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# EXCHANGE RATE TARGETING

## Ciljanje deviznog kursa

## Abstract

The NBS pursues a policy of exchange rate targeting, contrary to its official Memorandum on monetary policy. The NBS informally modified the Memorandum in two ways: it restricted the supply of securities under reverse open market operations and targeted informal exchange rate levels by frequent foreign exchange interventions. In this paper, we have provided empirical and econometric evidence for the second statement based on daily data for 11 years and Vector Error Correction models, while we did not address the first statement because it is evident if one compares market and repo interest rates.

Targeting the level of the exchange rate is not a problem in itself, but rather a non-transparent process that leads to an unrealistic level of the exchange rate. If monetary policy is to support a new development strategy in the context of the fourth technological revolution, it is not enough just to maintain a stable price level but also to support the realistic dinar exchange rate. The real appreciation of the dinar, which has been going on for some time, is not conducive to economic development. The first step in formulating a synchronised macroeconomic and development policy is to acknowledge these facts and then find appropriate solutions.

**Keywords:** *exchange rate, monetary policy, forex interventions, National Bank of Serbia.*

## Sažetak

NBS vodi politiku ciljanja deviznog kursa, iako to nije predviđeno u njenom zvaničnom Memorandumu o monetarnoj politici. To znači da ona ograničava ponudu svojih hartija od vrednosti u okviru reverznih operacija na otvorenom tržištu i ima neformalni cilj deviznog kursa koji postiže čestim deviznim intervencijama. U ovom radu dali smo empirijske i ekonometrijske dokaze za ovu poslednju tvrdnju na bazi dnevnih podataka za 11 godina, dok se prvom tvrdnjom nismo ni bavili jer je ona očigledna kada se uporede tržišna i oficijelna repo kamata.

Ciljanje nivoa deviznog kursa nije samo po sebi problem, nego je problem što je to netransparentan proces koji dovodi do nerealne visine deviznog kursa. Ako monetarna politika želi da podrži novu strategiju razvoja u okviru IV tehnološke revolucije, nije dovoljno da samo održava stabilan nivo cena, nego mora i da podstiče realni kurs dinara. Realna apresijacija kursa, koja traje već neko vreme, ne pogoduje privrednom razvoju. Prvi korak u formiranju sinhronizovane makroekonomske i razvojne politike jeste da se priznaju činjenice, a onda da se nađu odgovarajuća rešenja.

**Ključne reči:** *devizni kurs, monetarna politika, devizne intervencije, Narodna banka Srbije.*

## Introduction

For many years, the dilemma has been whether the National Bank of Serbia (NBS) is targeting or not targeting the dinar exchange rate, as the latter was stated in the Memorandum on Inflation Targeting as Monetary Strategy [3]. After eleven years of targeting inflation, an impressive database has been formed to help us address this dilemma. In this paper, we will use daily data from January 2, 2009, to October 31, 2019. That gives 2,825 observation points which, by the law of large numbers, must indicate what form of regularity existed in the NBS behaviour.

The NBS acknowledges that there is a significant impact of the dinar exchange rate on prices in Serbia; that is, there is a high pass-through effect. However, it considers the foreign exchange transaction channel as being secondary for managing inflation expectations. It can only be used if the primary impact of the repo interest rate cannot sustain inflation in the targeted corridor. Therefore, the NBS refuses to target the exchange rate but justifies its interventions in the foreign exchange market by excessive exchange rate fluctuations, the need to maintain the stability of the financial system or a secure level of foreign exchange reserves.

The data, however, are persistent, and they point out to another conclusion. If all the transitory effects of daily changes were eliminated, there would emerge an informal level of the exchange rate that the NBS wanted to achieve by its foreign exchange interventions. We will capture that information in this paper and explain it in detail. They speak convincingly enough for themselves. However, we will go one step further and offer an econometric analysis that separates the long-term from the short-term changes in the foreign exchange market. For these purposes, we will use VEC (Vector Error Correction) models because the original time series are non-stationary.

Targeting the exchange rate is against the current monetary strategy on inflation targeting in Serbia, although it is not in itself a problem. When there is a high pass-through effect of the exchange rate on domestic prices, exchange rate management can be one of the monetary means for stabilising prices. Some central banks do target the exchange rate, and there are many models in the economic literature about that. The problem is if the exchange rate target is not known to the public, and the NBS does not feel responsible for explaining what level of the dinar exchange rate it is targeting.

Hence, the level of the exchange rate is the problem. We judge that the current nominal foreign exchange rate is too low and is detrimental to the economic development based on investment and export-led strategy. Our goal is to use data to show that there is an informal exchange rate target, which either needs to be abandoned or formalised in line with the development strategy.

In the second part of this paper, we will explain the fundamental dilemma of monetary policy relating to monetary transmission channels. In the third part, we will analyse the pass-through effect of the exchange rate on prices and identify our first VEC model. In the fourth part, we will prepare the ground for a reverse analysis in which the exchange rate is a dependent variable, and other factors form a set of explanatory variables. In that section, we will analyse in detail the data on NBS foreign exchange interventions. In the fifth part of the paper, we introduce NBS foreign exchange interventions as an additional factor, which governs the exchange rate. The initial VEC model will be further developed and checked both against the monthly and daily data sets. Finally, in the sixth part, we will conclude by answering the initial question of whether or not the NBS is targeting the exchange rate.

## Monetary policy rules

According to the NBS, the repo rate is the main monetary policy instrument in the inflation targeting regime. Other monetary policy instruments, including interventions in the foreign exchange market, only have supporting roles. The key policy rate is the interest rate applied in the conduct of main monetary policy operations (currently, one-week open market operations). It is an operational objective for short-term money market interest rates. Its role as an operational objective will be supported by a corridor of interest rates on lending and deposit facilities and other open market operations. Adjustments in the key policy rate will be based on the assessment of the current economic situation, inflation developments and their projections.

The size and timing of such adjustments will be aligned with the mechanism of monetary transmission, respecting its lags and "the currently dominant role of the foreign exchange channel" [3].

Foreign exchange interventions are an infrequent secondary instrument used to support the achievement of the inflation target only if the impact of the key policy rate is exhausted. When evaluating such an effect, it is crucial to monitor movements in the foreign exchange market as the exchange rate channel remains by far the most robust means of influencing inflation. However, no numerical objectives for the exchange rate will be set.

As the NBS claims, it will resort to foreign exchange interventions to limit excessive daily oscillations in the exchange rate for the dinar, contain threats to financial stability, and safeguard an adequate level of foreign exchange reserves.

At the end of 2012, the NBS introduced two substantive modifications that convert the inflation targeting system into a dirty inflation targeting[1]: (i) the sale of NBS treasury bills in open market operations was restricted, with the consequence that the market repo rate was permanently below the official repo rate, and (ii) regular interventions in the foreign exchange market were conducted, targeting a certain level of the exchange rate without transparent announcement. The last change has never been acknowledged by the NBS, while the previous move has been already embodied in the data published by the NBS.

In this paper, we will not deal with modifications on the side of open market operations (OMOs), but only with foreign exchange interventions. We have shown this schematically in Figure 1. We are not interested in the monetary policy channel denoted by number ① but instead whether channel ② has been informally transformed into channel ③. We will find the answer to this question by evaluating the data presented in this paper. We have been collecting daily data on foreign exchange interventions and exchange rates for quite some time (11 years). We will now use them. What do the data show?

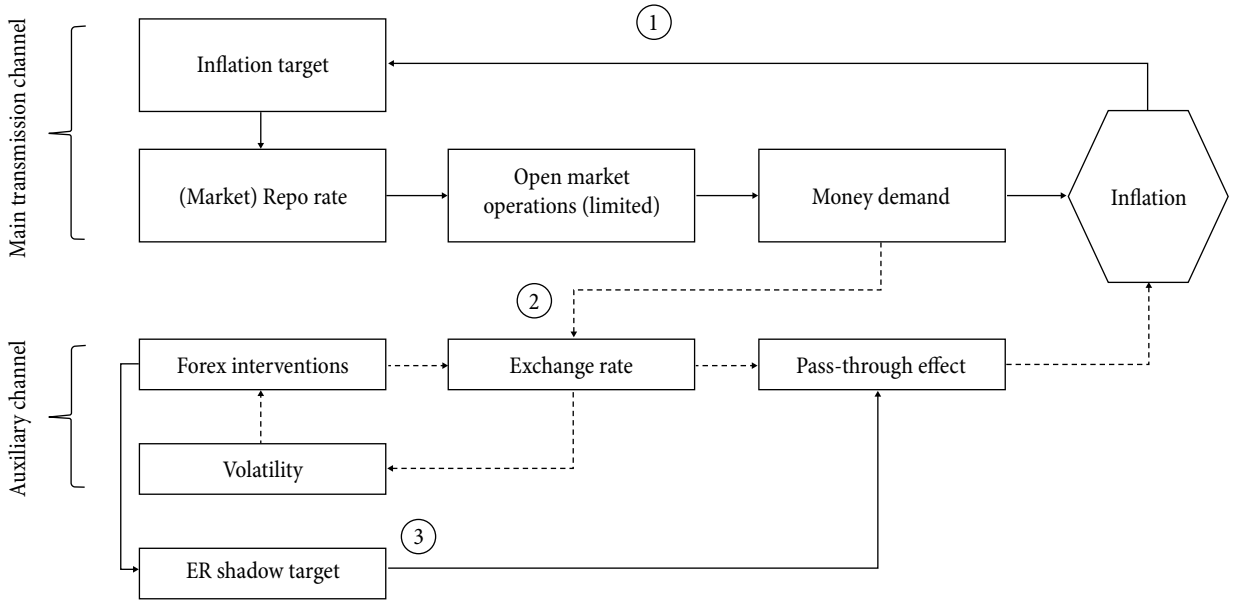
## The pass-through effect

Let's start our analysis from the pass-through effect of the dinar exchange rate on the price level. If there is such an effect, then the probability that the NBS pursues an exchange rate targeting is increasing. If such a result does not exist or is not strong, then there is no reason to believe that the NBS is targeting any level of the exchange rate, since such a policy would be irrelevant.

Prices and nominal exchange rates are time series represented by their levels. We will logarithmise these

1 We called this form of inflation targeting after the dirty float manipulation of a currency. A dirty float is a floating exchange rate where a country›s central bank intervenes to change the direction or the pace of change of a country›s currency value.

**Figure 1: Channels of monetary policy instruments**



levels to exclude the linear trend initially. Even after this operation, these variables are not stationary. The price level is the ~ I (2) process, and the nominal exchange rate is the ~ I (1) process. That means we have to differentiate prices twice to get stationary rates of inflation acceleration or deceleration (which are the first difference of the price level logarithm). On the other hand, the nominal exchange rate is a stationary series after the first differentiation of its data, which means that rates of change of exchange rate are a stationary series.

Prices, of course, depend not only on the nominal dinar exchange rate against the euro but also on the relationship between the euro and the dollar. The reason for this claim is quite understandable if we know that Serbia imports energy significantly and that energy prices are expressed in dollars. Since Serbia imports a lot of other goods and services from the EU, its market is also sensitive to price movements in the EU. We show this through HICP (Harmonized Indices of Consumer Prices)[2].

That is why we have included in the analysis two new time series: the dollar-euro exchange rate and the price level in the EU. The price level in the EU is a ~ I (2) time series stationary only after twice differentiating its logarithmic value. The dollar-euro exchange rate is a ~ I (1) process that becomes stationary after the first differentiation of its logarithmic values. We have shown all the time series in Figure 1. We have normalised the price level to the average value 1 for 2010.

So from a stationarity standpoint, we have two time series ~ I (2) and two time series ~ I (1). Cross-regression does not give correct estimates of the coefficients, because behind all series there is a common stochastic trend that pushes them in a particular direction. Also, there was high heteroscedasticity up to 2015, which means that the variance of data over time was changing rapidly in the first half of the analysed period.

That is why we designed the VEC model (Vector Error Correction) with four lags. It is well known that a VAR model (Vector Auto Regression) can be specified in the VEC form that includes cointegration relations[3]:

$$\Delta\tilde{y}_t = \alpha \cdot \beta' \cdot \tilde{y}_{t-1} + \sum_{i=1}^{n-1} \Gamma_i \cdot \Delta\tilde{y}_{t-i} + B \cdot x_t + \varepsilon_t \quad (1)$$

Cointegration vectors are contained in matrix β that describes long-run equilibrium relations, while matrix α contains adjustment coefficients that define the mechanism for correcting long-run disequilibrium[4]. The vector $\tilde{y}'_t = [p_t^{RS}, ER_t^{\frac{RSD}{EUR}}, ER_t^{\frac{USD}{EUR}}, p_t^{EU}]$ contains logarithmic values of time series of the price level in Serbia, the dinar exchange rate, the dollar exchange rate against the euro and the price level in the EU. Vector $x_t$ is a vector of exogenous variables, including the intercept and trend, while vector $\varepsilon_t$ contains random errors with a mean of zero, normally distributed and uncorrelated.

According to Johansen's trace test, there is one cointegration equation that is stationary[5]. It describes the long-term relationship between prices in Serbia and the explanatory variables. We have estimated its parameters in equation (2). The long-term impact of the exchange rate on prices in Serbia is significant. If the dinar exchange rate rises by 1%, the price level increases by 0.76%. The price elasticity of the exchange rate is positive, but less

2 The HICPs are Laspeyres-type price indices and are computed as annual chain-indices allowing for weights changing each year. We have embodied those indices into the price level with the starting average value one in 2010.

3 The VEC model restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the *error correction* term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. See [1]. The initial model of autocorrelation equations with n time lags and stochastic errors $\varepsilon_t$ is:

$$\tilde{y}_t = A_1 \cdot \tilde{y}_{t-1} + \cdots + A_n \cdot \tilde{y}_{t-n} + B \cdot x_t + \varepsilon_t$$
$$\varepsilon_t \sim N_k(0,\Omega) \quad t = 1,\ldots,T$$

It can be rearranged until it takes the form:

$$\Delta\tilde{y}_t = \Pi \cdot \tilde{y}_{t-1} + \sum_{i=1}^{n-1} \Gamma_i \cdot \Delta\tilde{y}_{t-i} + B \cdot x_t + \varepsilon_t$$

where matrices are . If there is a reduced rank of the matrix Π, so taht r<k, then it exists kxr matrices α and β each of the rank r, while $\Pi = \alpha\beta'$ and $\beta'\tilde{y}_{t-i}$ are stationary linear combinations ~I(0). In this way, we obtain the error correction model in the vector form of equation (1).

4 In the case of only one cointegration relation, the matrix α becomes vector because there is only one row.

5 The test results are shown in the table below:

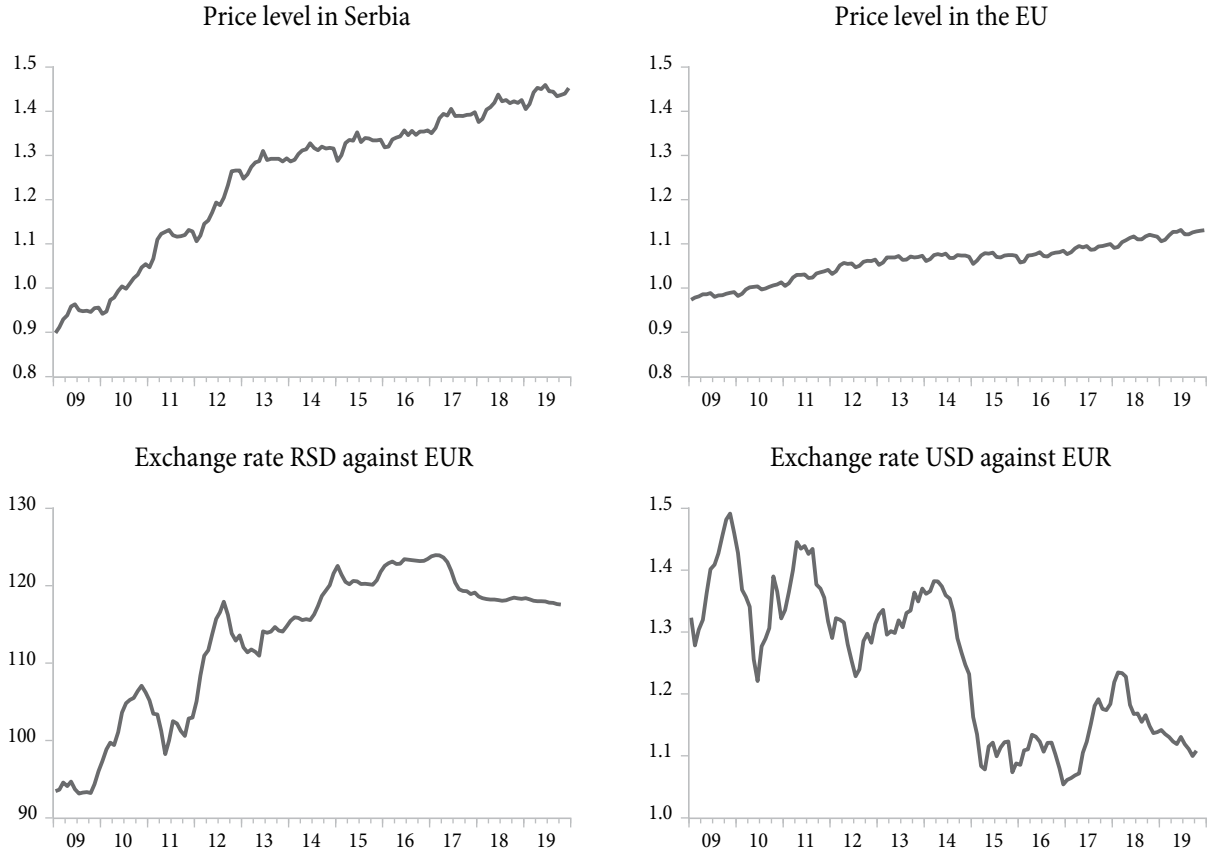
| Unrestricted Cointegration Rank Test (Trace) | | | | |
|---|---|---|---|---|
| Hypothesized | Trace | | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| None * | 0.220124 | 52.72617 | 47.85613 | 0.0163 |
| At most 1 | 0.113966 | 21.6486 | 29.79707 | 0.3185 |
| At most 2 | 0.04158 | 6.523616 | 15.49471 | 0.6336 |
| At most 3 | 0.009672 | 1.214914 | 3.841466 | 0.2704 |

Trace test indicates 1 cointegrating equation at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

**Figure 2: Selected time series**

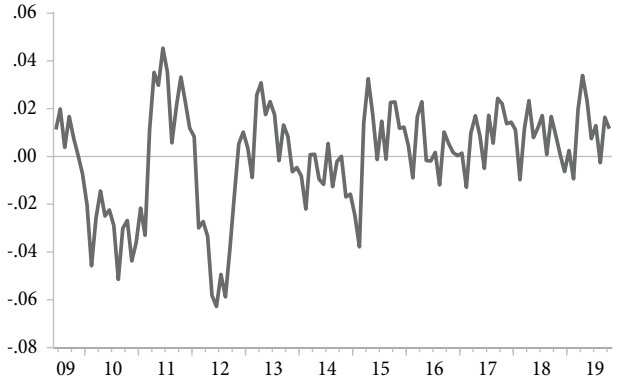



than one. It is also positive, but much smaller in the case of the dollar-euro exchange rate. If it rises by 1%, the price level in Serbia will increase by 0.16%. Prices in Serbia, however, are much more sensitive to the HICP in the EU. If these prices rise by 1%, prices in Serbia will increase by 2.09% in the long run.

$$\log\left(P^{RS}_{t-1}\right) = \underset{[13.0928]}{0.7635} \cdot \log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) + \underset{[4.4203]}{0.1624} \cdot \log\left(ER^{\frac{USD}{EUR}}_{t-1}\right) + \underset{[18.8527]}{2.0928} \cdot \log\left(P^{EU}_{t-1}\right) - 0.1276 \qquad (2)$$

Equation (2) is so normalised that the coefficient with the domestic price level variable is fixed to unit level: $\log\left(P^{RS}_{t-1}\right) = 1$. Nothing changed in the relationship between cointegrated variables if the normalisation is modified, and the exchange rate coefficient is fixed to one unit: $\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right)$. Then we get equation (3), which shows the long-term relations between the dinar exchange rate against the euro, on the one hand, and domestic and foreign prices, as well as the dollar exchange rate against the euro, on the other.

**Figure 3: Cointegration relation**



$$\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) = \underset{[11.9477]}{1.3097} \cdot \log\left(P^{RS}_{t-1}\right) - \underset{[5.1400]}{0.2127} \cdot \log\left(ER^{\frac{USD}{EUR}}_{t-1}\right) - \underset{[7.5271]}{2.2710} \cdot \log\left(P^{EU}_{t-1}\right) + 0.1672 \qquad (3)$$

In Figure 3, we show a graph of cointegration relation. Oscillations around the long-run equilibrium were much larger in the 2009-12 sub-period than later by the end of 2019.

Vector α contains coefficients of adjustment of the cointegration relation to the long-run equilibrium:

$$\alpha = \begin{bmatrix} \Delta\log(P_t^{RS}) & \Delta\log(ER_t^{RSD/EUR}) & \Delta\log(ER_t^{USD/EUR}) & \Delta\log(P_t^{EU}) \\ -0.2163 & 0.0577 & 0.1643 & -0.0139 \\ [-3.0869] & [0.9360] & [1.1211] & [-0.3708] \end{bmatrix}$$

About 21 % of disequilibrium are corrected each month by changes in the price level in Serbia, while that correction is much lower for the price level in the EU (1%). About 6% is corrected by the dinar exchange rate against the euro and 16% by the exchange rate of the dollar against the euro.

On the other hand, the graph of IRFs in Figure 4 is so instructive. It contains mutual responses of the dinar exchange rate and price level in Serbia to one unit innovation. Both series are, of course, cointegrated, but the impact of the exchange rate is dominant. The one unit impulse to the exchange rate change accelerates price growth, but not immediately. There is a delay of three months. Its effect is manifested after the third month and grows until the end of the first year. Later its impact on the price level declines. However, this impact is permanent. On the other hand, the impact of prices on the exchange rate is much smaller, but transitory. It is negative in the first year, and it is only in the second year that price increases cause some positive adjustment of the exchange rate. In the long-run, this influence disappears, which is consistent with the deed of the PPP theory.

Such an outcome should not surprise us. Purchasing power parity is not known to affect the exchange rate in the short-run [2]. Other factors, not price increases, change the exchange rate and determine its movement much more than the general price level. In this respect, it becomes an interesting question of how much foreign exchange interventions affect the dinar exchange rate in the long-run.

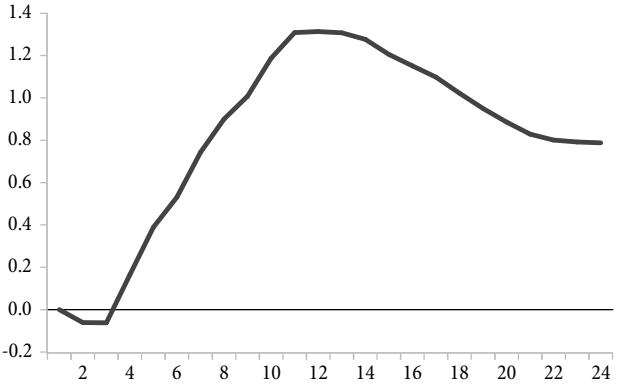
## Foreign exchange interventions

We measured foreign exchange interventions and exchange rate fluctuations daily from January 2, 2009, to October 31, 2019. It is a period of almost eleven years[6]. Since the workweeks are five days long, that means we had 2,825 daily data. The upper part of Figure 5 on the left shows the sale and purchase of the NBS foreign exchange to manage the exchange rate. According to the NBS convention, foreign currency sales are shown in positive numbers, and foreign currency purchases are shown in negative numbers. Data are expressed in millions of euro (right scale). The chart includes daily data on exchange rate changes throughout the entire period both when the NBS intervened as well as when it did not. During this period, the NBS intervened 734 times, of which 387 times by selling foreign currency and 347 times by buying foreign currency. We have shown these statistics in Table 1.

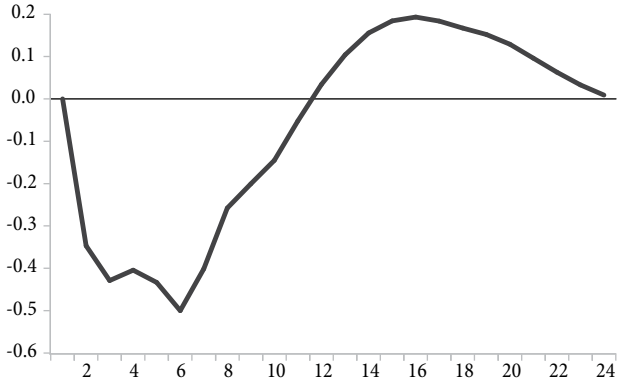
6 The NBS does not explicitly publish data series on foreign exchange interventions. However, these series can be found on the NBS website as Statistics from the Inflation Report, IV.1. Determinants of Inflation - Financial Market, Table G.IV.1.14. Positive data are foreign currency sales, negative data are foreign currency purchases. Currently, only data from 2011 onwards are available.

**Figure 4: Impulse response functions to one unit innovation**

(a) Response of Prices to One Unit Exchange Rate Innovation




(b) Response of Exchange Rate to One Unit Price Innovation



The NBS claims that it did not affect the level of the exchange rate because its interventions were intended to mitigate the exchange rate volatility. There are two ways to measure exchange rate volatility. The first method is straightforward, and it represents the daily changes in exchange rates expressed as a percentage. The other way is to calculate the standard deviation of the exchange rate over, say, a week. Both measures very similarly show the dinar exchange rate volatility.

In Figure 5 (on the left and above), we have given daily exchange rate changes (left scale) with a marked corridor of +/- 0.3%. Namely, there was an informal explanation by the NBS that the trigger for foreign exchange interventions was a daily change in the exchange rate of more than 0.3%. All foreign exchange interventions based on exchange rates outside this corridor should endorse the NBS policy, while interventions within the corridor would challenge it.

Visual inspection of Figure 5 does not confirm that there was any rule for foreign exchange interventions based on exchange rate volatility. By 2013, there were numerous situations where there were high exchange rate volatility and no foreign exchange interventions. If such a rule existed, it did not apply after 2015 at all. The daily exchange rate fluctuations were mostly within the informal corridor of its target change, with numbers of foreign exchange purchases and sales, as shown in Table 1.

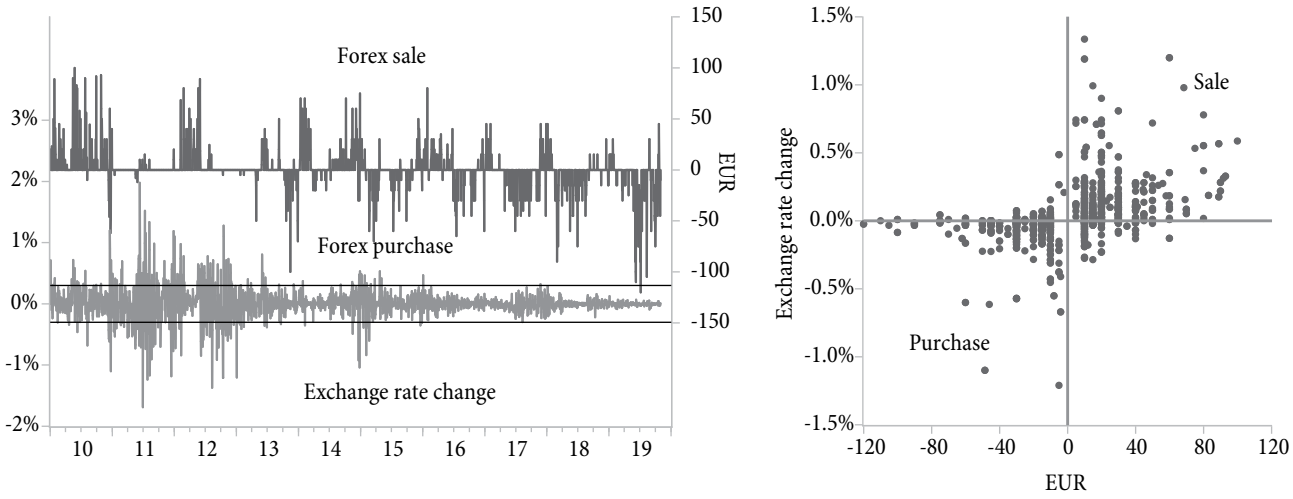
We divided the whole observation period into two parts. The first part covers four years from the beginning of 2009 to the end of 2012. The monetary policy changed at the end of 2012, but these changes have only come into force as of January 2013. Therefore, the second period covers seven years from the beginning of 2013 to the end of October 2019.

In terms of foreign currency sales, these interventions were almost identical by values in both sub-periods, although the number of cases was higher in the second period. In the first period, 4,664.9 million euro was sold in 162 cases, while slightly more 4,880.0 million euro was sold at 225 interventions in the second period. On the other hand, only 286.5 million euro were purchased in the first period in 16 interventions and 8,445.0 million euro in 331 interventions in the second period. Thus, in the second period, foreign currency purchases dominate, while the relative importance of foreign currency sales is present in the first period. The net effect over the entire

**Table 1: Foreign exchange intervention statistics**

| Period | Forex sale total | | Forex sale if ΔER>0.3% | | Forex purchase total | | Forex purchase if ΔER>0.3% | |
|---|---|---|---|---|---|---|---|---|
| | Value (EUR mil.) | Number of cases | Value (EUR mil.) | Number of cases | Value (EUR mil.) | Number of cases | Value (EUR mil.) | Number of cases |
| 2009-12 | 4,664.9 | 162 | 1,692.9 | 48 | -286.5 | 16 | -195.5 | 11 |
| 2013-19 | 4,880.0 | 225 | 385.0 | 14 | -8,445.0 | 331 | -90.0 | 5 |
| Total | 9,544.9 | 387 | 2,077.9 | 62 | -8,731.5 | 347 | -285.5 | 16 |

**Figure 5: Volatility and forex interventions**



period of eleven years is that more foreign currency has been sold than purchased. The difference amounted to 813.4 million euro.

The right-hand side of Figure 5 is much more informative, although it is based on the same data as the left part of Figure 5. It shows a scatter diagram of foreign exchange interventions against exchange rate changes. There is one remarkable regularity here. As a rule, foreign currency funds were sold when the exchange rate was rising, that is, in 78% of all cases of the exchange rate growth. Only 20% of all cases occurred when the exchange rate declined, and 2% when there was no change in the exchange rate. On the other hand, foreign funds were purchased in 67% of cases when the exchange rate fell. That happened in 21% of all cases when the exchange rate increased, and in 12% of cases when there was no change in the exchange rate.

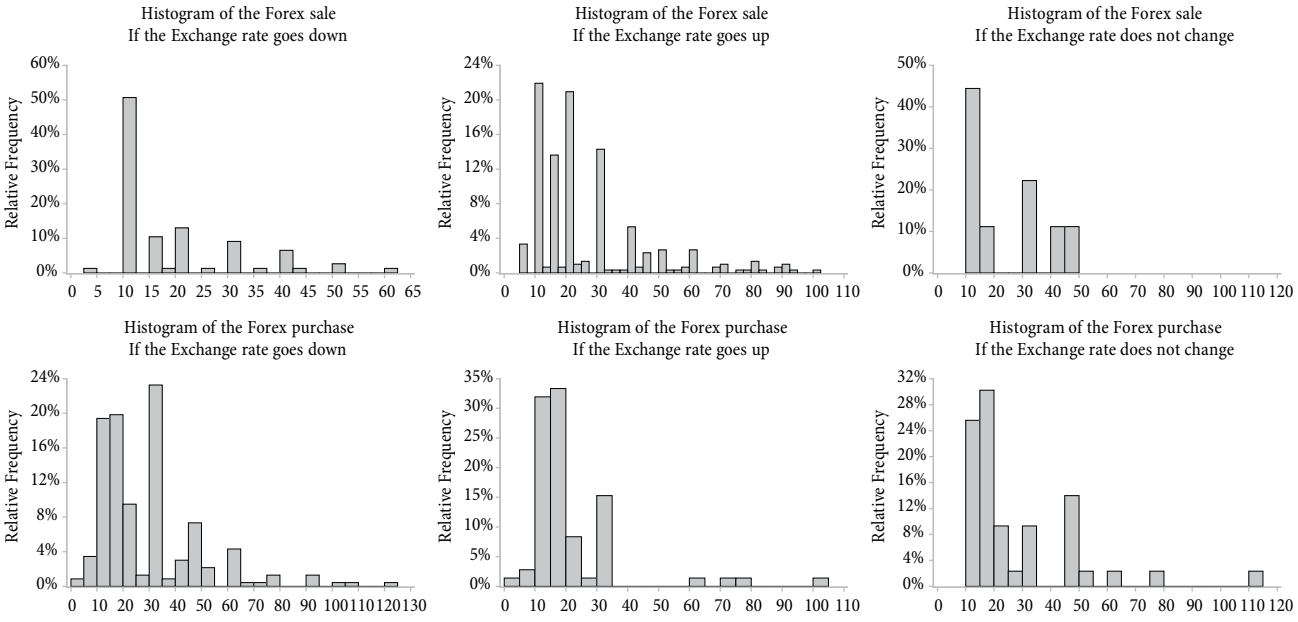
The second part of the information in Table 1 is of particular interest. Here, we singled out cases of foreign exchange interventions when the daily exchange rate change exceeded 0.3%. We marked them as excessive fluctuations. It is striking that there were only 78 foreign exchange interventions in such cases (59 in the first period and only 19 in the second period). The NBS sold 2,077.9 million euros (1,692.9 million euros in the first period and only 385.0 million euros in the second period) and purchased only 286.5 million euro (195.5 million euros in the first period and 90.0 million euros in the second period) during these excessive fluctuations.

Additionally, there are 52 cases when the NBS intervened in the foreign exchange market while there was no change in the dinar exchange rate. These cases directly refute the claim that foreign exchange market interventions are exclusively performed to mitigate exchange rate volatility. The NBS claims that foreign exchange interventions may also be due to contain threats to financial stability or to safeguard an adequate level of foreign exchange reserves. However, a careful analysis of all cases pointed out that none of those cases were present.

Therefore, the only logical explanation is that the NBS was targeting a level of the exchange rate and wanted to achieve it independently of its daily fluctuations. In Figure 6, we have provided histograms for all six possible types of interventions. We see that interventions without reliance on exchange rate fluctuations were restricted to small foreign fund transactions (around 50% of all cases). They were aiming to provide an additional incentive for the market to sustain the already achieved level of the exchange rate.

In Table 2, we have provided summary statistics of the number of interventions for all their types. In typical cases - the sale of foreign exchange if the exchange rate rises and the purchase of foreign exchange when the exchange rate falls - the variability is much higher than in

**Figure 6: Histograms with relative frequencies**



the non-standard cases. The maximum amount of foreign exchange sales or purchases are also incomparably higher. Interestingly, the average values and the medians are almost identical, whether they are buying foreign exchange or selling foreign currency. If it were two unrelated random data generation processes, such an identity would not exist.

**Table 2: Foreign exchange intervention cases**

| Exchange rate movement | Number of cases | Mean | Median | Max | Min | St.dev. |
|---|---|---|---|---|---|---|
| **Forex sale** | | | | | | |
| Up | 301 | 26 | 20 | 100 | 5 | 19 |
| Down | 77 | 18 | 12 | 60 | 4 | 12 |
| No move | 9 | 22 | 15 | 45 | 10 | 14 |
| **Forex purchase** | | | | | | |
| Up | 72 | 19 | 15 | 100 | 2 | 16 |
| Down | 232 | 27 | 20 | 120 | 4 | 20 |
| No move | 43 | 26 | 15 | 110 | 10 | 21 |

Daily data are instrumental, but they contain the impact of many unique shocks, from daily news that affect the change in expectations regarding oil and gas prices, the emission of money, war events, the imposition of sanctions and customs, and the like. However, the law of large numbers neutralises these shocks and shows long-term regularity. Based on the reading of the data, this fact is very clearly outlined: the NBS sells foreign exchange funds when the exchange rate rises and purchases them when the exchange rate falls. For us, that is a sure sign that a certain level of the exchange rate has been targeted. Foreign exchange interventions are an instrument, though not the only one, to achieve the desired exchange rate. That was the rule in 533 out of 734 NBS interventions. Thus, this represented 73% of all interventions. In 20% of cases, there were exceptions, half of which can be explained by the inertia of the interventionist policy, while in 7% of all cases, there was a direct refutation of the rules.

## The long-term effect of foreign exchange interventions

What are the long-term effects of foreign exchange interventions? From an econometric point of view, we can go in two directions. One is to continue to work with the daily data of 2,825 observations and to generate the remaining missing daily data by benchmarking the monthly series. Monthly data refer to prices in Serbia and the EU, and daily data to exchange rates in Serbia and the EU. Alternatively, we can aggregate daily data into monthly aggregates and do econometrics with 130 observation points[7]. We will apply both procedures.

Before we proceed on, we must mention that we had expanded vector $\widetilde{y}'_t$ by another item, foreign exchange intervention in Serbia $Q_t^{RS}$:

$$\widetilde{y}'_t = [p_t^{RS}, ER_t^{\frac{RSD}{EUR}}, ER_t^{\frac{USD}{EUR}}, p_t^{EU}, Q_t^{RS}].$$

According to the Johansen trace test, there are now two cointegration equations in which linear combinations of variables become stationary[8]. The question is how to identify those cointegrating equations. We stick to the previous cointegration analysis of the prices and exchange rates in Serbia and the EU and keep the already identified cointegrating equation (3). Further, we add another rate-determining equation that is independent of the previous variables. That is a cointegration relation between the dinar exchange rate and NBS foreign exchange interventions. We assume that foreign exchange interventions are entirely independent of the other explanatory variables. Therefore, we had to test the following constraints for $\beta$ vector:

$$\beta' = \begin{bmatrix} 1 & \beta_{12} & \beta_{13} & \beta_{14} & 0 & \beta_{16} \\ 1 & 0 & 0 & 0 & \beta_{25} & \beta_{26} \end{bmatrix} \quad (5)$$

In Table 3, we show the results of the test for constraints on the parameters of cointegration equations (5). The two cointegration equations are unambiguously identified. The likelihood that restrictions can be accepted

7 The third way is to work with data of different time frequencies and to apply the MIDAS regression estimation technique (Mixed Data Sampling). We have not opted for that approach, because the time series have different properties with respect to stationarity. There are two series ~I(2), the other two series are ~I(1), while the foreign exchange intervention series is a stationary time series ~I(0).

8 The results of the trace test concerning the number of cointegration relations are shown in the table below:

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Trace Eigenvalue | Statistic | 0.05 Critical value | Prob.** |
|---|---|---|---|---|
| None * | 0.366996 | 108.6709 | 69.81889 | 0 |
| At most 1 * | 0.203644 | 51.5111 | 47.85613 | 0.0218 |
| At most 2 | 0.12168 | 23.04741 | 29.79707 | 0.2437 |
| At most 3 | 0.046393 | 6.829409 | 15.49471 | 0.5976 |
| At most 4 | 0.007106 | 0.891472 | 3.841466 | 0.3451 |

Trace test indicates 2 cointegrating equations at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

is high enough to support the hypothesis that the data supports theoretical constraints. So, in reality, there are two separate processes, independent of each other, that affect the exchange rate. One process goes through the purchasing power parity channel (PPP) of domestic and foreign prices, and the pass-through effect of the dollar exchange rate against the euro. The second process channels the impact of foreign exchange interventions on the dinar exchange rate. We repeat, by definition, these are two mutually independent processes.

Equation (6) shows the long-term relationship in both cointegration processes estimated on monthly data, while equation (7) shows the same by using daily data. The graphs of cointegrating equations are presented in Figure 7.

$$\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) = \underset{[8.5343]}{1.0190}\cdot\log\left(P^{RS}_{t-1}\right) - \underset{[-5.5843]}{0.2499}\cdot\log\left(ER^{\frac{EUR}{USD}}_{t-1}\right) - \underset{[-4.5000]}{1.7955}\cdot\log\left(P^{EU}_{t-1}\right) + 0.2027$$

$$\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) = \underset{[-6.6027]}{-0.0366}\cdot Q^{RS}_{t-1} + 0.1014 \qquad (6)$$

$$\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) = \underset{[8.6743]}{1.1763}\cdot\log\left(P^{RS}_{t-1}\right) - \underset{[-3.6238]}{0.1852}\cdot\log\left(ER^{\frac{EUR}{USD}}_{t-1}\right) - \underset{[-4.4462]}{2.1276}\cdot\log\left(P^{EU}_{t-1}\right) + 0.1389$$

$$\log\left(ER^{\frac{RSD}{EUR}}_{t-1}\right) = \underset{[-17.5382]}{-0.1078}\cdot Q^{RS}_{t-1} + 0.2175 \qquad (7)$$

The estimated coefficients are very similar. Of course, we are primarily interested in the second cointegration equation, which links foreign exchange interventions and exchange rates. It has a negative sign, as expected. That means that in the long-run, increased foreign currency sales reduce the exchange rate, but that increased foreign currency purchases (with a negative sign) increase the exchange rate.

We couldn't log the series of foreign exchange interventions (because foreign currency purchases are with a minus sign), so we can't talk about elasticities in this case. In contrast, the first cointegration equation shows other long-term elasticity coefficients. Although in the short-term PPP does not work, in the long-run it does, because the coefficients of elasticity are very close to the unit in both cases. The strengthening of the dollar against the euro has the effect of reducing the dinar nominal dinar exchange rate. The similar outcome would happen if the EU raised inflation. All estimated coefficients of elasticity are statistically significant.

## Conclusion

Data show that excessive daily fluctuations in the dinar exchange rate were not the main reason for NBS interventions in the foreign exchange market. These fluctuations were neither launched to defend the stability of the financial system nor to achieve a safe level of foreign exchange reserves. Combining this conclusion with data describing how foreign exchange interventions were performed, we note the much more important finding that the NBS in the last eleven years has always had some levels of the exchange rate as informal targets.

Targeting the exchange rate is against the current monetary strategy on inflation targeting in Serbia, although it is not in itself a problem. When there is a high pass-through effect of the exchange rate on domestic prices, exchange rate management can be one of the

**Table 3: Tests of cointegrating restrictions**

Restrictions: b(1,1)=1, b(1,5)=0, b(2,1)=1, b(2,2)=0, b(2,3)=0, b(2,4)=0

| Hypothesized No. of CE(s) | Daily data: Convergence achieved after 322 iterations. Restrictions identify all cointegrating vectors | | | | Monthly data: Convergence achieved after 101 iterations. Restrictions identify all cointegrating vectors | | | |
|---|---|---|---|---|---|---|---|---|
| | Restricted Log-likelihood | LR Statistic | Degrees of freedom | Probability | Restricted Log-likelihood | LR Statistic | Degrees of freedom | Probability |
| 2 | 39353.66 | 5.147822 | 2 | 0.076237 | 1417.054 | 4.282733 | 2 | 0.117494 |
| 3 | 39364.59 | 1.436699 | 1 | 0.230674 | 1426.003 | 1.96092 | 1 | 0.161415 |
| 4 | 39368.32 | NA | NA | NA | 1428.941 | NA | NA | NA |

NA indicates restriction not binding.

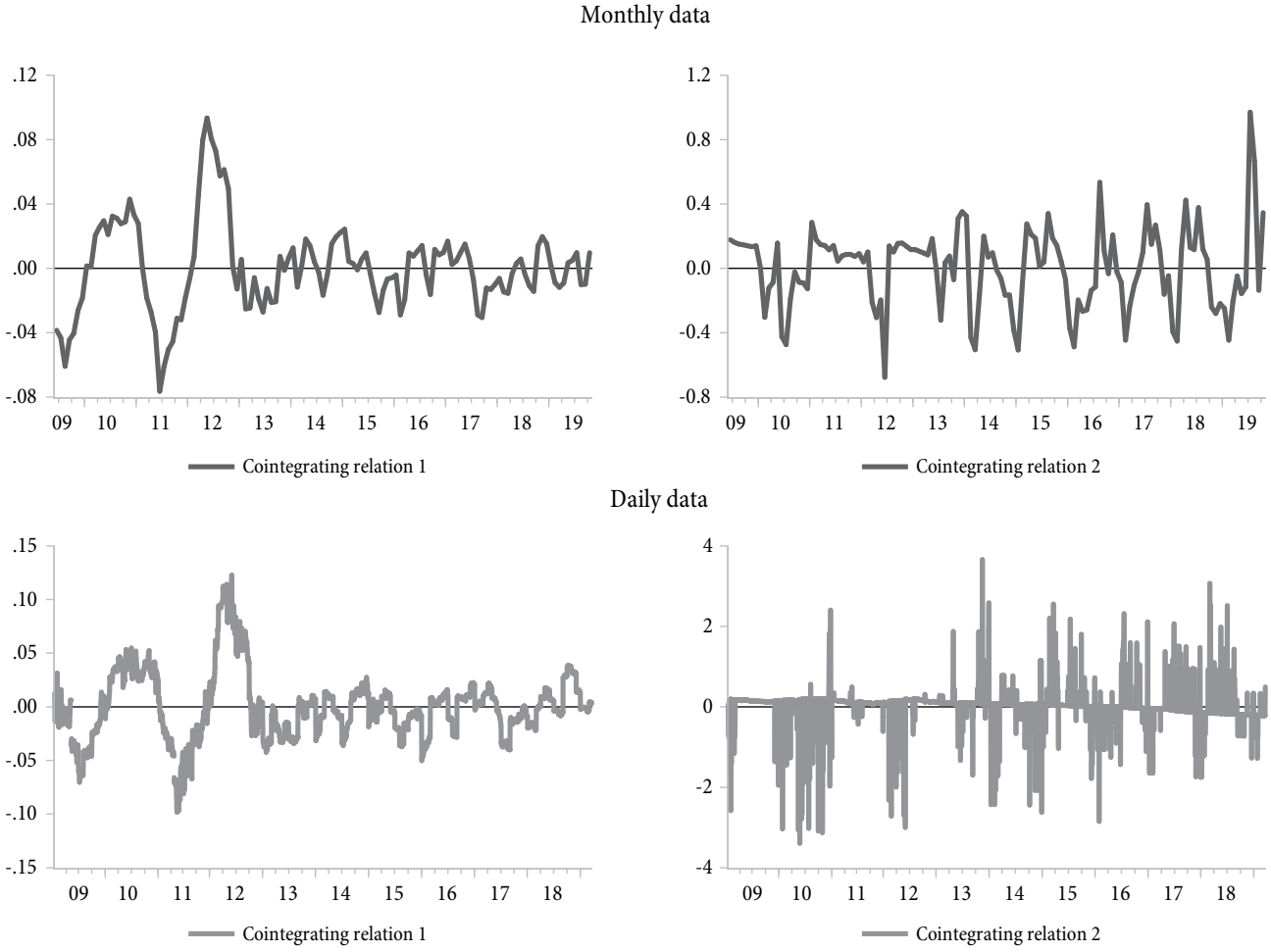
monetary means for establishing price stability. Some central banks are targeting the exchange rate, and there are many models in the economic literature about this. The problem is if the exchange rate target is not known to the public, and the NBS does not feel responsible for explaining what level of the dinar exchange rate it was targeting.

We judge that the current foreign exchange rate target is too low and is detrimental to the economic growth and investment and export-led development strategy. However, that was not the theme of this paper. Our goal was to use data to show that there is an informal exchange rate target, which either needs to be abandoned or formalised in lines with the development strategy.

In this paper, we have used econometric analysis based on VEC models, which were estimated using daily and monthly data for eleven years, from the beginning of January 2009 to the end of October 2019. First, we showed the pass-through effect of the exchange rate on prices, and afterwards, we turned the analysis around and asked which causing factors had been determining the level of the exchange rate over the past eleven years. We have identified two cointegrating relations which are, by definition, independent of one another. One relation describes the long-term realisation of PPPs and the impact of the dollar exchange rate against the euro. The second relation shows how foreign exchange interventions have managed the dinar exchange rate. As a rule, foreign exchange funds were sold by the NBS to lower the dinar exchange rate and were purchased by the NBS to raise it when needed.

The data speak for themselves. In the last three years, price growth in Serbia has been much faster than in the EU, but the nominal value of the dinar exchange rate has been steadily declining. It follows that there was a real appreciation of the dinar exchange rate, which was

**Figure 7: Two cointegrating relations: for monthly data (upper graph) and daily data (lower graph)**



not supported by the corresponding productivity growth and improved competitiveness of the Serbian economy. An export-based development strategy can hardly be sustained in such circumstances. That is the main finding of this paper, which suggests that monetary, foreign exchange and development policies need to be synchronised. The first necessary step is that the NBS admits it has been pursuing a dirty inflation targeting policy and now wants to adjust it to the development strategy.

## References


1. Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford: Oxford University Press.
2. Labus, M. (2013). Exchange rate and repo interest rate in Serbia: What happened in 2012 and lessons for reindustrialization. *Ekonomika preduzeća, 61*(1-2), 19-30.
3. Narodna banka Srbije (2008). *Memorandum Narodne banke Srbije o ciljanju (targetiranju) inflacije kao monetarnoj strategiji*. Beograd. Retrieved from https://www.nbs.rs/internet/latinica/30/memorandum_monetarna_ strategija_122008.pdf.



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