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EXCHANGE RATE AND REPO INTEREST RATE IN SERBIA: WHAT HAPPENED IN 2012 AND LESSONS FOR REINDUSTRIALIZATION

Devizna i monetarna politika u Srbiji: šta se desilo 2012. i kakve su lekcije za reindustrijalizaciju

Abstract

Monetary policy changes in 2012 were unpredictable. This cannot be simply attributed to the election cycle. More fundamentally, incoherent policy measures have been present since the onset of the 2008 global recession. Within such a framework, industrialization and economic policy were treated as unrelated and not in need of alignment. In our view, they are essentially associated, but in an asymmetric way. It is difficult for monetary and exchange rate policy measures to stimulate growth, which is the essence of industrialization, but they can easily discourage it. Hence, the Government of Serbia has to transparently define the industrialization policy over the medium term, and align it with other policy measures, including the monetary policy of the National Bank of Serbia.

The first thing to do so is to remove economic policy obstacles to growth. High interest rates and the overvalued domestic currency are serious obstacles to industrialization in Serbia. Looking back at 2012, the National Bank of Serbia pursued a stop-and-go monetary policy. It eventually returned to the repo rate as the main policy instrument to cure inflation. This initially stabilized the exchange rate level, but increased its volatility and overvalued the currency. In the long run the exchange rate should asymptotically approach its purchasing power parity level, which has happened two times in recent history in Serbia. In the meantime, short term factors are predominant, including inflation targeting monetary policy and delayed adjustment of the exchange rate to its equilibrium value. This is considered costly in terms of forgone output and export.

Key words: *exchange rate, purchasing power parity, uncovered interest rate parity, monetary policy, VEC model, DSGE model, industrialization*

Sažetak

Monetarna politika u 2012 godini bila je nepredvidljiva. To ne može jednostavno da se pripiše neizvesnosti zbog izbora. Generalno rečeno, neusaglašene mere ekonomske politike postoje od početka Globalne recesije iz 2008. godine. U tom okviru, industrijalizacija i druge ekonomske politike su odvojeno tretirane, bez potrebe da se usaglase. Po našem mišljenje, one su međusobno povezane, ali na jedan asimetričan način. Monetarna politika ne može da stimuliše rast, koji je ključna tačka industrijalizacije, ali može da ga ometa. Zbog toga bi Vlada RS trebalo da jasno formuliše industrijsku politiku na srednji rok i da usaglasi sve druge ekonomske mere s njom, uključujući i mere monetarne politike Narodne banke Srbije.

Ono što najbrže može da pomogne reindustrijalizaciju zemlje jeste otklanjanje prepreka za rast. Visoke kamatne stope i realno precenjen dinar su ozbiljne prepreke za reindustrijalizaciju. Prošle godine Narodna banka Srbije vodila je „stani-kreni" monetarnu politiku. Na kraju ona se vratila svom oprobanom instrumentu za suzbijanje inflacije koji se zasniva na repo kamatnoj stopi. To je brzo stabilizovalo nivo deviznog kursa, realno apresiralo kurs i povećalo njegovu promenljivost. Na dugi rok devizni kurs moraće da se približi svom ravnotežnom nivou određenom na osnovu pariteta kupovne snage valuta. To se dva puta desilo od 1994. godine do danas. U međuvremenu kratkoročni faktori, uključujući i monetarnu politiku NBS, odbijaju devizni kurs od njegovog ravnotežnog nivoa. To je skupa politika zbog izgubljenog GDP i propuštenog izvoza.

Ključne reči: *devizni kurs, paritet kupovnih snaga, nepokriveni paritet kamatnih stopa, monetarna politika, VEC model, DSGE model, industrijalizacija*

JEL classification: E58, F31, C68

Introduction

Monetary and exchange rate policy changes in 2012 were unpredictable. This cannot be simply ascribed to the election cycle. More fundamentally, incoherent policy measures have been present in the Serbian macroeconomic framework since the onset of the global recession in 2007. Within such a framework, industrialization and economic policy were treated as unrelated and not in need of alignment. In our view, they are essentially associated, but in an asymmetric way. It is difficult for monetary and exchange rate policy measures to stimulate growth, which is the essence of industrialization, but they can easily discourage it.

Industrialization is a policy of stimulating economic growth, especially through government aid, to modernize aging industries and encourage growth of new ones. This is a long-term policy, which may or may not be aligned with other economic policies of a short-term nature. This issue of consistency is often neglected or simply ignored. In this paper we will switch our focus from government aid to monetary and exchange rate policy, and check its coherence with industrialization policy in Serbia. The first thing to do to stimulate growth is to remove economic policy obstacles to growth. We consider high interest rates and an overvalued currency as the two most important examples of these obstacles.

There is a general complaint about the level and variability of the exchange rate in Serbia. Fewer complaints are made about the monetary system of inflation targeting and free floats of the exchange rate. Euroization is considered pathology of the system, while the presence of a dual currency system is almost completely ignored. However, all these issues are connected and mutually reinforcing. Two incidents last year, the sharp depreciation of the dinar (RSD) in the first half of the year, and an inflation shock with a corresponding increase of the repurchase agreement (repo) rate in the second half of the year, remind us that policy measures may have unintended effects. They contributed to a deeper recession with gloomy prospects for growth. We believe that lessons learned last year are that an overvalued currency and high interest rates do not stimulate industrialization. This is our main conclusion in this paper.

Unintentionally, Serbia was in 2012 a very interesting laboratory to study the conduct of macroeconomic policy. The inflation targeting system was in fact postponed in the first half of the year, and instead of it the exchange rate stabilization policy was vigorously pursued. The dual currency system was kept unchanged. Macroeconomic results were poor, which forced the monetary authority to resume a classical inflation targeting policy in the second half of the year. This policy change had recessionary effects that are not yet fully unveiled. It appreciated the dinar and increased the cost of borrowing, which are not of much support for export and growth this year. The economy this year will be off the long-term path of reindustrialization even if prospects for moderate GDP growth are realistic.

The paper is organized in the following way. We set the framework for analyzing industrialization, monetary and exchange rate policy in the first part. Then, we explain in the second part what happened to the policy regime in Serbia in 2012. In the third and fourth parts we check how relevant two theories of the exchange rate, i.e. purchasing power parity and uncovered interest rate parity, were in Serbia. In the fifth part we formulate a small Dynamic Stochastic General Equilibrium (DSGE) model of an open economy to replicate econometric findings and simulate reactions of output to monetary policy measures. Finally, we conclude in the last part.

Five hypotheses

We identify five hypotheses in the framework for discussing industrialization, monetary and exchange rate policy. It is difficult for a depreciated exchange rate to stimulate reindustrialization over the long run, since it is not sustainable. On the other hand, an appreciated exchange rate discourages reindustrialization in both the short run and long run, because it makes exports less competitive. This is the first hypothesis.

The second hypothesis is related to the dual currency system and high euroization. The dual currency system creates high transaction costs and postpones trade integration into the wider market of the EU. Reindustrialization is not only about revitalization of Serbia's aging industry, but also should improve the supply of traded goods in order

to promote exports. Trade-based industrialization is a promoter of Serbia's growth. However, the dual currency system creates obstacles to it.

The third hypothesis incorporates the monetary policy of targeting inflation into the framework. If inflation is under pressure from the cost side, an anti-inflationary policy, conducted through high repo interest rates that constrain aggregate demand, will not help reindustrialization. Quite the opposite is true; as such a policy inflates the cost of financing new investment projects and hurts competitiveness. External cost shocks, like an increase in the price of crude oil, cannot be avoided, and have to be accommodated through higher repo rates even if this has negative impacts on output. On the other hand, domestic cost shocks, like an increase in administered prices or prices of food due to bad harvests, should be significantly reduced. Otherwise, the inflation targeting policy would have significant negative effects on output and employment.

The fourth hypothesis refers to the way that inflation targeting policy is technically conducted. Recall that reindustrialization is at least the medium-term goal, if not completely the long-run one. Adjustment of the repo rate makes sense if underlying shocks on the price level have permanent effects in the economy. Shocks with temporary effects on the price level, like a seasonal increase in food prices due to a bad agricultural season, should not be allowed to cause increase costs of funding. As already said, reindustrialization is sensitive to the cost of financing investment projects.

The fifth hypothesis accounts for needs to diversify financing of reindustrialization. Expectations that foreign direct investments are the only way to finance industrialization in Serbia are wrong and misleading. Domestic savings must be also productively used for such a purpose. Long-term loans and domestic portfolio investments should accompany foreign direct investments. Therefore, the exchange rate and domestic interest rates are vital for reindustrialization, because domestic savings are overwhelmingly held in foreign currencies.

Let's briefly summarize the five hypotheses here:

H1: A depreciated exchange rate is not sustainable in the long term, while an appreciated exchange rate discourages reindustrialization in both the short term and the long term.

H2: The dual currency system hinders growth.

H3: Inflation targeting policy should take a normal use of economic resources into account, not only inflation.

H4: Inflation targeting policy should be conducted with the aim of reindustrialization to avoid a possible inconsistency in the long run.

H5: Financing of reindustrialization should be diversified with domestic savings as well as foreign investments.

This approach based on five hypotheses is axiomatic or based on general theoretical propositions. Nevertheless, it sets a useful framework to examine relationships among the exchange rate, repo interest rate and industrialization policy in Serbia's economy. We will demonstrate this by explaining what happened in 2012, and why the framework may be indispensable for deriving more general conclusions.

What happened in 2012?

The nominal exchange rate rose spectacularly in the first part of 2012, and appreciated in real terms equally spectacularly in the second part of that year. The first half of the year was the period of real depreciation of the dinar, while the second half marked its real appreciation. Ironically, the episode of depreciation coincided with strong interventions of the National Bank of Serbia (NBS) on the Belgrade foreign exchange (forex) market. NBS spent more than 1.3 billion euros (EUR) from official reserves for that purpose. The dinar started to recover in real terms shortly after termination of these interventions. The switching point occurred at the beginning of June 2012. Two months later, the new Governor of NBS was appointed. The incoming management of NBS claimed that they did nothing to strengthen the national currency, but only cancelled speculative attacks on it. The question is what governed the exchange rate behaviour last year – speculative attacks or monetary policy?

Our view is that stabilization of the exchange rate was due to a switch of monetary policy. This was the means by which speculation was eliminated. NBS decided at some point to reinforce the role of the repo interest rate in defending the exchange rate, instead of relying

on forex interventions. This policy switch demonstrated that forex interventions are not effective in an inflation targeting system based on a dual currency system. Forex interventions provided an additional supply of foreign currency assets with a view to supporting market forces to balance the exchange rate on a lower level. However, this market balance was achieved, to the contrary, on the higher level of the exchange rate with a lower level of forex transactions. What happened was an unintentional rise of investors' expectation that the exchange rate would continue to lose purchasing power. Therefore, they reduced their own supply of foreign resources. Aggregate daily turnovers on the Belgrade forex market shrank, driving up the exchange rate. On the top of that, the election crises increased the level of risk that was not covered by the active repo rate. Investors started to sell out NBS' Certificates of Debts (CDs) and demanded more foreign exchange to buy. NBS policy was to keep a low level of inflation by suppressing the pass

Figure 1: Repo and exchange rates

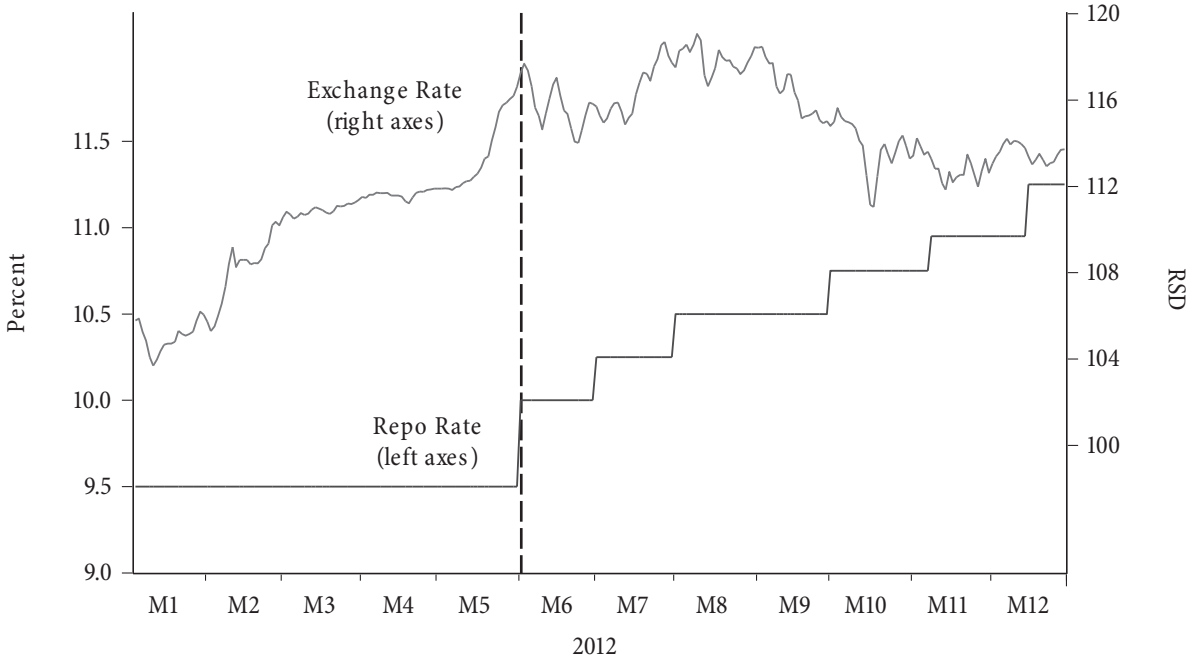
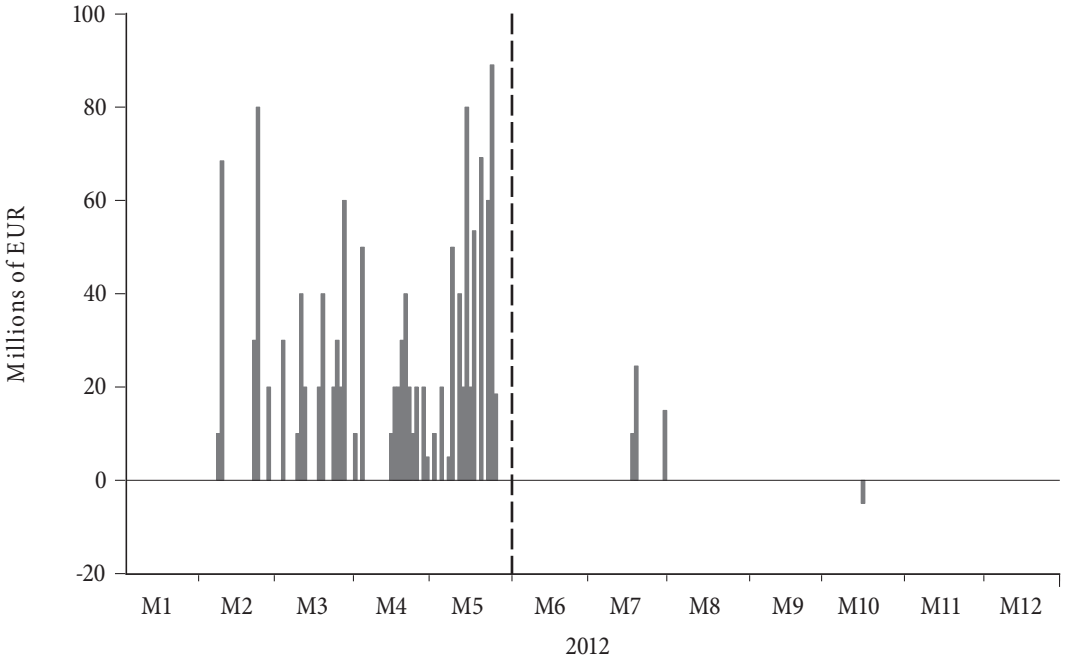


Figure 2: NBS forex interventions



through of the rising exchange rate to domestic prices, but later on the net result of this policy was the complete opposite. The real exchange rate depreciated, and foreign exchange reserves were wasted. A temporary substitution of the active repo policy for forex interventions was truly costly. An important question is whether the alternative monetary policy based on a high repo rate is less costly or even cost-free. Certainly, it has no costs in terms of forgone official reserves. It may have a cost, however, in terms of lost output or an increasing output gap. So far, no one has estimated the contribution of high interest rates to the deepening recession in Serbia in 2012.

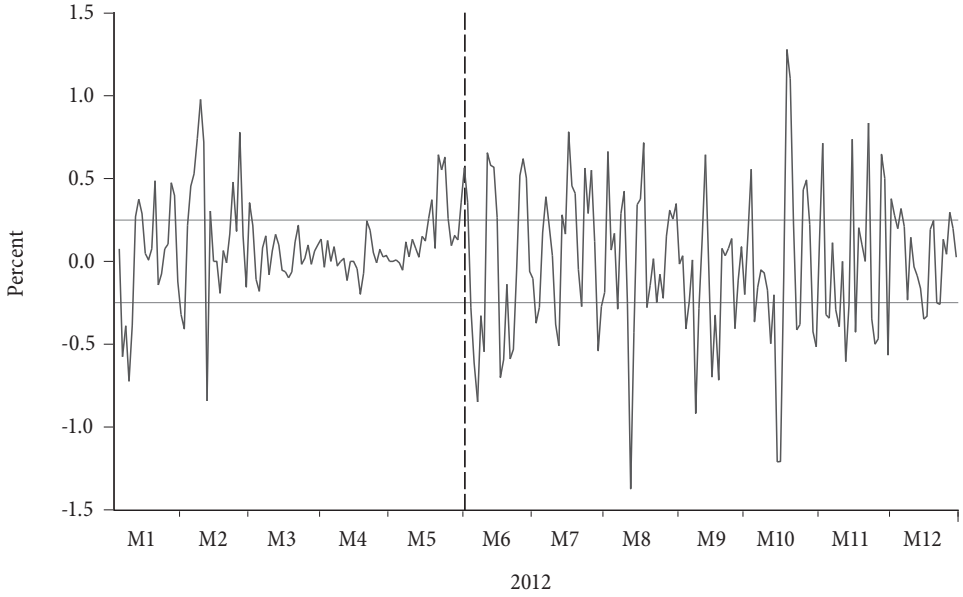
We report in Figure 1 daily movements of the exchange rate and corresponding levels of the repo rate in 2012. A vertical dotted line separates the two policy regimes in 2012. It can be easily noticed that the switch of policy regime took place at the beginning of June. In the first half of the year the repo rate was flat with no changes. The exchange rate rose from RSD 104 to RSD 117.7 for one euro. As a complement to this figure, we graph daily NBS forex interventions in Figure 2. They were high and frequent, but ineffective.

When NBS started to increase the repo rate in June, the forex interventions were abolished. Figure 1 reveals a stepwise pattern of the rising repo rate. After some hesitant oscillations, the exchange rate assumed a clear downward trend. Forex interventions disappeared rather soon with NBS' one-off purchase of forex assets in October for a symbolic amount.

The repo rate serves to suppress inflationary expectations. Actual inflation rates in the first half of 2012 were declining. NBS refused to reduce the repo rate, claiming that inflationary expectations would rise in the remaining part of the year. They failed to notice that political crises increased the country's risk, which was not compensated by a higher premium in the repo rate. Instead, NBS relied on forex interventions. In the second half of 2012 political risk went down, but inflationary expectations were fuelled by rising prices of food due to bad harvests. NBS resumed an active repo policy. We are convinced that higher interest rates contributed to the deepening recession. The expected recession at the beginning of 2012 was 0.5%. The year, however, ended with a recession higher than 2%. Part of this difference is due to higher interest rates in the second half of the year.

The fall of GDP because of the active repo policy is difficult to demonstrate using exact statistical data. Still, it is possible to point to another consequence of the new monetary policy. The active exchange rate policy in the first half of 2012 had one positive effect. It reduced daily variability of the exchange rate. This is visible in Figure 3 on the left side of the vertical dotted line. On the other hand, relative stabilization of the exchange rate level was correlated with higher daily variations. The corresponding

Figure 3: Exchange rate volatility: Daily changes of the exchange rate in Serbia



area in Figure 3 is to the right of the dotted vertical line. We draw the corridor of +/- 0.25% around the average daily percent change of the exchange rate. This corridor was violated many times in the second half of the year. The conclusion is that based on presented historical data in Serbia for the last year, it is not possible to simultaneously achieve both stabilization of the exchange rate level and removal of its daily volatility.

PPP exchange rate standard

What we know so far is the following: (1) in conducting monetary policy, NBS abandoned forex interventions and returned to the repo rate as the main policy instrument; (2) this stabilized the exchange rate level, but (3) increased volatility of the exchange rate, and finally (4) all these outcomes coincided with a recession in 2012 that was deeper than expected. We will now proceed with the question of whether the current level of the exchange rate is sustainable over the long run.

Two types of factors drive the behaviour of a nominal exchange rate between two regions, say between Serbia and the EU, with the dinar and the euro. One set of factors are of a long-term equilibrium nature, while the others are short-term cyclical or news-driven factors. We will address the first set in this section, and continue with the second in the following section of the paper. The first group of factors refers to the current account of the home country as indicated by its imports and exports of goods and services, terms of trade, and domestic price level**,** as well as the main foreign trade partner's price level. It is explained by the theory of the purchasing power parity (PPP) in relation to exchange rates.

PPP states that exchange rates between two currencies are in equilibrium when their purchasing power is the same. This means that the exchange rate between two countries should equal the ratio of the two countries' price level of a given basket of goods and services. When the home country's domestic price level is increasing due to inflation, its exchange rate must depreciate in order to return to PPP. The basis for PPP is the "law of one price". In the absence of transportation and other transaction costs, competitive markets will equalize prices of an identical basket of goods in two countries when the prices are expressed in the same currency. The economic forces behind PPP will eventually equalize the purchasing power of two currencies. This can take many years, with a time horizon between four and ten years.

The real exchange rate is defined as:

$$z_t = s_t \cdot \frac{p_t^w}{p_t}$$

where z_t, s_t, p^w_t and p_t are real and nominal exchange rates and domestic and foreign price levels, respectively. The PPP exchange rate is a particular case of the real exchange rate for $z_t = 1$, in which case the nominal exchange rate reveals the ratio of domestic prices to foreign prices ($s_t = p_t/p^w_t$). We draw it in Figure 4 and label it "PPP Exchange Rate" (solid line). The series goes from the beginning of 1994 to the end of 2012. Another series presented in Figure 4 is the nominal exchange rate between the dinar and the euro**,** referred to as the "Nominal Exchange Rate" (dotted line). Both series are normalized to one in 2005 in order to be easily visually compared.

The new dinar was introduced at the end of January 1994, and since then there were two periods that fully complied with PPP standards. The first period started in the first quarter of 1994 and lasted to the third quarter of 1998. The second period resumed in the first quarter of 2002 and ended in the second quarter of 2006. Both of these periods are presented as shaded areas in Figure 4. Between these two periods the dinar was depreciated in real terms. This is the first non-shaded area in Figure 4. The nominal exchange rate was above the PPP exchange rate. On the other hand, the dinar was appreciated in real terms from the third quarter of 2006. The nominal exchange rate was below the PPP exchange rate. The gap between the two series was slightly closer in the first half of 2012, but widened in the rest of the year. The dinar is also overvalued today in real terms.

We can conclude that the PPP theory of the exchange rate is supported by historical data in Serbia. Deviations of the actual exchange rate from its long-run equilibrium can take several years, but eventually the nominal exchange rate must return to the PPP level. This happened twice in the country's recent history. There are no reasons to expect it will never again happen. At the very least, there

are economic forces which will drive the actual exchange rate toward its equilibrium level.

Uncovered interest rate parity

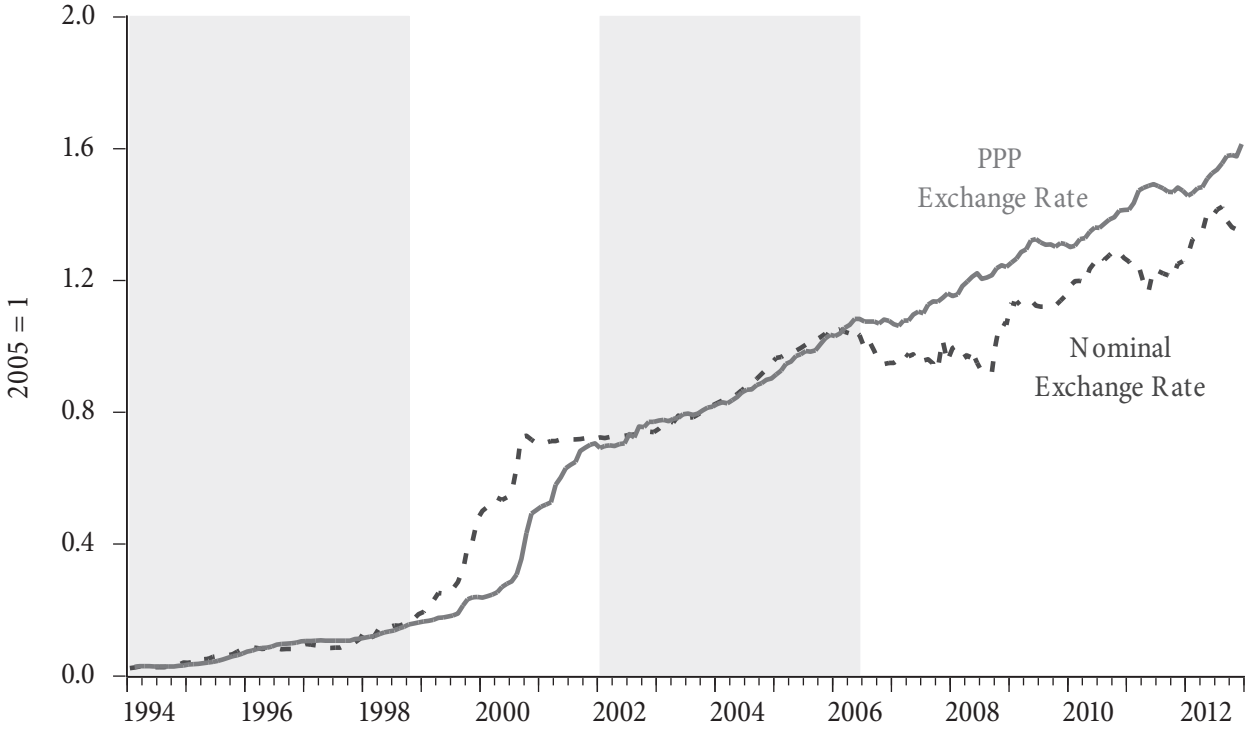
When the equilibrium forces will prevail over alternative short-term or news-driven forces in determining the nominal exchange rate level in Serbia is not clear. In the short run there are many drivers that cause its deviations around the equilibrium level. They originate in the country's capital account and financial markets. Let us mention some of them: inflow and outflow of short-term capital, portfolio and direct foreign investments, domestic and foreign interest rates, the country's risk and demand for domestic and foreign financial assets. The theory of uncovered interest rate parity (UIP) takes account of most of them. We write domestic interest rate as (i_t), foreign interest rate as (i^w_t), the country's risk premium as (u_t), current exchange rate as (s_t), and expected future change of the exchange rate based on all available information in the current period as ($E_t s_{t+1}$); (t) stands for time period and (E_t) is expectation operator. UIP states that the current exchange rate is a function of its expected exchange rate, risk premium, and domestic and foreign interest rates:

$$s_t = (1+u_t) \cdot \frac{i^w_t}{i_t} \cdot E_t s_{t+1}$$

An increase in the domestic interest rate drives down the nominal exchange rate, and *ceteris paribus*, appreciates it in real terms. Real depreciation, in the opposite case, implies a decline of the domestic interest rate, and a nominal rise of the exchange rate, under the *ceteris paribus* assumption. On the other hand, an increase in the foreign interest rate or the market risk pushes up the nominal exchange rate and, *ceteris paribus*, depreciates the exchange rate in real terms.

The repo rate in Serbia governs, more or less successfully, all other interest rates. It has the status of the monetary policy rate. The interest rate, which immediately reacts to a change of the repo rate, is Belgrade OverNight Index Average (Beonia). Looking at the whole of 2012, we see that it approached the upper bound of the repo rate corridor in the middle of 2012, then deviated a while around it, and finally asymptotically headed to the lower bound of the corridor toward the end of 2012. Short-term interest rates react to the repo rate as well, but also take into account monthly changes in the price level and inflation expectations. Long-term interest rates bear some resemblance to the short-term interest rates, but are more

Figure 4: PPP nominal exchange rate



influenced by expected inflation and investors' assessment of the country's risk. Short-term interest rates on loans in foreign currency terms are also correlated with the repo rate, but the coefficient of correlation is significantly lower compared to loans in the domestic currency. Being aware that there are differences between interest rates in terms of maturity and currency denomination, we will continue by approximating all of them by a single repo policy rate. We also take into account demand for financial assets. On that account, we study operations in the open market conducted by NBS and commercial banks, where short-term Certificates of Debt (CDs) issued by the NBS are traded. Alternative assets are Republic of Serbia Treasury bills, denominated in the dinar and issued for the local currency market or denominated in euros or US dollars for trading on the European money market. We additionally noticed that deposits with domestic commercial banks may be held in foreign currencies as well.

So far we know that PPP driving forces are present in the Serbian market. Now, the question is whether UIP drivers were also present in the same market**,** causing high volatility of the exchange rate in 2012**.** In order to answer this question we need to return from the monthly data in Figure 4 to the daily data already presented in Figures 1, 2 and 3. These figures indicate that there is a high probability of a positive answer. They show a relationship between the repo rate and the nominal exchange rate that is typical of a UIP pattern. It is more visible in the second half of the year, but we will econometrically test the hypothesis for the whole year. For that we will use a vector autoregression (VAR) model.

As said, we will use daily data for the model. The reason for such a time profile is that we have already detected daily changes of the relevant variables and a policy switch in the middle of the year. If data have lower frequencies, the policy switch cannot be properly detected and evaluated. However, there are some complications in formulating a proper VAR model. We do not take into account expectations due to the lack of data on a daily basis. Also, we do not have data on daily bases to approximate the country's financial risk. On the other hand, we take care of relative asset demand, for which we have corresponding data. Demand for local currency assets is approximated by the stock of outstanding NBS CDs that are traded through open market operations. Demand for foreign assets on the domestic market is approximated by daily turnover on the Belgrade forex market (F). Finally, the foreign interest rate is represented by the spread between Beonia (i_t - daily average overnight interest rate for non-secured loans on the Belgrade Stock Exchange) and Eonia (i^w_t - the corresponding market interest rate in the euro zone)[1]. Hence, model variables are: R_t (repo rate), $i_t - i^w_t$ (spread between Beonia and Eonia market interest rates), s_t (spot exchange rate), CD_t (NBS' Certificates of Debt), and F_t (turnover on the Belgrade forex market).

In order to avoid daily outliers, we smooth series by transforming them into 5-day moving average values. Consequently, we start from an unrestricted VAR model with 5 lags, which correspond with the weekly time series profile:

$$y_t = A_1 \cdot y_{t-1} + \cdots + A_p \cdot y_{t-p} + B \cdot x_t + \varepsilon_t$$

where $\varepsilon_t \sim N_p(0,\Omega)$ for t = 1,...,T. A_i are matrices of regression coefficients with lags $p = 1,...,5$; y_t is the k^{th} vector of five endogenous variables (5x1); x_t is the vector of exogenous variables (including intercept and trend variables), and ε_t are random errors with a mean value of zero, normally distributed and mutually uncorrelated. The time period is defined as: t=January 4th, 2012, and T=December 31st, 2012. The starting VAR model can be reparameterized in the following way [6], [7].

$$\Delta y_t = \Pi \cdot y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \cdot \Delta y_{t-i} + B \cdot x_t + \varepsilon_t$$

If there is a reduced rank of matrix Π r < k, then there is a k x r matrix α and β, each in rank r, so that $\Pi = \alpha \cdot \beta'$ and $\beta' \cdot y_{t-1}$ are stationary linear combinations. This is how we arrived at the vector error correction model (VEC) in the form:

$$\Delta y_t = \alpha \cdot \beta' \cdot y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \cdot \Delta y_{t-i} + B \cdot x_t + \varepsilon_t$$

For us, it is of primary interest what form the matrix β has because it contains cointegration vectors that describe the long-run equilibrium relationship among the model's variables. On the other hand, the matrix α puts together adjustment coefficients that defines the mechanism of arriving at such a long-term equilibrium.

1 Alternative spreads between Belibor2W and Euribor2w, and Belibor3M and Euribor3M were, also, examined. The corresponding IRF was not significantly different from one reported in Figure 5.

Table 1: Unrestricted cointegration rank tests

Trace Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace/Max Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.266505	120.1374	69.81889	0
At most 1	0.082318	43.27369	47.85613	0.126
At most 2	0.052705	21.96954	29.79707	0.3002
Maximum Eigenvalue Test				
None *	0.266505	76.86369	33.87687	0
At most 1	0.082318	21.30415	27.58434	0.2583
At most 2	0.052705	13.42776	21.13162	0.4137
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis p-values				

We present in Table 1 two cointegration tests which indicate that there is only one cointegration vector in the VEC model. This cointegration vector has the following form:

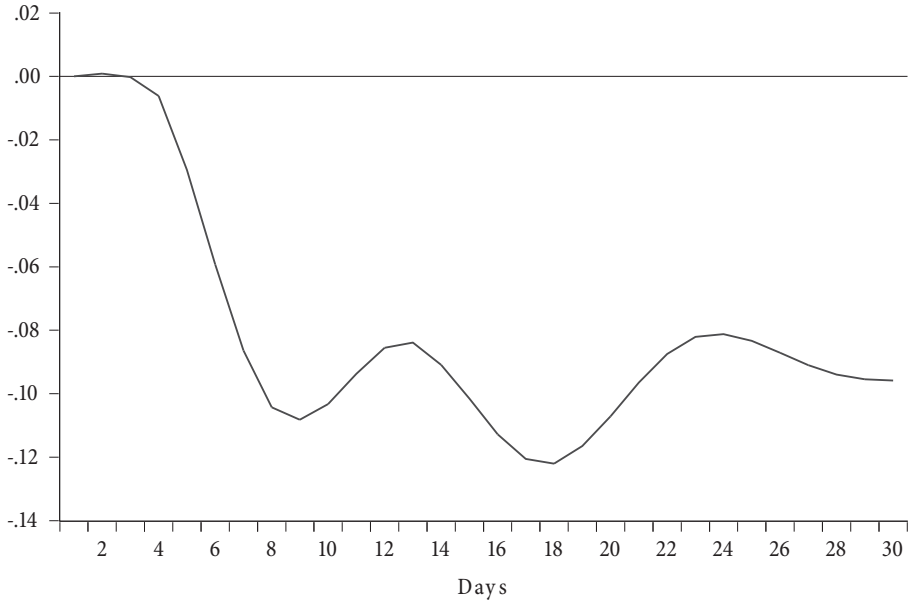
$$s = -0.17 \cdot CD - 9.64 \cdot R + 4.69 \cdot \Delta F - 1.72 \cdot (i - i^{w}) - 253$$

It represents the long-run equilibrium of the nominal exchange rate due to which all time subscripts are removed, and variables are italicized. A rise of the repo rate and short-term commercial interest rate pulls down, in the long run, the nominal exchange rate**,** which, *ceteris paribus*, appreciates in real terms. This finding is to be expected since such a rise stimulates demand for domestic assets and, consequently, makes demand for foreign assets less attractive. Therefore, the pressure on the exchange rate eases to nominal inflation. Rising demand for NBS's CDs also reduces the nominal exchange rate, and it is connected to a higher repo interest rate. On the other hand, an increasing change of the demand for forex assets drives up the nominal exchange rate. It is not the level, but the rate of change of this variable, that matters in this relationship.

The reported equation is a long-run relationship embodied in daily changes in the forex market. The actual movement in the market is a consequence of long-run equilibrium forces and short-run adjustment coefficients, which bring the exchange rates back to equilibrium. As already indicated, the short-term adjustment mechanism is represented by matrix α which has the dimensions 25x5. It would be cumbersome to print and analyze it. Instead, we present in Figure 5 the impulse response function (IRF) of the exchange rate with a repo rate innovation. The IRF simulates an adjustment process which takes into account both long-term equilibrium and short-term cyclical forces.

Figure 5 portrays one month reactions of the exchange rate caused by a one-off shock of the repo interest rate. The shock is of a size corresponding to one standard deviation.

Figure 5: Impulse response function: Response of exchange rate to one S.D. repo rate innovation



We see that there were not many changes in the first week. However, from then, the nominal exchange rate started to sharply decline. The rate of decline fluctuated around a stable level in the following weeks. All together, the accumulative decrease of the nominal exchange rate is evident. The VEC model supports intuitive expectations that the repo monetary policy stabilized the nominal exchange rate in the second half of 2012.

A small DSGE model of an open economy

What we know so far is that the monetary policy, based on forex interventions as the main policy instrument to stabilize the nominal level of the exchange rate in 2012, was highly costly. The estimated cost in terms of forgone official foreign exchange reserves is 4.5% of GDP. However, we do not know whether the new monetary policy is costly or not. If it is costly, this has to show up in a suppressed output due to reduced aggregate demand, not in declining official reserves. In order to check this proposition we need data. However, there are no data on daily GDP to test this hypothesis econometrically. Even quarterly GDP is available only after a significant delay. What we can do is to formulate a DSGE model, as a mirror image of the VEC model, to simulate general equilibrium effects of the repo rate policy on output.

We have indeed formulated such a model which, of course, takes into account the variables similar to those in the VEC model and some additional ones (output and price level). Model parameters are also calibrated in a way to mimic results of the reported VEC model[2].

2 We have assigned the following values to parameters: alpha=0.7, beta=0.65, gamma=0.7, rho1=0.99, rho2=0.99, rho3=0.5, mu=0.8, phi=0.2 and delta=0.3. The target inflation rate is set to zero.

Equations of the model are reported in Table 2. All variables but the interest rate and inflation are in levels and transformed into logarithms. The DSGE model relies on both theories of the exchange rate (PPP and UIP). There is a dynamic Investment-Saving curve which accepts moderate output inertia, and further relates the output level to the real interest rate and changes in the real exchange rate. The price equation takes account of a pass through effect of the exchange rate to the domestic price level. The monetary authority follows standard rules on how to conduct inflation targeting policy, which is focused only on inflation, not on an output gap or exchange rate gap. The real interest rate is defined along Fisher's line. Foreign assets, the foreign interest rate, and the foreign price level are modelled as autoregressive processes with stochastic shocks that are independently and identically distributed with a mean value of zero and variance of 1. All together these equations represent a small DSGE model of an open economy, and are solved using Dynare and MATLAB software [1].

We will now proceed in the same way as in the case of the VEC model. This means we will trace general equilibrium effects that the one-off increase in the repo rate makes on all the model variables. Those effects are best expressed by means of IRFs. We report in Figure 6 impulse response functions of the main variables with one unit of innovation of the repo rate. The first two panels at the top of Figure 6 show the inflation pattern. The next two panels in the middle refer to the exchange rate reactions. The last two panes at the bottom of Figure 6 deal with output and real interest rate reactions. All series are measured as deviations from the corresponding

Table 2: A small open economy DSGE model

Name	Equation
Real exchange rate	$z_t = s_t + p_t^w - p_t$
Uncovered Interest Rate Parity	$\Delta E_t s_{t+1} = \alpha \cdot (i_t - i_t^w) - (1-\alpha) \cdot E_t f_{t+1} + \varepsilon_t^s$
Policy Rule	$i_t = \gamma \cdot i_{t-1} + (1-\gamma) \cdot (E_t \pi_{t+4} - \pi_{target}) + \varepsilon_t^i$
Dynamic IS Curve	$y_t = \mu \cdot y_{t-1} + (1-\mu) \cdot E_t y_{t+1} - \delta \cdot r_t + \varphi \cdot \Delta E_t z_{t+1} + \varepsilon_t^y$
Real Interest Rate	$r_t = i_t - E_t \pi_{t+1}$
Pass Through Equation	$p_t = \beta \cdot p_{t-1} + (1-\beta) \cdot E_t s_{t+1} + \varepsilon_t^p$
Annualized Inflation Rate	$\pi_t = 4 \cdot (p_t - p_{t-1})$
Foreign Price Process	$p_t^w = \rho_1 \cdot p_{t-1}^w + \varepsilon_t^{p^w}$
Foreign Interest Rate Process	$i_t^w = \rho_2 \cdot i_{t-1}^w + \varepsilon_t^{i^w}$
Foreign Assets Process	$f_t = \rho_3 \cdot f_{t-1} + \varepsilon_t^f$

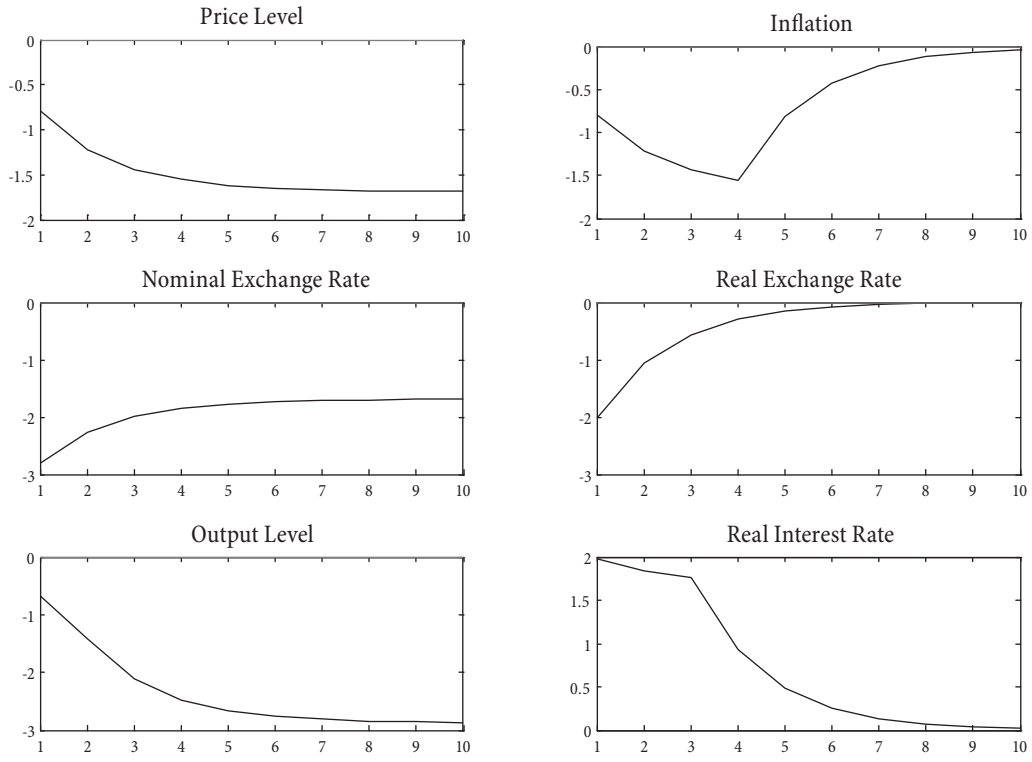
steady state levels. Negative values indicate undershooting of the steady state, while positive values, oppositely, point toward an overshoot of the steady state.

The inflation targeting system is designed to cure high inflation. It is clear from Figure 6 that such a task can be successfully performed using the repo policy rate. The domestic price level continuously declined over the specified time horizon of ten periods. The inflation rate initially declined rapidly, and after some time slowed down as inflation pressure died out over the ten periods. It should be noticed that both nominal and real exchange rates assume negative numbers. Since all reported figures are deviations from the steady state, this means that the nominal exchange rate declines bellow the steady state, while the real exchange rate appreciates in real terms[3]. All of these results reported so far closely resembled outcomes in the VEC model. What have been missed in the VEC model are responses of output and real interest rates to monetary policy. We have filled this gap with IRFs from the DSGE model. The real interest rate has increased as should be expected after reduction of inflation and an initial increase in the repo rate. The real interest rate increased and in addition the real exchange rate appreciated. The only meaningful consequence of those two pressures should be a fall in the output level. This is exactly what happened in the model. This is shown in the left panel at the last row of Figure 6. By visual inspections, we can see that the fall in output is permanent, while the rise of the real interest rate has a temporary effect. Also, the fall of the nominal exchange rate is permanent, while the real exchange returned to the steady state level after nine periods.

Of course, all reported outcomes of the simulation depend on the way the DSGE model is formulated and the particular values of its parameters. However, the model is able to replicate the relationship between the exchange rate and repo rate embodied in the empirical VEC model for the Serbian economy in 2012. It is reasonable to claim that the output contracts after an increase in the repo policy rate. From our point of view, we have demonstrated a result which is apparent. The problem is that such a result is often ignored. Anti-inflationary policy based on inflation targeting is treated as a cost-free policy. How costly it is in the real-world environment of the Serbian economy is a question that still requires a proper answer.

3 Let us reiterate that the real exchange rate is so defined that its positive value means real depreciation, while negative value indicates real appreciation.

Figure 6: Impulse response functions of the main variables with one unit of repo rate innovation



Conclusions

We can briefly summarize our findings in the paper as follows. By conducting a stop-and-go monetary policy, NBS abandoned forex interventions at the middle of last year, and returned to the repo rate as the main policy instrument to fight inflation. This policy switch rather quickly stabilized the exchange rate level, but increased its volatility and overvalued the local currency. From the long-term perspective, the PPP exchange rate has prevailed in Serbia over last fifteen years. This indicates that the present level of the exchange rate is not sustainable. In the meantime, the short-run destabilizing drivers have been active, which delayed necessary adjustment of the contemporary exchange rate to its long-run equilibrium level. The monetary policy based on an active role of the repo rate in a system of inflation targeting was one of the disturbing drivers. These drivers contributed to high interest rates and an overvalued exchange rate that made the recession in 2012 deeper than expected. This last outcome was not econometrically tested, due to the lack of high frequency data, but was demonstrated by impulse response functions in a small DSGE model of an open economy. Other findings have been econometrically supported.

As far as reindustrialization of the Serbian economy is concerned, overvalued currency and high interest rates do not support it. Within the analytical framework we outlined in the paper, industrialization and economic policy measures were treated as closely related in an asymmetric way. It is difficult for monetary and exchange rate policy measures to stimulate growth, which is the essence of industrialization, but they can easily discourage it. From this proposition, we would suggest that the Government of Serbia transparently define the industrialization policy over the medium term and align other short-term policy measures with this principal goal.

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