ESTIMATON OF THE IMPACT OF GLOBAL AND DOMESTIC FACTORS ON INFLATION IN SERBIA

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Estimation of the impact of global and domestic factors on inflation in Serbia

Ana Ivković, Mirjana Miletić, Savo Jakovljević

Abstract: To test the extent to which global and domestic factors have impacted the inflation dynamics in Serbia in the past fifteen years, we have applied three approaches in this paper: 1. the principal component analysis, which allowed us to separate the contribution of global and domestic factors to y-o-y inflation; 2. the estimate of the ARDL model to examine the impact of concrete domestic and global factors on the quarterly inflation rate; 3. the estimate of the SVAR model, based on which we followed the inflation's response to different shocks from the domestic and international environment.
The econometric analysis of the impact of global and domestic factors on inflation in Serbia shows the statistical significance of coefficients for the exchange rate and inflation expectations, indicating the importance of the relative stability of the exchange rate and anchored inflation expectations for domestic inflation. In the period observed, inflation was influenced both by global shocks (rising global primary commodity prices) and domestic factors (dinar's depreciation against the euro). Their influence is different in subperiods. Since the start of 2017, the exchange rate diminished the variability of inflation, while inflation's rise since 2021 is led primarily by global factors.

Keywords: inflation, global factors, domestic factors, principal component analysis, structural VAR
[JEL Code]: C10, C5, E31, E37, E52

Non-Technical Summary

Numerous papers examine the factors behind the inflation dynamics. These factors are usually divided into domestic and global. Understanding them well makes it easier for central banks to adopt optimal monetary policy decisions aimed at achieving the inflation target. Generally, from the aspect of monetary policy, it is necessary to estimate in the best possible way the nature and character of inflationary pressures as they determine both the manner and scope of the monetary policy response. It is important to ascertain whether inflationary pressures originate from the demand or supply side, and whether they are led by domestic or global factors. Also, a clear difference should be made between short-term inflation movements, when inflation and its fluctuations are determined both by shocks in the domestic and international environment. In the medium and long run, inflation is determined mainly by monetary policy, structural factors and medium-term inflation expectations.

The empirical analysis of the impact of global and domestic factors on inflation intensified particularly since the global crisis. Particularly prominent global factors are the impact of globalisation and integration into global supply chains. The analyses also focus on the movement of global primary commodity prices, the degree of integration of the commodity market and the labour force markets through the impact on wage-related pressures. It is also estimated to what extent the cyclical component of inflation is explained by global factors, and to what extent its trend.

Despite numerous papers, the results of empirical analyses do not give unambiguous conclusions in terms of the prevailing factors. As a detailed analysis on a similar topic for Serbia, as far as we know, has not been carried out outside the National Bank of Serbia (NBS), we tested the extent to which global and domestic factors determined the inflation dynamics in Serbia in the past fifteen years.

The results obtained based on the structural VAR model in terms of the impact of global and domestic factors on inflation are largely aligned with the results obtained based on the principal component analysis, which indicates the robustness of the obtained estimates. The econometric estimate of the impact of concrete global and domestic factors on inflation in Serbia, carried out on quarterly data series for the period from Q1 2009 until Q3 2021, indicates the statistical significance of the coefficients for inflation expectations and the exchange rate, signalling the importance of anchored inflation expectations and relative stability of the exchange rate for domestic inflation.

In the 2010–2011 period, as well as during 2012, both global shocks and domestic factors contributed to inflation. In H1 2012, the impact of domestic factors was particularly pronounced. From late 2012 until 2016, global factors had a negative effect on inflation. Since early 2017, the exchange rate diminished the variability of inflation, while since the start of 2019 low and stable inflation was supported by wages in the domestic market as a result of fiscal consolidation. The results of analyses unambiguously show that inflation's rise since 2021 is led primarily by global factors.

In detail, the results of the conducted analyses show that until late 2012 inflation was significantly higher and more volatile than it was the case with the majority of other countries in the sample, primarily in comparison with the euro area, while since late 2013 inflation in Serbia and the euro area is moving at similar levels. In the period before 2013, the nominal depreciation of the dinar against the euro further fuelled the effect of higher import prices based on rising global prices of oil and primary agricultural commodities, as well as an inadequate structure of domestic demand led by the consumption. Since 2013 and until late 2020, the ensured relative stability of the exchange rate and anchored inflation expectations, along with the effects of global factors (lower global prices of primary commodities) were the key factors behind the y-o-y inflation of around 2% on average. The inflation dynamics since early 2021 has been determined by primary commodity prices and halts in global supply chains, i.e. global factors, which, taken together, impacted on the rise in cost-push pressures and producer prices. On the other hand, the preserved relative stability of the exchange rate in Serbia and anchored inflation expectations, including the opened negative output gap, prevented domestic factors from exerting a stronger impact on rising y-o-y headline inflation, while at the same time maintaining core inflation at a lower level than headline inflation.

Contents

1 Introduction

Medium-term price stability is the principal objective of the largest number of central banks in the world. If not explicitly defined as the principal objective, it is certainly on the list of key objectives. The possibility of proper inflation forecasting is exceptionally important for the conduct of monetary policy that has defined its objective as such, which also implies the indispensability of quality identification of factors impacting inflation. Why? The isolation of factors determining the dynamics of domestic inflation makes it easier for central banks to adopt reasonable, timely and optimal monetary policy decisions aimed at achieving the inflation target. This is particularly important for central banks pursuing inflation targeting regimes, where inflation is the main or only numerical target of monetary policy. It is even more important for small and open economies which foster strong trade and financial links with other countries and which are, in the nature of things, exposed to external shocks.

According to economic theory, **in the medium and long run** inflation is mainly determined by monetary policy, structural factors and inflation expectations. **In the short run**, its movement and fluctuations are also determined by shocks in the domestic and international environment. The **domestic factors** impacting inflation are: the relation between domestic aggregate supply and demand, i.e. the phase of the economy's business cycle; unit labour costs; government measures concerning administered price changes; import and export limitations through customs, levies etc.; the level of profit margins which reflect cost-push pressures and the degree of market competition; weather conditions impacting the success of the agricultural season and, by extension, food prices; and other factors. The nominal exchange rate also plays an important role as it can amplify or diminish the effect of import prices on domestic inflation, particularly in case of small and open economies. **Inflation factors from the international environment** are also numerous. The speed of global economic growth, primarily the economic growth of countries that are the most important trade partners, can have a *direct* impact on domestic inflation – through higher/lower import prices, and higher/lower demand for domestic goods, as well as an *indirect* impact – through the impact on global primary commodity prices and capital flows in the international financial market. Important factors behind domestic inflation are also global primary commodity prices (energy, metals, agricultural products) which, in addition to the speed of global economic growth, may also be impacted by numerous supply- and demand-side factors, as well as geopolitical tensions. The impact of global primary commodity prices on domestic prices is direct – as in the case of petroleum product prices, or indirect – through higher or lower production costs. International factors which may impact domestic inflation also include the monetary policies of leading central banks, global capital flows that are significantly impacted by those monetary policies, the global risk premium and many other factors.

The impact of global factors became particularly pronounced with the process of globalisation and the increasing integration of countries in global production chains. **Some economists estimate that inflation is largely a global phenomenon** [Ciccarelli and Mojon, 2010; Borio et al., 2017; Carney 2017] and that **globalisation, as a structural factor, makes domestic inflation less dependent on limitations originating from production capacities in the domestic market**. Globalisation influences domestic inflation as it leads to higher trade openness of a country, which results from greater economic integration and lower labour costs.

According to the estimate of the European Central Bank (ECB) [ECB 2017], this further contributes to a higher degree of synchronisation of inflation across countries because, in the event of a sudden rise in demand in the domestic market, it will be compensated for by higher import rather than higher prices. Pressures on domestic inflation diminish through this channel. Moreover, wages and prices are less sensitive to changes in domestic demand in those branches of industry which are exposed to strong external competition.

Sluggish global economic growth in the years after the global financial crisis of 2008, falling global primary commodity prices, inflation expectations anchored at levels significantly below the inflation targets of central banks of a large number of countries in the world, despite their exceptionally accommodative monetary policies (accommodation was carried out both through conventional and unconventional measures), and technological innovations support the claim that global factors led to inflation trending very low in advanced economies since 2013. They are also stated as the factors leading to the weakening of the link between domestic inflation and domestic demand, i.e. a reduced slope of the Phillips curve. **On the other hand, numerous empirical analyses confirm that the importance of domestic factors, despite the effect of globalisation, has not diminished and is not negligible [Rieth, 2015; IMF WEO, 2018; ECB 2017; Bobieca and Jarocinski 2017].**

From the aspect of monetary policy, it is necessary to estimate, in the best possible way, the nature and character of inflationary pressures, as they determine the manner and scope of the monetary policy response. The scope of the response also depends on whether inflationary pressures originate from the supply or demand side, and on whether inflation is driven by global or domestic factors. It is generally true that monetary policies are more efficient when inflationary pressures are generated on the demand side and when they are led by domestic factors. For instance, in conditions when inflation was dominantly influenced by global factors (notably global primary commodity prices), which are usually temporary, a large-scale response can be a challenge for monetary policy in terms of the preservation of price stability once global conditions change. For a central bank to estimate the potential effects of a monetary policy response on overall macroeconomic stability, and to decide whether it should respond and to what extent, it should identify the factors, as well as the character, strength and duration of inflationary pressures. The analyses presented in this paper rely on these considerations.

To test the degree to which global and domestic factors determined the inflation dynamics in Serbia in the past years, we applied three approaches: 1. the principal component analysis, which enabled us to separate the contribution of global and domestic factors to y-o-y inflation for the period from 2007 until October 2021; 2. the estimate by the ARDL model in order to examine the impact of concrete domestic and global factors on the quarterly inflation rate, and; 3. the estimate of the Structural Vector Autoregression (SVAR) model, based on which we observed the inflation's response to various shocks from the domestic and international environment.

The paper consists of four chapters. The introduction is followed by an overview of empirical literature on this topic, with a special emphasis on emerging countries. The following chapter elaborates on the methodology used in the analysis. The third chapter

describes the data series used in the analysis and presents the results of the empirical analysis. The last chapter consists of final considerations.

2 A brief overview of empirical literature

The empirical analysis of the impact of global and domestic factors on inflation intensified particularly since the global crisis, though this topic was relevant even before the crisis, primarily for advanced economies [Ciccarelli and Mojon, 2005; Fisher, 2006; Yellen, 2006; Bernanke, 2007; Borio and Filardo, 2007 et al.]. After the global economic crisis, the influence of global factors on inflation was increasingly becoming the subject of empirical analyses, **but the results obtained do not lead to unambiguous conclusions**. When it comes to global factors, empirical analyses particularly emphasize the impact of globalisation and integration into global supply chains on a reduction in inflation. One group of papers, however, does not test directly the impact of globalisation on inflation. By applying the principal component analysis or the dynamic factor model, the authors of these papers give the estimate of the global common factor assumed to be the effect of globalisation [Hakkio, 2009; Ciccarelli and Mojon, 2010; Neely and Rapach, 2011 et al.]. **The results of these studies mainly indicate that global factors largely explain inflation, but the results in terms of the strengthening or weakening of the role of global factors with the lapse of time are uneven. In addition, based on these studies, it is not possible to clearly determine the exact global factor that influences inflation, i.e. whether it is the global prices of primary commodities, a higher degree of trade integration, similar responses of central banks, or something else.** For instance, Ciccarelli and Mojon (2010) determined that around 70% of inflation variability in OECD countries can be explained by the effect of a single joint factor, but the authors do not analyse in detail the global factor that determined inflation, or perhaps a higher degree of synchronisation of inflation by country is the result of synchronised monetary policies of these countries.

According to the ECB (Economic Bulletin 2017), the estimates of the role of the global factor largely **depend on the type of the sample and the output gap measure used in the analysis**, which is why it is no surprise that different results are obtained. According to the results of this study for the euro area, the impact of global and domestic factors on inflation varies over time. Global factors gave the key contribution to inflation's slowdown in 2008–2009, while domestic factors had a stronger influence during 2012–2015. The most relevant global factor were global primary commodity prices, while a higher degree of integration of the commodity and labour force markets had an impact on wage-related pressures. However, according to the results of the estimated Phillips curve, the slowdown in global economic growth and integration in global production chains account for euro area inflation only to a lesser degree.

The impact of global and domestic factors on inflation was empirically tested for CSEE countries as well [Krusper, 2012; Alexova, 2012; Macchiarelly, 2013; Pop and Murarasu, 2018; Halka and Kotlowski, 2016; Nagy and Tengely, 2018; Jovičić and Kunovac, 2017]. Pop and Murarasu (2018) estimated the impact of global and domestic shocks on inflation in Romania by applying the Bayesian VAR model. They concluded that inflation dynamics is

determined by both global and domestic factors, with the former ones contributing more to its slowdown as of 2013. Jovičić and Kunovac (2017) obtained similar results for Croatia. Also, Nagy and Tengely (2018) concluded that global factors were the key factors contributing to inflation in Hungary after 2012. On the other hand, Halka and Kotlowski (2016) showed that domestic factors (output gap) have a significant influence on inflation in the Czech Republic and Poland, and that the impact of global factors which are not related to global primary commodity prices is diminishing.

One group of empirical papers rely on the estimate of the New Keynesian Phillips curve [Auer et. al., 2017; Bems et. al. 2018; IMF WEO 2018; Forbs 2019]. According to the results of the analysis by Bems et. al. (2018), carried out for the group of 19 emerging economies for the 2004–2018 period, the key factor behind inflation's departure from the target are longer-term inflation expectations, while the impact of global factors is less significant. This further means that domestic factors were the key contributor to inflation's slowdown since the mid-2000s and that central banks still have a strong control over inflation. The IMF's analysis [IMF WEO 2018] by Bems et. al. contains a concrete estimate that global factors account for 5–15% of inflation's departure from the target, while the rest is owed to domestic factors. Even if it is assumed that the entire residual of the estimated link concerns unidentified foreign factors, the average contribution of foreign factors to core and headline inflation equals 26% and 44%, respectively, which is still less or the same as in the case of domestic factors (68% core and 44% headline inflation). According to Forbs 2019 results, **the impact of global factors on headline inflation gained in strength since the global economic crisis, primarily factors not related to global oil prices, which explain the cyclical component of inflation to a larger, and its trend to a lesser extent**. As indicated by the results obtained, although the link has weakened, domestic demand still has a significant role in explaining inflation, primarily core inflation.

Several recent empirical analyses examined the impact of global and domestic shocks on inflation by using the SVAR, Bayesian VAR [Maćkowiak, 2007, Globan et al., 2015, Bobeica and Jarocinski, 2017] or FAVAR methodology [Aastveit et al., 2011; Kamber and Wong, 2018; Ha et. al., 2019)]. The results of these analyses show that global factors have an important impact on inflation dynamics, but some of them also confirm the importance of regional and domestic factors. For instance, Maćkowiak (2007) showed that around 50% of inflation variability for the group of emerging economies (Latin America and Asia) can be explained by external shocks. Aastveit et al. (2011) believe that between 50% and 80% of the inflation forecast error variance can be explained by external shocks. The results of the analysis by Kamber and Wong (2018) show, on the example of Asian countries, that global factors have a greater impact on inflation's departure from the trend than on the trend itself. Global primary commodity prices play an important role and inflation targeting as a monetary strategy contributes to the reduction in the impact of global shocks on inflation. However, Ha et. al., 2019 showed that **despite the growing importance of global factors for inflation, domestic factors are providing the key contribution to inflation in emerging and developing economies (around three quarters of the contribution originates from domestic factors), while the impact of global factors is more important in advanced economies due to strong trade links**. Bobeica and Jarocinski (2017) show that domestic factors have also provided a significant contribution to disinflation in euro area countries as of 2013.

As far as we know, a similar analysis for Serbia outside the NBS has not been carried out or is not available to us. We therefore believe that the key contribution of this paper to empirical literature is to present results for Serbia.

3 Methodology used in the analysis

We estimated the impact of global factors on inflation in Serbia first by applying the principal component analysis. This method is a statistical technique used to diminish the dimensionality of the dataset which contains a large number of mutually related variables – in our case, the data series for y-o-y inflation rates for a large number of countries. This is obtained by calculating the new set of uncorrelated variables, which are called the principal system components. The first component covers the largest part of the variance of original data series, and each following component covers the largest part of the remaining variance. Components are mutually uncorrelated, which enables the cumulation of each of their contributions.

Individually observed, the **principal component** can be presented as a linear combination of original variables as they are weighted by relevant values of characteristic vectors:

$$Z_1 = a_1^T X = a_{11} X_1 + a_{12} X_2 + \ldots + a_{1p} X_p, \quad (1)$$

where Z_1 is the first principal component, coefficients $a_{11} \ldots a_{1p}$ are the values of relevant characteristic vectors, and $X_1 \ldots X_p$ is the sample of p variables. In other words, based on the vectors of characteristic values obtained from the correlation matrix of Σ variables, we determined the share of each variable in a specific component. The second principal component is obtained as a linear function $a_2^T X$ uncorrelated with $a_1^T X$.

One of the most important questions in carrying out this statistical procedure is the choice of the optimal number of principal components. Their total number may equal the number of data series used in the analysis. For instance, Kaiser (1960) suggests that it is necessary to include only those components that have a higher eigenvalue than one, i.e. whose variance is higher than the variance of original variables. According to Beck et al. (2006), it is necessary to include those components which, taken together, account for minimum 75% of the total variance.

We decomposed the y-o-y inflation rate by applying the approach used by Krusper (2012) on the example of Hungary, following the methodology of Stock-Watson (2002). This methodology is based on the application of a two-stage procedure in singling out external and domestic factors of inflation. In the first step, we used the series of y-o-y inflation rates for a larger number of countries, from which the global (common) factor is singled out by applying the principal component analysis. In the second step, we again applied the principal component analysis to the series of residuals obtained from the estimated relationship between y-o-y inflation rates for a smaller group of countries and the global factor obtained in the first step. In this way, we obtained the so-called regional factor. We then estimated the **link between the y-o-y inflation rate (π_t) for a concrete country (in our case Serbia) and global (f_t) and**

regional factors (r_t), while the residuals from the obtained link in that case are the contribution of domestic factors (ε_t), as shown in the following equation:

$$\pi_t^* = \beta_1 f_t + \beta_2 r_t + \varepsilon_t. \quad (2)$$

The principal component analysis is applied on standardised y-o-y inflation rates:

$$\pi_t^* = \frac{\pi_t - \mu}{\sigma} \quad (3)$$

where μ is the arithmetic mean, and σ is the standard deviation of the series of y-o-y inflation for the entire period observed. As the principal components are calculated based on the correlation matrix, whereby the variances of variables can significantly influence the results obtained, we standardised the original data series in order to avoid that variables with a higher variance have a higher share in the principal components.

Global and regional factors obtained based on the principal component analysis cannot be clearly economically identified, although a degree of correlation can be observed on the basis of comparison of their movement with concrete global factors (such as global primary commodity prices or euro area inflation). It is in this way possible to indirectly determine the impact of concrete factors represented by such estimated global or regional factor.

To identify global and domestic factors determining inflation in Serbia, we also carried out the econometric estimate of the link between inflation and a different set of factors from the domestic and international environment. The analysis was done using ARDL (*autoregressive distributed lag*) method, which is a linear regression form of the dependent variable y_t with itself from p previous periods and with the set of k explanatory variables $(x_1, x_2, \dots x_k)$ and their lags for $(q_1, q_2, \dots q_k)$ period. General form of ARDL (p, $q_1, q_2, \dots q_k$) model is given by:

$$y_t = c + \sum_{i=1}^{p} \psi_i \, y_{t-i} + \sum_{j=1}^{k} \sum_{lj=0}^{qj} \beta_{j,l_j} \, x_{j,t-lj} + \epsilon_t, \quad (4)$$

where δ_i are the coefficients associated with the dependent variable on the different lags and $\beta_{j,lj}$ are coefficients for the explanatory variables $(x_1, x_2, \dots x_k)$ on the different lags. ARDL method is suitable for estimating links between series with I(0) or I(1) level of integration, and that it allows a different number of lags for different explanatory variables.

Previous model can be transformed into the error correction form as:

$$\Delta y_t = c - \psi(1) y_{t-1} + \sum_{j=1}^{k} \delta_j(1) \, x_{jt-1} + \widetilde{\psi}(L) \Delta y_{t-1} + \sum_{j=1}^{k} \tilde{\beta} \, j \Delta x_{jt-1}) + \sum_{j=1}^{k} \beta_j(L) \, \Delta x_{jt} + \epsilon_t. \quad (5)$$

If *Bound* F test confirms long run relationship between the variables, one should estimate model presented in equation (5), while in the case of no cointegration *OLSM* (ordinary least square method) is adequate, with the series put in stationary form.

In our case using *ARDL* model **the following equation will be estimated:**

$$\Delta \ln prices_t = \psi(1) lnprices_{t-1} + ln \sum_{j=1}^{k} \delta_j(1)\, X^*_{jt-1} + \widetilde{(\psi}(L) \Delta lnprices_{t-1} + + \sum_{j=1}^{k} \tilde{\beta}_j(L)\, \Delta X^*_{jt-1}) + \sum_{j=1}^{k} \beta_j\, \Delta X^*_{jt} + c + \varepsilon_t \quad (6)$$

where $\pi_t = \Delta \ln prices_t$ is actually quarterly inflation rate and X^*_t is set of factors from the domestic and international environment.

In the third part of the empirical analysis, we identified shocks from the international and domestic environment which influence inflation variability in Serbia by applying the following multidimensional SVAR model:

$$A_0 y_t = c + \sum_{i=0}^{p} A_i y_{t-i} + u_t \quad (7)$$

where y_t is the vector of endogenous variables and u_t is the vector of uncorrelated random shocks.

The reduced form of the VAR model can therefore be presented as follows:

$$y_t = A_0^{-1} c + \sum_{i=0}^{p} \Phi_i y_{t-i} + \varepsilon_t \quad (8)$$

where $\Phi_i = B\mathrm{A}_i$, $\varepsilon_t = \mathrm{B}u_t$, $\mathrm{B}=A_0^{-1}$ and ε_t are a reduced form of model errors.

There are several ways of setting limitations in order to identify and estimate the SVAR model, and we shall use here the conditional (recursive) form, by setting the limitation that matrix B has a shortened diagonal form, so that $\Sigma = \mathrm{E}(\varepsilon\varepsilon') = BB'$, where Σ is the error covariance matrix ε_t. For instance, in the model with p variables, the following limitations were set:

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \dots \\ \varepsilon_p \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & & 0 \\ b_{2t} & b_{22} & \dots\dots\dots & 0 \\ \dots & \dots & & \dots \\ b_{p1} & b_{p2} & & b_{pp} \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \\ \dots \\ u_p \end{pmatrix} \quad (9)$$

The limitations set in such way indicate that the first-ranked variable responds to shocks of other variables in the model with a lag, i.e. the shocks of other variables in the model do not have a simultaneous impact on this variable. Such approach is identical to the *Choleski* decomposition – when calculating the function of the response to impulses and decomposition of variances, the so-called most exogenous variables are ranked the first, in our case factors from the international environment, and finally the variables such as the exchange rate and interest rates that a central bank can influence.

4 Data used in the analysis and results of the empirical analysis

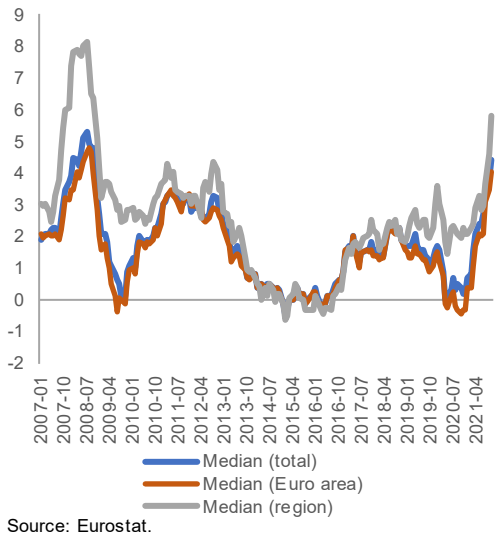
The estimate of the contribution of the global, regional and domestic factors to y-o-y inflation by applying the principal component analysis was conducted using monthly data series of standardised y-o-y inflation rates, for the period January 2007 – October 2021, for 33

European countries, including Serbia.[1] Data about the change in the Harmonised Index of Consumer Prices (HICP) from Eurostat's database were used as a measure of inflation, whereby the comparability of data by country was ensured. The sample included advanced European countries, countries in the Central and South-East Europe (CSEE) region and Turkey.

Based on standardised series (equation 3), we noted that y-o-y inflation rates in CSEE countries in the observed period were high in the following periods: 1. from mid/end-2007 and during the major part of 2008; 2. since mid-2010 until mid-2011; 3. during the major part of 2012, and; 4. in 2021. As these were also the periods when the global prices of oil and/or primary agricultural commodities recorded significant growth, it is clear that global factors had an important impact on inflation in these countries.

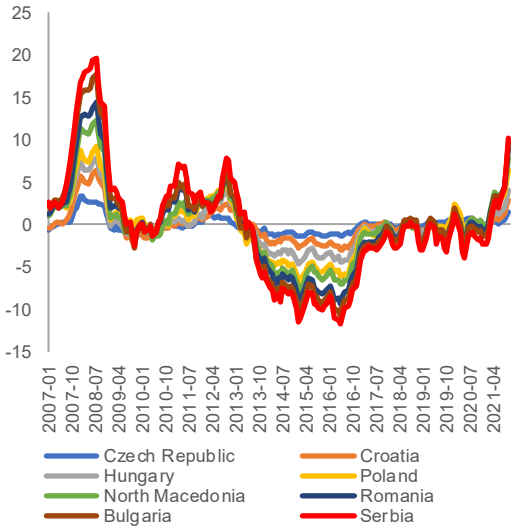
Still, there are differences in inflation rates, and **during the major part of the observed period, in countries of our region y-o-y inflation recorded higher rates, indicating that domestic or regional factors also had a significant influence on inflation dynamics in observed countries.**

Chart 1 **Y-o-y inflation measured by HICP** (in %)



Source: Eurostat.

Chart 2 **Inflation movements in regional countries** (standardized y-o-y rates, in %)

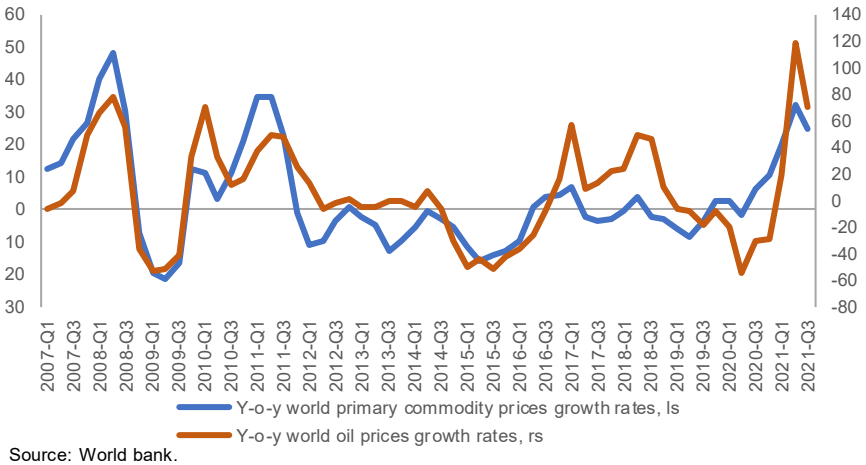


Source: Eurostat.

[1] See the Annex for details.

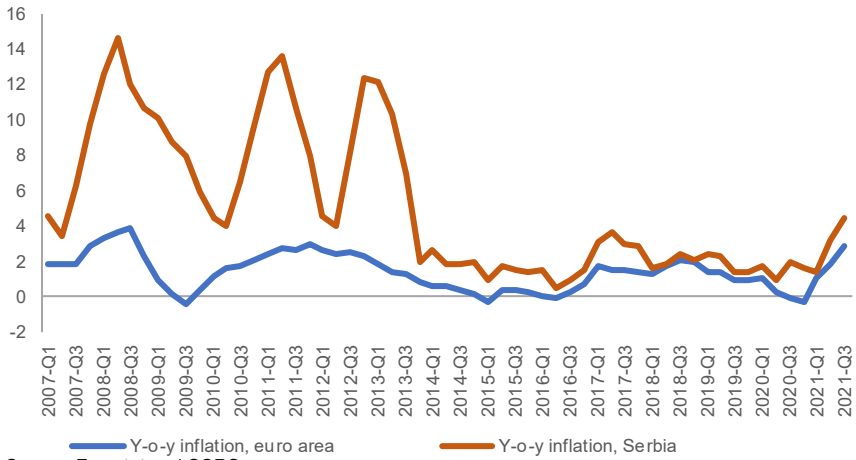
Speaking about inflation in Serbia specifically, until end-2012 it was much higher and more volatile than in the majority of other countries, notably compared to the euro area, while as of end-2013 inflation in Serbia and in the euro area has trended at similar levels.

Chart 3 **World oil and primary agricultural commodity prices**
(USD)



Source: World bank.

Chart 4 **Inflation movements in Serbia and euro area** (in %)

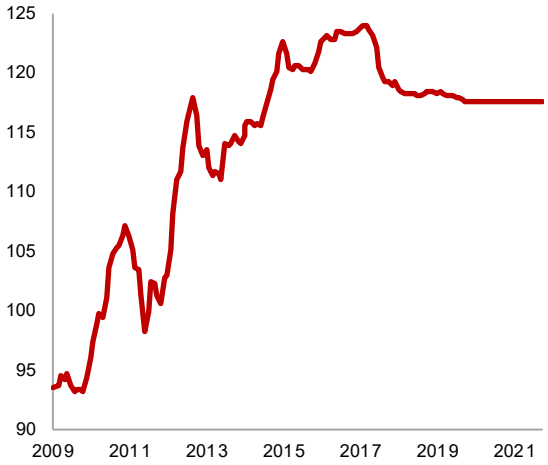


Source: Eurostat and SORS.

The significantly higher inflation in Serbia in the period before 2013 was also under the influence of the nominal depreciation of the dinar against the euro, which additionally amplified the effect of higher import prices on account of the hike in the global prices of oil and primary agricultural commodities. Conversely, the ensured relative stability of the exchange rate and anchored inflation expectations, together with the effects of global factors (lower global prices of primary commodities), were the key factors contributing to the y-o-y inflation from 2013 until end-2020 averaging around 2%.

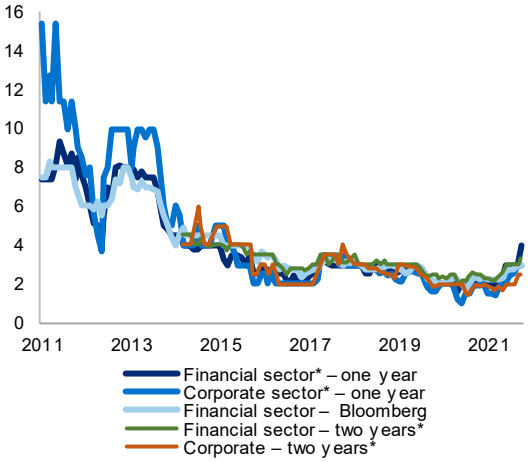
For the sake of a more detailed estimate and quantification of the impacts of global and domestic factors on inflation dynamics, we conducted an in-depth empirical analysis.

Chart 5 **Dinar exchange rate**
(EUR/RSD, monthly average*)



Source: NBS.
* 1 EUR in RSD.

Chart 6 **Inflation expectations**
(y-o-y rates, in%)



Sources: Gallup, Ipsos/Ninamedia, Bloomberg and NBS.

* Ipsos and Gallup until December 2014, Ninamedia since December 2014, and Ipsos since January 2018.

First, by applying the principal component analysis, we extracted the effect of the so-called global factor from 33 time series of standardised y-o-y inflation rates, representing a common trend in the movement of series of y-o-y inflation rates. The results of the analysis indicate that the first principal component explains around 62% of the total variance (Table 1). The values of the eigenvector for the first component are relatively close for all observed countries, excluding Ireland, Poland, and Turkey, where the values are higher in the case of the second and the third principal component. This means that inflation rates of the majority of observed countries were included in the calculation of the first common factor with similar weights.

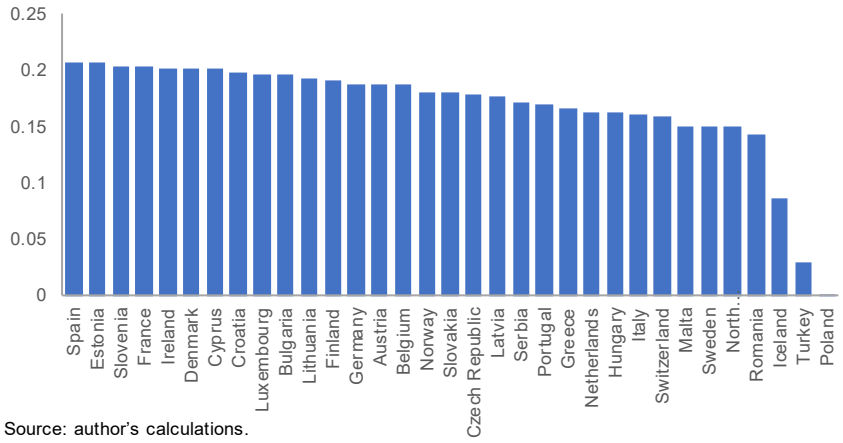
Table 1 **Eigenvalues of correlation matrix and cumulative proportion of variance of y-o-y inflation for 33 countries**

Number of components	Value	Diffrerence	Proportion	Cumulative value	Cumulative proportion
1	20.35	17.70	0.62	20.35	0.62
2	2.65	0.42	0.08	23.00	0.70
3	2.23	0.66	0.07	25.23	0.76
4	1.57	0.26	0.05	26.80	0.81
5	1.31	0.17	0.04	28.11	0.85
6	1.14	0.45	0.03	29.25	0.89

As the first three principal components explain more than 75% of the total variance, we kept them for the estimate of the global factor. Individual percentages of explanation of the total variance were used as weights with which these components entered the calculation of the global factor. The global factor estimated in this manner is presented in Chart 8.

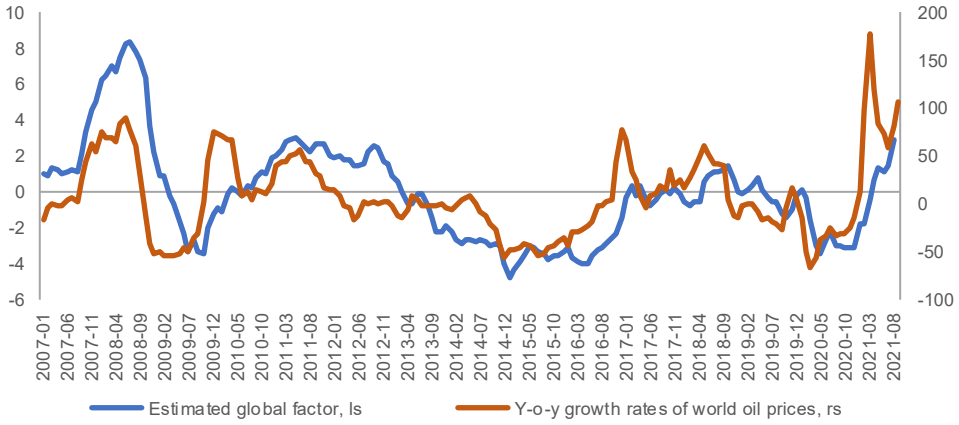
If we compare the movements in the obtained global factor with the y-o-y growth rate of global oil prices, we can see that they keep up with each other relatively well, which indicates that the obtained global factor could explain to a great extent the impact of global oil prices on inflation movements in the observed group of countries.

Chart 7 **The first common factor and its loadings**



Source: author's calculations.

Chart 8 **Estimated global factor using the main component method and y-o-y growth rates of world oil prices**



Sources: author's calculations and World Bank.

In the next step we regressed the series of y-o-y inflation rates for a group of eight countries in the region, Serbia included (the Czech Republic, Poland, Hungary, Croatia, North Macedonia, Bulgaria and Romania), to the estimated global factor. Then we applied the principal component analysis on the series of estimated residuals in order to separate the regional factor. The results of the application of principal component analysis are presented in Table 2.

Table 2 **Eigenvalues of correlation matrix and cumulative proportion of variance for residuals obtained from the estimated relationship between inflation in 8 CEE countries and calculated global factor**

Number of components	Value	Diffference	Proportion	Cumulative value	Cumulative proportion
1	2.26	0.47	0.28	2.26	0.28
2	1.79	0.30	0.22	4.05	0.51
3	1.49	0.59	0.19	5.54	0.69
4	0.90	0.16	0.11	6.43	0.80
5	0.74	0.35	0.09	7.17	0.90
6	0.39	0.12	0.05	7.56	0.95
7	0.26	0.09	0.03	7.82	0.98
8	0.18	---	0.02	8.00	1.00

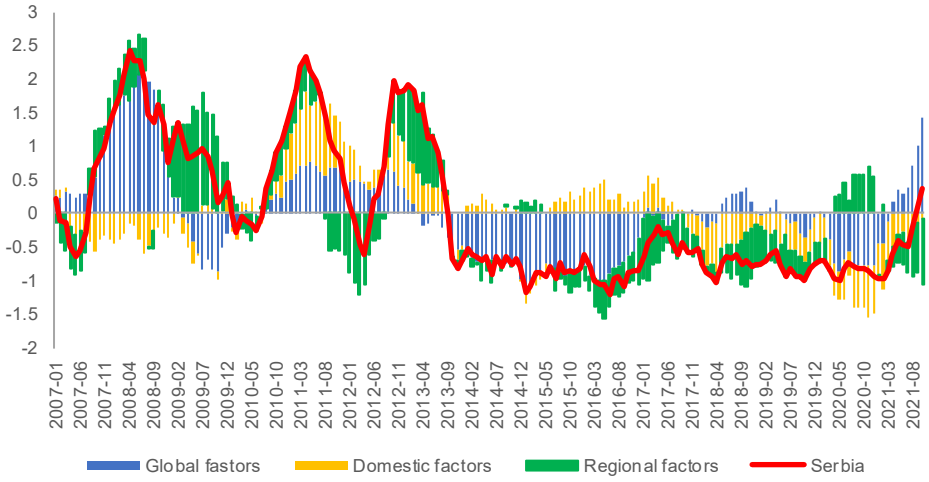
Again, we kept the first three principal components because they are characterised by the roots of the correlational matrix larger than 1, and together they explain close to 70% of the total variance.

Lastly, **by regressing the series of y-o-y inflation rate in Serbia to the estimated global and regional factors, we obtained the contribution of domestic factors.**

The obtained results indicate that in the period immediately preceding and during the global financial crisis, international factors impacted inflation growth in Serbia, while in the period 2011–2012, high and volatile inflation in Serbia was also attributable to domestic factors, which can primarily be associated with the effects of the dinar's depreciation against the euro, the expansive fiscal policy and unanchored inflation expectations of market participants. Since October 2013, there is a significant calming down of inflation, which was facilitated by both global as well as domestic factors. At the same time, the NBS's monetary policy accommodation, which began in May 2013, helped avoid the risk of deflation in the period between 2014 and until the start of 2017, where the global factors would have led. In this period, domestic factors gave a positive contribution to y-o-y inflation, though a much lower one than in the period between end-2010 and October 2013. During a period of fiscal consolidation, the contribution of domestic factors was negative, which the NBS mitigated by lowering the key policy rates and intervening in the FX market with FX purchases, thus preventing the excessive appreciation of the dinar which would have driven inflation further down.

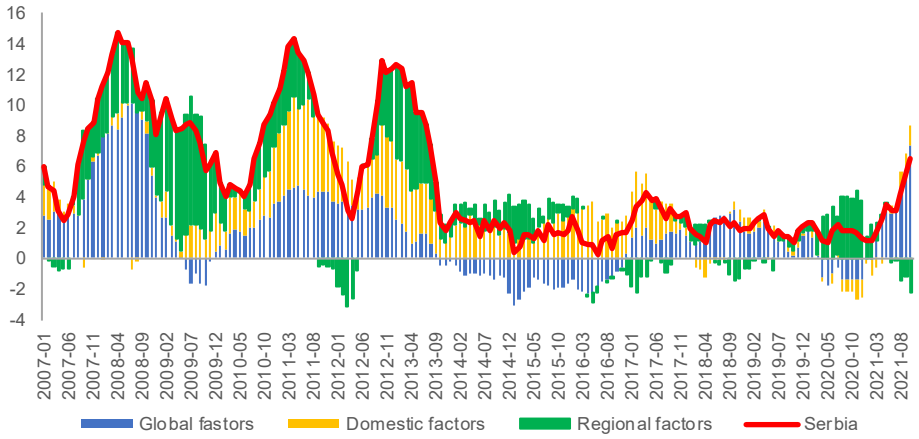
The results of the analysis indicate that since the start of 2021, inflation growth was primarily driven by global factors, which can be associated with the rising prices of primary commodities, halts in global supply chains which, aggregately, led to a significant rise in cost-push pressures and higher producer prices. Conversely, the preserved relative stability of the exchange rate, anchored inflation expectations, as well as the negative output gap prevented the domestic factors from exerting a major contribution to growth of y-o-y inflation.

Chart 9 **Contributions of global, regional and domestic factors to deviation of y-o-y from average inflation** (in pp)



Sources: author's calculations.

Chart 10 **Contributions of global, regional and domestic factors to y-o-y inflation**
(in pp)



Sources: author's calculations.

Bearing in mind that the application of the principal component analysis alone cannot help identifying the precise global and domestic factors that affect the inflation dynamics, in the second part of the empirical analysis we conducted an econometric estimate of the impact of concrete global and domestic factors on inflation in Serbia. The analysis was conducted on quarterly data series for the period between Q1 2009 and Q3 2021. We estimated the equation (6), where $\pi_t = \Delta logprices\_sa$ is the quarterly change of the CPI, which has been previously seasonally adjusted, $logneer_t$ is a logarithm of the nominal effective exchange rate (rise in this value indicates appreciation), $logwages\_sa_t$ is the log transformation of seasonally adjusted series of total net wages, while Z_t^* is set of factors from the international environment depending on the model's specification (global oil prices, global primary agricultural commodity prices, euro area prices). All above mentioned series were log transformed to get relationship between growth rates in the short run. A more detailed description of the series and the data sources used with the variables are presented in the Annex.

The results of the analysis presented in Table 3 indicate that based on the Bound F test it can be confirmed there is a long-run relationship between Serbian CPI, nominal effective exchange rate, nominal wages, prices in the euro area as our main foreign trade partner and the global prices of primary agricultural commodities. All coefficients with the analysed factors in the long-run relationship have the correct sign and are statistically significant. The estimate also includes, as the exogenous variable, the dummy variable that takes the unit value in Q4 2012, when the VAT rate was raised from 18% to 20%. Optimal number of lags in the ARDL model is chosen by the *Akaike* information criterion.

The presented model explains around 73% of variations in quarterly inflation. Also, the estimated model has satisfactory statistical properties – model errors were not autocorrelated and have a normal distribution.

Table 3 **ARDL estimate of relationship between inflation and factors from domestic and international environment**

Dependent variable: DLOG(PRICES_SA)
Selected model: ARDL(1, 0, 1, 0, 1)

Conditional error correction regression			
Variable	Coefficient	t-statistics	p value
C	-1.256191	-2.742	0.00850
LOG(PRICES_SA(-1))	-0.199103	-6.293	0.00000
LOG(EA_PRICES_SA)	0.466902	3.065	0.00350
LOG(NEER(-1))	-0.101809	-4.174	0.00010
LOG(AGRIC_PRICES)	0.04332	5.467	0.00000
LOG(WAGES_SA(-1))	0.035862	1.633	0.10880
DLOG(NEER)	-0.001989	-0.056	0.95570
DLOG(WAGES_SA)	-0.140954	-1.767	0.08350
VES2012Q4	0.023141	3.20302	0.0024
JB=1.618 (0.445)	R2=0.73		
Levels equation			
Variable	Coefficient	t-statistics	p value
LOG(EA_PRICES_SA)	2.345	5.284	0.0000
LOG(NEER)	-0.511	-3.469	0.0011
LOG(AGRIC_PRICES)	0.218	3.804	0.0004
LOG(WAGES_SA)	0.180	2.113	0.0397
C	-6.309	-4.589	0.0000
F-Bounds Test f(logprices/logea_prices, logneer, logagric_prices, logwages) Ho: no levels relationship			
F-statistics	23.7		
	n=55	I(0)	I(1)
Critical values	10%	2.35	3.28
	5%	2.76	3.813
	1%	3.74	4.95

Beside the model whose results have been presented in the Table 3, several other models with different explanatory variables have been estimated and obtained results are given in the tables below.

The obtained results indicate that in addition to factors emanating from the international environment (import prices – $logea\_prices\_sa_t$, global prices of primary agricultural commodities – $logagric\_prices_t$ and world oil prices – $logoil\_prices_t$), inflation in Serbia is also under the impact of domestic factors – inflation expectations, exchange rate and wages. Also, **the coefficient with the nominal effective exchange rate indicates that the nominal effective depreciation of the dinar does not fully transmit to the inflation even in the long run**. Similar results are obtained when the exchange rate of the dinar to the euro ($logkeur_t$) is used instead of the nominal effective exchange rate. **The statistical significance of coefficients with inflation expectations and the exchange rate indicates the importance of anchored inflation expectations and the relative stability of the exchange rate for inflation at home. This way we empirically confirmed the official stance of the NBS, namely that the preserved relative stability of the dinar against the euro and anchored inflation expectations played a significant role in preserving price stability from 2013 onwards.**

Table 4 **ARDL estimate of relationship between inflation and factors from domestic and international envrironment**

Dependent variable: DLOG(PRICES_SA)			
Selected model: ARDL(1, 1, 0, 1)			
Conditional error correction regression			
Variable	Coefficient	t-statistics	p value
C	0.149139	1.385	0.17210
LOG(PRICES_SA(-1))	-0.155037	-6.197	0.00000
LOG(NEER(-1))	-0.093569	-3.281	0.00190
LOG(OIL_PRICE)	0.012247	3.542	0.00090
LOG(WAGES_SA(-1))	0.100793	5.144	0.00000
DLOG(NEER)	0.030477	0.780	0.43900
DLOG(WAGES_SA)	-0.082713	-1.148	0.25630
VES2012Q4	0.024971	3.062	0.00350
JB=0.28 (0.87)	R2=0.65		
Levels equation			
	Coefficient	t-statistics	p value
LOG(NEER)	-0.604	-2.872	0.0060
LOG(OIL_PRICE)	0.079	3.010	0.0041
LOG(WAGES_SA)	0.650	1.579	0.0000
F-Bounds Test f(logprices/logneer,logwages, logoil_prices)		**Ho: no levels relationship**	
F-statistics	17.2		
Critical values	n=55	I(0)	I(1)
	10%	2.84	3.92
	5%	3.41	4.62
	1%	4.83	6.20

Table 5 **ARDL estimate of relationship between inflation and factors from domestic and international envrironment**

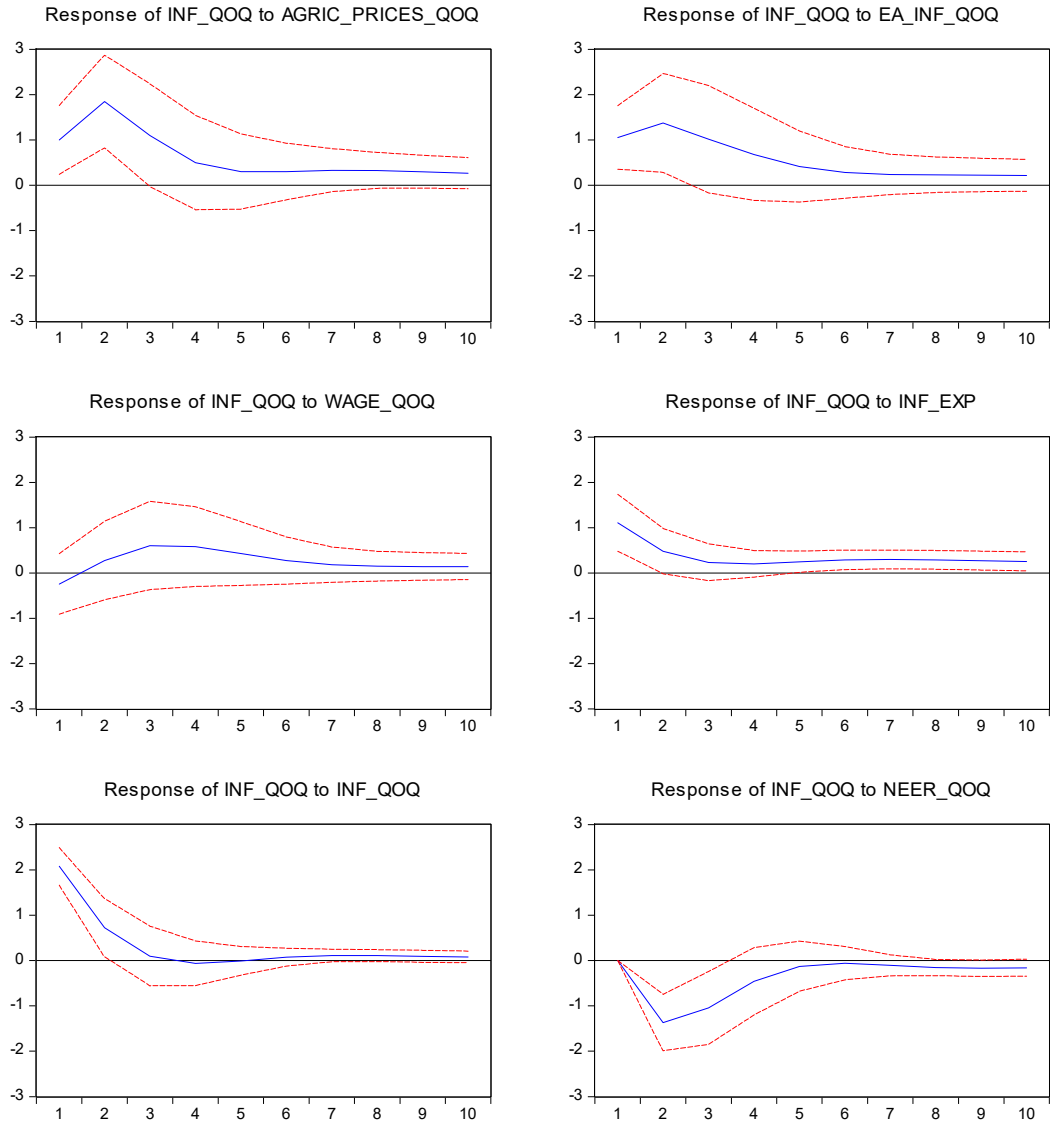
Dependent variable: DLOG(PRICES_SA)			
Selected model: ARDL(1, 2, 1, 0)			
Conditional error correction regression			
Variable	Coefficient	t-statistics	p value
C	-3.494022	-6.765	0.00000
LOG(PRICES_SA(-1))	-0.382612	-7.950	0.00000
LOG(NKEUR(-1))	0.238802	6.384	0.00000
INF_EXP(-1)	0.003428	3.661	0.00070
LOG(EA_PRICES_SA)	0.918118	7.268	0.00000
DLOG(NKEUR)	0.004525	0.097	0.92360
DLOG(NKEUR(-1))	-0.02085	-0.505	0.61610
D(INF_EXP)	0.007508	5.390	0.00000
JB=0.38 (0.82)	R2=0.82	Breusch-Godfrey LM Test: 2.03 (0.1436)	
Levels equation			
Variable	Coefficient	t-statistics	p value
LOG(NKEUR)	0.624	1.024	0.0000
INF_EXP	0.009	5.966	0.0000
LOG(EA_PRICES_SA)	2.400	2.263	0.0000
C	-9.132	-2.053	0.0000
F-Bounds Test f(logprices/lognkeur, inf_exp, logea_prices)		**Ho: no levels relationship**	
F-statistics	39.8		
	n=55	I(0)	I(1)
Critical values	10%	2.87	3.97
	5%	3.50	4.7
	1%	4.87	6.36

The obtained results show that domestic factors also play an important role in inflation in Serbia, and that to ensure low and stable inflation, the relative stability of the exchange rate and anchored inflation expectations must be secured, as well as control of domestic demand growth.

To verify the robustness of the obtained results, we also assessed the structural VAR model and based on the function of impulse response, variance decomposition and historical decomposition, we analysed the impact of domestic and global factors on inflation variability.

Below we will present the results of the VAR model, which includes the following variables: quarterly inflation rate in Serbia, (π_t), change in the global prices of primary agricultural commodities (*Δagric_prices)*, quarterly inflation in the euro area (*ea_inf),* change in the nominal exchange rate of the dinar against the euro (*Δnkeur),* one-year ahead inflation expectations of the financial sector (π_t^e), and changes in nominal wage bill, (*Δwages)*.

Chart 11 **Impulse response function of inflation to one standard deviation shock in variables in SVAR model**



The optimal number of lags in the VAR model was selected based on the *Akaike* and *Schwartz* information criterion, as they suggest using one lag in the model. Also, there is no autocorrelation in the estimated model, and model errors are normally distributed.

The results of the impulse response function obtained based on the structural VAR model indicate similar results, as do the results of the estimation using the ARDL method. Inflation responds positively to the shocks of primary agricultural products and inflation in the euro area, as well as to inflation expectations, and this impact is statistically significant in the first two quarters. The impact of the exchange rate is also significant, with a one quarter lag and is of the correct sign. The one quarter horizon pass-through is around 0.25% which is similar to our previously obtained estimates (see Đukić et. al., 2010) In this case, only the impact of wage shock on inflation did not turn out to be statistically significant. Similar results are also obtained when the output gap is used instead of the wages. This could indicate that in the case of Serbia, the link between inflation and the output was also weakened in the prior period.

Decomposition of the inflation forecast error variance shows how large is the contribution of each of the observed shocks to inflation forecast variance error. In Table 6 we presented contributions to the prediction horizon of one quarter, one year, two years and 10 quarters ahead. It turned out that **global shocks explain around 50% of inflation variation in Serbia, meaning that when predicting inflation one and two years ahead, around one half of errors will stem from global factors.**

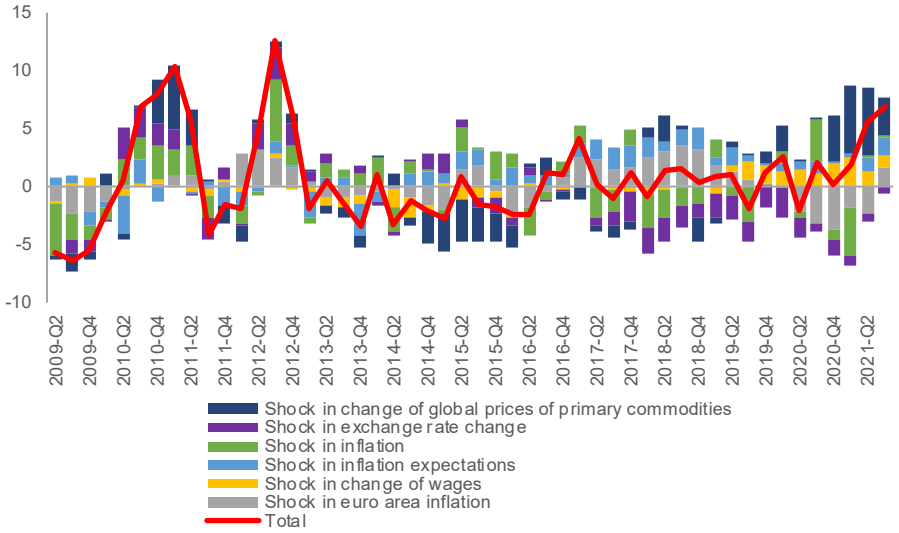
Table 6 **Variance decompostion of quarterly inflation from SVAR**

Period	Δagr_prices	ea_inf	Δwages	π_t^e	π	Δnkeur
1	10.53	17.08	0.39	17.40	54.60	0.00
4	27.76	24.17	3.91	9.09	24.64	10.43
8	28.10	24.03	4.77	9.99	23.21	9.90
10	28.19	23.94	4.83	10.39	22.81	9.84

While the impulse response function and variance decomposition indicate how much on average inflation responds to various shocks in the movement of domestic and global factors, historical decomposition enables us to quantify how big a part of inflation fluctuation from a historical perspective can be explained by shocks of specific global and domestic factors used in the model.

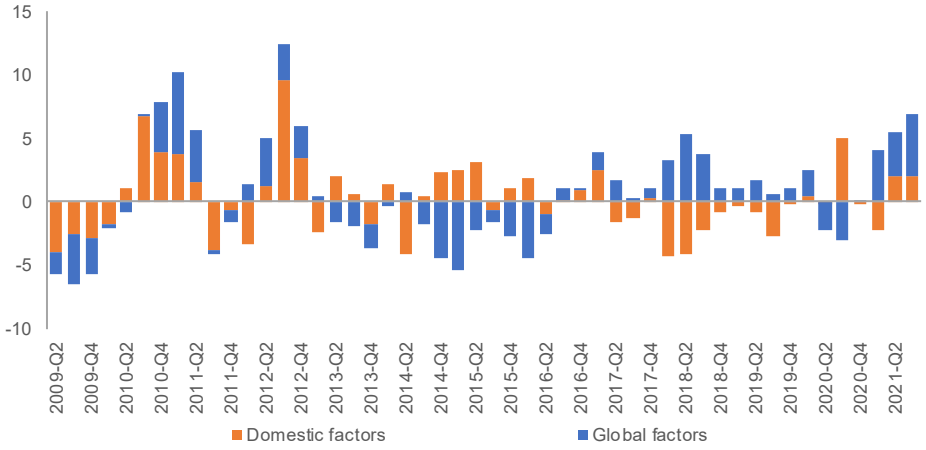
Chart 12 shows the historical decomposition of deviations of the achieved quarterly inflation rate from the non-conditional projection generated based on the VAR model (the baseline projection, on conditions that there are no shocks throughout the period), as well as the contribution to the deviation of each of the shocks in the variables used in the model. The negative value of the deviation based on the historical decomposition does not indicate deflation, but rather that these factors lead to inflation falling below its baseline projection generated on condition that there are no shocks throughout the period [see Finck and Tillmann, 2019].

Chart 12 **Historical decomposition of quarterly inflation based on SVAR model**



Sources: author's calculations.

Chart 13 **Historical decomposition of quarterly inflation based on SVAR model on domestic and global factors**



Sources: author's calculations.

The obtained results indicate that in the period 2010–2011, as well as during 2012, the contribution to inflation came both from global shocks (growth in global primary commodity prices) and from domestic factors (dinar depreciating against the euro), with the impact of domestic factors being particularly pronounced in the first half of 2012. Since end-2012 and until 2016, global factors had a negative effect on inflation, which was partly offset by domestic factors and can be associated with the effects of the NBS's monetary policy easing, which prevented inflation from going into the negative territory. At the same time, since the start of 2017, the exchange rate led to the decrease in inflation variability, and until the beginning of 2019 on wages in the local market, which can be primarily associated with the effects of fiscal consolidation. The results of the analysis also suggest that inflation growth as of 2021 is mostly driven by global factors. Also, for the sake of a simpler interpretation, in the graph shocks are divided into domestic and global ones.

The obtained results based on the structural VAR model in terms of the impact of global and domestic factors on inflation are largely aligned with the results based on the principal component analysis, which indicates the robustness of the obtained estimates.

5 Conclusion

In conclusion we will present the results of three approaches which we used in testing to what extent global and domestic factors in the past fifteen years determined the inflation dynamics in Serbia and which factors prevailed in what period.

The estimate of the contributions of global, regional, and domestic factors to y-o-y inflation based on the principal component analysis was performed for the period January 2007 – October 2021 for 33 European countries, including Serbia. The results obtained for Serbia point to an obvious conclusion – that by end-2012 inflation was much higher and more volatile than in most countries in the sample, primarily when compared to the euro area. It can also be observed that since end-2013 inflation in Serbia and in the euro area moves at similar levels. Based on further analyses and observed by components, it was explained that a considerably higher inflation in Serbia in the period before 2013 was also under the impact, on the one hand, of the nominal depreciation of the dinar against the euro, which additionally amplified the effect of higher import prices based on the rise in the global prices of oil and primary agricultural commodities, and on the other hand, the wage-driven consumption growth. In contrast, the ensured relative stability of the exchange rate and anchored inflation expectations, with the effects of global factors (lower global prices of primary commodities), were the key factors contributing to the average y-o-y inflation rate of around 2% in the period from 2013 until end-2020.

Further, the econometric estimate of the impact of concrete global and domestic factors on inflation in Serbia, performed on quarterly data series for the period from Q1 2009 and concluding with Q3 2021, confirms that apart from the factors from the international environment (import prices and global prices of primary agricultural commodities), inflation in Serbia was also influenced by domestic factors – the dinar exchange rate, inflation expectations and wages. The statistical significance of coefficients for the exchange rate and inflation expectations points to the importance of anchored inflation expectations and relative stability of the exchange rate for domestic inflation, which confirms that the preserved relative stability of the dinar exchange rate against the euro and anchored inflation expectations significantly contributed to the preservation of price stability in Serbia in the period since 2013. The estimates arrived at through several additional models in which we varied the external factors while the estimated coefficients for domestic factors did not change significantly, prove the robustness of the obtained estimates. The obtained results unequivocally indicate that domestic factors also have a significant impact on inflation in Serbia and that securing low and stable inflation requires relative stability of the exchange rate and anchored inflation expectations, as well as the control of domestic demand growth.

The estimate of the structural VAR model, which includes the quarterly inflation rate in Serbia, change in the global prices of primary agricultural commodities, quarterly inflation in the euro area, change in the nominal exchange rate of the dinar against the euro, one year ahead

inflation expectations of the financial sector and change in the nominal wage bill, indicates that inflation responds positively to shocks in the global prices of primary agricultural commodities and inflation in the euro area, as well as inflation expectations, and that this impact is statistically significant in the first two quarters. The impact of the exchange rate is also significant with a one quarter lag and is in the correct sign. Only the impact of wage shock on inflation did not prove statistically significant in this case. Similar results are also obtained when the output gap is used instead of wages. This could indicate that in Serbia's case, the link between inflation and aggregate demand has weakened in the previous period.

Using historical decomposition, we also quantified what part of inflation fluctuation can be explained by the impact of shocks of concrete global and domestic factors used in the model. The results obtained indicate that in the period 2010–2011 and during 2012, the contribution to inflation originated both from global shocks (the rise in the global prices of primary commodities) and from domestic factors (depreciation of the dinar against the euro), whereas in the first part of 2012 the impact of domestic factors was particularly pronounced. From late 2012 until 2016, global factors had a negative effect on inflation movements, which was partly compensated for by domestic factors, including the NBS's monetary policy measures, which prevented inflation from entering into the negative territory. Also, since early 2017 the exchange rate helped to reduce inflation variability.

The results of all analyses indicate that inflation growth since the beginning of 2021 was driven primarily by global factors, which may be associated with the rise in the prices of primary commodities, halts in global supply chains which, taken together, triggered a significant rise in cost-push pressures and higher producer prices. On the other hand, the preserved relative stability of the exchange rate, anchored inflation expectations, with the opening of the negative output gap, prevented the domestic factors from contributing to the rise in y-o-y headline inflation to any significant extent and preserved core inflation at a low level.

Finally, we arrived at the result that global shocks account for around 50% of variation in inflation in Serbia, which means that when forecasting inflation one and two years ahead, global factors account for around one half of forecasting errors.

Appendix

Review of countries included in the PCA

Belgium	Malta	Czech Republic
Denmark	Netherlands	Croatia
Germany	Austria	Hungary
Estonia	Slovenia	Poland
Ireland	Slovakia	Romania
Greece	Finland	North Macedonia
Spain	Portugal	Serbia
France	Sveden	
Italy	Island	
Ciprus	Norway	
Latvia	Switzerland	
Lithuania	Turkey	
Luxemburg	Bulgaria	

Description of the series used in the analysis

Mark	Variable	Source of data
prices_sa	Consumer price index, seasonally adjusted by X-12 ARIMA method	SORS
inf_exp	One year ahead inflation expectations of financial sector	Inflation expectations survey, Bloomberg
$neer_t$	Nominal effective exchange rate based on the basket with EUR and USD at an 80:20 ratio; increase means appreciation, decrease means depreciation	NBS
$nkeur_t$	Nominal RSD/EUR exchange rate; increase means depreciation, decrease means appreciation	NBS
$wages\_sa_t$	Nominal net total wages, seasonally adjusted by X-12 ARIMA method	SORS
$ea\_prices\_sa_t$	HICP for euro area, seasonally adjusted by X-12 ARIMA method	Eurostat
$agric\_prices_t$	World prices of primary agrucultural commodities, in USD	World bank
oil_price_t	World oil prices, Brent, in USD	World bank

Imposed Restrictions in the SVAR model in order to identify shocks

Variable/Shocks	Global	Global	Domestic	Domestic	Domestic	Domestic	Exchange rate
World primary agricult. commodity prices	*	0	0	0	0	0	0
Inflation in euro area	*	*	0	0	0	0	0
Wages	*	*	*	0	0	0	0
Changes of consumer prices	*	*	*	*	0	0	0
Inflation expectations	*	*	*	*	*	0	0
Exchange rate	*	*	*	*	*	*	0

Note: * without limits.

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