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Estimating the Equilibrium Exchange Rate in Belarus

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Estimating the Equilibrium Exchange Rate in Belarus

Executive summary

The exchange rate of the Belarusian ruble has recently regained substantial attention. After serious balance-of-payments problems, the National Bank devalued eventually at the end of May 2011 the ruble versus the US-dollar by 56%. At the same time, this action has not restored order in the market, which is still not working properly.

These developments also renewed interest in a quantitative assessment of the equilibrium exchange rate of the ruble. This is the level of the exchange rate that is determined by the values economic variables ("fundamentals") that are projected to prevail in the medium-term such as relative inflation, interest rates or economic growth. However, market exchange rates are also influenced by other "non-fundamental" factors, which can lead to substantial short-run movements away from its fundamental value.

The economic literature has developed a number of different approaches for determining the equilibrium value of the exchange rate. We focus in the following on three widely used and well-established models: The Purchasing Power Parity (PPP) approach, the External Sustainability (ES) approach, and the Macroeconomic Balance (MB) approach. Using a number of approaches, rather than focusing only on one particular approach allows us to check the validity of our results. Depending on the approach, we use data until the first/second quarter of 2011 in our estimations. The following table gives an overview of the quantitative results obtained from the estimations. The results refer to the nominal bilateral USD/BYR exchange rate (which seems to be most ostensive) as of the first quarter of 2011:

Method	**Value (USD/BYR)**
1) Purchasing Power Parity (PPP)	2602
2) External Sustainability (ES)	6665
3) Macroeconomic Balance (MB)	6621

If we focus on results obtained by the MB/ES-approaches, which are in our view the most relevant benchmarks, we see that the USD/BYR rate consistent with fundamentals is around 6600. The recent devaluation undertaken by the National Bank thus brought the exchange rate a step closer to its equilibrium rate, even though there is still a considerable gap. The PPP-approach, which gives a different result, should be considered with a degree of caution, as it has only very long-term implications, and is thus of less use.

Furthermore, it should be stressed that our analysis in no way implies that the National Bank should treat the equilibrium rate as a value at which the exchange rate should be fixed or targeted. At the same time, this equilibrium is also not meant to be a forecast, but rather an indicator or reference value. On the contrary, we reiterate our long-standing position that Belarus would benefit from a more flexible exchange rate. This also requires that the currently rather dysfunctional foreign exchange market is quickly brought back into function. Especially in uncertain times, it is important to let supply and demand in the market determine the value of the currency. This does not imply that the National Bank should completely withdraw from the market, but rather limit its activities to preventing potentially harmful excess volatility.

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1. Introduction

It's well known that exchange rates influence different macroeconomic variables. Significant movements in real exchange rates have a direct influence on the demand for exports and imports and, as a result, the trade balance, the current account and output growth. An overvalued currency leads to a current account deficit, and, if the deficit is sustained in the long run, this can result in the currency crisis. It also must be noted that undervalued currency problem may seem not as important as overvalued, but it also leads to negative consequences such as a slow growth rate in the non-tradable goods sector and the current account balance worsening of main trading partners. Thus, deviations of exchange rates from their equilibrium values are, in most cases, undesirable.

Looking back into the past we recall that in the second half of the 1990s Belarus had already faced such a problem. Currency overvaluation caused a situation of various restrictions on the foreign exchange market, multiple exchange rates, high inflation and a lack of goods. The problem was solved by tightening of monetary policy and the official devaluation of the Belarusian ruble to the market level. However, the national currency was then pegged to the US dollar, which thus predetermined the possibility of the same situation in the future. The exchange rate was relatively stable in the 2000s and there was stable economic growth. However, since 2007 the growth of trade and current account deficits strengthened, mainly as a result to external (energy price) shocks. The currency was then devalued in 2009 and pegged to a basket of currencies. Nevertheless, the current account deficit continued to rise and reached the level of 15.6% relative to GDP in 2010. In the beginning of 2011, there was significant pressure at the currency market, which resulted in currency restrictions introduced by authorities and later on, in the devaluation of the official exchange rate. However, there are still some distortions at the market, expressed in the gap between the official exchange rate and the unofficial ("black market") one. This shows the importance of equilibrium exchange rate estimation, while the latter reflects the levels of economic fundamentals without capturing speculative incentives.

The paper is organized as follows. In Section 2, we briefly review the methods for estimation the equilibrium level of the exchange rate. In Section 3, we describe the assessment procedure of the equilibrium exchange rate of the Belarusian ruble to the US dollar using different methods of estimation. In Section 4 we provide policy recommendations.

2. Methodology

Before describing methods for equilibrium exchange rate estimation we briefly review the basic concepts of the exchange rate.

First, exchange rates can be bilateral or multilateral. A bilateral exchange rate is the relative price of two currencies. A multilateral (or effective) exchange rate is an index of bilateral exchange rates of one currency to different others.

Second, exchange rates can be nominal and real. A nominal exchange rate is a price of one currency expressed in terms of another. A real exchange rate is a nominal exchange rate corrected for inflation, i.e. multiplied by the price level of the base country relative to the price level of the foreign country. Nominal as well as real rates can be expressed both bilaterally and multilaterally.

In the practice of assessing equilibrium exchange rates the objective is usually a multilateral real exchange rate, the so-called real effective exchange rate (REER) because this type of exchange rate influences the trade and current account balance. In our paper we will estimate the equilibrium real effective exchange rate, nominal effective exchange rate and the bilateral nominal exchange rate (USD/BYR). Traditionally, the US dollar plays an important role in the Belarusian economy and the level of dollarization is relatively high.

2.1 The purchasing power parity (PPP) approach

The PPP concept is based on the law of one price, i.e. prices of goods in different countries valued in one currency should be the same. This assumption is then extended to price levels and an exchange rate is determined as a relative price level.

$$E = \frac{P}{P^*} \tag{1}$$

where E – is an exchange rate (units of the national currency for one unit of the foreign currency, i.e. a rise of E means a depreciation of the national currency), P - is a price level in the national economy and P^* - is a price level in the foreign economy.

The PPP concept in the form (1) is known as the absolute PPP. Similarly we can express the PPP concept in a dynamic form, which is known as the relative PPP concept.

$$\Delta \ln(E) = \Delta \ln(P) - \Delta \ln(P^*) \tag{2}$$

where $\ln$ denotes natural logarithm of the variable and Δ is a difference operator.

Relative PPP assumes that the level of exchange rate is driven by the comparative dynamics of prices in the domestic and the foreign country.

It should be noted that the PPP concept holds only in the case of fully free markets without any barriers, which restrict international movement of goods and thus arbitrage. It can be assumed that in the long run there are no such barriers, thus the PPP approach can be used for a long-run

equilibrium exchange rate estimation. One important problem is that it's not clear what price index should be used for PPP estimation, because estimates based on different indexes sometimes lead to very different results (Isard, 2007). Moreover, in the case of absolute PPP it's often hard to find appropriate data of price levels.

However, regarding transition countries, the most important issue is a necessity for the correction of the results obtained for the Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964). This effect can be described as follows. Productivity growth in the tradable goods sector leads to the rise of output, profits and wages in this sector. At the same time prices of tradable goods remain constant, because they are determined in the world market. As wages in the tradable goods sector rise, wages in the non-tradable goods sector must also rise, because employees in the non-tradable goods sector would reduce their labor supply otherwise. But the rise of wages in the non-tradable goods sector could be achieved only through the rise of prices, because competition in this sector is lower, productivity grows slower and firms don't want to lose profits. As a result the general price level will rise as well as the real exchange rate. This means that countries with lower real income levels have lower price levels and vice versa. In terms of (1) this means that the national currency is overvalued in more poor countries and undervalued in richer countries according to PPP approach. Thus, a correction for differences in real income should be done while using the PPP approach.

2.2 The external sustainability approach

This approach could be used to estimate whether the prevailing real exchange rate and current account balance stabilize country's international investment position. Based on the desirable level of the international investment position the current account balance, which would stabilize this level, can be calculated in the following way (Lee et al., 2008).

$$\Delta IIP_t = CA_t + KG_t \quad (3)$$

where IIP - is the international investment position, CA – is the current account and KG denotes capital gains from valuation changes.

In (3) we assume the absence of errors and omissions, which can lead to differences between growth of the international investment position and sum of the current account and capital gains.

Dividing (3) by the level of nominal GDP and assuming that asset prices remain constant, we obtain (4).

$$ca_t = iip_t - \frac{IIP_{t-1}}{GDP_t} \quad (4)$$

where small letters denote that variables are taken as the share of GDP.

From (4), we can obtain (5) and (6):

$$ca_t = iip_t - \frac{iip_{t-1}}{GDP_t} GDP_{t-1} \quad (5)$$

$$ca_t = iip_t - \frac{iip_{t-1}}{(1+g)(1+\pi)} \quad (6)^1$$

where g - real GDP growth rate, and π - inflation rate (measured by GDP deflator).

We can use (6) for defining the equilibrium current account. It might be based on our target rate of the international investment position. For instance, it may reflect the maximum level of external debt accumulation eligible for the period under review. Further, this condition may be made more rigorously: we can treat the equilibrium level of current account as the one, which stabilizes the international investment position at the current level. If the latter condition is used, (7) is used for assessing the equilibrium exchange rate.

$$ca = \frac{\pi + g(1+\pi)}{(1+g)(1+\pi)} iip \quad (7)$$

When we know the equilibrium level of the current account we can estimate the equilibrium exchange rate based on estimated long-term elasticity of the current account balance on real effective exchange rate.

This approach should be treated as the most influential in our opinion, since during the last decade productivity growth in Belarus was mainly driven by domestic demand. The latter meant substitution of potential external demand by domestic one, which moved the economy away from external equilibrium. Hence, restoration of the external equilibrium seems to be the prior challenge for the economy, which may cause additional adjustment in assessment of the internal equilibrium, i.e. potential output. Thus, we treat this approach as the prevailing and most meaningful one.

2.3 The macroeconomic balance approach

According to this approach, an equilibrium exchange rate is an exchange rate which prevails in the situation of internal and external balance in the national and foreign economy. This assumes that current account balance (external balance) should be equal to the equilibrium savings-investment balance (internal balance). The underlying current account balance is the one which would prevail

[1] It must be noted, that current account and international investment position on the one side and output on the other side as a rule are nominated in different currencies. So either current account and international investment position should be re-estimated to the national currency or output should be assessed in foreign currency. Thus, (7) will be true only if all variables are measured in one currency.

in the medium-term if all the countries were operating at full employment (i.e. zero output gap) and when all past real exchange rates movements had fully influenced the economy (Isard, 2007). To estimate an equilibrium exchange rate using the macroeconomic balance approach, models for the current account and savings-investment balances must be formulated. The current account is usually modeled as dependent on the real exchange rate and the national and foreign output. The savings-investment balance is modeled as dependent on different variables, but not the exchange rate. Then equilibrium values of variables that explain the current account and savings-investment balances must be determined. This is usually done by using mid-term forecasts of these variables[2]. When we have these models, we compare an equilibrium savings-investment level (and accordingly equilibrium current account level) and underlying current account and estimate the necessary adjustment of the exchange rate on order to close this gap. The latter assumes usage of the elasticity of the current account on the real exchange rate.

2.4 Other approaches

Apart from the approaches described above, there are also other useful approaches. An equilibrium exchange rate could be estimated using a reduced-form econometric model or a dynamic stochastic general equilibrium model (DSGE). In the case of econometric models, it was shown in various researches, that they usually provide relatively good long-term estimates. On the contrary, DSGE models provide better short-term estimates, but there estimation is usually not a simple process and the appropriate data is not always available. In both cases the problem of finding equilibrium values of independent variables is relevant. Furthermore, there can be difficulties in explaining obtained results to the public, because knowledge of econometrics and advanced mathematics is required to fully understand the results obtained. Assumptions about whether the current value of the exchange rate is at its equilibrium level can also be done by analysis of different indicators of trade competitiveness. If, for example, profitability of the tradable goods sector is low, then it can signal that the currency is overvalued. However, this approach cannot provide an absolute level of an equilibrium exchange rate, but simply shows if the current rate is above or below equilibrium.

3. Assessment of the equilibrium exchange rate in Belarus

3.1 Assumptions and preconditions for equilibrium exchange rate assessment

When assessing an equilibrium exchange rate, the definition of the latter is worth to be explicitly defined, because different understanding of the term "equilibrium" may drive to different interpretations of the results. In the majority of related studies (for instance, see Isard (2007), IMF (2006), Hakura and Billmeier (2008)) a nominal equilibrium exchange rate (under approaches

[2] Thus the estimates provided by the macroeconomic balance approach can be viewed as medium-term estimates.

of macroeconomic balance and external sustainability) may be treated as one, which provides restoration of equilibrium in a medium-term. The strategy here looks like as follows: The first step is the assessment of an equilibrium level of a current account based on the projected medium-term values of the macroeconomic fundamentals (those under the condition of a closed output-gap in the country of interest and its trading partners). The second step is the assessment of a long-term exports and imports elasticity on a real exchange rate (also elasticity of prices on nominal exchange rate if needed, but in most cases the latter is ignored) basing on historical values. The third step is the assessment of a medium-term elasticity (semi-elasticity) of current account balance (as the share of GDP) on a real exchange rate. Finally, the level of nominal exchange rate which will drive baseline (projected) the current account/GDP-ratio to its equilibrium level (through correspondent changes in the real exchange rate) taking into account medium-term elasticity is called the equilibrium one. It may be interpreted as the nominal rate, which equilibrates the market in a medium-term perspective.

However, for Belarus another issue seems to be more urgent. Taking into account large deviations from the level of potential output during last year, the problem of finding the rate, which may clear the market today (not in a medium-term) is the priority one. This necessity is strengthened because of low level of international reserves, which cannot fulfill its role of resisting short-term market hesitations. Through this, our strategy differs slightly from the benchmark one. The first and the second step are kept unchanged: we define an equilibrium level of a current account based on the projected medium-term values of the correspondent macroeconomic variables and obtain needed long-term elasticities. But in the third step, we assess the semi-elasticity of the current account-to-GDP ratio on a real exchange rate based on the actual values of macroeconomic variables (not projected medium-term ones). Furthermore, we treat the equilibrium exchange rate as one that provides adjustment of the current account-to-GDP ratio from its current level to the equilibrium one. Hence, the estimations provided in this paper answer the question which level of the nominal exchange rate may equilibrate the market at a definite period of time (not in a medium-term).

Furthermore, there is one more substantial difference from the benchmark approach. When deriving the formula for semi-elasticity of current account-to-GDP ratio, by default a precondition of a zero pass-through effect from the nominal exchange rate to prices is used. This approach determines a direct link between real exchange rate and nominal exchange rate. However, in case of a large pass-through from nominal exchange rate to prices, it cannot be neglected, while the difference in a needed nominal appreciation/devaluation (in percentage points) and the real one is huge. This effect is captured in our approach when deriving the semi-elasticity of current account-to-GDP ratio on the real exchange rate (see Annex A for technical issues).

3.2 The purchasing power parity (PPP) approach

First, we find the PPP estimate of the Belarusian ruble to the international dollar exchange rate from the International Comparison Program (ICP) 2005 data, the latest available data. The value of the exchange rate is 779.

Second, we correct the ICP estimate for the relative inflation in Belarus and the United States during the period of 2006 – the second quarter of 2011. We use GDP deflators. The relative inflation corrected estimate then becomes 1381.

Third, we make the correction for the Balassa-Samuelson effect. This is done through several steps (Weber, Kirchner, 2009). In the first step we calculate 2005 PPP GDP per capita of Belarus relative to the US and obtain the value of 0.201, i.e. in 2005 PPP GDP per capita in the US was five times larger than of Belarus. Then we calculate relative real GDP per capita growth in Belarus and the US from 2006 until the second quarter of 2011. The index obtained in the previous step becomes then 0.305.

Finally, we make a correction of the PPP estimate for the calculated difference of real GDP per capita. We use an elasticity of a real exchange rate to relative real GDP per capita of 0.388, which is an average value from estimates obtained in Rogoff (1996), De Broeck and Sløk (2001), Frankel (2005) and Oomes et al. (2009). The estimated equilibrium exchange rate becomes then **2602 USD/BYR**.

3.3 The external sustainability approach

First, we must determine the desired level of the international investment position. We select the level of external debt of 60% of GDP as the target (maximum acceptable) level, which is the critical level for emerging markets (Reinhart, Rogoff, 2010). The latter corresponds to the level of international investment position at about -55.7% of GDP.

We further need assumptions about nominal GDP medium-term growth nominated in US dollars. We assume real growth of 4% and dollar inflation of 3.5%. Hence, our projected value for nominal GDP growth in dollar terms is 7.64%. Thus (according to (7)), correspondent equilibrium medium-term level of current account-to-GDP ratio is -3.95%.

Taking into account the values of semi-elasticity (according to (12)) calculated for 2010 (on a quarterly basis) and 2011-1Q, actual current account-to-GDP ratio in a correspondent periods, we get the following values of needed real and nominal exchange rate devaluation in order to reach the equilibrium medium-term level of current account. Furthermore, for information purposes we provide an assessment of the equilibrium level of the exchange rate with respect to the US dollar, calculated as actual USD/BYR exchange rate during the correspondent quarter devaluated by the number of percentage points needed for nominal effective exchange rate devaluation. This

approach comes to the conclusion that the equilibrium rate based on the latest available fundamentals is 6621 USD/BYR.

Table 1. Equilibrium exchange rates according to external sustainability approach

	2010-Q1	2010-Q2	2010-Q3	2010-Q4	2010 (average)	**2011-Q1**
Needed devaluation of REER, %	24.2	37.3	36.0	51.1	38.2	**66.7**
Needed devaluation of NEER, %	43.4	66.8	64.5	91.6	68.5	**119.5**
USD/BYR equilibrium rate	4167	4988	4941	5772	5018	**6621**

Source: Own estimations

3.4 The macroeconomic balance approach

This approach requires estimation of the equilibrium level of savings-investment balance. As a rule, such an equilibrium level is assessed basing on panel data. For instance, such a model was elaborated by the IMF Consultative Group on Exchange Rate Issues (CGER). Application of two different specifications of the CGER model to Belarus (IMF (2010)) gives the estimates of the equilibrium level of savings-investments balance of -2.05 and -2.70% of GDP. However, these estimates assume in our opinion rather optimistic developments of the respective fundamentals. For instance, these values of savings-investment balance (-2.05 and -2.70% of GDP) are obtained under following preconditions: medium-term output growth – 7%, fiscal deficit – 1.5%. We exploit IMF's pooled estimation model, but change a number of values of underlying variables in comparison to those used in IMF (2010). More specifically, for fiscal deficit we use the value of -2.5% of GDP, for population growth – -0.3%, international investment position - -55.7% of GDP, oil balance - -9% of GDP, output growth – 4%. Finally, we get the equilibrium medium-term level of current account-to-GDP ratio of -3.67% of GDP.

Table 2. Equilibrium exchange rates according to macroeconomic balance approach

	2010-Q1	2010-Q2	2010-Q3	2010-Q4	2010 (average)	**2011-Q1**
Needed devaluation of REER, %	25.0	38.2	37.1	52.0	39.2	**67.5**
Needed devaluation of NEER, %	44.9	68.5	66.4	93.2	70.2	**120.9**
USD/BYR equilibrium rate	4211	5038	4999	5820	5068	**6665**

Source: Own estimations

4. Policy recommendations

The analysis conducted above gives rise to a number of policy recommendations, which are summarized below:

1. The currently observed, significant deviation of the official exchange rate from the equilibrium level may cause serious distortions in the economy. Hence, this mismatch should be eliminated by taking the necessary steps.
2. Maintaining a fixed exchange rate regime requires a substantial level of international reserves that may be needed to bridge any difference between the current equilibrium level in comparison to the desired, i.e. fixed level of the exchange rate. However, these interventions with respect to nominal rate may be large and volatile due a high pass-through effect from nominal exchange rate to prices. Hence, it would require additional funds to be accumulated in international reserves. From this view, the regime of flexible exchange rate seems to be worthwhile for implementing.
3. The difference in needed nominal and real devaluation due to the pass-through effect may cause a long-lasting disequilibrium in the real exchange rate due to the desired level of nominal rate. From this view, a more flexible exchange rate seems to be reasonable as well.

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Annex A. Elasticities Assessments

We can decompose the semi-elasticity of current account (actually not the current account but the trade balance of goods and services, which is close to the current account) in the following way.

$$El_{\frac{TB}{GDP}} = \frac{\partial \frac{TB}{GDP}}{\partial E} E = \frac{\partial\left(\frac{P_X X - P_M M}{P_Y Y}\right)}{\partial E} E =$$

$$= \frac{P_Y Y\left(X\partial P_X + P_X \partial X - M\partial P_M - P_M \partial M\right) - \left(P_X X - P_M M\right)\left(Y\partial P_Y + P_Y \partial Y\right)}{P_y^2 Y^2 \partial E} E =$$

$$= \frac{P_X X}{GDP}\left(El_{P_X} + El_X\right) - \frac{P_M M}{GDP}\left(El_{P_M} + El_M\right) - \frac{TB}{GDP}\left(El_{P_Y} + El_Y\right) \quad (8)$$

where TB – is the trade balance of goods and services, GDP – is the gross domestic product, E – is the real effective exchange rate, X - is real exports, P_X - is the exports deflator, M - is real imports, P_M - is the imports deflator, Y - is the real GDP, P_Y - is the GDP deflator, El denotes the elasticity of a variable with respect to E (in the case of $El_{\frac{TB}{GDP}}$ it is a semi-elasticity), ∂ denotes a differential.

It's more correct to estimate elasticities of price indices with respect to the nominal effective exchange rate (NEER) rather than the real effective exchange rate (REER). Thus we transform REER-elasticities of deflators to NEER-elasticities. For example, in the case of the exports deflator the transformation is as follows.

$$\frac{\partial P_X}{\partial E}\frac{E}{P_X} = \frac{\partial P_X}{\partial\left(\frac{1}{e}\frac{P_Y}{P_y^*}\right)}\frac{\frac{1}{e}\frac{P_Y}{P_y^*}}{P_X} = \frac{P_Y \partial P_X}{P_X\left(\partial P_Y - \frac{P_Y}{e}\partial e - \frac{P_Y}{P_y^*}\partial P_y^*\right)} = \frac{\frac{\partial P_X}{\partial e}\frac{e}{P_X}\frac{P_X}{e}}{\frac{\partial P_Y}{\partial e}\frac{e}{P_Y}\frac{P_X}{e} - \frac{P_X}{e}} = \frac{k}{v-1} \quad (9)^3$$

where e - is the NEER (national currency for one unit of foreign currencies), k - is the NEER-elasticity of exports deflator, v - is the NEER-elasticity of GDP deflator.

Similarly REER-elasticities of imports deflator and GDP deflator can be represented in the following way.

[3] We assume that the NEER-elasticity of P_y^* is 0.

$$\frac{\partial P_M}{\partial E}\frac{E}{P_M}=\frac{\eta}{v-1} \tag{10}$$

$$\frac{\partial P_Y}{\partial E}\frac{E}{P_Y}=\frac{v}{v-1} \tag{11}$$

where η - is the NEER-elasticity of imports deflator.

Now we can modify (8) considering (9), (10) and (11).

$$El_{\frac{TB}{GDP}}=\frac{P_X X}{GDP}\left(\frac{k}{v-1}+El_X\right)-\frac{P_M M}{GDP}\left(\frac{\eta}{v-1}+El_M\right)-\frac{TB}{GDP}\left(\frac{v}{v-1}+El_Y\right) \tag{12}$$

Knowing the REER-elasticity of $\frac{TB}{GDP}$ the equilibrium value of REER can be calculated.

$$E^e=E\left(1+\frac{\partial\frac{TB}{GDP}}{El_{\frac{TB}{GDP}}}\right) \tag{13}$$

where E^e - is the equilibrium value of REER.

It simply can be shown that the NEER-elasticity of REER equals $v-1$. Then the equilibrium value of NEER can be calculated as follows.

$$e^e=e\left(1+\frac{\partial E}{E(v-1)}\right) \tag{14}$$

where e^e - is the equilibrium value of NEER.

Now our main task is to estimate necessary long-term elasticities.

We assume that real exports depend on REER, external demand and real imports (because the production of export goods largely depends on the imports of intermediate goods). In a given context, we need an elasticity of exports of both goods and services on the real exchange rate. However, using correspondent series gives ambiguous results. Through this, we estimate the elasticity of exports of goods on real exchange rate and after that adjust the results to our assumptions on the elasticity of exports of services on real exchange rate, given the weights of goods and services in total exports. For exports of goods we obtain the following long-run relationship.

$$rx\_g\_sa = 2.889 - 0.723reer + 0.407rgdpru\_sa + 0.309rm\_g\_sa - 0.012trend \quad (15)^4$$

where $\_sa$ denotes seasonally adjusted (X-12-ARIMA method), rx_g_sa - is the real exports of goods, $rgdpru\_sa$ - is Russian real GDP, rm_g_sa - is the real imports of goods, $trend$ - is a trend variable. All variables are in natural logarithms.

Our assumption of exports of services elasticity on real exchange rate is -0.45. Finally we use the value of -0.690 as the elasticity of total exports on real exchange rate.

Real imports are assumed to be dependent on real exchange rate, domestic demand components (real households' consumption and real investment) and external demand. The results of the estimation are provided in (16).

$$rm\_sa = -2.937 + 0.523reer + 0.389rhc\_sa + 0.202ri\_sa + 0.758rx\_sa \quad (16)^5$$

where rm_sa - is real imports of goods and services, rhc_sa - is real households' consumption, ri_sa - is real investment, rx_sa - is real exports of goods and services. All variables are in natural logarithms.

The GDP deflator is assumed to be dependent on nominal exchange rate, monetary aggregate M2, deposits in foreign currency and the real interest rate on loans. The estimated long-run relationship is as follows.

$$defgdp\_sa = -2.846 + 0.442neer + 0.195m2\_sa + 0.143doll\_abs - 0.187rirl \quad (17)$$

where $defgdp\_sa$ - is the GDP deflator, $m2\_sa$ - is the monetary aggregate M2, $doll\_abs$ - is the stock of foreign currency deposits, $rirl$ - is the real interest rate on new loans. All variables are in natural logarithms.

The prices of imports in national currency are modeled as a function of prices of imports in dollars, BYR/USD nominal exchange rate index, and CPI inflation. The results are provided in (18):

$$pm = 0.817 * pmusd + 0.793ner + 0.324cpi\_sa \quad (18)$$

where pm - import prices in BYR terms, $pmusd$ - imports prices in USD terms, ner - index of nominal BYR/USD exchange rate (2005=1), cpi_sa - CPI inflation index (2005=1).

Finally the values used for assessment of (12) are as follows.

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[4] Equations (15) and (16) were estimated using PcGive Autometrics method with dummy saturation. In (15) dummies were for all quarters of 2001-2003, for 1st and 3rd quarter of 2008 and for 4th quarter of 2010.

[5] Dummies are for 2001(3), 2001(4), 2003(1), 2003(2), 2004(4), 2005(1), 2009(3), where a number in brackets denotes the corresponding number of the quarter.

Table 3. The values of the variables used for estimation of semi-elasticity

Variable	Notation	Value
Elasticity of exports on real exchange rate	El_X	-0.690
Elasticity of imports on real exchange rate	El_M	0.523
Elasticity of prices (GDP deflator) on nominal exchange rate	v	0.442
Elasticity of exports prices on nominal exchange rate	k	0.442[6]
Elasticity of imports prices on nominal exchange rate	η	0.793
Elasticity of real GDP on real exchange rate	El_Y	0[7]

Source: Own estimations

[6] Assumed to be equal to elasticity of domestic prices on nominal exchange rate.

[7] This is an assumption we make.