Managing Exchange Rate Fluctuations in Inflation Targeting Framework – Experiences of Serbia and Selected Transition Economies

Kosta Josifidis, Jean-Pierre Allegret**, and Emilija Beker Pucar****

Abstract: The paper analyses the necessity and the way of managing exchange rate fluctuations in inflation targeting regime in the cases of Serbia and selected (former) transition economies Poland, Czech Republic, Slovakia, and Hungary. Managed floating regime could basically assume: hidden exchange rate targeting, manipulations of exchange rate fluctuations, and mitigating the exchange rate fluctuations. From the aspect of intensity, managed floating could be hard (manipulations of exchange rate fluctuations) or soft (mitigating the fluctuations), and from the aspect of the way of managing, indirect (via interest rate) or direct (via foreign exchange interventions). By revealing the strength and the way of managing the fluctuations *de facto* applied exchange rate and monetary sub-regimes could be supposed, as well as the distinction between *de jure* and *de facto* regimes. Empirical investigation of (in)direct managing the exchange rate fluctuations in inflation targeting framework is based on VAR model in the cases of Serbia with the comparison of former transition economies Poland, Czech Republic, Slovakia, and Hungary. The investigation is focused to the period of managed floating and implicit/explicit inflation targeting regimes in selected countries. The results point to differences concerning the strength (hard *vs.* soft) and the way (direct *vs.* indirect) of managing exchange rate fluctuations in explored economies and the differences in exchange rate and monetary sub-regimes. Also, the expectation that monetary authorities could influence the exchange rate fluctuations more certainly, faster and stronger via foreign exchange interventions compared to indirect influence via reference interest rate, has been empirically confirmed.

Key words: Managed floating sub-regimes, Inflation targeting sub-regimes, Hard, manipulative, dirty vs. soft, mitigative managing exchange rate fluctuations.

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Introduction

According the International Monetary Fund (2009a) managed floating is an exchange rate regime in which an exchange rate is determinated with market forces, but there is a possibility of monetary authorities to intervene in order to limit excessive oscillations that could endanger financial stability. Hence, there is no word about managing fluctuations in order to permanently deviate market pressures and/or to determine a path or an exchange rate level. In the literature related with theoretical and empirical aspects of flexible exchange rate regimes there is no consensus concerning defining and positioning of managed floating regime[1]. Habermeier et al. (2009) realize the need for IMF re-classification having in mind, among other factors, that the residual category of managed floating has become overly heterogeneous. The group of floating regimes is observed as free floating, managed floating and other managed arrangements which is the new residual category (the sub-regimes which don't belong to free or managed floating regimes).

Some authors believe that managed floating is a kind of intermediate regime, while others argue that it is a form of a flexible regime. From *de jure* stand-point, managed floating is a form of flexible exchange rate regime. From *de facto* stand-point it is important to identify the variant or sub-regime of managed floating in order to position exchange rate regime in the spectrum from rigid to flexible. Therefore, the positioning of managed floating depends from practised sub-regime. Revealing the sub-regime is related with the fact how often and how much monetary authority reacts, limits and influence the exchange rate fluctuations.

Since monetary regime is inseparable from exchange rate regime, managed floating exchange rate regimes are usually followed with inflation targeting monetary framework or with less transparent monetary strategy. Since an exchange rate doesn't serve as a nominal anchor, transparent nominal anchor is found in inflation targets in most emerging and transition economies. The position of developed economies is different because these economies don't have the necessity to firmly anchor inflationary expectations with specific nominal anchor. However, certain developed economies practise transparent monetary strategy of the inflation targeting (Great Britain, Canada, New Zealand), while others practise non-transparent, hybrid monetary strategy (USA, EMU and Japan).

In the phase of macroeconomic stabilization, emerging and transition economies used exchange rate as a natural anchor for relatively fast restraining of inflationary expectations. The policy of exchange rate as a nominal anchor, during time creates raising costs (inflation inertia, real exchange rate appreciation, current account deficit) and decreasing benefits from inflation drop (Josifidis and Beker 2007; Josifidis, Allegret and Beker 2009b). The solution was found in a monetary path towards higher exchange rate and monetary flexibility usually in a gradual form, from fixed to intermediate, and finally to managed/clean floating regimes. The paper is focused to (ex)transition economies which changed the nominal anchor and accordingly the exchange rate regimes. Poland, Czech Republic, Slovakia, Hungary and Serbia at the phase of macroeconomic stabilization used exchange rate as a nominal anchor.

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[1] There is no consensus neither concerning the existence of clean or free floating regime. Most authors, however, do believe that free floating is only theoretical solution because in practise intervening is always present having in mind that exchange rate is the most important price in an open economy which influences simultaneously internal and external balances. The point is only how frequent and how strong the intervention is, or is it planned or *ad hoc*. The answers depend from concrete macroeconomic fundamentals of the economy in question.

After phase of macroeconomic stabilization, the mentioned economies have moved towards intermediate exchange rate form and, at last, accepted managed/free floating in the combination with inflation targeting monetary framework.

Inflation targets as a nominal anchor assumes completely focus of monetary authorities to hitting the defined targets without targeting some other variable, especially not the exchange rate. Monetary framework of inflation targeting assumes the appropriate exchange rate regime. Inflation targeting isn't compatible with exchange rate regimes which belong to monetary framework of exchange rate targeting: currency board (dollarization/euroization is not included because exchange rate doesn't exist in these cases; as well as a monetary union because there is no sovereign monetary policy in this case), conventional fixed parity, adjustable parity, crawling parity, crawling parity with narrow fluctuation margins. Intermediate regimes in the form of a corridor with wider fluctuation margins are compatible with inflation targeting, as well as managed/free floating regimes. It is possible to target the inflation whenever significant exchange rate fluctuations are possible i.e. whenever the exchange rate is not the targeted variable. The situation concerning inflation targeting monetary strategy is more complex in the circumstances where exchange rate fluctuations affect the inflation targets. Therefore, the necessity to limit fluctuations in order to hit the inflation target is more emphasized. Significant exchange rate pass-through, financial dollarization/euroization, internal and external (im)balances, as well as non-coordinance between monetary and fiscal policy, are key vulnerable points in emerging and transition economies in conducting flexible monetary policy. Hence, inflation targeting framework isn't applied in the same way in all countries. Sub-regimes could be also identified depending from specific macroeconomic circumstances.

The idea of the paper is to reveal the difference concerning the combination of managed floating and inflation targeting regimes in selected transition economies with the intention to shed some light to the sub-regimes of managed floating and inflation targeting. The Section 1 identifies managed floating and inflation targeting sub-regimes due to literature review and authors' opinion. Section 2 explains the used methodology. Section 3 presents the results of empirical research in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia. Section 4 concludes.

1. Identification of Managed Floating and Inflation Targeting Sub-regimes

1.1 Managed Floating Sub-regimes

Bofinger and Wollmershauser (2001) differ clean floating (with no interventions), independent floating (mitigating fluctuations), and managed floating (exchange rate targeting). The first regime, *clean/free floating* is a theoretical model with no empirical confirmation; the second regime, *independent floating*, is esentially managed floating (according to the mentioned IMF classification); while the third type, *managed floating*, is some kind of hybrid, non-transparent form of intermediate exchange rate regime. However, it is not possible to include the third type of fluctuating exchange rate regime in existing intermediate regimes. It is the closest to the corridor with wider fluctuations margins but, in this case, without determinated (announced) margins. Hence, there is no parity and there is no exchange rate target, while certain fluctuation is permitted which is the subject of monetary authority's estimation respecting the determinated goals. However, hybrid, non-indentified,

exchange rate regime in the spectrum from rigid to flexible exchange rate regime, could be placed between a corridor or target zone, on one side, and managed floating, on the other side. It is called hard managed floating or dirty floating because there is a distinction between *de jure* and *de facto* exchange rate regimes or the hidden regime.

Jonas and Mishkin (2003) differ active and passive approach concerning exchange rate regimes in inflation targeting monetary framework. *Active approach* assumes that a central bank is concerned in exchange rate above the effects of exchange rate to inflation or above the exchange rate transmission effects. *Passive approach* means that a central bank is concerned only in the degree in which exchange rate influences aggregate demand and inflation, not trying to manipulate an exchange rate directly and reacting only to exchange rate changes that endanger the inflation target. By analysing managed floating in inflation targeting framework in transition economies, authors conclude that Hungary practiced active approach (manipulation) of managing exchange rate fluctuations, follows Czech Republic, and, at the end, Poland where the exchange rate transmission is the lowest having in mind low openess of Polish economy. Mishkin (2004) considers that mitigating exchange rate fluctuations is related with an interest rate policy as an indirect influence to an exchange rate, while the orchestring and manipulation is related with foreign exchange interventions as a direct influence to an exchange rate.

In the case of **emerging and transition economies** the situation of impossibility to ignore exchange rate movements is imanent because the exchange rate influences external and internal macrostability, very fragile in the cases of mentioned economies. Namely, exchange rate appreciation is limited due to already present (chronic, growing) current account deficits, while exchange rate depreciation transmits to an inflation and initiates negative balance sheet effects in financially dollarized/euroized economies. In the mentioned circumstances, it is not possible to allow free, even the significant exchange rate fluctuations because any movement, up or down, deteriorates the situation from internal or external plan. We could regard the disputable exchange rate regime as *dirty floating* and assume that it includes several elements:

- manipulating fluctuations (free fluctuations are not allowed);
- intervention is not connected only with mitigating fluctuations; but
- exchange rate is not targeted neither.

In the dirty floating regime monetary authority reacts (intervene on a foreign exchange market) *ad hoc*, relatively frequent, with constant monitoring because significant fluctuation endanger macroeconomic stability and, above all, inflationary stability in the form of inflation targets in inflation targeting monetary framework.

Overall, it is obvious that managed floating regime covers more subregimes. Sorted by higher degree of exchange rate flexibility, sub-regimes within managed floating are:

- Hidden, *de facto* exchange rate targeting;
- Manipulation of exchange rate fluctuations – dirty/hard managed floating;
- Mitigating exchange rate fluctuations – soft managed floating.

Mentioned sub-regimes differ according to the purpose of interventions on a foreign exchange market: to target the exchange rate, to mitigate exchange rate fluctuations, or to manipulate the exchange rate fluctuations.

i. **De facto exchange rate targeting** - assumes preventing exchange rate movements according to market pressures and directing exchange rate towards unofficial parity, with eventual narrow fluctuation margins. The combination of *de facto* exchange rate targeting and *de jure* managed floating presents a form of an

intermediate exchange rate regime. This sub-regime isn't the subject of the paper because it doesn't actually include the change of a nominal anchor in observed transition economies.

ii. **Manipulating exchange rate fluctuations or dirty/hard managed floating** - permits certain exchange rate flexibility, but limited, having in mind impossibility of monetary authorities to allow significant fluctuations due to macrostability worsening. There is no hidden parity, but authorities react according the judgement or *ad hoc*; exchange rate is constantly monitored and reaction is promptly to any fluctuation that could endanger economic policy goals (and above all, targeted inflation level). The problem mainly rests in unfavorable macroeconomic circumstances, because dirty floating is used by economies which cannot permit stronger fluctuations due to: external imbalance (preventing significant appreciation), internal imbalance in the form of weak real economy (a connection between an exchange rate on one side and export and inflow of FDI on the other side), internal imbalance in the form of threatening inflationary pressures (rigid inflationary expectations, strong wage and price indexation due to (hyper)inflationary episodes, strong transmission of exchange rate depreciations to consumer prices), significant financial dolarization/euroization (depreciation induces negative balance sheet effect due to currency mismatching problem). The regime of manipulating exchange rate fluctuations, as identified sub-regime of managed floating, actually belongs to intermediate exchange rate regimes.

iii. **Mitigating exchange rate fluctuations or soft managed floating** – is a tipical textbook version of managed floating because authorities react only when fluctuations are excessive and present the threat to the financial stability. Mentioned sub-regime of managed floating is practised by developed economies (above all, USA, EMU and Japan) according to more favorable macroeconomic performances, more stable macroeconomic position on internal and external plan, low exchange rate pass-through and absence of financial dolarization/euroization. From three identified subregimes of *de jure* managed floating, the sub-regime of mitigating or soft managing the exchange rate fluctuations is *de facto* flexible.

1.2 Inflation Targeting Sub-regimes

Carare and Stone (2003) differ three sub-regimes of the inflation targeting: full-fledged inflation targeting, eclectic inflation targeting and light inflation targeting. *Full-fledged inflation targeting* is most famous and classic variant of inflation targeting which assumes institutionalized obligation to the anchor of inflation target, transparent monetary strategy, while monetary authority has medium to high credibility level and high level of financial stability. Despite relatively favorable macroeconomic indicators, countries which use full-fledged inflation targeting cannot achieve low inflation without clear obligation to the goal, which significantly reduce the flexibility concerning the achievement of other goals, above all the output stabilization. *Eclectic inflation targeting* could afford only countries with strong monetary credibility in the way that clear, transparent and institutionalized obligation to any anchor isn't necessary. Eclectic form of the inflation targeting is actually flexible inflation targeting (Genberg 2002; Orlowski 2005; Svensson 2007), while monetary policy, besides the

goal of low inflation or inflationary stability, could also focus the goal of output stabilization (so called, policy with dual objectives)[2]. *Light inflation targeting*, contrary to eclectic and flexible approach, conducts less developed economies (emerging and, within this group, transition economies) with relatively lower monetary credibility, vulnerable to different shocks in the development and transition process, with impossible relying to single nominal anchor.

Orlowski (2000, 2005) investigates the monetary strategy of transition economies on the road towards the EMU. The author proposes *dynamic approach to inflation targeting* considering that transition economies which pretend to join the euro-zone, and which left the exchange rate as a nominal anchor policy, should adopt direct inflation targeting. *Direct inflation targeting* is acceptable solution in the circumstances of still fragile macrostability with present wage/price indexation and inflation inertia. In the monetary framework of direct inflation targeting, nominal anhor is specific inflation rate or inflation corridor with the central value. Inflation target (with or without narrow inflationary corridor) as an exclusive target and primary goal of a monetary policy, indicates the strict inflation targeting. In the *strict inflation targeting framework*, disinflation is solely goal of a monetary policy which demands frequent, discretionary, corrective reaction of a monetary policy to any inflationary shock. If inflationary corridor is wider, reaction is less discretionary and monetary authority could also target an exchange rate stability or income growth. Less rigid approach to disinflation is compatible with flexible inflation targeting framework. *Flexible inflation targeting* assumes targeting of relatively wider inflationary corridor which provides targeting of other variables, for example, exchange rate stability. Orlowski proposes dynamic approach to inflation targeting in the sense of initially accepting of strict, and later the flexible form of the inflation targeting in the process of a monetary convergence towards EMU. It is clear that process of monetary or nominal convergence to the EMU assumes satisfying the inflation and exchange rate criteria, and flexible inflation targeting sub-regime could provide accomplishment of both indicators.

Ball and Reyes (2004), reviewing the paper of Calvo and Reinhart (2002), tend to widen the research by identifying the difference between "fear of floating", inflation targeting and exchange rate targeting. Esentially, the research is based on revealing the distinction between *de jure* and *de facto* applied exchange rate and monetary regimes. Thus, countries with *de jure* inflation targeting monetary regime could *de facto* target the exchange rate or express, so called, "fear of floating". Authors investigate exchange rate, nominal and real interest rate, and foreign exchange reserves variability, in order to distinquish strict inflation targeting and exchange rate targeting. After identification of three monetary regimes, Ball and Reyes via regression analysis research the reaction of real interest rate to nominal exchange rate changes (depreciation), foreign reserves changes, changes of inflation rate in different monetary regimes in the cases of 88 exchange rate regimes in 20 selected countries. Key difference between "fear of floating" and strict inflation targeting lies in the reaction of

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[2] Although inflation targeting proves as successful monetary regime even in the cases of less developed economies, USA, EMU and Japan haven't yet accepted inflation targeting, but the policy is moving in this direction. The main reason for refusing the inflation targeting framework is the fear from too much emphasize on inflation target with the neglecting the goals in the sphere of a real economy or other economic goals. But, even in the case of accepting the inflation targeting, the developed economies will most likely accept flexible inflation targeting, not rigid or strict form of the inflation targeting (Svensson 2007). Genberg (2002) also differs strict and flexible inflation targeting. Author argues that strict inflation targeting assumes solely focus of monetary authority to achieving of the inflation target, while flexible inflation targeting allows certain concentration to other goals of economic policy, but only in the cases of subordination to primary goals of price stability.

monetary authorities to changes (depreciation) of nominal exchange rate. Interest rate in inflation targeting regime should react to nominal exchange rate depreciation only in the case of endangering the inflation target, not in all depreciation episodes. Besides, credible, strict inflation targeting regime is compatible with managed and free floating, while the "fear of floating" is closer to exchange rate targeting. In most analysed cases, *de jure* and *de facto* inflation targeting are matching, except in the case of five countries which *de jure* target the inflation but *de facto* are exposed to the "fear of floating" problem (case of Brasil, Columbia, Peru, South Africa and Poland).

By researching the inclusion of the exchange rate into the inflation targeting framework, Roger, Restrepo, and Garcia (2009) differ four types of inflation targeting regime: *the first*, standard open economy inflation targeting framework where exchange rate changes are only indirectly included in monetary policy reaction function; *the second type*, an open economy approach with explicitly included the exchange rate movements in the reaction function; *the third type*, inflation targeting with an explicit exchange rate band; and *the fourth type* presents inflation targeting with the exchange rate, rather than short-term interest rate, as the policy instrument or operative objective. Obviously, for emerging and transition economies are interesting the second, third and fourth type concerning the inclusion of the exchange rate to monetary policy reaction function. The second type could be regarded as classic, full-fledged inflation targetig sub-regime. The third type is interesting in the phase of participation in ERM II because, despite the unchanged nominal anchor, exchange rate regime has to be modificated to the intermediate form. The fourth type assumes, here researched, influence to exchange rate fluctuations in the circumstances where the exchange rate limiting is actually the way to achieve the inflation target, although the authors don't directly distinquish hard vs. soft managed floating sub-regimes.

Identification of inflation targeting sub-regime in this paper is connected with the identification of managed floating sub-regime. If managed floating is dirty or hard managed with the manipulation elements, then the inflation targeting couldn't be full-fledged, but rather soft or light inflation targeting imanent to vulnerable economies. If managed floating is soft/light with the mitigating elements in limiting exchange rate fluctuations, compatible inflation targeting sub-regime could be full-fledged or classic form. Of course, the final conclusion concerning *de facto* applied combination of exchange rate and monetary regimes assumes further investigation of fulfillment of other elements of full-fledged inflation targeting. Our suggestion is based on the empirical results concerning the intensity of managing fluctuations and revealed exchange rate sub-regime.

2. Methodology

The aim of the empirical research is to uncover which type of managed floating is actually practiced in selected transition economies. Indirectly, this conlusion could reveal the type or variant of practised inflation targeting sub-regime. In order to empirically investigate the nature of managed floating regime, time series analysis is based on variations of foreign exchange reserves, reference interest rates, and nominal exchange rates in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of changed nominal anchor or adoption of inflation targeting monetary regime. Therefore, if variations of foreign exchange reserves and interest rates are significant, while variations of nominal exchange rates are weak, managing fluctuations is present. However, it is difficult to determine the exact critical level or range concerning the acceptable variations of foreign exchange reserves

and interest rates (direct and indirect influence to the exchange rate) in order to classify the regime as a soft (mitigating fluctuations) or hard (manipulating fluctuations) managed floating. But, the results could be compared between selected cases in order to reveal the intensity and dominant fashion of influencing fluctuations as a way of uncovering different shades of the same *de jure* managed floating regime. The results of (in)direct managing of exchange rate fluctuations are also observed in the light of exchange rate pass-through, as well as the degree of financial euroization. In the case of emphasized exchange rate pass-through and financial euroization, managing fluctuations is stronger in order to provide hitting the inflation target and to avoid negative balance sheet effects.

On purpose to compare the strength of direct and indirect influence to nominal exchange rate movements in the phase of inflation targeting, the interdependence between three crucial variables has been explored: foreign exchange reserves, reference interest rate, and nominal exchange rate. The cases for empirical research are transition economies which abandoned exchange rate as a nominal anchor and accepted inflation targets in the transition process on the road towards the EU: Poland, Czech Republic, Slovakia, Hungary and Serbia. Time series with monthly frequency are used from IMF database (International Monetary Fund 2009b). The investigated period is related with the adoption of inflation targeting monetary regime in the combination with *de jure* free/managed floating exchange rate regimes. In the case of Poland investigated period is 2000:04-2009:01, for Czech Republic 1997:12-2009:01, Slovakia 1998:10-2005:11, Hungary 2001:05-2009:01, and for Serbia 2006:09-2009:01.

Before estimation of the VAR/VEC model, time series of foreign exchange reserves, reference interest rates and nominal exchange rates are transformed to logarithms and deseasonalized. After transformation follows augmented Dickey-Fuller test in order to check stationarity of time series. After stationarity test in the case of confirmed non-stationarity, cointegration test, i.e. Johansen's method, is used to determine eventual existence of a long-run equilibrium relationship between time series. If cointegration is confirmed, VEC model is estimated; if not, VAR model (previously non-stationary time series are transformed to stationary series with differencing procedure). On the base of estimated models, the results of variance decomposition are derived. The results of variance decomposition lead us to the conclusion if managing of exchange rate fluctuations is present and in which way is managing conducted – directly or indirectly. Empirical steps towards the final results are presented in the Appendix, while final results are graphically presented in the next section.

Indirect managing exchange rate fluctuations is revealed through the influence of nominal effective exchange rate (NEER) shock to the variations of reference interest rate (IR). The influence of nominal exchange rate shock to the changes of the interest rate is tracked during 24 months, as well as the direct influence to an exchange rate. Direct managing of exchange rate fluctuations is observed through the influence of nominal effective exchange rate shock to the variations of foreign exchange reserves (FE) changes. High and growing level of interest rate and foreign exchange reserves variations explained with the nominal effective exchange rate shock points to stronger managing fluctuations. Comparison between selected cases indicates in which case the managing is relatively hard or relatively soft.

In order to identify how much influence to the exchange rate have interest rate and foreign exchange reserves, the inverted relation is also observed: the influence of foreign exchange reserves (FE) shock to nominal effective exchange rate (NEER) changes has been tracked, as well as the influence of reference interest rate shock (IR) to nominal effective exchange rate changes (NEER). Interest rate transmission has naturally longer time lag (even

two years), while foreign exchange interventions have stronger and faster impact to the exchange rate in the short run. If the exchange rate pass-through is emphasized in the economy, with naturally fast transmission to consumer prices via direct channel, foreign exchange interventions or direct influence to exchange rate fluctuations must be practised in order to limit exchange rate spillover effects to inflation. Although foreign exchange reserves have faster impact to exchange rate fluctuations, the effects are confined to the short run. Hence, indirect influence to exchange rate fluctuations via interest rate policy is necessary as an additional way of managing the fluctuations.

3. Empirical Results

Empirical investigation of managing exchange rate fluctuations within inflation targeting framework includes investigation of (in)direct influence to the exchange rate in the case of Poland, Czech Republic, Slovakia, Hungary and Serbia. In order to identify which country used, and in which extent, direct and indirect influencing exchange rate fluctuations, the period of combination of managed/free floating and implicit/explicit inflation targeting regimes[3] is focused. The results of variance decomposition in Figure 1 show direct and indirect influence to the exchange rate within implicit/explicit inflation targeting framework in the case of mentioned economies.

Figure 1 Indirect influence to exchange rate fluctuations via interest rate in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of the inflation targeting
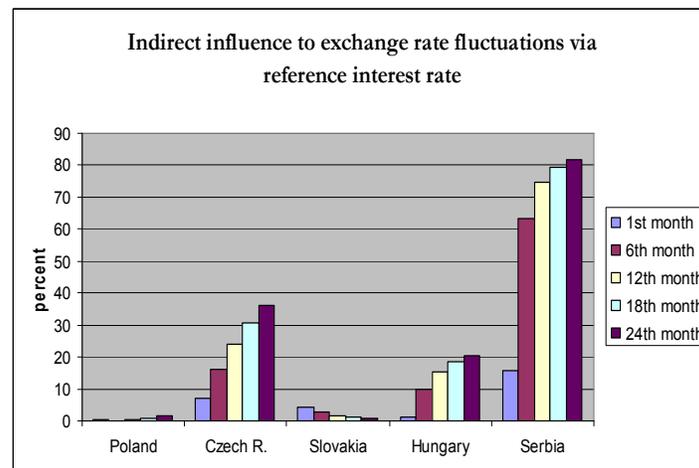
Source: Josifidis, Allegret and Beker Pucar (2009a).

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[3] See more concerning identification of different subperiods in monetary practice of selected transition economies in Josifidis, Allegret, and Beker Pucar (2009a). From the beginning of transition, mentioned transition economies experienced three different subperiods: the first subperiod of exchange rate as a nominal anchor with appropriate fixed exchange rate regime; the second subperiod of intermediate exchange rate regime and transitional, non-transparent monetary strategy; and the third subperiod of inflation targeting combined with flexible (managed/clean) exchange rate floating.

On the base of empirical results, it is evident that the highest level of indirect influence to exchange rate via interest rate in the period of inflation targeting regime is recorded in the case of Serbia. Namely, the percent of reference interest rate variations determinated with the variations of a nominal exchange rate is 30% after 6 months, 33% after 12 months, 35% after 18 months, and close to 40% after 24 months. The level of indirect influence is on significantly lower level in other observed economies. The highest percent of reference interest rate variations explained with the changes of a nominal exchange rate in Poland is 8% after two years, 8% in Slovak Republic after 12 months, and 13% in Czech Republic after two years.

Figure 2 shows the percent of foreign exchange reserves variations explained with the changes of nominal exchange rate. By exploring direct influence to exchange rate fluctuations, the conclusion has been made that Republic of Serbia in the highest extent (compared to other cases) directly manages exchange rate fluctuations within inflation targeting regime. After six months, percent of foreign exchange reserves variations explained with the changes of a nominal exchange rate is 17% in the first month of the intervention, after 12 months 63%, 18 months 75%, and after two years 82%. Compared to other former transition economies which also changed a nominal anchor by accepting inflation targeting, the level of a direct influence is significantly higher. For example, in the case of Czech Republic (which is the second according to direct influencing the exchange rate movements, but significantly below Serbia), foreign exchange interventions affect exchange rate fluctuations with 37% 24 months after the intervention, Hungary with 20%, while direct influence in the case of Poland and Slovakia is inconsiderable.

Figure 2 Direct influence to exchange rate fluctuations via foreign exchange interventions in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of the inflation targeting

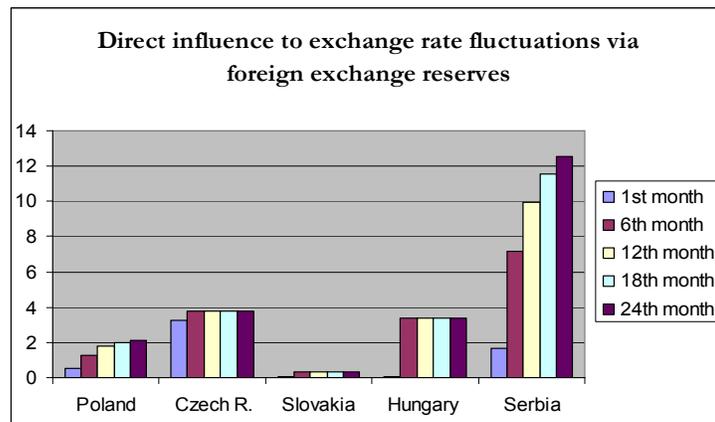**Source**: Josifidis, Allegret and Beker Pucar (2009a).

Observing the results of exchange rate pass-through to consumer prices in the period of inflation targeting[4] (see Figure 3), the highest pass-through is evident in the case of Serbia,

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[4] Exchange rate pass-through is researched via the time series of nominal effective exchange rate (NEER) and consumer price index (CPI) in the period of inflation targeting. Variance decomposition is also used to track

then Hungary, Slovakia, Czech Republic and, at the end, Poland. Certainly, this empirical finding is related with the previously explained findings concerning (in)direct managing the exchange rate fluctuations. The economy with the highest pass-through (Serbia) has the highest indirect and direct influence to exchange rate fluctuations. From the other side, the economy with the lowest exchange rate pass-through has relatively low direct and the lowest indirect influence to exchange rate fluctuations (Poland).

Figure 3 Exchange rate pass-through to consumer prices in inflation targeting monetary regime in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia
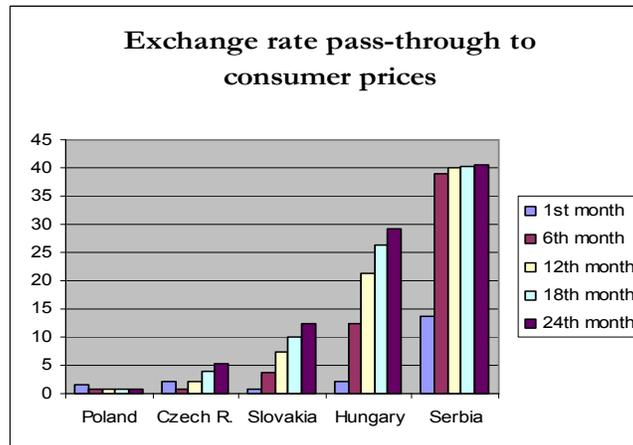
Source: Josifidis, Allegret and Beker Pucar (2009a).

The necessity to limit exchange rate fluctuations is primarily connected to exchange rate pass-through indicator. If exchange rate transmission is relatively strong, depreciations have to be confined in order to attain the inflation target. Besides this crucial reason, exchange rate depreciations are limitied due to emphasized financial euroization. Therefore, there is considerable pressure to dampen exchange rate depreciations because of the negative balance sheet effects. Figure 4 shows the effect of Euribor changes (shock) to changes in domestic credit activities. Higher influence of euro-zone interest rate points to higher financial euroization. In the case of Serbia is evident the highest indicator of financial euroization, follows Czech Republic, Hungary, Poland and Slovakia. The highest level of financial euroization in the case of Serbia is also confirmed in Dvorsky, Scheiber and Stix (2008) who analyse the cash and saving deposits denominated in euro as *per capita* indicator in selected former (Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria) and current (Serbia, Croatia, Bosnia and Hercegovina, Albania) transition economies. Serbia has the highest *per capita* level of financial euroization with above 650 euro cash *per capita* and 3400 euro *per capita* saving deposits. Poland, Czech Republic, Slovakia and Hungary as a former transition economies have significantly lower indicators of financial euroization, while countries in the region have higher levels of the indicator, although on a lower level compared to Serbia.

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the influence of NEER shock to the changes of CPI in order to reveal the influence during 24 months after initial shock. For more details, see in Josifidis, Allegret, and Beker Pucar (2009a).

Figure 4 The influence of Euribor to domestic credit activities in the cases of Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of inflation targeting
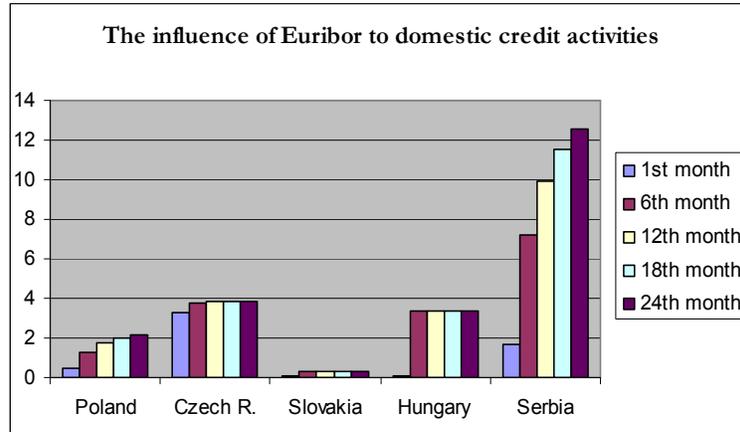

Source: The authors' calculations.

In order to reveal other findings concerning managing fluctuations within inflation targeting regime, inverted relation is also investigated: a strength of the influence of interest rate and foreign exchange reserves on exchange rate fluctuations. In fact, the intention is to get the answer on the following question: What affects more and faster the exchange rate - reference interest rate or foreign exchange interventions? According to theoretical assumptions, it is expected that foreign exchange interventions or direct managing exchange rate fluctuations exert stronger and faster effects on nominal exchange rate movements. A variable which reflects direct managing of exchange rate fluctuations is a change in foreign exchange reserves level, while the change of reference interest rate reflects indirect exchange rate managing. Figure 5 shows the results of the strength and dynamic of transmission concerning reference interest rate and foreign exchange reserves changes to a nominal exchange rate movements in the cases of Poland, Czech Republic, Slovakia, Hungary and Republic of Serbia.

Figure 5 The influence of foreign exchange reserves and reference interest rate shocks to nominal exchange rate changes during six months in Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of inflation targeting and flexible exchange rate regimes

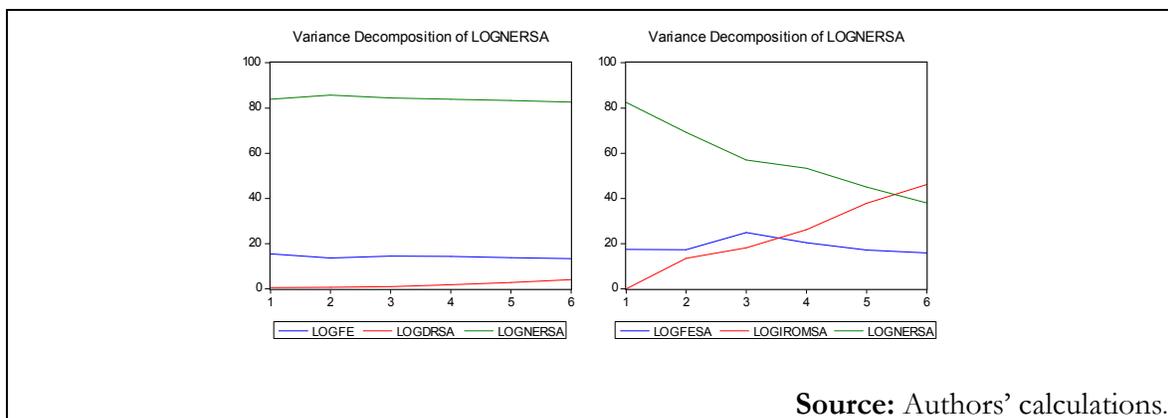Variance Decomposition of LOGNERSA   Variance Decomposition of LOGNERSA
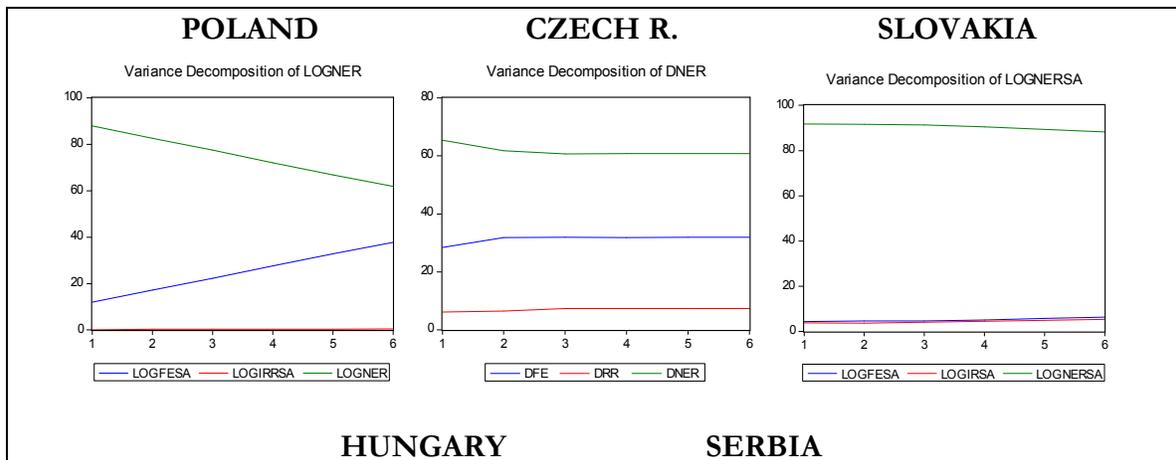
Figure 5 shows the percentage ratio of foreign exchange reserves shock (blue line) and reference interest rate shock (red line) in explaining nominal exchange rate movements (green line) in Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of inflation targeting and floating (managed/free) exchange rate regimes. Under impact of changes (shocks) of reference interest rate and foreign exchange reserves, the ratio of own shocks in explaining of nominal exchange rate variations decreases in all investigated economies. General conclusion is stronger (Poland, Czech Republic, Serbia) or equal (only in the case of Slovakia) impact of foreign exchange reserves changes in the short run compared with the influence of reference interest rates. In the case of Serbia is evident stronger and growing impact of foreign exchange reserves shock compared to interest rate policy, but the ratio of direct and indirect influence is inverted after three and a half months. After three and a half months, the dominant influence is indirect one, through changes of the reference interest rate.

In the case of Poland, a change of foreign exchange reserves, as a variable for direct foreign exchange interventions, explains 12% of nominal exchange rate variations in the first month of the initial shock, while this direct impact is growing over time reaching 38% of nominal exchange rate variations after six months. The impact of reference interest rate shock after six months explains only 0.4% of exchange rate variations, which is inconsiderable compared to direct influence. In the case of Czech Republic direct influence explains 28% of exchange rate variations in the first month and 32% after six months. Indirect influence via interest rate is stronger compared to the Polish case, thus after six months interest rate shock explains about 7% of nominal exchange rate variations. In Slovak Republic, the results point to approximately equal influence of foreign exchange reserves and interest rate shocks in explaining nominal exchange rate variations. Direct influence is growing from 4.35% in the first month to 6.4% after six month, while indirect influence is growing from 3.9% to 5.4%. Concerning the relationship between direct and indirect influence to exchange rate fluctuations, Slovak Republic is an exception having in mind that in other cases direct impact dominates in the first three months. Direct influence via foreign exchange interventions is also stronger in the case of Hungary. While the ratio of foreign exchange reserves in explaining nominal exchange rate variations is about 13%, the ratio of interest rate changes is about 4% six months after the initial shock. However, direct influence doesn't grow during observed six months (as in the case of Poland, Czech and Slovak Republic, and Serbia), but slightly decreases from 15.5% to 13%, while indirect influence slightly grows from 0.6% to nearly 4%. In the case of Serbia, three months after

initial direct/indirect shock, direct influence is stronger, but in the fourth month indirect influence expresses stronger effect to the exchange rate. Namely, changes of foreign exchange reserves explain 17.5% of nominal exchange rate variations in the first month, while reference interest rate changes have no influence to exchange rate fluctuations in the first month. After three months, the influence of foreign exchange reserves shock grows to 25% and interest rate shock to 18%. After six months, indirect influence via reference interest rate dominates explaining 46% of nominal exchange rate variations which is three times stronger impact compared to direct influence via foreign exchange reserves (about 16% of variations).

4. Concluding Remarks: Lessons for Serbian Monetary Policy

Having in mind given results on the base of comparison between the Polish, Czech, Slovak, Hungarian and Serbian cases, managing fluctuations in the case of Serbia is hard, with manipulative elements. Although the crucial economic imbalances are not emphasized here in the paper, the reasons for hard managed floating regime are clear if we take into account: huge and growing current account deficit as an external imbalance (reasons for limiting appreciation pressures), persistent inflationary expectations (reasons for limiting depreciations), relatively high exchange rate pass-through (limiting depreciations), as well as the fact that Serbian economy is highly financially euroized (negative balance sheet effects in the case of significant depreciations). In the short run, foreign exchange interventions are used to manage fluctuations and, in the medium run, interest rate policy as an indirect way of managing fluctuations.

According the results of empirical investigation, **Poland** is most suitable economy (compared to other researched economies) for conducting flexible exchange rate and inflation targeting monetary regimes. Josifidis, Allegret and Beker Pucar (2009a) conclude that Poland has the lowest exchange rate pass-through compared to Slovakia, Czech Republic, Hungary and Serbia. The changes of the nominal exchange rate are the least transmitted to consumer prices, not only in the period of inflation targeting (investigated in this paper), but in previous sub-periods independently from used nominal anchor (exchange rate or inflation target) or exchange rate regime (fixed, intermediate or flexible). Weak exchange rate channel is also the structural characteristic of Polish economy that is confirmed with the lowest index of openess. Relatively lower ratio of import/export activities in GDP points to weaker dependence from world market and relatively closed economy, hence, the narrower space for exchange rate transmission. Since it is possible to allow fluctuation without the fear of significant transmission, there is no need for hard managing the exchange rate fluctuations. Empirical results in this paper confirm the expectation: General impression is that Polish monetary authorities the least manage the exchange rate fluctuations, directly or indirectly.

Conclusions concerning **Slovakia, Czech Republic and Hungary** are not so clear as in the cases of Poland and Serbia. It is certain, however, that the exchange rate transmission is relatively higher with asymmetric character. On this conclusion points the results of exchange rate transmission in different subperiods (investigated in Josifidis, Allegret, and Beker Pucar 2009a), and especially in the phase of nominal exchange rate depreciations when the exchange rate pass-through was the strongest. Compared to Poland, other explored economies have to monitor the exchange rate movements having in mind the influence of

depreciation to prices, i.e. hitting the inflation targets. Besides the exchange rate pass-through results, index of openess for Czech Republic, Slovakia and Hungary is relatively higher, and the space for transmission relatively wider compared to Poland. In Hungary is evident relatively high exchange rate pass-through. Consequently, indirect exchange rate managing is the highest in Hungary with also relatively high level of direct influences to exchange rate. Mentioned findings indicate that Hungarian economy, compared to Poland, Czech and Slovak Republic, is the least suitable for flexible exchange rate regime and inflation targeting, which is one of the reason for delaying and relatively later acceptance of flexible exchange rate.

If managing fluctuations is weaker or soft, the distinction between *de jure* and *de facto* exchange rate and monetary regimes is less emphasized. The results indicate that in the case of Poland the distinction is the least, hence *de facto* is applied managed floating (soft variant) with sub-variant of strict (classic, full-fledged) inflation targeting. From the other side, the distinction between *de jure* and *de facto* monetary and exchange rate regimes is present in the case of Hungary in the sense that *de jure* managed floating is *de facto* manipulative and hard managed floating, and *de jure* full-fledged inflation targeting *de facto* light inflation targeting with the presence of both operative targets.

The empirical results suggest that exchange rate transmission in **the case of Serbia** is the highest compared to former transition economies which have chosen the same monetary path towards the EU and EMU. The strength of the exchange rate channel in monetary transmission mechanism also underlines the pointed conclusion, as well as the indicator of high openess index. Therefore, the achievement of inflation target assumes limiting significant exchange rate depreciations. Besides expressed exchange rate transmission, significant fluctuations are not possible due to the highest level of financial euroization compared to other transition economies. Managing fluctuations is certain and unavoidable respecting the significance of exchange rate for hitting the inflation target and the role of exchange rate in financially euroized economy. The managing is hard, manipulative or dirty. In the circumstances of dominant exchange rate channel, inferior interest rate channel, and manipulative managing fluctuations, it isn't possible to use full-fledged, but initially light inflation targeting. Having in mind perspective on the road towards the EMU and the necessity to target both, exchange rate and inflation within ERM II, it is clear that balancing between two targets will be also necessary in the perspective.

Strong exchange rate channel usually assumes weak interest rate channel. Josifidis, Allegret, and Beker Pucar 2009a confirms the weakness of interest rate channel in Serbia. This could be expected since the interest rate as a key instrument of a monetary policy is *de facto* activated with light inflation targeting adoption and since financial euroization is still high, hence the space for domestic reference interest rate is quite narrowed. Besides the indicators of deposits and credits denominated in euro, compared to total amount of deposits and credits, financial euroization in Serbia is confirmed with the investigation of a credit channel via tracking the Euribor influence to domestic credit activities. The influence of euro-zone interest rate to credit activities in Serbia is the highest in the period of inflation targeting compared to Poland, Czech Republic, Slovakia and Hungary.

The weakness of interest rate and credit channel in the circumstances of high financial euroization in Serbia, indicates that managing exchange rate fluctuations is necessary. The estimation of intensity of managing fluctuations points to hard or manipulative managing. Compared to other investigated economies, the highest usage of interest rate (indirect influence) and foreign exchange reserves (direct influence) in order to limit exchange rate fluctuations is evident in the period of inflation targeting. Concerning that exchange rate

channel is most dominant in the case of Serbia and that this channel is naturally dynamic, the question is which way is the most appropriate to limit exchange rate fluctuations. The empirical research confirms the expectations that direct influence is faster and stronger in the short run in all cases, including Serbia. Although foreign exchange interventions of National bank of Serbia faster and stronger limit exchange rate fluctuations, after certain period (the result indicates after three months), the influence of the interest rate to exchange rate fluctuations prevails. Managing exchange rate fluctuations is conducted as a combination of direct and indirect mechanisms, while the intensity of managing could be regarded as strong or hard.

The current combination of dirty/hard/strong managed floating and light/soft inflation targeting framework is subjected to further changes with the improvements in a transition process. Improvements from the aspect of external/internal balance and the progress on the road towards the EU/EMU, as well as changes concerning exchange rate pass-through and financial euroization, will demand further modifications of managed exchange rate floating and inflation targeting regimes. Namely, further transition progress towards the membership to the EU naturally assumes movements from hard towards soft managed floating and from light to full-fledged inflation targeting. However, after EU joining and the new challenges of monetary convergence (participation to ERM II), target zone will impose new modification of managed floating and inflation targeting sub-regimes. The exchange rate regime will be transformed from flexible towards intermediate form of the target zone, while the full-fledged or strict inflation targeting have to be modified towards flexible inflation targeting.

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APPENDIX

Appendix 1: The symbol, the name, the way of expressing, source and availability of time series used in the research of selected monetary transmission channels in the case of Poland, Czech Republic, Slovakia, Hungary and Serbia

The symbol of the time series	The name of used time series	The way of expressing	Database
Poland 1990:01-2009:01			
CPI	Consumer price index	Index, base year 2000	International Financial Statistics, IMF
NEER[5]	Nominal effective exchange rate	Index, base year 2000	International Financial Statistics, IMF
NER	Nominal exchange rate	Direct noting, zloty/dollar	International Financial Statistics, IMF
FE	Foreign exchange reserves	In millions of dollar	International Financial Statistics, IMF
IRR[6]	Repo interest rate	Yearly percentage rate	International Financial Statistics, IMF
REFR	Refinancing rate of the Polish central bank	Yearly percentage rate	International Financial Statistics, IMF
EURIBOR[7]	Three-month euro-repo interest rate	Yearly percentage rate	International Financial Statistics, IMF
DOMCR	Domestic credit activities	U millions of zloty	International Financial Statistics, IMF
Czech Republic 1993:01-2009:01			
CPI	Consumer price index	Index, base year 2000	International Financial Statistics, IMF
NEER	Nominal effective exchange rate	Index, base year 2000	International Financial Statistics, IMF
NER	Nominal exchange rate	Direct noting, Czech crown/dollar	International Financial Statistics, IMF
DR	Discount rate of the central bank	Yearly percentage rate	The web-site of Czech National Bank
RR[8]	Repo interest rate	Yearly percentage rate	The web-site of Czech National Bank

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[5] Time series of nominal exchange rate zloty/euro aren't available since 1990, while the time series of zloty/dollar aren't adequate for the period after 2000 when the basket structure has been changed in favor of the euro with the approaching the EU membership and preparations for the EMU joining. Therefore, in the empirical research has been used nominal effective exchange rate (NEER) time series in the period of 1990:01-2009:01. Nominal effective exchange rate points to weighted average of zloty exchange rate regarding basket of currencies.

[6] Note: Repo interest rate is available since 1998:01 having in mind the attention of Polish monetary authorities to accept the inflation targeting regime which assumes that reference (repo) interest rate becomes the key instrument of a monetary policy.

[7] The data concerning three-month euro-repo interest rate are available since January 1994.

FE	Foreign exchange reserves	In millions of dollar	International Financial Statistics, IMF
DOMCR	Domestic credit activities	In billions of Czech crowns	International Financial Statistics, IMF
Slovakia **1993:01-2005:11**			
CPI	Consumer price index	Index, base year 2000	International Financial Statistics, IMF
NEER	Nominal effective exchange rate	Index, base year 2000	International Financial Statistics, IMF
NER	Nominal exchange rate	Direct noting, Slovak crown/dollar	International Financial Statistics, IMF
DR	Discount rate of the central bank	Yearly percentage	International Financial Statistics, IMF
FE	Foreign exchange reserves	In millions of dollars	International Financial Statistics, IMF
DOMCR	Domestic credit activities	In millions of Slovak crowns	International Financial Statistics, IMF
Hungary **The period 2001:05-2009:01**			
CPI	Consumer price index	Index, base year 2000	International Financial Statistics, IMF
NEER	Nominal effective exchange rate	Index, base year 2000	International Financial Statistics, IMF
NER	Nominal exchange rate	Direct noting, Hungarian forint/dollar	International Financial Statistics, IMF
FE	Foreign exchange reserves	In millions of dollar	International Financial Statistics, IMF
DR	Discount rate	Yearly percentage	International Financial Statistics, IMF
DOMCR	Domestic credit activities	In millions of forint	International Financial Statistics, IMF
Serbia **2001:01-2009:01**			
CPIS	Consumer price index	Index, base year 2000	International Financial Statistics, IMF
NER	Nominal exchange rate dinar/euro	Dinar/euro (direct noting)	Statistic review, National bank of Serbia
IROMO[9]	Interest rate for open market operations	Yearly percentage rate	Statistic review, National bank of Serbia

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[8] Time series of repo interest rate is available since 1995:01 and has been taken from the database of Czech National Bank web-site.

[9] With the period of preparation for the adoption of full-fledged inflation targeting regime, since September 2006, two-week repo interest rate – reference interest rate.

DR[10]	Foreign exchange reserves	In millions of dollars	International Financial Statistics, IMF
DOMCREDIT	Domestic credit activities	In millions of dinars	International Financial Statistics, IMF
EURIBOR	Three-month repo interest rate of the euro-zone	Yearly percentage rate	International Financial Statistics, IMF

Appendix 2: The results of unit root tests – ADF test

The results of ADF stationarity test in the level and first differences of used time series in the case of Poland, Czech Republic, Slovakia, Hungary and Serbia

Time series	ADF test in the level (constant and trend)	ADF test in the first differences (constant)	Time lag	Critical value α=0.05	Conclusion
Poland 1990:01-2009:01					
CPI	5.473252	-	4	-3.4312	Stationary
NEER	-0.605381	-5.592357	4	-3.4313 (-2.8748)	Non-stationary, I(1)
NER	-0.047071	-5.790466	4	-3.4313 (-2.8748)	Non-stationary, I(1)
FE	-1.841279	-4.927445	4	-3.4311 (-2.8746)	Non-stationary, I(1)
REFR	-3.726328	-	4	-3.4311	Stationary
IRR	-1.715477	-3.434189	3	-3.4458 (-2.8845)	Non-stationary, I(1)
DOMCR	-5.621479	-	4	-3.4313	Stationary
EURIBOR	-2.743919	-2.984912	4	-3.4363 (-2.8781)	Non-stationary, I(1)
Czech Republic 1993:01-2009:01					
CPI	-2.344055	-4.412366	4	-3.4346 (-2.8770)	Non-stationary, I(1)
NEER	-1.945479	-5.278129	4	-3.4348 (-2.8771)	Non-stationary, I(1)
NER	-1.463264	-5.640783	4	-3.4347 (-2.8771)	Non-stationary, I(1)
FE	-3.206506	-6.390050	4	3.4347 (-2.8771)	Non-stationary, I(1)
DR	-2.033729	-4.247958	4	-3.4346 (-2.8770)	Non-stationary, I(1)
RR	-1.907621	-3.452695	4	-3.4398 (-2.8805)	Non-stationary, I(1)
DOMCR	-1.195138	-4.549083	4	-3.4350 (-2.8772)	Non-stationary, I(1)
EURIBOR	-2.743919	-2.984912	4	-3.4363 (-2.8781)	Non-stationary, I(1)
Slovakia 1993:01-2005:11					
CPI	1.562895	-4.921342	4	-3.4347 (-2.8771)	Non-stationary, I(1)
NEER	1.048373	-3.914694	4	-3.4348 (-2.8771)	Non-stationary, I(1)
NER	-0.736637	-5.515829	4	-3.4347 (-2.8771)	Non-stationary, I(1)
FE	-3.514506	-5.675126	4	-4.0098*	Non-stationary, I(1)

[10] Data available from January 2002.

				(-2.8771)	
IR	-2.745550	-4.341709	4	-3.4348 (-2.8771)	Non-stationary, I(1)
DOMCR	-1.529477	-5.176066	4	-3.4351 (-2.8773)	Non-stationary, I(1)
EURIBOR	-2.743919	-2.984912	4	-3.4363 (-2.8781)	Non-stationary, I(1)
Hungary 1990:01-2009:01					
CPI	-2.361511	-3.822972	4	-3.4312 (-2.8747)	Non-stationary, I(1)
NEER	-0.811362	-5.776520	4	-3.4312 (-2.8747)	Non-stationary, I(1)
NER	-0.638540	-6.071468	4	-3.4311 (-2.8746)	Non-stationary, I(1)
FE	-3.397398	-6.394226	4	-3.4316 (-2.8750)	Non-stationary, I(1)
DR	-2.646640	-5.689893	4	-3.4311 (-2.8746)	Non-stationary, I(1)
DOMCR	3.206484	-6.493023	4	-3.4312 (-2.8747)	Non-stationary, I(1)
EURIBOR	-2.743919	-2.984912	4	-3.4363 (-2.8781)	Non-stationary, I(1)
Serbia 2001:01-2009:01					
CPI	-7.529912	-	2	-3.4591	Stationary
NER	-1.084772	-3.731233	2	-3.4591 (-2.8936)	Non-stationary, I(1)
FE	-1.048968	-3.912427	2	-3.4673 (-2.8991)	Non-stationary, I(1)
IROMO	-2.273757	-5.055798	2	-3.4591 (-2.8936)	Non-stationary, I(1)
DOMCR	-2.753453	-5.036522	2	-3.4673 (-2.8991)	Non-stationary, I(1)
EURIBOR	-1.722173	-2.838713	2	-3.4591 (-2.5838)*	Non-stationary, I(1)

Note: Critical values for the first differences are given in paranthesis; * is related to the level of significance α=0.10. Time series are previously logarithmed and deseasonalized before performing the stationarity test.

Appendix 3: The results of Johansen's cointegration test

The results of Johansen's cointegration test on non-stationary time series with exactly one unit root I(1)

The combination of I(1) time series	Lag	Trace statistics (τ statistics)	Critical value 5%	Conclusion
Poland 1990:01-2009:01				
FE and NEER	1_3	23.79741	15.41	1 cointegration equation at the significance level of 5%
		2.969831	3.76	
FE, IRR and NER	1_3	30.21833	29.68	1 cointegration equation at the significance level of 5%
		8.577243	15.41	
		1.268546	3.76	
Czech Republic 1993:01-2009:01				
CPI and NEER	1_4	16.48994	15.41	1 cointegration equation at the significance level of 5%
		0.498169	3.76	
NEER, CPI and DR	1_4	41.49102	29.68	1 cointegration equation at the significance level of 5%
		8.579852	15.41	
		2.442119	3.76	
FE and NEER	1_4	21.32632	15.41	1 cointegration equation at the significance level of
		0.213021	3.76	

				5%
FE, IR and NER	1_4	46.21149	29.68	1 cointegration equation at the significance level of 5%
		7.116871	15.41	
		0.571413	3.76	
Slovakis 1993:01-2009:01				

Slovakis **1993:01-2009:01**				
NEER and CPI	1_4	17.59730	15.41	1 cointegration equation at the significance level of 5%
		0.493991	3.76	
IR, NEER and CPI	1_4	29.90948	29.68	1 cointegration equation at the significance level of 5%
		10.50746	15.41	
		0.582675	3.76	
NEER and FE	1_4	22.44410	15.41	1 cointegration equation at the significance level of 5%
		1.050354	3.76	
Hungary **1990:01-2009:01**				
NEER and CPI	1_4	29.10506	15.41	1 cointegration equation at the significance level of 5%
		1.150940	3.76	
NEER, CPI and DR	1_3	57.53905	29.68	1 cointegration equation at the significance level of 5%
		14.58368	15.41	
		4.089007	3.76	
NEER and FE	1_4	15.89519	15.41	1 cointegration equation at the significance level of 5%
		2.684817	3.76	
FE, DR and NER	1_4	34.98367	29.68	1 cointegration equation at the significance level of 5%
		15.08492	15.41	
		2.022805	3.76	
Serbia **2001:01-2009:01**				
FE and NER	1_2	16.52584	15.41	1 cointegration equation at the significance level of 5%
		2.271667	3.76	
EURIBOR, IROMO and DOMCREDIT	1_2	31.94553	29.68	1 cointegration equation at the significance level of 5%
		9.191269	15.41	
		0.102550	3.76	
FE, IROMO and NER	1_2	35.96477	29.68	1 cointegration equation at the significance level of 5%
		13.71577	15.41	
		2.907620	3.76	

Note: The assumptions of the test – linear deterministic trend in the data. Estimated VEC model is in order 2. Constant is the part of the cointegration relation.

Appendix 4: The results of variance decomposition within VAR/VEC model

Exchange rate pass-through, indirect and direct influence to exchange rate fluctuations, and credit channel, in the period of managed exchange rate floating and inflation targeting regimes in Poland

Shock transmission during 24 months (percentage ratio)	**Exchange rate pass-through**	**Indirect influence to exchange rate fluctuations**	**Direct influence to exchange rate fluctuations**	**Credit channel**
	Transmission of NEER shock to CPI	*Transmission of NEER shock to REFR/IRR*	*Transmission of NEER shock to FE*	*Transmission of EURIBOR shock to DOMCR*
1st month	1.520634	0.069752	0.335224	0.520340
6th month	0.904606	0.585732	0.161026	1.260698
12th month	0.818558	0.587263	0.463380	1.776817
18th month	0.793302	7.835916	0.925674	2.014154
24th month	0.781546	8.330368	1.446956	2.135894

Note: Exchange rate pass-through→ variable ordering NEER-CPI, impulse responses of CPI; indirect influence to NEER → variable ordering NEER-CPI-REFR/IRR, impulse responses of REFR/IRR; direct influence to NEER → variable ordering NEER-FE, impulse responses of FE; credit channel → variable ordering EURIBOR-REFR/IRR-DOMCR, impulse responses of DOMCR.

Exchange rate pass-through, indirect and direct influence to exchange rate fluctuations, and credit channel, in the period of managed exchange rate floating and inflation targeting regimes in Czech Republic

Shock transmission during 24 months (percentage ratio)	Exchange rate pass-through	Indirect influence to exchange rate fluctuations	Direct influence to exchange rate fluctuations	Credit channel
	Transmission of NEER shock to CPI	*Transmission of NEER shock to DR/RR*	*Transmission of NEER shock to FE*	*Transmission of EURIBOR shock to DOMCR*
1st month (1997:12-2001:01)	2.090504 (1.317709)	1.267797 (5.143566)	7.173883	3.274993
6th month (1997:12-2001:01)	0.766756 (47.04658)	1.632316 (81.93783)	16.04633	3.772509
12th month (1997:12-2001:01)	2.066622 (65.97062)	5.209146 (90.25681)	24.10995	3.805342
18th month	3.827606	8.877681	30.80058	3.806462
24 month	5.278379	12.74496	36.35207	3.806474

Note: Exchange rate pass-through→ variable ordering NEER-CPI, impulse responses of CPI; indirect influence to NEER → variable ordering NEER-CPI-REFR/IRR, impulse responses of REFR/IRR; direct influence to NEER → variable ordering NEER-FE, impulse responses of FE; credit channel → variable ordering EURIBOR-REFR/IRR-DOMCR, impulse responses of DOMCR.

Exchange rate pass-through, indirect and direct influence to exchange rate fluctuations, and credit channel, in the period of managed exchange rate floating and inflation targeting regimes in Slovakia

Shock transmission during 24 months (percentage ratio)	Exchange rate pass-through	Indirect influence to exchange rate fluctuations	Direct influence to exchange rate fluctuations	Credit channel
	Transmission of NEER shock to CPI	*Transmission of NEER shock to IR*	*Transmission of NEER shock to FE*	*Transmission of EURIBOR shock to DOMCR*
1st month	0.721297	1.660716	4.238217	0.067819
6th month	3.794384	8.174605	2.832146	0.328382
12th month	7.240321	5.964050	1.575951	0.328409
18th month	10.12596	4.514342	1.061975	0.328409
24.th month	12.31707	3.608723	0.798249	0.328409

Note: Exchange rate pass-through→ variable ordering NEER-CPI, impulse responses of CPI; indirect influence to NEER → variable ordering NEER-CPI-REFR/IRR, impulse responses of REFR/IRR; direct influence to NEER → variable ordering NEER-FE, impulse responses of FE; credit channel → variable ordering EURIBOR-REFR/IRR-DOMCR, impulse responses of DOMCR.

Exchange rate pass-through, indirect and direct influence to exchange rate fluctuations, and credit channel, in the period of managed exchange rate floating and inflation targeting regimes in Hungary

Shock transmission during 24 months (percentage ratio)	Exchange rate pass-through	Indirect influence to exchange rate fluctuations	Direct influence to exchange rate fluctuations	Credit channel
	Transmission of NEER shock to CPI	*Transmission of NEER shock to IR*	*Transmission of NEER shock to FE*	*Transmission of EURIBOR shock to DOMCR*
1st month	2.033334	17.62429	1.219310	0.089330
6th month	12.40917	10.53935	9.867060	3.386903
12th month	21.40839	8.585459	15.32739	3.390335
18th month	26.42024	7.595988	18.50226	3.390354
24.th month	29.34319	7.029353	20.43320	3.390355

Note: Exchange rate pass-through→ variable ordering NEER-CPI, impulse responses of CPI; indirect influence to NEER → variable ordering NEER-CPI-REFR/IRR, impulse responses of REFR/IRR; direct influence to NEER → variable ordering NEER-FE, impulse responses of FE; credit channel → variable ordering EURIBOR-REFR/IRR-DOMCR, impulse responses of DOMCR.

Exchange rate pass-through, indirect and direct influence to exchange rate fluctuations, and credit channel, in the period of managed exchange rate floating and inflation targeting regimes in Serbia

Shock transmission during 24 months (percentage ratio)	Exchange rate pass-through	Indirect influence to exchange rate fluctuations	Direct influence to exchange rate fluctuations	Credit channel
	Transmisija šoka NER na CPI	*Transmisija šoka NER na IROMO*	*Transmisija šoka NER na FE*	*Transmisija šoka EURIBOR na DOMCREDIT*
1st month	13.68096	0.096457	15.85959	1.648291
6th month	38.90179	30.27787	63.38531	7.187812
12th month	39.96571	32.75575	74.61353	9.930609
18th month	40.30910	35.37767	79.48954	11.55502
24th month	40.47336	37.97048	81.91291	12.55374

Note: Exchange rate pass-through→ variable ordering NEER-CPI, impulse responses of CPI; indirect influence to NEER → variable ordering NEER-CPI-REFR/IRR, impulse responses of REFR/IRR; direct influence to NEER → variable ordering NEER-FE, impulse responses of FE; credit channel → variable ordering EURIBOR-REFR/IRR-DOMCR, impulse responses of DOMCR.

Comparison of strength of foreign exchange reserves (FE) and reference interest rate (IRR, RR, IR, IROMO) influences to nominal exchange rate NER in Poland, Czech Republic, Slovakia, Hungary and Serbia in the period of explicit/implicit inflation targeting and managed/free floating

Months	Poland		Czech R.		Slovakia		Hungary		Serbia	
	Shock FE	Shock IRR	Shock FE	Shock RR	Shock FE	Shock IR	Shock FE	Shock IR	Shock FE	Shock IROMO
1st	12.05	0.03	28.42	6.14	4.35	3.86	15.50	0.61	17.51	0.00
2nd	17.09	0.23	31.78	6.45	4.64	3.70	13.61	0.74	17.36	13.44
3rd	22.19	0.22	31.89	7.35	4.62	4.06	14.46	1.07	24.88	18.13
4th	27.64	0.26	31.85	7.35	5.09	4.50	14.35	1.84	20.46	26.22
5th	32.87	0.32	31.89	7.34	5.70	4.94	13.86	2.83	17.15	37.84
6th	37.74	0.42	31.88	7.35	6.39	5.37	13.36	4.07	15.85	46.16

Note: Variable ordering FE – NEER (direct managing via foreign exchange interventions); IRR/RR/IR/IROMO – NER (indirect managing via interest rate).