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# Pass-through ефекат девизног курса на инфлацију у Србији

Снежана Виларет и Мирјана Палић

# Exchange rate pass-through effect on prices in Serbia

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## Pass-through ефекат девизног курса на инфлацију у Србији

Снежана Виларет и Мирјана Палић

**Апстракт:** Циљ ове анализе је био оцена pass-through ефекта девизног курса на инфлацију у Србији. Резултати ADL и VAR методологије указују да је ефектат девизног курса на инфлацију у Србији релативно висок, али као и у случају већине земаља непотпун и мањи од јединице. Иако су оцене непрецизне, крећу се ос 0,3 до 0,7, у зависности од коришћене спецификације модела и обима узорка, у највећем броју случаја, pass-through коефицијент у кратком року је нижи од 0,3, а у дугом року је нижи од 0,6.

**Кључне речи:** pass-through ефекат, девизни курс, инфлација

## Exchange rate pass-through effect on prices in Serbia

Snežana Vilaret and Mirjana Palić

**Abstract:** This analysis aims to quantify features of exchange rate pass-through to inflation for Serbian economy. In summary of our results, ADL and recursive VAR methodologies confirm that pass-through effect in Serbia is relatively high, but, like in most countries, incomplete and well below one. Although, the estimates are very imprecise and range from 0.3 to 0.7, depending on the specification and sample size, the thrust our results suggests that the short term pass-through elasticity is less than 0.3 and the long run elasticity is less than 0.6.

**Key words:** pass-through effect, exchange rate, inflation

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## 1. Introduction

This analysis aims to quantify features of exchange rate pass-through to inflation for Serbian economy. In light of historically strong correlation between exchange rate movements and domestic prices in Serbia it is important to asses the impact of the exchange rate movements on domestic prices, in particular as Serbia moves to an inflation targeting regime[1].

As a developing country with a high share of imports, Serbia is expected to have exchange rate pass-through relative high, compared to developed and more closed economies. Indeed, using post 2001 data, our analysis confirms that pass-through effect in Serbia has been relatively high, but, like in most countries, incomplete and well below one. In general, the pass-through has been as strong as in other transition open economies, and much stronger than in developed countries. The estimates of a short-term pass-through elasticity are below 0.3 and those of a long-term pass-through below 0.6. Though the quality of the estimates is undermined by data quality and structural breaks over the sample period, the estimates come surprisingly robust across different methodologies, specifications and samples used in the analysis.

Impact of exchange rate on prices in literature is known as **pass-through** effect of exchange rate on prices. It is measured as a percentage change of domestic prices developed as a consequence of one-percent change of nominal exchange rate (i.e. as an elasticity). Researchers typically examine various types of pass-through effects: pass-through into imported prices versus CPI, immediate (short-term) pass-through versus long-term pass-through.

Our analysis aims to quantifies the impact of exchange rate movements on different prices in Serbia using two widely applied methodologies: ADL and recursive VAR, which renders our results to international comparisons. As a background, we produce stylized facts allowing a qualitative conjecture about the degree and the speed of adjustment of domestic prices to exchange rate movements.

Using 2001 to 2006 sample period, we applied our methodologies on both seasonally adjusted and unadjusted monthly data, as well as seasonally unadjusted quarterly data[2]. We also tested for robustness of results by playing with the sample size.

In summary of our results, both used methodologies confirm that pass-through effect in Serbia is relatively high, but, like in most countries, incomplete and well

[1] Assessment of the effect of the exchange rate movements on prices is important for the choice of monetary policy regime. Large pass-through effect suggests using exchange rate targeting as a regime of monetary policy, while small pass-through effect suggests using inflation targeting.

[2] We did not find evidence of seasonality in quarterly data.

below one. Although, the estimates are very imprecise and range from 0.3 to 0.7, depending on the specification and sample size, the thrust our results suggests that the short term pass-through elasticity is less than 0.3 and the long run elasticity is less than 0.6. The results from applying the VAR model suggest that pass-through effect of nominal effective exchange rate is most pronounced for tradable goods and producer prices. Large pass-through effect on producer prices indicate a high share of import component in the producer price index. On the other hand, the pass-through of euro exchange rate to core inflation is more pronounced compared to the pass-through to either retail prices or tradable goods, which means that prices of goods and services included in core basket are much more formally or informally indexed to the dinar-euro exchange rate than other prices.

Comparing our results to the empirical evidence of pass-through effect for other countries, we find that the pass-through effect in Serbia is close to that in other transition counties and much larger than in developed countries.

We also compared our results to some empirical evidence for Serbia. For example IMF Country Report (Gorbanyov, 2005) using the period of analysis 2001-2004 obtained a higher long-term pass-through coefficient for core inflation - 0.89, the latest version of IMF Country Report (by Tokhir Mirzoev, 2006) using period January 2003-Jun 2006 obtained 0.75, while Petrovic and Mladenovic (2005) using the period May 2001- September 2005 got results closer to ours.

Finally, by running the analysis on time periods with different exchange rate volatility we found that a higher exchange rate volatility is associated with a weaker pass-through. This is consistent with other findings (e.g. Tokhir Mirzoev, 2006), and could be explained by different perceptions of the persistence in exchange rate movements economic agents held in these two periods.

## 2. Some stylized facts - link between prices and exchange rate in Serbia

The analysis of exchange rate pass-through has to be performed understanding the role of exchange rate and monetary regimes played in affecting the exchange rate and inflation. During 2001 and 2002 exchange rate was used as nominal anchor to prevent prices from accelerating after they surged at the end of 2000. The movement of the dinar in relation to foreign currency was being stabilized for the purpose of eliminating inflationary expectations. The strict exchange rate policy was successful in reducing expectations about inflation in the first stage of transition. From 2003 exchange rate started to depreciate which didn't have immediate impact on headline and core inflation in that year, but in the next year. In 2004 inflation started to increase but slower than exchange rate depreciated, which suggests that depreciation of the exchange rate wasn't the main source of inflation in that year. Depreciation of the exchange rate continued also though the 2005, than stabilized during the

beginning of 2006 after which it started to appreciate. Period of high capital inflows during the last two years was combined with exchange rate flexibility from the end of 2005 and appreciation in 2006, which contributed to disinflation process in the second part of the 2006.

As a way of introduction, we examine the relationship between prices and exchange rate qualitatively, using a set of charts with monthly, quarterly and annual growth rates.

*Figure 1. Monthly growth rates of retail prices and euro exchange rate*

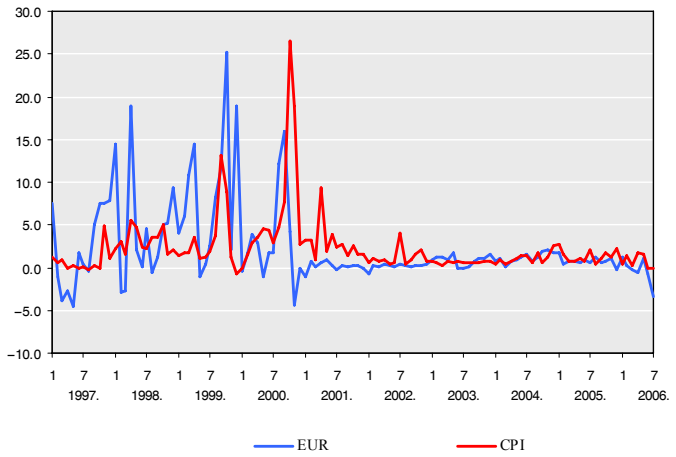



*Figure 2. Quarterly growth rates of retail prices and euro exchange rate*

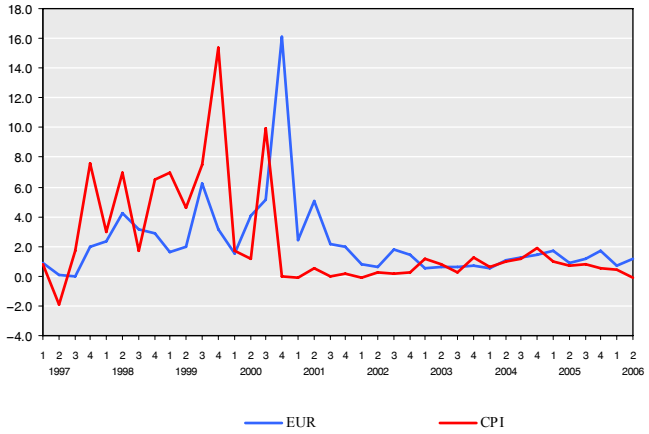
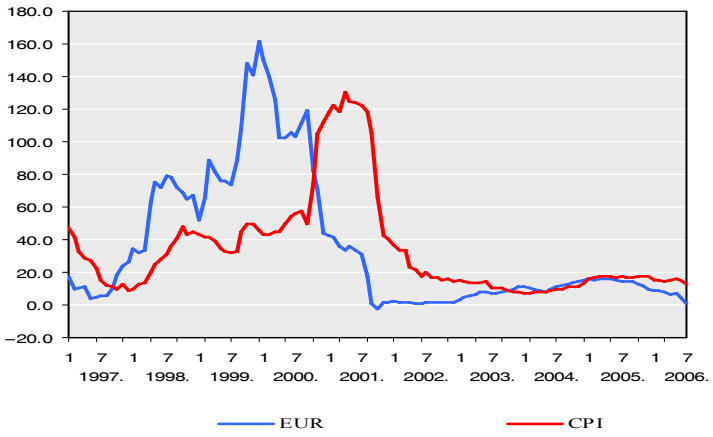



*Figure 3. Annual growth rates of retail price and euro exchange rate*



The link between changes of the exchange rate and prices on monthly bases is not as obvious as in the case when we are observing quarterly and annual growth rates. That can point out long-run relationship between exchange rate and inflation.

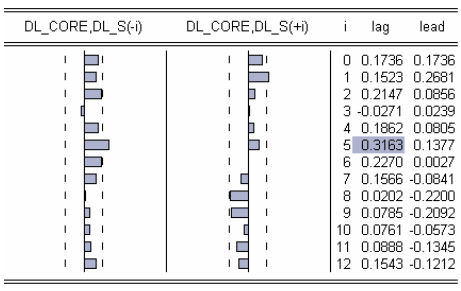
From the graphs we can see that relationship between exchange rate and prices is more obvious in the periods of stronger depreciation of the exchange rate (2003-2005), while in the periods of disinflation and price liberalization (2000-2002) in the beginning of transition process and periods of deceleration of depreciation (from the beginning of 2006) or even appreciation, inflation responds less and with some more time lag in accordance with the changes in exchange rate, which probably reflects sticky price expectations.

Next, we formalize these observations using a simple analysis of moments. The analysis of cross-correlations gives a useful idea about the size of the pass-through and its distribution in time (see tables).

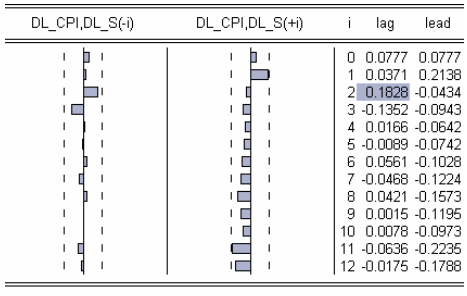
Main conclusions of cross-correlation analysis looking at monthly data are:

- the effect of an exchange rate change is stronger for the core than for headline inflation;
- core inflation is more correlated with the nominal effective than with the Euro exchange rate;
- core inflation reacts to Euro exchange rate with the lag of two months, while in the case of nominal effective exchange rate this reaction is slower (five months);
- correlation between headline inflation and Euro and nominal effective exchange rates is not clear (estimated coefficients of correlation on different lags have both positive and negative signs).

*Table 1. Correlation between nominal effective exchange rate changes and headline and core inflation on monthly basis*

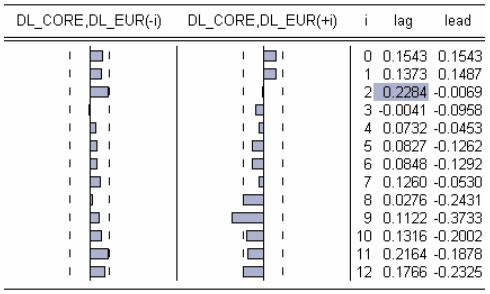


| DL_CORE,DL_S(-i) | DL_CORE,DL_S(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.1736 | 0.1736 |
| | | 1 | 0.1523 | 0.2681 |
| | | 2 | 0.2147 | 0.0856 |
| | | 3 | -0.0271 | 0.0239 |
| | | 4 | 0.1862 | 0.0805 |
| | | 5 | 0.3163 | 0.1377 |
| | | 6 | 0.2270 | 0.0027 |
| | | 7 | 0.1566 | -0.0841 |
| | | 8 | 0.0202 | -0.2200 |
| | | 9 | 0.0785 | -0.2092 |
| | | 10 | 0.0761 | -0.0573 |
| | | 11 | 0.0888 | -0.1345 |
| | | 12 | 0.1543 | -0.1212 |

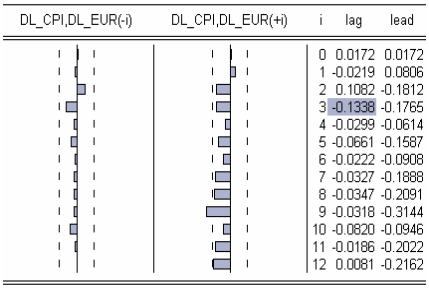


| DL_CPI,DL_S(-i) | DL_CPI,DL_S(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.0777 | 0.0777 |
| | | 1 | 0.0371 | 0.2138 |
| | | 2 | 0.1828 | -0.0434 |
| | | 3 | -0.1352 | -0.0943 |
| | | 4 | 0.0166 | -0.0642 |
| | | 5 | -0.0089 | -0.0742 |
| | | 6 | 0.0561 | -0.1028 |
| | | 7 | -0.0468 | -0.1224 |
| | | 8 | 0.0421 | -0.1573 |
| | | 9 | 0.0015 | -0.1195 |
| | | 10 | 0.0078 | -0.0973 |
| | | 11 | -0.0636 | -0.2235 |
| | | 12 | -0.0175 | -0.1788 |

*Table 2. Correlation between euro exchange rate changes and headline and core inflation on monthly basis*



| DL_CORE,DL_EUR(-i) | DL_CORE,DL_EUR(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.1543 | 0.1543 |
| | | 1 | 0.1373 | 0.1487 |
| | | 2 | 0.2284 | -0.0069 |
| | | 3 | -0.0041 | -0.0958 |
| | | 4 | 0.0732 | -0.0453 |
| | | 5 | 0.0827 | -0.1262 |
| | | 6 | 0.0848 | -0.1292 |
| | | 7 | 0.1260 | -0.0530 |
| | | 8 | 0.0276 | -0.2431 |
| | | 9 | 0.1122 | -0.3733 |
| | | 10 | 0.1316 | -0.2002 |
| | | 11 | 0.2164 | -0.1878 |
| | | 12 | 0.1766 | -0.2325 |

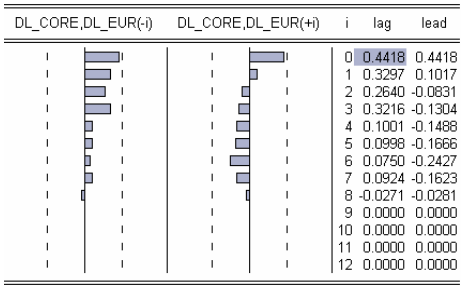


| DL_CPI,DL_EUR(-i) | DL_CPI,DL_EUR(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.0172 | 0.0172 |
| | | 1 | -0.0219 | 0.0806 |
| | | 2 | 0.1082 | -0.1812 |
| | | 3 | -0.1338 | -0.1765 |
| | | 4 | -0.0299 | -0.0614 |
| | | 5 | -0.0661 | -0.1587 |
| | | 6 | -0.0222 | -0.0908 |
| | | 7 | -0.0327 | -0.1888 |
| | | 8 | -0.0347 | -0.2091 |
| | | 9 | -0.0318 | -0.3144 |
| | | 10 | -0.0820 | -0.0946 |
| | | 11 | -0.0186 | -0.2022 |
| | | 12 | 0.0081 | -0.2162 |

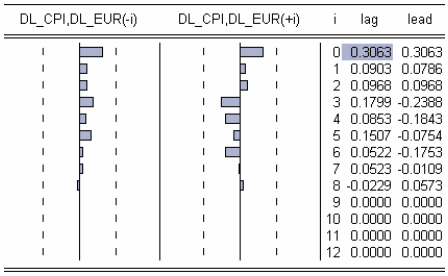
Main conclusions of cross-correlation analysis looking at quarterly data are:

- the effect of an exchange rate change is stronger for the core than for headline inflation;
- both, headline and core inflation are more correlated with the nominal effective than with the Euro exchange rate;
- pretty strong reaction of core inflation to the exchange rate in the same quarter;
- headline inflation has strongest reaction to the exchange rate in the same quarter.

*Table 3 .Correlation between euro exchange rate changes and headline and core inflation on quarterly basis*

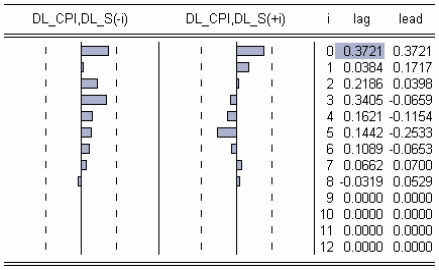


| DL_CORE,DL_EUR(-i) | DL_CORE,DL_EUR(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.4418 | 0.4418 |
| | | 1 | 0.3297 | 0.1017 |
| | | 2 | 0.2640 | -0.0831 |
| | | 3 | 0.3216 | -0.1304 |
| | | 4 | 0.1001 | -0.1488 |
| | | 5 | 0.0998 | -0.1666 |
| | | 6 | 0.0750 | -0.2427 |
| | | 7 | 0.0924 | -0.1623 |
| | | 8 | -0.0271 | -0.0281 |
| | | 9 | 0.0000 | 0.0000 |
| | | 10 | 0.0000 | 0.0000 |
| | | 11 | 0.0000 | 0.0000 |
| | | 12 | 0.0000 | 0.0000 |

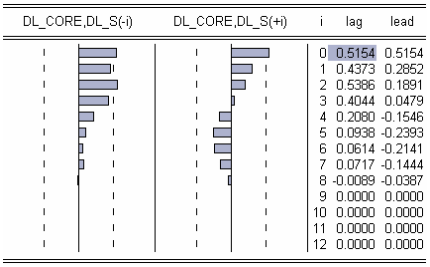


| DL_CPI,DL_EUR(-i) | DL_CPI,DL_EUR(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.3063 | 0.3063 |
| | | 1 | 0.0903 | 0.0786 |
| | | 2 | 0.0968 | 0.0968 |
| | | 3 | 0.1799 | -0.2388 |
| | | 4 | 0.0853 | -0.1843 |
| | | 5 | 0.1507 | -0.0754 |
| | | 6 | 0.0522 | -0.1753 |
| | | 7 | 0.0523 | -0.0109 |
| | | 8 | -0.0229 | 0.0573 |
| | | 9 | 0.0000 | 0.0000 |
| | | 10 | 0.0000 | 0.0000 |
| | | 11 | 0.0000 | 0.0000 |
| | | 12 | 0.0000 | 0.0000 |

*Table 4. Correlation between nominal effective exchange rate changes and headline and core inflation on quarterly basis*



| DL_CPI,DL_S(-i) | DL_CPI,DL_S(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.3721 | 0.3721 |
| | | 1 | 0.0384 | 0.1717 |
| | | 2 | 0.2186 | 0.0398 |
| | | 3 | 0.3405 | -0.0659 |
| | | 4 | 0.1621 | -0.1154 |
| | | 5 | 0.1442 | -0.2533 |
| | | 6 | 0.1089 | -0.0653 |
| | | 7 | 0.0662 | 0.0700 |
| | | 8 | -0.0319 | 0.0529 |
| | | 9 | 0.0000 | 0.0000 |
| | | 10 | 0.0000 | 0.0000 |
| | | 11 | 0.0000 | 0.0000 |
| | | 12 | 0.0000 | 0.0000 |



| DL_CORE,DL_S(-i) | DL_CORE,DL_S(+i) | i | lag | lead |
|---|---|---|---|---|
| | | 0 | 0.5154 | 0.5154 |
| | | 1 | 0.4373 | 0.2852 |
| | | 2 | 0.5386 | 0.1891 |
| | | 3 | 0.4044 | 0.0479 |
| | | 4 | 0.2080 | -0.1546 |
| | | 5 | 0.0938 | -0.2393 |
| | | 6 | 0.0614 | -0.2141 |
| | | 7 | 0.0717 | -0.1444 |
| | | 8 | -0.0089 | -0.0387 |
| | | 9 | 0.0000 | 0.0000 |
| | | 10 | 0.0000 | 0.0000 |
| | | 11 | 0.0000 | 0.0000 |
| | | 12 | 0.0000 | 0.0000 |

In formalizing the correlation analysis further, we estimated the exchange rate elasticity of headline and core inflation using different ECM regression specifications

on several samples. While these regressions are just another possible look at the data properties, their results can be a useful input into the calibration of structural models and for policy inference.

Overall, the results are relatively robust to the sample used and confirm the above conjectures: on monthly data, the core pass-through is weaker than headline, while the opposite is true for quarterly data. The estimates on quarterly data are generally higher than those on monthly, confirming that persistence in the exchange rate movements is an important factor affecting the pass-through.

Using monthly data, of the estimates of the pass-through elasticity vary from 0.3 to 0.68, depending on the sample and number of lags. For example, using monthly data from May of 2001 to June of 2006 we get the pass-through effect on core inflation of 0.2, while that on inflation is 0.7. By shortening the sample to the beginning of 2003, the pass-through coefficient for core remains unchanged, while that for the headline inflation drops somewhat to 0.53.

1) DL_CORE = 0.34*DL_CORE(-1) + 0.20*(DL_EU_CPI+DL_EUR) + 0.02*L_IP_SA_GAP_HP(-1) + 0.34

(sample 2001:m5 2006:m6)

2) DL_CPI=(1-0.67)*DL_CPI(-1)+0.67*(DL_EU_CPI(-1)+DL_EUR(-1))+0.15*L_Z_GAP(-1)+0.35

(sample 2001:m5 2006:m6)

3) DL_CPI=(1-0.53)*DL_CPI(-1)+0.53*(DL_EU_CPI(-1)+DL_EUR (-1))+0.07*L_Z_GAP(-1)-0.02

(sample 2003:m1 2006:m6)

Using quarterly data from the first quarter of 2001 to the second quarter of 2006, for example, we got that pass-through effect on core inflation is 0.4 and using shorter sample, from 2003, that pass-through is 0.6.

4) DL_CORE=0.62*DL_CORE(-1)+(1-0.62)* (DL_EU_CPI+DL_EUR) +0.04*L_IP_SA_GAP(-1)

(sample 2001:q1 2006:q2)

5) DL_CORE=0.42* DL_CORE (-1)+(1-0.42)*( DL_EU_CPI(-1)+DL_EUR(-1))+0.18 *L_IP_SA_GAP(-1). (sample 2003:q1 2006:q2)

Where: DL_CPI - headline inflation, DL_CORE - core inflation, DL_EU_CPI – inflation in EU, DL_EUR – change of euro exchange rate, L_Z_GAP – real exchange rate gap, L_IP_SA_GAP – industrial production seasonally adjusted gap.

## 3. Empirical analysis - ADL and VAR approach

In order to more precisely define pass-through elasticity and compare our results to the results of other countries, we applied ADL and recursive VAR models, two standardized methodologies which are used in most empirical studies of exchange rate pass-through.

### *3.1 ADL approach*

Standard econometric model used to estimate the exchange rate pass-through effect (Devereux et al., 2003) takes the following form (autoregressive distributed lag model):

$$\Delta CPI_t = \alpha + \beta(\Delta NEEK_t + \Delta FXCPI_t) + \sum_{i=1}^{k} \gamma_i \Delta CPI_{t-i} + error$$

where $\Delta CPI$ represents headline inflation measured by retail prices, $\Delta NEEK$ change of nominal effective exchange rate of dinar and $\Delta FXCPI$ foreign basket inflation[3]. Instead of headline inflation, other prices measures may also be used, for example, core inflation.

Short-run exchange rate pass-through is given by the estimate of β, while the long-run exchange rate pass-through is based on the form $\frac{\beta}{1-\gamma_1-\ldots-\gamma_k}$.

Using ADL method we estimated pass-through effect of nominal effective exchange rate on headline and core inflation for monthly seasonally unadjusted and seasonally adjusted data and for quarterly data (only seasonally unadjusted, as no seasonality detected). Sample period runs from January 2001 to June 2006. A dummy variable was included to account for the retail price inflation jump in July, 2002, mostly affected by corrections of electricity prices.

Before estimating the pass-through effect we tested for stationarity of the retail prices, core prices and nominal effective exchange rate on monthly and quarterly bases. Unit root ADF test shows that all mentioned time series are integrated of order one, which means that series of headline inflation, core inflation and exchange rate changes are stationary. Because there is no clear evidence of cointegration between

[3] More datailed description of the data is given in Appendix 1.

prices and exchange rate, we estimated relationship between inflation and exchange rate changes.

### *3.1.1 Monthly data*

Parameters are estimated by ordinary least squares method. Full equation is given in Appendix 1, while estimates of exchange rate pass-through effects are summarized in Table 5.

Table 5. **Estimates of exchange rate pass-through on CPI and CORE using monthly data**

| | CPI | CPI_SA | CORE | CORE_SA |
|---|---|---|---|---|
| Short-run ( | 0.20 | 0.15 | 0.20 | 0.22 |
| Long-run ( $\sum_{i=1}^{k}\gamma_i$ ) | 0.39 | 0.28 | 0.26 | 0.31 |

The results using seasonally unadjusted montly data, point to an incomplete pass-through effect in Serbia, as even in a long term 1% of change in exchange rate doesn't imply 1% change in the price level. The estimate of the short-term exchange rate pass-through coefficient is 0.20 and long-run coefficient is 0.4. These findings means that, in the short term, about 20% of an initial exchange rate shock has been passed through to retail prices and in a long term about 40% of the shock has passed through to retail prices.

Using seasonally adjusted retail prices we got even smaller pass-through coefficients, short run coefficient is 0.15, and long run coefficient is 0.28 .

The same model is used to estimate exchange rate pass-through effect on core inflation. Results show that pass-through effect of exchange rate on core inflation is also incomplete, short run elasticity is 0.20 and long term elasticity is below 0.3.

Overall, the pass-through to headline inflation is in long run more pronounced compared to pass-through to core inflation, and for the short run coefficients are the same.

On the other hand, pass-through effect on seasonally adjusted core inflation is larger compared to the pass-through effect on seasonally adjusted headline inflation.

We tested robustness of pass through coefficients by shortening the sample period. The results suggest that the long term exchange rate elasticity of the headline inflation became smaller with shortening of the sample, while for the short run coefficients remained similar. For coefficints for core inflation pass-through are also stable, both for long and short term.

### *3.1.2. Quarterly Data*

Beside monthly data, we also tried to estimate pass-through effect of exchange rate on inflation using quarterly data. The quarterly data are derived from monthly data, by taking simple averages of the monthly data over each quarter. The sample period runs from Q1 2001 to Q2 2006.

Table 6. **Estimates of exchange rate pass-through on CPI and CORE using quarterly data**

| | CPI | CORE |
|---|---|---|
| Short-run ( | 0.26 | 0.26 |
| Long-run ( $\sum_{i=1}^{m} \delta_i$ ) | 0.50 | 0.40 |

The estimated pass-through effect to CPI is larger than using monthly data. Short run coefficient is about 0.25 and long term is 0.50. If we estimate the pass-through effect on core inflation we got the same results for short term and lower coefficient for long term. The similar results we got for monthly data, in sense that pass-through effect is larger for headline inflation. Since there is no evidence of seasonality in these two series we didn't estimate pass–through effect with seasonally adjusted series.

We compared our results to some empirical evidence. For example, pass-through effect of exchange rate on core prices for Serbia (in Petrovic and Mladenovic, 2005) is similar to our results. Using the same methodology, they obtained the short run pass-through coefficient on core inflation of 0.28 and the long term coefficient of 0.4. On the other hand, our results are completely different to the results presented in IMF Country Report (2005), where pass-through effect, both in short run and in long run is higher and close to 1. Results presented in latest version of IMF Country Report (2006) are closer to ours, but obtained pass-through coefficients are also higher.

We also compared our results to the results for some other transition countries and developing countries that were obtained using the same methodology.

The pass-through effect in Serbia is close to that in other transition counties and much larger compared to the developed countries. In all observed transition countries, except Hungary, the estimated pass-through is quick which suggests that the exchange rate shock has a relatively rapid effect on consumer prices. In all these countries pass-through effect is incomplete, though.

Table 7. **Pass-through effect estimated for different countries using ADL methodology**

| OLS | Serbia | Hungary | Turkey | Romania[1] | Germany | Italy | France |
|---|---|---|---|---|---|---|---|
| Short-run | 0.26 | 0.18 | 0.36 | 0.30 | 0.05 | 0.04 | -0.01 |
| Long-run | 0.50 | 0.48 | 0.51 | 0.48 | 0.13 | 0.11 | 0.11 |

[1)] in estimating pass-through effect is also included period of hyperinflation, pass-through effect is not fully comparable.

### *3.2 VAR approach*

The recursive VAR approach, according to McCarthy (2000), is the other standard methodology of measuring the pass-through that we used. Unlike ADL, it aims at capturing potential interlinkages between the exchange rate and inflation and other variables, thereby hoping to describe (and measure) the exchange rate transmission more realistically. Originally, McCarthy investigates the impact of exchange rate and import prices on producer and consumer prices by estimating a six-variable VAR with the following ordering of the variables: oil price inflation denominated in local currency, output gap, nominal exchange rate, import price inflation, producer price inflation and consumer price inflation. The pass-through coefficient is then defined as the ratio between the cumulative change in the price level and the cumulative change in the nominal effective exchange rate over the same time period, or:

$$PT_{t,t+j} = P_{t,t+j} \big/ E_{t,t+j}$$

where $P_{t+j}$ is the cumulative change in the price level and $E_{t+j}$ is the cumulative change in the nominal exchange rate between months t and t+j.

Because of the endogeneity of the exchange rate reaction after the initial period, the pass through coefficents from the VAR approach cannot be compared to those of the ADL or ECM regressions that assumed a one time change in the exchange rate. This also renders them less useful for structural models and policy inference. On the other hand, there is large literature on other countries using this methodology, enabling a qualitative cross-country comparison.

Our data sample covers the period from January 2001 to June 2006. Pass-through coefficients were obtained from impulse response function using Cholesky decomposition with the following ordering of the variables:

$$\pi_t^{oil} \rightarrow \Delta y_t \rightarrow \Delta e_t \rightarrow \pi_t^{PPI} \rightarrow \Delta m_t \rightarrow \pi_t^{CPI}$$

where $\pi_t^{oil}$ is oil price inflation denominated in local currency, $\Delta y_t$ output gap, $\Delta e_t$ nominal exchange rate changes, $\Delta m_t$ change in broad money, $\pi_t^{PPI}$ producer price inflation and $\pi_t^{CPI}$ inflation measured by retail prices, core prices, tradable good prices, etc.

We obtained relative high values of the pass-through coefficients, indicating a significant influence of the initial shock of exchange rate on retail prices, but also incomplete, as in the case of applying ADL approach. The value of short term pass-through elasticity is around 0.3, and long term around 0.45.

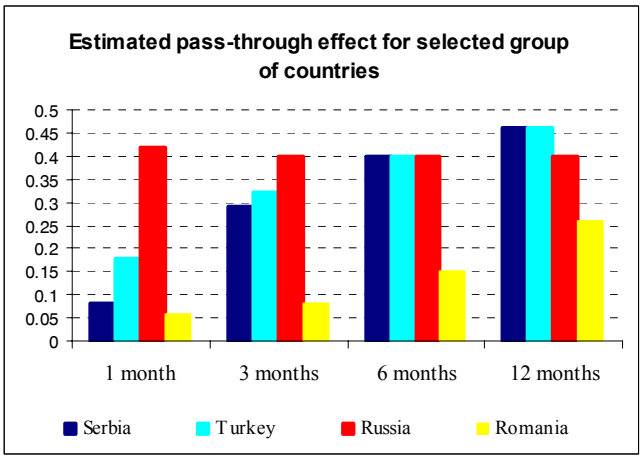
The impact of an exchange rate shock on domestic prices takes place over a year, but is mostly felt in the first three months. Two thirds of total pass-through effect have been reflected into retail prices in the first three months and completed by one year. In the period of six months around 40% initial shock of exchange rate is transmit to retail prices which is almost 90% of total pass-through effect this rate on retail prices. After half a year effect changing rate on retail prices is stabling which proves a small revaluation calculated cumulative pass-through factors. It could say that after half a year prices stopped to react on changing exchange rate.

We adjusted the analysis the pass-through on prices for a shorter sample, from January 2001. until December 2005, with aim to see if influence of exchange rate on prices is getting weaker or stronger, depending on the volatility of the exchange rate (evident especially from the beginning of the year 2006). Results for the shorter period with a lower exchange rate volatility point to a bigger influence of the exchange rate on prices. This appears to correspond to other evidence that the persistence in exchange rate movements is an important factor of an exchange rate pass-through.

Table 8. **Coefficients of variation (in %)**

| Period | **EUR** | **NEEK** |
|---|---|---|
| 2001:01 2005:12 | 13.06 | 8.88 |
| **2001:01 2006:06** | 14.43 | 10.39 |

The next chart puts our results into an international perspective. Comparing with this group of countries we can say that estimated pass-through coefficients for Serbia are not much more different from coefficients obtained in these countries.




All the examined countries have a very fast and strong exchange rate pass-through. In all of them, the bulk of the pass-through takes place in the first four months, and after that, in almost all cases, the pass-through culminates within one year, An interesting example of a country with a very fast and strong pass-through effect is Russia, where biggest effect takes place in the first month.

Using VAR we also tried to measure effect of exchange rate on different price sub-indices: e.g. producer prices, prices of tradable and non-tradable goods, etc.

Results of pass-through coefficients for headline and core inflation obtained from VAR are similar to the results which were got using ADL methodology. Using both methodologies, effect of nominal effective exchange rate is larger for headline inflation compared to core inflation.

Results obtained from VAR show that the pass-through effect of nominal effective exchange rate is more pronounced for tradable goods than for the headline inflation or core inflation, which was expected. The same story goes when it comes to producer prices, probably reflecting a high import component in the producer price index.

Table 9. **Estimated Cumulative Pas-through coefficients (NEEK)**

| | CPI | CORE | Producer prices | Tradable goods | Tradable goods (core) |
|---|---|---|---|---|---|
| 1 month | 0.10 | 0.15 | 0.33 | 0.00 | 0.13 |
| 3 months | 0.30 | 0.24 | 0.36 | 0.46 | 0.61 |
| 12 months | 0.46 | 0.38 | 0.72 | 0.60 | 0.69 |
| Impact of NEEK on prices is over after | 6 months | 9 months | 8 months | 8 months | 5 months |

On the other hand, the pass-through of euro exchange rate to core inflation is more pronounced compared to the pass-through to either retail prices or prices of tradable goods.

Table 10. **Estimated Cumulative Pas-through coefficients (EUR)**

| | CPI | CORE | Tradable goods |
|---|---|---|---|
| 1 month | 0.10 | 0.24 | 0.01 |
| 3 months | 0.16 | 0.41 | 0.20 |
| 12 months | 0.41 | 0.51 | 0.36 |
| Impact of EUR on prices is over after | 6 months | 8 months | 6 months |

## 4. Conclusion

The exchange rate pass-through effect in Serbia is incomplete and well below one (even in the long term it doesn't exceed 0.6), but still relatively high. This means that exchange rate is a very important factor of inflation in Serbia. Relatively high values of obtained pass-through coefficients in our case is not unexpected having in mind that we are small open economy with high concern of import in BDP (import dependence) and high dependence of external tendency and changes of foreign trade balance state (with high trade deficit). Also, relatively high values of pass-through coefficients can be explained with relevance concern of import goods in retail prices structure, low economy competition and high level of eurization which lead to relevant link of movement exchange rate and inflation expectations. However, there are reasons to be cautious in the interpretation of these results. First, we have to take into consideration the structure of our retail price index in which 45% are administratively controlled prices and the fact that our sample period covers the period in which prices are progressively liberalized. So, that could be one reason why we have relatively high pass-through coefficient for retail prices. Second, the share of tradable goods, which are highly dependent on the variability of the exchange rate, in retail price index is relatively high which could be also reason for relatively high pass-through coefficient. Third, the variability of the exchange rate over the most of the sample period is relatively low mostly because of hard managed floated exchange rate regime, which by itself makes it difficult to identify statistically significant relations with other variables. Relatively larger exchange rate movements which are presented since the second half of the last year and especially in 2006 and which are not clearly understood by the public could easily destabilize inflation expectations.

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# Appendix

## Data description

| Name of the series | Notation (dlog values) | Source | Description |
|---|---|---|---|
| Headline Inflation | CPI | National Bank of Serbia | Change in logarithms of retail price index |
| Core inflation | CORE | National Bank of Serbia | Change in logarithms of core price index. Derived from retail prices by eliminating prices fixed administratively and agricultural prices. |
| Nominal effective exchange rate | NEEK | National Bank of Serbia | Weighted monthly average of dinar per euro and dollar rate (70%, 30%). Index above 100 mean appreciation and those below 100 the depreciation of the dinar. |
| Dummy variable | D1 | | Dummy variable takes only non-zero value of actual growth of retail price index in July, 2002 (electricity prices). |
| Dummy variable | D2 | | Dummy variable takes only non-zero value in January, 2005 |
| Foreign (basket) inflation | DLFXCPI | National Bank of Serbia | Includes US CPI and EU CPI with weights 30%, 70%, respectively |

## TABLE 1

Dependent Variable: DLCPI
Method: Least Squares
Date: 08/23/06 Time: 07:56
Sample (adjusted): 2001M05 2006M06
Included observations: 62 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLNNEEK+DLFXCPI | -0.202706 | 0.092334 | -2.195349 | 0.0322 |
| DLCPI(-2) | 0.326406 | 0.059769 | 5.461107 | 0.0000 |
| DLCPI(-3) | 0.150013 | 0.058614 | 2.559325 | 0.0132 |
| D1 | 0.034622 | 0.006013 | 5.758214 | 0.0000 |
| C | 0.004438 | 0.001360 | 3.262579 | 0.0019 |

| | | | |
|---|---|---|---|
| R-squared | 0.532504 | Mean dependent var | 0.011826 |
| Adjusted R-squared | 0.499698 | S.D. dependent var | 0.008272 |
| S.E. of regression | 0.005851 | Akaike info criterion | -7.367281 |
| Sum squared resid | 0.001951 | Schwarz criterion | -7.195737 |
| Log likelihood | 233.3857 | F-statistic | 16.23158 |
| Durbin-Watson stat | 1.846958 | Prob(F-statistic) | 0.000000 |

## TABLE 2

Dependent Variable: DLCPI_SA
Method: Least Squares
Date: 08/23/06 Time: 08:20
Sample (adjusted): 2001M05 2006M06
Included observations: 62 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLNNEEK+DLFXCPI | -0.152995 | 0.080391 | -1.903134 | 0.0621 |
| C | 0.005064 | 0.001183 | 4.281431 | 0.0001 |
| DLCPI_SA(-2) | 0.294502 | 0.053858 | 5.468100 | 0.0000 |
| DLCPI_SA(-3) | 0.148539 | 0.052834 | 2.811435 | 0.0068 |
| D1 | 0.031065 | 0.005226 | 5.944213 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.561045 | Mean dependent var | 0.011873 |
| Adjusted R-squared | 0.530241 | S.D. dependent var | 0.007445 |
| S.E. of regression | 0.005103 | Akaike info criterion | -7.640838 |
| Sum squared resid | 0.001484 | Schwarz criterion | -7.469294 |
| Log likelihood | 241.8660 | F-statistic | 18.21347 |
| Durbin-Watson stat | 1.661496 | Prob(F-statistic) | 0.000000 |

## TABLE 3

Dependent Variable: DLNCORE
Method: Least Squares
Date: 08/23/06 Time: 08:46
Sample (adjusted): 2001M04 2006M06
Included observations: 63 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLNNEEK+DLFXCPI | -0.204897 | 0.093614 | -2.188751 | 0.0325 |
| C | 0.005665 | 0.001252 | 4.523431 | 0.0000 |
| DLNCORE(-2) | 0.229000 | 0.119717 | 1.912838 | 0.0605 |

| | | | |
|---|---|---|---|
| R-squared | 0.131456 | Mean dependent var | 0.008077 |
| Adjusted R-squared | 0.102504 | S.D. dependent var | 0.006394 |
| S.E. of regression | 0.006057 | Akaike info criterion | -7.328704 |
| Sum squared resid | 0.002201 | Schwarz criterion | -7.226650 |
| Log likelihood | 233.8542 | F-statistic | 4.540551 |
| Durbin-Watson stat | 1.300165 | Prob(F-statistic) | 0.014580 |

## TABLE 4

Dependent Variable: DLCORE_SA
Method: Least Squares
Date: 08/23/06 Time: 08:41
Sample (adjusted): 2001M04 2006M06
Included observations: 63 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLNNEEK+DLFXCPI | -0.224551 | 0.086597 | -2.593059 | 0.0119 |
| C | 0.005243 | 0.001204 | 4.352875 | 0.0001 |
| DLCORE_SA(-2) | 0.280745 | 0.115915 | 2.421987 | 0.0185 |

| | | | |
|---|---|---|---|
| R-squared | 0.176567 | Mean dependent var | 0.008141 |
| Adjusted R-squared | 0.149119 | S.D. dependent var | 0.006088 |
| S.E. of regression | 0.005616 | Akaike info criterion | -7.480066 |
| Sum squared resid | 0.001892 | Schwarz criterion | -7.378012 |
| Log likelihood | 238.6221 | F-statistic | 6.432843 |
| Durbin-Watson stat | 1.300149 | Prob(F-statistic) | 0.002943 |

## TABLE 5

Dependent Variable: DLCPI
Method: Least Squares
Date: 08/23/06 Time: 09:16
Sample (adjusted): 2001Q3 2006Q2
Included observations: 20 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLNEEK+DLFXCPI | -0.256341 | 0.139671 | -1.835314 | 0.0851 |
| DLCPI(-1) | 0.502324 | 0.085562 | 5.870862 | 0.0000 |
| C | 0.011482 | 0.004562 | 2.516609 | 0.0229 |
| D1 | 0.031587 | 0.010608 | 2.977565 | 0.0089 |

| | | | |
|---|---|---|---|
| R-squared | 0.700201 | Mean dependent var | 0.035179 |
| Adjusted R-squared | 0.643988 | S.D. dependent var | 0.016095 |
| S.E. of regression | 0.009603 | Akaike info criterion | -6.276530 |
| Sum squared resid | 0.001476 | Schwarz criterion | -6.077384 |
| Log likelihood | 66.76530 | F-statistic | 12.45635 |
| Durbin-Watson stat | 2.469875 | Prob(F-statistic) | 0.000187 |

## TABLE 6

Dependent Variable: DLCORE
Method: Least Squares
Date: 08/23/06 Time: 09:39
Sample (adjusted): 2001Q3 2006Q2
Included observations: 20 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLCORE(-1) | 0.334105 | 0.175484 | 1.903907 | 0.0740 |
| DLNEEK+DLFXCPI | -0.265007 | 0.144642 | -1.832163 | 0.0845 |
| C | 0.012569 | 0.004861 | 2.585649 | 0.0192 |

| | | | |
|---|---|---|---|
| R-squared | 0.332191 | Mean dependent var | 0.022853 |
| Adjusted R-squared | 0.253625 | S.D. dependent var | 0.012232 |
| S.E. of regression | 0.010568 | Akaike info criterion | -6.124525 |
| Sum squared resid | 0.001899 | Schwarz criterion | -5.975165 |
| Log likelihood | 64.24525 | F-statistic | 4.228184 |
| Durbin-Watson stat | 2.286446 | Prob(F-statistic) | 0.032326 |