

# Assessing Inflation Persistence in Belarus

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*Generally speaking, inflation persistence can be defined as the speed at which inflation returns to its equilibrium level after a shock. Since 1995, the dynamics of inflation in Belarus is affected by the various internal and external shocks, which, in turn, cause the structural breaks in the corresponding historical data. The deep currency crisis in 2011 led to a huge increase of inflation, and reached a three-digit value. In the current year, the reduction of inflation is one of the most vital problems for the Belarusian authorities. In this context, the understanding of inflation persistence in Belarus is of great importance for appropriate monetary policy and macroeconomic stabilization measures. Additionally, the issue of inflation persistence is topical in the debates on the possibilities of inflation targeting in Belarus. There is an extensive body of literature on the inflation persistence in the US, the EU member states, and in other countries. Inflation persistence, however, has not yet been a subject of analysis in Belarus. In this policy brief, we have attempted to fill the gap by presenting the results of an inflation persistence assessment in Belarus.*

The issue of inflation persistence is controversial among economists. For instance, Pivetta and Reis (2007), in analyzing the US economy, argue that inflation persistence has been high and approximately unchanged over the examined sample, as well as that the null hypothesis of a unit root for US inflation cannot be rejected. However, various studies within the Inflation Persistence Network (IPN) for the euro-area countries has pointed out that inflation in these countries is moderately persistent or not persistent at all when structural break(s) in inflation dynamics is (are) taken into account.

In this policy brief, we present the results of inflation persistence assessment in Belarus, based on the approach discussed in Pelipas (2011). This approach allowed linking an inflation-persistence measure with a unit root test and multiple structural breaks. Assessing inflation persistence in Belarus for the period 1995-2011, we used quarterly seasonally adjusted data on GDP-deflator inflation and CPI inflation. Assessments of inflation persistence have essential policy implications for economic authorities in terms of monetary

policy and macroeconomic stabilization measures.

## Defining and Measuring Inflation Persistence

In accordance with the definition adopted by the Inflation Persistence Network (IPN) for the euro-area countries, inflation persistence is “the tendency of inflation to converge slowly towards its long-run value following a shock which has led inflation away from its long-run value” (Altissimo et al. (2006)). There are two main approaches to measuring inflation persistence. The first one is usually based on univariate autoregression models, where a shock to inflation comes from a residual term of autoregression and the sum of the autoregressive coefficients for all included lags is considered as a measure of inflation persistence. The second approach is based on structural multivariate models, where the shocks come from the casual variables explaining inflation dynamics. When assessing

inflation persistence in Belarus, we utilize the univariate framework.

To properly handle the multiple structural breaks in inflation dynamics while assessing its persistence, it is important to use appropriate econometrics approaches. We relied on the approach discussed in Pelipas (2011). This paper addresses the issue of determining the order of integration of inflation and growth rates of monetary aggregates in Belarus under multiple structural breaks. It also proposes a modified test where, on the first stage, the structural break points are determined endogenously by an impulse indicator saturation technique. Then, the matching break points are utilized exogenously in the conventional Dickey-Fuller unit root test. This approach allows for unit root testing for any number of structural breaks.

## Determining Structural Breaks in Inflation Dynamics

Since 1995, the dynamics of inflation in Belarus is affected by various internal and external shocks, which, in turn, cause the structural breaks in the corresponding time series. Such structural breaks should be properly detected and taken into account while assessing inflation persistence otherwise one can get erroneous conclusions about the degree of persistence. Moreover, these conclusions will be dependent on the particular break testing method since different techniques can give distinct break dates or even different number of breaks (Santos and Oliveira (2010)).

In order to detect the number and the dates of possible structural breaks in inflation dynamics in Belarus, we recently employed a developed impulse indicator saturation technique (Hendry et al. (2008); Johansen and Nielsen (2009); Hendry and Santos (2010)).

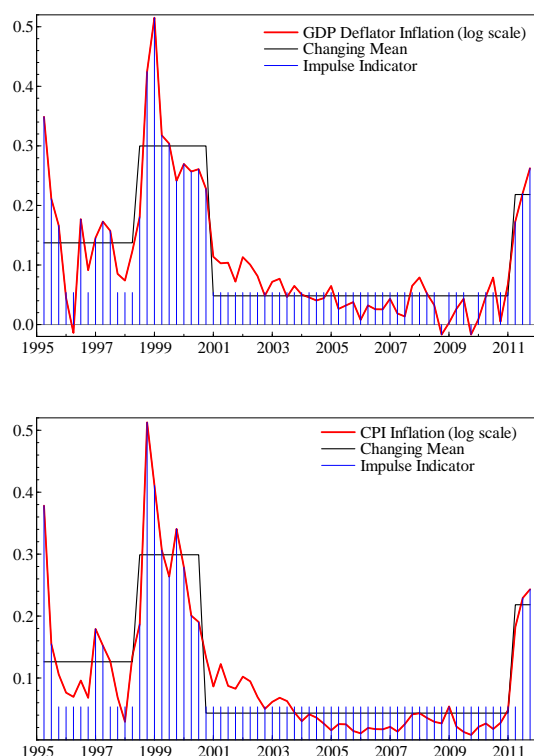
To analyze the properties of the econometric model, this method uses zero-one impulse indicator dummies. Since there are potentially

$T$  such dummy variables, inclusion all of them in a model is not feasible. The impulse indicator dummies, however, can be included in a model as separate blocks. In the simplest case with two blocks, the sample is split in two equal parts ( $T/2$ ), then the impulse indicator dummies are included only for the first half of the sample, and statistically significant dummies at a chosen significant level are stored. Further, chosen in the previous step, the impulse indicator dummies are dropped and another part of the dummies are included in the model. After that, the procedure is repeated for the second part of the sample. Statistically significant impulse indicator dummies from two blocks are combined and jointly significant ones are retained. A computational algorithm, utilized in recent versions of OxMetrics software, performs optimal splitting and selection of the final model for any number of blocks.

Impulse indicator saturation technique allows determining structural breaks, outliers and possible data contaminations. In particular, the impulse indicator saturation break test is discussed in Santos (2008), Castle et al. (2010), and implemented for assessing French inflation persistence in Santos and Oliveira (2010), Oliveira and Santos (2010).

We applied impulse indicator saturation break test to identify breaks in the dynamics of GDP-deflator inflation and CPI inflation in Belarus, using the model with a constant as the only regressor. For visualization, the obtained results are presented in graphical form (figure 1).

Figure 1: Structural breaks in dynamics of inflation in Belarus, 1995-2011



Source: Author' calculation, based on the National Statistical Committee data.

We consider a structural break as a continuous sequence of statistically significant indicator variables with the same signs and approximately the same magnitudes (continuous sequence equal to 6 quarters are chosen arbitrary for practical reasons; additionally, we also considered a sequence of only 3 quarters at the end of the sample as a structural break). All other statistically significant indicator variables are treated as outliers.

The index lines in figure 1 graphically represent the results of the impulse indicator saturation break test. Continuous sequences of statistically significant indicator variables compose the segments characterizing the changes of regimes in the dynamics of GDP-deflator inflation and CPI inflation. On this basis, the step dummies that take into account the changes in means of the variables are created (dotted line in figure 1). It is evident, that GDP-deflator inflation and CPI inflation in Belarus, according to the impulse indicator saturation break test, have several structural

breaks over a period of 1995-2011. All in all, three structural breaks (4 different regimes) were detected in the dynamics of GDP deflator inflation and CPI inflation. The specific dates of the structural breaks have been obtained by impulse indicator saturation break test and are presented in table 1.

Table 1: The dates of structural breaks

Variable	The dates of the structural breaks (year and quarter)	Number of the different regimes
GDP deflator inflation	1998:3; 2001:1; 2011:2	4
CPI inflation	1998:3; 2000:4; 2011:2	4

Source: Author' calculations.

The results of the structural break test based on impulse indicator saturation are clearly consistent with the real dynamics of GDP-deflator inflation and CPI inflation, and the break points have an explicit economic interpretation. Specifically, the structural break in 1998Q3 is caused by the Russian financial crisis in August 1998. The structural break in 2000Q4-2001Q1 occurs due to adoption of unified exchange rate for Belarusian ruble and the following changes of monetary policy. Finally, the structural break in the second quarter of 2011 is related to the deep currency crisis and the consequent huge devaluation of Belarusian ruble.

Since all break points have a clear-cut economic interpretation, the inclusion of the appropriate dummies, taking into account the impact of such breaks in a unit root test, used for an assessment of inflation persistence, is not just a "fitting" of the regression; it is based on a solid economic ground. It is also important, that the break points are chosen endogenously within the impulse indicator saturation break test and that they reflect real peculiarities of inflation dynamics in Belarus.

It is interesting to note, that the widely used Bai-Perron break point test (Bai and Perron (2003)) in our case is not able to determine the third structural break at the end of the sample correctly (see explanations of this in Castle et al. (2010)).

## Examining Inflation Persistence

To analyze inflation persistence in Belarus over the period of 1995-2011, we utilize a modified approach for unit root testing with multiple structural breaks (Pelipas (2011)). The essence of this approach is as follows.

- (1) As discussed earlier, the break points in the dynamics of GDP deflator and CPI inflation are determined endogenously using multiple structural breaks test based on impulse indicator saturation.
- (2) On the basis of the impulse indicator saturation break test mentioned above, the step dummies are created; these step dummies characterize different regimes in dynamics of GDP deflator and CPI inflation and reflect the changes in variables mean.
- (3) The step dummies are then included in the univariate Dickey-Fuller unit root test by analogy with dummy variables included in cointegrated vector in the Johansen (1988) multivariate cointegration test.
- (4) Testing the null hypothesis of a unit root,  $t$ -statistics in Dickey-Fuller test ( $t$ -ADF) are compared with critical values calculated for cointegration test in the conditional equilibrium correction model framework (see Ericsson and MacKinnon (2002)).

Thus, we have an equilibrium correction model but only for one variable with the set of deterministic terms (constant and step dummies). The autoregressive coefficient with one lag of GDP deflator and CPI inflation ( $\rho - 1$ ) can be treated as an equilibrium correction mechanism and its significance can be tested using critical values from the cointegration test for conditional equilibrium correction model. At that, the dummy variables included in Dickey-Fuller unit root test are considered as additional variables when determining the appropriate critical values. If the break points are preliminary determined endogenously using impulse indicator saturation technique, then the proposed approach permits unit root

testing with practically any number of structural breaks.

Table 2: Unit root test with three structural breaks

Variable	$t$ -ADF (n)	$\rho - 1$	Persistence measures	
			$\rho$	$1/1 - \rho$
GDP deflator inflation	-6.55 (0)**	-0.673	0.327	1.49
CPI inflation	-4.93(1)**	-0.473	0.527	1.90

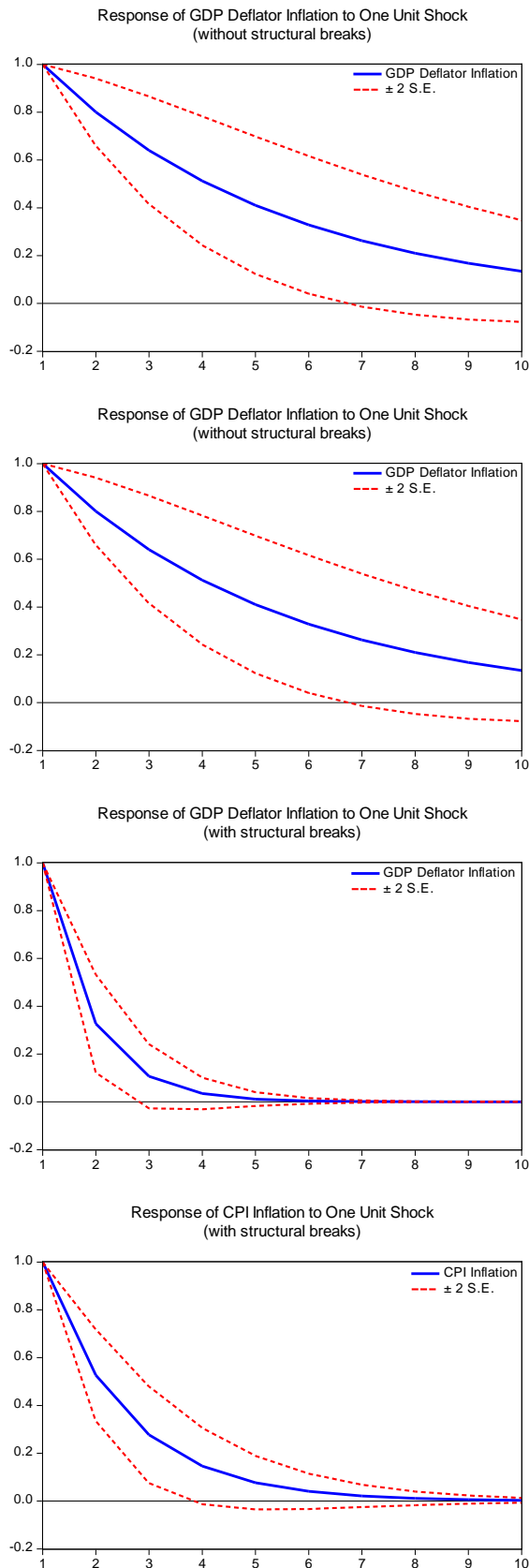
Source: Author' calculation.

Notes: \*\* denote rejection of null hypothesis at the one per cent significance level.  $t$ -ADF(n) is  $t$ -statistic in ADF-test for unit root with changing mean; n is the lag length chosen so to eliminate residual autocorrelation. Critical values are determined on the basis of Ericsson and MacKinnon (2002).

Table 2 reports the results of the unit root tests for GDP-deflator inflation and CPI inflation. The lag structure of the tests is chosen so to eliminate residual autocorrelation. It should be noted that the coefficients at the dummies, characterizing changes in the mean, are statistically significant. Their signs correctly indicate the direction of the regimes changes in the dynamics of the variables. As was mentioned earlier, all structural breaks have clear-cut economic interpretation. According to  $t$ -ADF, the null hypothesis of a unit root is rejected at 1 per cent significance level for all examined variables. Therefore, GDP-deflator inflation and CPI inflation are stationary variables with changing means. This fact rules out inflation persistence in Belarus over the sample period. It should be added that point estimates of inflation persistence for GDP-deflator inflation and CPI inflation are quite small (0.32 and 0.53 correspondently). As follows from table 2, GDP-deflator inflation returns to its equilibrium level after a shock in about 1.5 quarter; for CPI inflation, this value is about 2 quarters.

Additionally, we consider inflation persistence in terms of impulse response functions, based on the unit root test with multiple structural breaks (figure 2).

*Figure 2: Response of inflation to one unit shock in Belarus*



Source: Author' calculation.

The upper panels of figure 2 represent the response of GDP-deflator inflation and CPI inflation to a one unit shock (with appropriate confidence bands) without taking into account multiple structural breaks in the dynamics of the inflation variables. In such case, it takes about 7 quarters to return GDP inflation and CPI inflation to an equilibrium level after a shock. Thus, inflation in Belarus without taken into account structural breaks, can be erroneously classified as a persistent process.

It is also important to note that the results of the ADF-test of GDP-deflator inflation and CPI inflation without structural breaks are very sensitive to the sample period and lag length. The null of a unit root is rejected for these variables only for the whole sample and when the optimal lag length is chosen by the different information criteria. However, if the lag length would be chosen so to remove autocorrelation of the residuals and, at the same time, the sample would be shifted barely two or three quarters ahead, then the unit root null hypothesis would not be rejected for either of the two examined variables. Hence, the usage of a unit root test without structural breaks does not, in our case, provide reliable and non-contradictory results.

On the contrary, the impulse response functions presented in the lower panels of figure 2 are in line with the results from table 2. When multiple structural breaks are taken into account, the impulse responses are "well-behaved". In such case, it takes about 1.5 and 2.5 quarters respectively to return GDP-deflator inflation and CPI inflation return to its equilibrium level after a shock. Therefore, impulse response analysis also rules out inflation persistence in Belarus.

## Summing Up

The assessment of inflation persistence in Belarus on the basis of quarterly seasonally adjusted data for 1995-2011, using a univariate framework and taking into account the structural breaks in the dynamic of inflation, have led to the following results:

- (1) As a result of an impulse indicator saturation break test, three structural breaks were detected in the dynamics of GDP-deflator inflation and CPI inflation. All break points have a clear-cut economic interpretation. The first structural break in 1998Q3 is caused by the financial crisis in Russia in August 1998. The second break has occurred in 2000Q4-2001Q1 due to adoption of unified exchange rate for Belarusian ruble and the following changes of monetary policy. The third structural break in the second quarter of 2011 is related to the deep currency crisis and the consequent huge devaluation of Belarusian ruble.
- (2) When these structural breaks are taken into account, GDP-deflator inflation and CPI inflation in Belarus are stationary variables with changing means. Formal unit root testing demonstrated that non-stationarity is rejected at a one per cent significant level. Thus, persistence in GDP-deflator inflation and CPI inflation is ruled out. At most, one can consider inflation persistence in Belarus over the period of 1995-2011 as very moderate. The point estimates of inflation persistence for GDP deflator and CPI inflation are quite small (0.32 and 0.53 respectively). GDP-deflator inflation and CPI inflation return to its equilibrium level after a shock in about 1.5 and 2 quarter, respectively.
- (3) The results of the point estimates of inflation persistence are confirmed by the impulse response analysis. Thus, impulse response analysis also rules out inflation persistence in Belarus.
- (4) The results presented above have explicit policy implications. Low inflation persistence in Belarus is a sound prerequisite for macroeconomic stabilization and anti-inflation monetary policy. In any case, adequate monetary policy will lead to a substantial reduction of inflation in 2012. Additionally, the stationarity of inflation can be considered as an

important element of the technical possibilities of implementing inflation targeting in Belarus.

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