

ARE INFLATION RATES STATIONARY IN THE WESTERN BALKAN COUNTRIES? EVIDENCE FROM UNIT ROOT TESTS*

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Abstract

Monitoring of inflation rate dynamics is one of the most important tasks in order to identify the current economic conditions of the observed countries. The aim of this study is to examine the unit root properties of inflation in the Western Balkan countries. It also investigates the existence of structural breaks and nonlinearity. The time horizon encompasses the period 2006Q1–2020Q2. The results suggest that the inflation in Albania and Montenegro manifests a nonstationary process and structural breaks. The macroeconomic shocks will have more persistent effects on the inflation rate if it is characterized by nonstationarity. The inflation rates of Serbia and Bosnia and Herzegovina are characterized by nonlinear mean reverting behaviour. This implies less costly implementation of the proclaimed monetary strategy.

Keywords: Inflation, unit root, nonlinearity, structural break, nonstationarity

JEL Classification: C22, E31, O52

Introduction

The Western Balkans is a region whose economic flows are deeply burdened by the past political and ethnic tensions and conflicts. Therefore, studies of the inflation phenomenon can contribute to solving many of the economic and other issues that these countries are facing in their desire to join the EU. Inflation is one of the most prominent issues for the countries of this region. Susceptibility to this issue is of utmost importance regarding the close experience that the countries had in the past, especially in the last decade of the 20th century.

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All the central banks in the sample declare the goal of keeping the inflation rates low. In the implementation of this goal, the National Bank of Serbia implemented inflation targeting as an adopted monetary strategy during the observed period. Montenegro and Bosnia and Herzegovina adopted exchange rate targeting based on euroization and a currency board, respectively. The Bank of Albania implemented a monetary targeting framework.

This paper aims to answer the main research question about the absence or presence of a unit root in inflation. A high level of inflation persistence, as a rule, has significant implications regarding the modelling and formulating of the monetary strategy. Considering the theoretical aspect, it is possible to derive and apply a variety of approaches based on the integration properties of the inflation rate and further develop the appropriate theoretical model accordingly. The main research questions answered in this paper are as follows:

- Are inflation rates in the observed sample nonstationary?
- Are there structural breaks in the inflation dynamics?
- Is there a nonlinearity of the inflation behaviour in the observed sample of countries?

There is no consensus considering the inflation unit root hypothesis in the existing literature (P. K. Narayan and S. Narayan, 2010). The working hypothesis being tested is based on the experience of inflation in the Western Balkans. We investigate whether all the countries in the region simultaneously show linear dynamics, stationarity and structural breaks as the behaviour of the inflation rate in accordance with the promoted monetary strategy. In the search for the answers to this hypothesis, a number of solutions are obtained that are not uniform for all the countries of the observed sample.

If there is a unit root in the time series data, it means that the inflation rate is nonstationary. Every shock affecting the inflation will have permanent effects, if it is the case of such an integration property. On the other hand, stationary inflation means lower expenses for the central bank authorities in the monetary policy implementation (Cecchetti and Debelle, 2006). The absence or presence of stationarity in inflation is crucial, because it not only makes a distinction among the various macroeconomic hypotheses, but it is also the basis for the application of different statistical techniques in analysing the appropriate data. The stationarity property of the inflation rate can be identified using a linear or nonlinear model. The nature of the inflation process (linear or nonlinear) is of great importance for the stabilization policy (Yellen and Akerlof, 2006). The goal of this study is to examine whether the inflation rates in Serbia, Bosnia and Herzegovina, Montenegro and Albania can be characterized as stationary or non-stationary processes.

This paper makes several specific contributions to the research literature: firstly, it applies a test to determine linearity and nonlinearity as an inflation rate property; secondly, the nonlinear data series testing is done by applying two tests, and a robustness check is carried out by an additional test based on Fourier approximation. In the analysis of the nonlinear inflation rate behaviour, we apply two nonlinear unit root tests proposed by Kapetanios *et al.* (2003) and Sollis (2009). In addition, when analysing the linear inflation rate dynamics, we use a test that includes structural breaks. The assessment of the results in the case of linear properties of the inflation rate is done using a univariate test with two breaks. We are interested in establishing the dynamics of the inflation rate that is present according to the stationarity property. To some extent, we find this paper to be a headway, as, to the authors' knowledge, no such study on this specific sample of countries has been conducted so far.

The remainder of the paper is organized as follows. Section 2 provides a review of the literature that investigates inflation rate stationarity with the corresponding results of the studies. Methodology is given in Section 3, whereas Section 4 discusses the empirical results. We conclude the study in the last section.

1. Literature Review

If empirical studies relied only on conventional unit root tests, they would probably confirm the unit root hypothesis of the inflation rate. The impossibility of rejection of the unit root hypothesis arises, among others, from two potential reasons. The exclusion of structural breaks from the analysis reduces the possibility of ascertaining and accepting stationarity. The inflation rate is susceptible to various shocks generated by structural breaks. The effect of these real and monetary shocks is persistent only if it is determined by the corresponding test procedure incorporating structural breaks that determine the inflation rate as nonstationary. On the contrary, if, by applying the structural break test, the inflation rate shows a stationarity property, as a rule, we have transitory variations around the mean value or the deterministic trend.

The other reason refers to the indistinction between the mean reversion and non-stationarity in elaboration of the inflation dynamics. Under this assumption, a conditional central tendency is accepted, which claims that regardless of the shock force, the inflation adjustments are of equable dynamics. As a rule, inflation is not characterized by a normal distribution, although it does not have to be the case. A more probable option for inflation is skewed and leptokurtic distribution (Charezma *et al.*, 2005). The unit root testing in the inflation rates has generated an interest reflected in a number of studies in the last few decades, such as Culver and Papell (1997), Cuestas and Harrison (2010), Arize and

Malindretos (2012), Martins and Rodrigues (2014) and Chen and Hsu (2016). There is no common and conclusive finding regarding the inflation rate stationarity properties. Researchers have used various methods in their empirical studies testing the hypothesis of unit root in inflation.

The conventional unit root tests have significantly reduced power for establishing the stationarity properties if time series show structural breaks (Perron, 1989). The recognition of the importance of possible structural breaks in testing the null hypothesis of the unit root test is present in studies such as Malliaropoulos (2000), Costantini and Lupi (2007) and Bataa *et al.* (2013). Basher and Westerlund (2008) tested the findings of Culver and Papell (1997). Their results confirm that inflation rate data belong to the $I(0)$ series. Caporale and Paxton (2013) examined inflation stationarity for five Latin American countries by implementing Bai and Perron's (1998, 2003) structural break test. Their results indicate evidence in favour of stationarity for all countries when structural breaks are incorporated.

The implying estimation of conventional linear tests assumes the symmetrical adjustment process, which can be of different nature. In the case of asymmetry, restrictive symmetrical adjustment would be an inaccurate model specification. For that reason, it is important to emphasize that a certain approach does not necessarily correspond to every inflation rate research, but that it is vital to determine whether asymmetric adjustment in inflation rate exists. When there is nonlinearity, *i.e.*, asymmetric adjustment, the stationarity properties are to be examined by a corresponding nonlinear unit root test, which is presented in this study. The understanding of behaviour of inflation rates in that manner is presented through both linear and nonlinear processes. That is in accordance with the standpoint that inflation can act as a linear process with multiple equilibria (Sargent and Wallace, 1973).

The application of nonlinear unit root techniques in the testing procedure is very common considering skewed and leptokurtic distributions of inflation. Chang *et al.* (2013) used a flexible Fourier form to test the order of integration of inflation in 22 OECD countries for the period from 1961 to 2011. They found that the inflation rates were mean reverting for all the countries. Zhou (2013) employed a test based on Kapetanios *et al.* (2003) to examine the possibilities of unit root for inflation rates. The results for the majority of 12 European countries suggested stationary inflation rates in the case of floating exchange rate periods. Tsong and Lee (2011) analysed the stationarity of inflation rates in 12 OECD countries using the specific quantile regression of Koenker and Xiao (2004). The findings indicated that the inflation rates were mean reverting, with asymmetries in their behaviour. Cicek and Akar (2013) also applied Koenker and Xiao's (2004) approach to investigate the dynamic behaviour of inflation in Turkey from 1994 to 2012. Their results exposed an asymmetric speed of inflation with a more mean-reverting process after the adoption of inflation targeting. Henry and Shields (2004) applied Caner and Hansen's (2001) method and found

that the dynamic behaviour of inflation proceeded as a two-regime threshold unit root process. Arize and Malindretos (2012) applied the exponential smooth transition autoregressive unit root test to explore the symmetric and asymmetric adjustment for 34 African countries, and found that the inflation was not characterized by a mean reverting process.

2. Methodology

Most macroeconomic variables, including inflation, have a univariate time series structure with a possible unit root. In order to formalize the analysis for the given time series, we apply linear and nonlinear models. The reason for adopting a certain set of model types was the results obtained using the linearity test (Harvey *et al.*, 2008). The analysis by Harvey *et al.* (2008) is appropriate for both linear and nonlinear modelling based on studies quoted in this research, namely Zivot and Andrews (1992), Lee and Strazicich (2013), Kapetanios *et al.* (2003) and Sollis (2009). In order to verify the results, we conduct an additional assessment applying tests developed by Enders and Lee (2012) and Clemente *et al.* (1998).

Harvey *et al.* (2008) constructed a regression model based on time series where the order of integration was unknown. It was developed based on the Taylor series expansion. This test uses the following form of the first difference model:

$$\Delta I_t = \lambda_1 \Delta I_{t-1} + \lambda_2 (\Delta I_{t-1})^2 + \lambda_3 (\Delta I_{t-1})^3 + \varepsilon_t. \quad (1)$$

For the regression, the null hypothesis of linearity is given when $\lambda_2 = \lambda_3 = 0$. The alternative hypothesis $\lambda_2 \neq 0$ and/or $\lambda_3 \neq 0$ means nonlinearity. Based on the aforesaid, the weighted average Wald statistics can be expressed as follows:

$$W_\lambda = \{1 - \lambda\} W_0 + W_1. \quad (2)$$

The function λ moves towards one point or another in probability. It can range from 0 to 1 determined by the order of integration for I_t . When we have linear adjustment, the structural breaks can have an impact on the decision about stationarity. The testing of inflation rates with perceived linear behaviour is first performed using Zivot and Andrews's (1992) Z-A test. This kind of unit root test is constructed with one structural break in order to increase its power over the conventional linear tests. In this study, we use a model formulated as the following regression equation:

$$I_t = \alpha + \beta^a t + \theta^a D_{it}(\lambda) + \psi I_t + \sum_1 a_i \Delta I_t - i + \varepsilon_t \quad (3)$$

where $Dit(\lambda)$ is a dummy variable which indicates mean shift where $Dit(\lambda) = 1$ if $t > T\lambda$: $Dit(\lambda) = 0$ if $t < T\lambda$. There is no break under the unit root null. We test whether the series

are nonstationary against the stationary alternative with one break through the endogenous procedure. This analysis also uses Lee and Strazicich's (2013) LM test with one structural break. The critical values for one break are based on Lee and Strazicich (2003). The Lagrange Multiplier unit root test examines the null hypothesis:

$$H_0 : I_t = \mu_0 + dBt + I_{t-1} + \varepsilon_t . \quad (4)$$

Against testing regression:

$$I_t = \mu_0 + \mu_1 t + \mu_2 Bt + \mu_3 Dt + \beta I_{t-1} + \sum_{i=1}^k a_i \Delta I_t - i + \varepsilon_t \quad (5)$$

where ε_t is error terms. The hypotheses are structured on the data-generating process and the unobserved components model:

$$I_t = \sigma' Z_t + X_t, X_t = \beta X_{t-1} + \varepsilon_t \quad (6)$$

where Z_t is a vector of the exogenous variables and the null hypothesis is formulated by $\beta = 1$. When nonlinear data are present, the power of nonlinear models surpasses those of linear tests (Enders and Granger, 1998). The ESTAR (exponential smoothing transitional autoregressive) model is a basis for the KSS test of Kapetanios *et al.* (2003). The ESTAR model is constructed as follows:

$$I_t = \lambda I_{t-1} + \rho I_{t-1} \theta(\theta; I_{t-d}) + \varepsilon_t \quad t = 1, \dots, T \quad (7)$$

in which λ and ρ are unknown variables. The expression ε_t contains the error term. I_t is the series under analysis. This can be expressed by the exponential function:

$$\theta(\theta; I_{t-d}) = 1 - \exp(-\theta I_{t-d}^2) \quad (8)$$

where $\theta \geq 0$, and $d \geq 1$. The previous functions in combination provide the ESTAR model:

$$\Delta I_t = \phi I_{t-1} + \rho I_{t-1} \left[1 - \exp(-\theta I_{t-d}^2) \right] + \varepsilon_t \quad (9)$$

where $\phi = \lambda - 1$. In the ESTAR model, θ provides the speed of transition to mean reversion. Kapetanios *et al.* (2003) demonstrate a model for the case of $\phi = 0$ and $d = 1$ as:

$$\Delta I_t = \rho I_{t-1} \left[1 - \exp(-\theta I_{t-1}^2) \right] + \varepsilon_t . \quad (10)$$

There are two hypotheses which consider the parameter θ ; H_0 : $\theta = 0$ against H_1 : $\theta > 0$. Testing of the hypotheses is not directly possible, so that Kapetanios *et al.* (2003) derive t -type statistics to overcome this problem with the transition function. The following regression from the Taylor approximation is as follows:

$$\Delta I_t = \sigma I_{t-1}^3 + \varepsilon_t . \quad (11)$$

The null hypothesis and the alternative can be represented as: $H_0: \sigma = 0$, and $H_1: \sigma < 0$, based on t -statistics:

$$t_{NL} = \frac{\hat{\sigma}}{s.e.(\hat{\sigma})} \quad (12)$$

where the OLS estimate of σ is $\hat{\sigma}$. In their study, Kapetanios *et al.* (2003) estimate the critical values for t_{NL} . The second type of the nonlinear test combines the exponential and logistic function (Sollis, 2009). The AESTAR (asymmetric exponential smoothing transitional autoregressive) model for inflation can be specified by extension:

$$\Delta I_t = \left[1 - \exp(-\theta_1 I_{t-1}^2) \right] \left[1 + \exp(-\theta_2 I_{t-1}) \right]^{-1} p_1 + \\ + \left[1 - (1 + \exp(-\theta_2 I_{t-1}))^{-1} p_2 \right] I_{t-1} + \sum_{i=1}^k K_i \Delta I_t - 1 + \varepsilon_t. \quad (13)$$

In this case, the null hypothesis can be stated as follows: $H_0: \theta_1 = 0$. The unknown parameters are θ_2 , p_1 and p_2 . In order to overcome this problem, the Taylor expansion is used to estimate the final, augmented model:

$$\Delta I_t = \lambda_1 I_{t-1}^3 + \lambda_2 I_{t-1}^4 + \sum_{i=1}^k K_i \Delta I_t - i + \varepsilon_t. \quad (14)$$

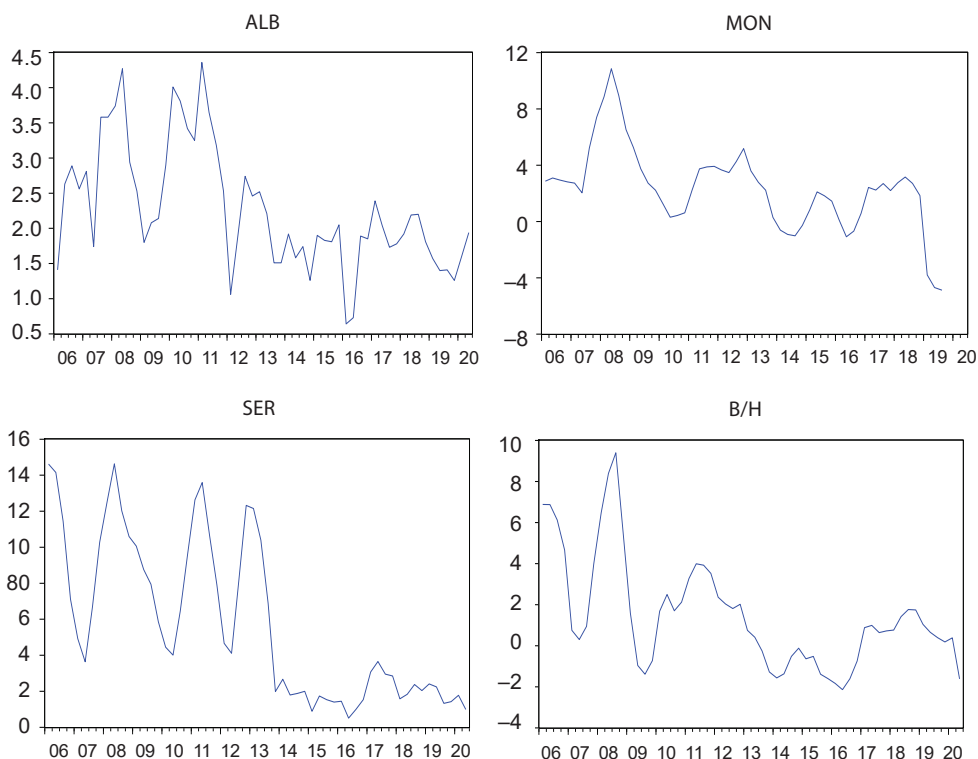
The null hypothesis $H_0: \theta_1 = 0$ replaced by $H_0: \lambda_1 = \lambda_2 = 0$. For testing the null hypothesis, an F -test is derived as a specific function which follows the asymptotic distribution. Finally, the existence of two structural breaks for inflation is tested using the test by Clemente *et al.* (1998). In the case of nonlinearity, the robustness of the results is assessed using the Fourier ADF test (Enders and Lee, 2012).

3. Empirical Investigation

The standard consumer price index growth rate has been estimated as an invaluable determiner of inflation or deflation. It stands as a basis for macroeconomic decisions and regulation. The inflation data were obtained from the International Financial Statistics database published by the International Monetary Fund (IMF, 2020). For the purpose of the basic analysis, quarterly data were used for the period from 2006Q1 to 2020Q2. This period was chosen so as to avoid the previous years of instability that followed the conflicts and transitional processes. Furthermore, data availability was an important factor, particularly in the case of Montenegro and Bosnia and Herzegovina. Our sample comprises four countries of the Western Balkans. We plot the inflation rate in time series data for each of the countries in our sample in Figure 1. A considerable volatility of the inflation rates for each of the countries can be noticed from the graph.

Descriptive statistics of the inflation rates, including the sample mean, maximum, minimum, standard error, skewness, kurtosis and Jarque-Bera test are provided in Table 1. The data regarding the average inflation rate for the given period show that it was highest in Serbia (5.7%). For Albania, Bosnia and Herzegovina and Montenegro, the average quarterly inflation rate was below 3%. The standard deviation suggests that for Serbia, which has the highest average inflation rate, volatility was most prominent and that it is followed by Montenegro. The volatility of inflation is lowest in Albania. The Jarque-Bera test for normality indicates that for Serbia and Bosnia and Herzegovina, the inflation rate is not normal, which is indicated by kurtosis and skewness as well. The coefficients of skewness are not negative, which implies that the series are flatter to the right. These data, characteristic of inflation, are not unusual. The Jarque-Bera test reveals normality in the data for the cases of Albania and Montenegro although the skewness and kurtosis coefficients are relatively high.

Figure 1: Inflation rates



Source: Author's calculations

Table 1: Summary statistics: quarterly inflation rate

Variable	Albania	Montenegro	Serbia	Bosnia and Herzegovina
Mean	2.278	2.343	5.759	1.469
Maximum	4.360	10.850	14.630	9.400
Minimum	0.640	−4.880	0.510	−2.140
Std. dev.	0.868	2.956	4.434	2.682
Skewness	0.613	0.206	0.597	1.068
Kurtosis	2.759	4.296	1.916	3.666
Jarque-Bera stat.	3.782	4.243	6.289	12.099
Probability	0.150	0.119	0.043	0.002

Source: Author's calculations

Table 2: ADF and PP unit root test results

Country	ADF		P-P	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Albania	−3.031** (0)	−4.277*** (0)	−3.084** (1)	−4.351*** (1)
Montenegro	−2.400 (1)	−3.520** (1)	−1.671 (3)	−2.474 (2)
Serbia	−0.901 (5)	−6.066*** (5)	−2.522 (3)	−3.325* (3)
Bosnia and Herzegovina	−4.275*** (1)	−5.626*** (1)	−2.804** (2)	−3.199* (2)

Note: The numbers in the parentheses indicate the optimal lag length suggested by the Schwarz information criterion (SIC). The numbers in the brackets for the P-P test indicate truncation for the Bartlett kernel, as suggested by the Newey-West test (1987). ** indicates significance at the 5% level; * indicates significance at the 10% level.

Source: Author's calculations

The first tests employed in the data testing are three conventional ones: ADF by Dickey and Fuller (1981), P-P by Philips and Perron (1988) and Ng-Perron by Ng and Perron (2001). The testing comprises each of the inflation rates of the given sample as a preliminary analysis, in order to compare the subsequent results. The results in Table 2 clearly indicate that the null hypothesis of the unit root can be rejected at the 5% and 1%

significance levels for the ADF statistics in the cases of Albania and Bosnia and Herzegovina. The results of the ADF and P-P tests suggest that the inflation rates of Serbia and Montenegro are not stationary processes in the case of intercept. The results of the Ng-Perron test in Table 3 can reject the unit root hypothesis for Albania and Montenegro. However, based on these results, we can only have an initial, not definitive, conclusion about stationarity of the inflation rates. We need to employ more robust unit root tests to reach an agreement about the stationarity of the Western Balkan inflation rates.

In order to obtain more precise results, our further research concept includes three-fold testing. First, we apply two tests from the methodological framework, and check the accuracy of the results to ascertain the valid conclusion by employing a third, complementary test. Based on the linear determination test, three tests with structural breaks are applied, whereas in the case of nonlinearity, threefold testing using nonlinear tests is done.

Table 3: Ng-Perron unit root test results

Country	<i>MZ_a</i>	<i>MZ_t</i>	<i>MSB</i>	<i>MPT</i>
Albania	-10.907** (0)	-2.334	0.214	2.248
Montenegro	-19.315* (1)	-2.881	0.149	2.053
Serbia	-0.202 (5)	-0.124	0.616	24.469
Bosnia and Herzegovina	-2.203 (3)	-0.844	0.383	9.621

Note: (X) indicates lag length. *, **, *** shows significance at the 1, 5 and 10% level, respectively.

Source: Author's calculations

The first model that we apply is a test by Harvey *et al.* (2008) that tests the null hypothesis of linearity in relation to nonlinear determination as an alternative. In the first two cases, according to Harvey *et al.* (2008), there is a linear path over the time period for the inflation rates. For Serbia and Bosnia and Herzegovina, the rates of inflation show nonlinear behaviour, so we need to detect the potential stationarity by nonlinear unit root testing. In case of the inflation rate exhibiting a nonlinear path over the time period, further use of the linear test will corrupt the accuracy of the obtained results. For linear relation, we employ two different unit root tests previously given in the methodological framework.

Table 4: Linearity test results

Country	Statistics	Prob. value	Result
Albania	0.316	0.426	Linear
Montenegro	0.025	0.493	Linear
Serbia	35.056	0.000	Nonlinear
Bosnia and Herzegovina	30.802	0.000	Nonlinear

Source: Author's calculations

The conventional linear unit root tests can provide misleading results when there are structural breaks in the observed time series. Thus, we employ the Z-A test by Zivot and Andrews (1992) and the LM test by Lee and Strazicich (2013). In the Z-A test, we test the null hypothesis of unit root series existence with drift against the alternative stationary process with a one-time break in the level. Based on the test results, we cannot reject the null hypotheses. The critical values of this test are derived so that there is no break under the null. The Z-A test is an endogenous break unit root test.

Table 5: Z-A unit root test results

Country	Z-A	
Albania	-3.949 (4)	2012Q4
Montenegro	-4.201 (2)	2016Q3

Note: The test includes the intercept term. The numbers in the parentheses indicate the optimal lag length suggested by the Akaike information criterion (AIC). The maximum lag length is 4.

*, ** and *** indicate significance at the 1, 5 and 10% level, respectively.

Source: Author's calculations

With the endogenous break unit root tests, there is a possibility of undesirable outcomes (Nunes *et al.*, 1997). In order to overcome this obstacle, it is necessary to employ a test that provides valid results even in the presence of a unit root with a structural break. The LM test is not affected by a break under the null and in the alternative situation. Considering the LM test with one structural break, we can conclude that there are no stationary processes with one-time level shifts in both series. There is a unit root series present with one level break.

Table 6: Results of LM unit root test with one break

Country	LM stat.	B_{t1}	T_{B1}
Albania	-1.286 (-4.046)	-0.096 (-0.190)	2013Q2
Montenegro	-0.345 (-3.619)	1.139 (1.036)	2016Q4

Note: The figures in the parentheses are t values. T_{B1} is the breakpoint. B_{t1} is the dummy variable for the structural break in the intercept.

Source: Author's calculations

Figure 2: Graphical interpretation of test by Clemente *et al.* (Albania and Montenegro)

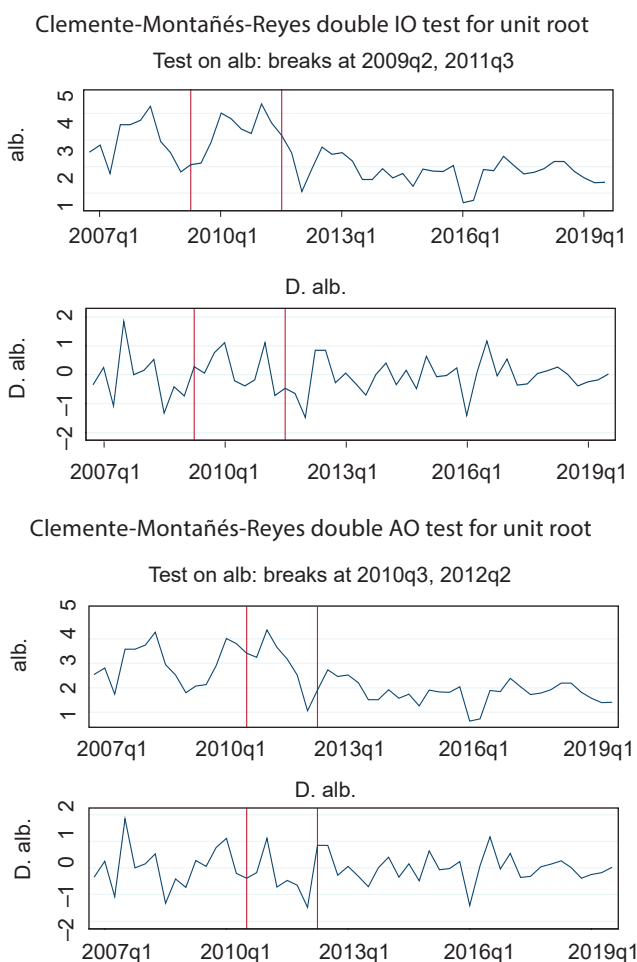
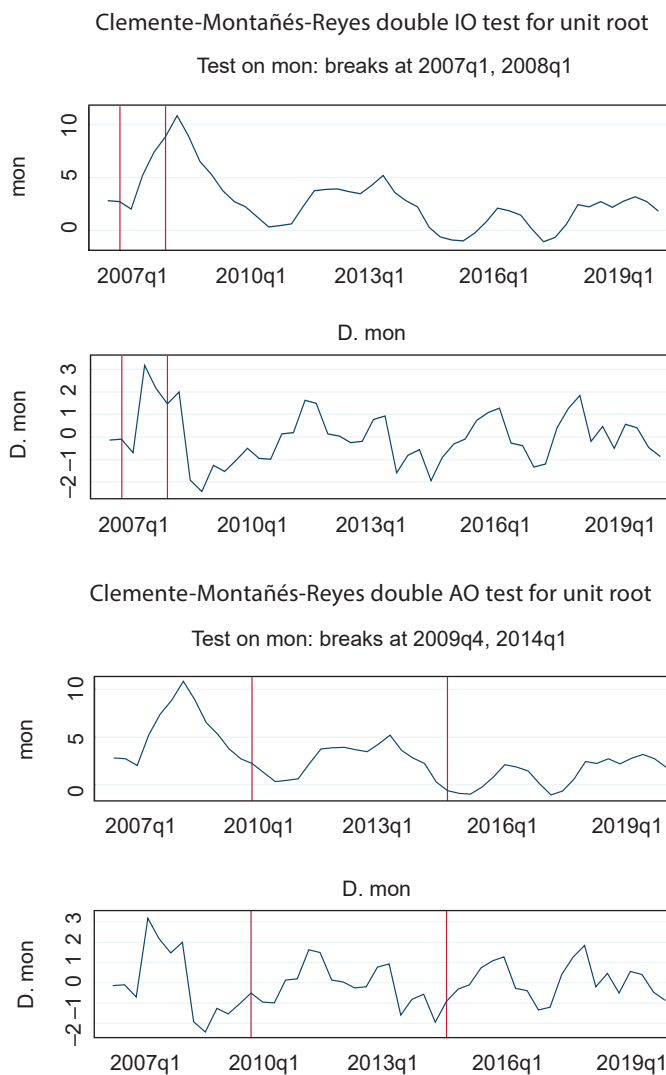


Figure 2: Continuation



Source: Author's calculations

The data are further tested in order to confirm the previous results. For the robustness check, we apply the CMR test by Clemente *et al.* (1998). Table 7 reports the unit root results that confirm that there is no stationary process with two level breaks. Given

the results from Table 7 and Figure 2, there is evidence of a unit root series with two level breaks. There are two statistically significant structural breaks (2009Q2 and 2011Q3) if we assume the sudden breaks in the case of Albania. By assuming additive outliers, we observe two structural breaks (2009Q4 and 2014Q1) in Montenegro's inflation according to Figure 2. Our findings are contrary to those of Caporale and Paxton (2013).

Table 7: CMR test by Clemente *et al.*

Country	Innovation outlier (IO)			Additive outlier (AO)		
	t-stat.	TB ₁	TB ₂	t-stat.	TB ₁	TB ₂
Albania	-4.236	2009Q2	2011Q3	-3.581	2010Q3	2012Q2
Montenegro	-1.487	2007Q3	2008Q3	-4.008	2009Q4	2014Q1

Note: The critical value of the Clemente-Montanes-Reyes unit root test for two mean shifts, for IO and AO, is -5.490 at the 5% significance level. TB₁ (TB₂) indicates first (second) mean shift period.

Source: Author's calculations

Table 8: Nonlinear unit root tests results

Country	ESTAR			AESTAR		
	Raw data	Demeaned	Detrended	Raw	Demeaned	Detrended
Serbia	-2.812**	-2.729***	-3.644**	4.865*	4.474***	3.971
Bosnia and Herzegovina	-2.792**	-2.828***	-5.843*	5.882*	5.939**	16.154*

FADF

Country	Coefficients		t-stat		AIC	SSR	F(k)	τDF
	Sin (.)	Cos (.)	Sin (.)	Cos (.)				
Serbia	0.581	-0.064	4.371	-0.705	2.481	107.645	9.594**	-5.799*
Bosnia and Herzegovina	0.279	0.105	3.579	1.745	1.510	38.535	6.709***	-5.276*

Note for ESTAR and AESTAR tests: *, ** and *** mean rejection of the null hypothesis of unit root at 1, 5 and 10% respectively. Note for F(k): The symbols *, ** and *** mean rejection of the null hypothesis of linearity at 1, 5 and 10% respectively. Note for τDF: *, ** and *** mean rejection of the null hypothesis of unit root at 1, 5 and 10% respectively (k = 1 for FADF).

Source: Author's calculations

We cannot apply the linear test to the nonlinear path of inflation and expect exact results. If the data are nonlinear, linear test results may be biased (Cuestas and Garratt, 2011). The ESTAR and AESTAR tests allow for the nonlinearity of inflation. We report the results of these tests in Table 8. The unit root null is rejected for Serbia and Bosnia and Herzegovina. For these countries, the inflation is a stationary process. Any possible shocks to the inflation are likely to be temporary. Stabilization policy has more capacity for long-lasting effects on the inflation rates for these countries. The obtained results are assessed using a Fourier ADF test (Enders and Lee, 2012) on monthly data for the same period. In both cases, we have strong evidence that confirms nonlinearity and stationarity for the inflation rates. Our Fourier ADF results show that the inflation rates follow a stationary process. There is no evidence of the unit root in the tested time series. Nonlinear stationarity of inflation rates has been confirmed for different European countries by studies such as Zhou (2013) and Chen and Hsu (2016). Similar results are also confirmed for Gulf Cooperation Council countries by Osman (2021).

Conclusion

This study applied a variety of tests in order to determine whether there is mean reversion of the inflation rates in the Western Balkan countries in the period from 2006Q1 to 2020Q2. The aim of the paper was to determine empirical validity of stationarity status in inflation rates of four South East European countries. The results of the study reject the unit root hypothesis in two out of four countries. In two countries, the inflation rates were found to be non-linear stationary processes. The results suggest stationary inflation rates for Serbia and Bosnia and Herzegovina. The conventional tests showed initial results, so to make conclusions about stationarity or nonstationarity of the inflation rates, we relied on a set of complementary tests depending on the linearity of data.

Based upon the established nonlinearity in the cases of Serbia and Bosnia and Herzegovina, the ESTAR and AESTAR tests were used, whereas the subsequent check of the obtained empirical results was conducted using a Fourier stationarity test. It was determined unambiguously that mean reversion of the inflation rates is held in both cases. In the cases of Montenegro and Albania, based on the given linearity of the data, we applied the Z-A and LM tests, which provided strong empirical evidence in favour of nonstationary inflation rates. The results were further confirmed using a CMR test. The results indicate that most shocks to the inflation rates affect the given countries in different ways. This requires distinct economic policies, depending whether the shocks are absorbed as temporary in the case of the expressed asymmetric stationarity or they have a persistent effect if the unit root null is not rejected.

In relation to the aforesaid, some policy implications could be made. Inflation can be critical for the Western Balkan countries because it generates associated issues regarding economic and political stability. Aggregate demand policies can be implemented successfully when the inflation rates are stationary. In the case of Serbia and Bosnia and Herzegovina, that could lead to a lower drop for the rest of 2020 and to some increase in the economic growth during 2021. Nonlinearity in the adjustment to equilibrium shows that the inflation rates in these two countries do not deviate much from the designated values. The adopted monetary strategies for these countries give the expected solid results considering the implementation of the proclaimed goals. The stable inflation inclines to a bearable level of unemployment based on the short-run trade-off relation. In the case of Albania and Montenegro, the monetary authorities need to pay attention to possible macroeconomic shocks. The government policy cannot ignore the structural breaks in order to avoid excessive costs of inflation. It means that central banks and governments should take stabilization policies as one of their main priorities considering the fact that most of the shocks to the inflation rates are not temporary. The previous experience of the Western Balkan countries suggests that any prolonged economic imbalance easily overflows into political instability; therefore, it is necessary to further develop facilities that can encourage better prevention and stabilization of inflation.

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