value we hypothesized. Luckily, knowing that $\beta_4 = \frac{1}{\theta} + l$, we can calculate a more likely theoretical value. This hypothetical coefficient should allow us to demonstrate the overshooting phenomenon, all other values still originating from the sample data.

Because our negative coefficient β_4 won't be used when defining the parameters θ, k and l, we can only find reasonable parameters if we insert a predetermined parameter value for the speed of adjustment (θ). As the value of θ increases, the extent to which the current exchange rate overshoots its long-run equilibrium value reduces. In a similar exchange rate prediction model based on the same assumptions as ours, Bilson (1978) estimates this value to be 0.758. We use the same value in order to estimate our parameters ($l = 14.66$ and $k = 0.055$) and new interest rate coefficient ($\beta_4 = 15.98$). The exact calculations can be found in Appendix (7.5).

Assuming both the foreign and the domestic interest rates show of the same characteristics and elasticity's hold on the short run, we can estimate liquidity effects by slightly modifying our basic money demand equation (2.3) to include oil and gas revenues:

$$lr = p - m + ky + kV \tag{2.3a}$$

Now we know a 10% increase in oil and gas prices would lead to an appreciation of 0.6%, but liquidity effects see this price change also effect the domestic interest rate. Equation (2.3a) shows that the result of kV is a $(0.055 * 10\% =)$ 0.55% increase of lr, this means the interest rate (r) will increase by 0.038%. This increase is inherently the size of exchange rate overshooting for we know from equation (2.2) that any increase in the interest rate is to be met by expected depreciation of the same size so to satisfy the UIRP condition. We assume both wealth- and transactions effect play a combined role in the total appreciation of the Russian ruble. The total initial appreciation is 0.638%, the economy is now at point C in figure (2.3). After prices give in and decrease the exchange rate depreciates back to its long-run net appreciation of 0.6%, point B in figure (2.3).

5. Conclusion

The main objective of this paper has been to project the effect a price increase of oil and gas will have on the RUB/EUR exchange rate. By applying an extended version of the Dornbusch model for exchange rate estimation it has proven possible to estimate a stable model with a significant negative value accompanying the oil price. This makes it possible for us to accept our main null-hypothesis (H_0: $\beta_5 < 0$) and conclude that a price increase of oil and gas will induce absolute appreciation of the Russian Ruble on the long-run.

The theory applied in this analysis also demonstrates how the overshooting phenomenon takes place within exchange rate fluctuations as a result of the transactions effect. Liquidity effects on the short-run affect the interest rate without delay, causing the exchange rate to overreact to any certain shock or event. With our interest rate showing of an unexpected negative variable, it hasn't been directly possible to display the effects of overshooting as a result of the oil and gas prices increasing. By instead determining the values of our parameters and calculating a new hypothetical positive coefficient, we do find overshooting of 0.038% as a result of a hypothetical 10% increase of the Russian oil and gas prices.

Further research on Eurozone-Russian relations in the timeframe 1999-2013 might provide an explanation as to why the foreign interest rate shows of such a significant negative value in our regression. On the whole, we've established that a sudden oil and gas price increase by Putin will lead to indefinite appreciation of the Russian Ruble based on monetary indicators of the past decade. It might even prove to be a desirable move on the long-run, for inflation is one thing the Russian economy historically fears and long-run appreciation is a well-known method to keep it at bay.

6. Reference list

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7. Appendix

7.1 Price per barrel calculation of oil

On average petroleum has a specific gravity of 0.88 which means:

1 $liter$ weighs 0.88 kg.

1 $barrel$ contains 158.9872972 $liter$.

1 $barrel$ weighs $158.9872972 * 0.88 = 139.908821536\ kg$.

One metric ton is equal to 1000 kilograms which means:

$1000/\ 139.908821536 = 7.1475121$.

There are a little over 7 barrels of petroleum in a metric ton . Now it's possible to translate the value of a month's oil export to dollar price per barrel:

$Value\ of\ oil\ exports\ /\ (Tons\ of\ oil\ exported\ *\ 7.1475121)$

7.2 Price per cubic meter times 1000 calculation of gas

$Value\ of\ gas\ exports/(\ m^3 *\ 1000)\ of\ gas\ exported$

7.3 Exchange rate RUB/EUR calculation

Both the Euro and the Ruble exchange rates are expressed in dollars. In order to get the exchange rate expressed in Ruble per Euro we divide both exchange rates through each other:

$$\frac{RUB/_{DOL}}{EUR/_{DOL}} = RUB/EUR$$

7.4 Data description

Titel	**Source**	**Date extracted**
Russian exports: Crude oil (cumulative order), currency US dollars, monthly.	Datastream	21-05-2014
Russian exports: Crude oil (cumulative order), volume in tons.	Datastream	21-05-2014
Russian exports: Natural gas (cumulative order), currency US dollars, monthly.	Datastream	21-05-2014
Russian exports: Natural gas (cumulative order), volume in billion cubic meters.	Datastream	21-05-2014
Monthly Monetary and Financial Statistics (MEI); Currency exchange rates, National units per US-Dollar (monthly average), Russian Federation.	OECD	22-05-2014
Monthly Monetary and Financial Statistics (MEI); Narrow Money (M1), Russian Federation and Eurozone.	OECD	22-05-2014

Key Short-term economic indicators; Industrial production, growth previous period, Russian Federation and Eurozone.	OECD	22-05-2014
Monthly Monetary and Financial Statistics (MEI); Short-term interest rates, Percent per annum, Russian Federation and Eurozone.	OECD	22-05-2014

7.5 Parameter calculation

We know; $\beta_1 = -\frac{1}{l\theta} = -0.09$ and, $\beta_3 = 1 + \frac{1}{l\theta} = 0.19$.

If we insert $\theta = 0.758$ into these equations, only β_1 yields a value for l which satisfies the restriction set in equation $(2.25b)$. Solving for l gives us $\theta\ = 0.758$ and $l = 14.66$

We know; $\beta_5 = -k\left(1 + \frac{1}{l\theta}\right) = -0.06$. By inserting the values for θ and l we solve for k yielding $k = 0.055$.

Inserting our new parameter values into β_4 gives us a positive hypothetical coefficient for the foreign interest rate: $\beta_4 = \frac{1}{\theta} + l = \frac{1}{0.758} + 14.66 = 15.98$.