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TESTING FOR STATIONARITY OF INFLATION IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

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Testing for stationarity of inflation in Central and Eastern European countries

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Abstract

In this paper we provide an insight into the inflation dynamics in a panel of Central and Eastern European countries. These countries are selected because of their increasing importance in the EU and their likely increased future importance in monetary policy decisions inside the euro area. By means of unit root testing and allowing for the possibility of a smooth asymmetric adjustment to equilibrium, we show that inflation rates in more than half of the countries investigated are stationary processes. Our results imply evidence against the persistence hypothesis for them.

Keywords: Inflation persistence, unit roots, nonlinearities.

JEL Classification: E31, E32, C22

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1. Introduction

The analysis of inflation persistence has become a very popular topic of investigation during the last decade. This is not surprising given that inflation targeting has become one of the corner stones of monetary policy design for a number of central banks. Whether inflation rates are stationary or unit root processes has several implications, not only from a theoretical perspective, but also for empirical purposes. From a theoretical perspective, a number of macroeconomic models (Dornbusch, 1976; Taylor, 1979, 1980; Calvo, 1983; and Ball, 1993) assume that inflation rates are stationary while from an empirical perspective central banks frequently design monetary policy on the assumption that inflation is a stationary process, as is the growth rate of the monetary base - the main instrument of monetary policy for a number of countries. [See Taylor (1985) and McCallum (1988) among others]. It has also been argued that inflation persistence may affect economic growth (Faria and Carneiro, 2001).

Unit root tests for inflation persistence have generated mixed and ambiguous results which seem to vary with the country reviewed, the period analysed and the econometric technique used. [See Baum, Barkoulas and Caglayan (1999) and Kumar and Okimoto (2007) for a literature review].

To the best of our knowledge, there has not been any attempt to formally test the hypothesis of persistence in inflation rates in the former transition economies of Central and Eastern European countries (CEECs) that have recently been admitted to the EU. Their importance is increasing for the EU given that several have recently been granted EU Membership (the Czech Republic, Estonia, Hungary, Poland, Latvia, Lithuania, Slovakia, Slovenia, Bulgaria and Romania) one (Slovenia) has adopted the euro. A number of these countries have also announced their aspiration of joining the euro in the near future. To join EMU, the candidate country must fulfil the Maastricht convergence criteria regarding inflation, debt, exchange rates and interest rates. Therefore, by analysing the hypothesis of inflation persistence in this group of countries, one may gain some insight into the effectiveness of their monetary policies in achieving convergent rates of inflation.

In this paper, our contribution to the literature is twofold. First, we test for the order of integration of the monthly inflation rates of the CEECs by applying two groups of unit root tests. First we use panel data unit root tests in order to take into account the cross-section and time series properties of the data (Levin, Lin and Chu, 2002; Im, Pesaran and Shin, 2003; Maddala and Wu, 1999; and Choi, 2001)[1]. We then apply a battery of individual unit root tests recently proposed by Ng and Perron (2001), which aim at improving existing unit root tests in terms of size and power. We also use the Kapetanios, Shin and Snell (2003) nonlinear unit root test which takes into account the possibility of asymmetric speed of adjustment towards equilibrium. This is particularly interesting to study since in less than two decades they have gone through transition from being centrally planned economies to functioning market economies. Transition brought considerable upheaval involving simultaneous dislocations in economic behaviour and major changes in multiple aspects of the economic system, what could provoke nonlinear behaviour in the main economic variables such as inflation. The second contribution to the literature stems from the fact that this is the first analysis of inflation persistence in the CEECs. Testing for inflation persistence therefore provides a review of the success of monetary policies in creating stability in the newly emerged market economies of Central and Eastern Europe.

[1] To the best of our knowledge only Culver and Papell (1997) applied panel unit root test to analyse inflation persistence in OECD countries.

The remainder of the paper is organised as follows. Section 2 summarises the econometric techniques and the main results. The last section concludes.

2. Econometric methodology and results

2.1 Data

The data for this empirical analysis consists of monthly CPI-based inflation rates for a number of Central and Easter European countries, that is, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Slovak Republic and Slovenia, from 1994:1 until 2007:12. The CPIs have been obtained from the International Financial Statistics database of the International Monetary Fund.

Table 1 displays preliminary information about the statistical properties of the inflation rates for our target countries.

Insert Table 1 about here

2.2 Panel unit root tests

In this section, we apply a group of panel unit root tests, that is, Levin, Lin and Chu (2002) (LLC), Im, Pesaran and Shin (2003) (IPS), Maddala and Wu (1999) and Choi (2001) (MWC). The first authors suppose a common unit root under the null hypothesis against the alternative of stationarity of all individuals, whereas the other tests allow for individual unit roots under the alternative hypothesis. This supposes a less restrictive framework since in the former case the assumption of a common unit root under the null, or general stationarity under the alternative may, be too strong.

Thus, Levin, Lin and Chu (2002) consider the following Augmented Dickey Fuller (ADF) regression for panel data:-

$$\Delta y_{it} = \rho y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \qquad (1)$$

where d_{mt} is a vector of deterministic components, so that d_{it} implies no deterministic component, d_{1t} incorporates a drift and d_{3t} includes a constant and a time trend. The null hypothesis is formulated as $\rho = 0$, against the alternative $\rho < 0$.

Alternatively, Im, Pesaran and Shin (2003) base their test on the assumption of different ρ for every individual in equation (1), that is, ρ_i. Hence, the null hypothesis is formulated as $\rho_i = 0$ for all *i*, against the alternative that $\rho_i < 0$ for $i=1,2,\ldots,N_1$ and $\rho_i = 0$ for $i=N_1+1,\ldots,N$.

An alternative approach is followed by Maddala and Wu (1999) and Choi (2001), who combine the different p-values of the individual auxiliary regressions, either for the ADF and Phillips-Perron tests, to obtain the following Fisher (1932)-type test

$$-2\sum_{i=1}^{N} \ln p_i \rightarrow \chi^2_{2N} \qquad (2)$$

where p_i are the asymptotic p-value of a unit root test for individual *i*. Additionally, Choi (2001) proposes the following test, based on the combination of individual p-values:-

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i) \rightarrow N(0,1) \qquad (3)$$

where Φ is the standard normal cumulative distribution function.

The results of applying the aforementioned tests are reported in Table 2. In all cases only a drift is considered as a deterministic component and the lag length has been chosen according to the Modified Akaike Information Criterion (MAIC) proposed by Ng and Perron (2001). Note that with the LLC test we cannot reject the null hypothesis of a common unit root. However, with the IPS and MWC, we do reject the null hypothesis of unit roots in favour of the alternative that some of the series are stationary. This implies that for our group of countries, we cannot accept the hypothesis of persistence of inflation rates for all countries. Therefore, our result suggest that for some of the CEECs, inflation rates can be explained by deterministic factors rather than stochastic processes, that is, shocks have only transitory effects. In order to distinguish the countries for which this hypothesis holds, we apply individual unit root tests in the following section.

Insert Table 2 about here

2.3 Individual unit root tests

In order to analyse the order of integration of inflation for the individual countries, in this section we apply two groups of unit root tests: Ng and Perron (2001) and Kapetanios, Shin and Snell (2003) (KSS).

The first authors propose some modifications to existing unit root tests in order to improve their performance in terms of power and size. To do this, they combine a Modified Information Criterion and a Generalised Least Squares method for detrending the data. Specifically, Ng and Perron (2001) propose the following tests; MZa and MZt that are the modified versions of Phillips' (1987) and Phillips and Perron's (1988) Za and Zt tests; the MSB that is related to Bhargava's (1986) R1 test; and, finally, the MPT test that is a modified version of Elliot, Rothenberg and Stock's (1996) Point Optimal Test. The results of these tests are displayed in Table 3. The tests include a constant term as a unique deterministic component and the lag length has been chosen by the MAIC. Table 3 suggests that for only one country (Bulgaria) is it possible to reject the null hypothesis of a unit root.

However, as pointed out by Kapetanios et al. (2003), among others, traditional (linear) unit root tests may suffer from important power distortions in the presence of nonlinearities in the data generating process. Thus, these authors propose a unit root test that takes into account the possibility of a globally stationary exponential smooth transition autoregressive (ESTAR) process under the alternative hypothesis. This makes it possible to characterise the target variable, in this case the inflation rate, as a two regime process for which the change in regimes is smooth rather than sudden. Therefore, the inflation rate may behave as a stationary process in the central regime, but a unit root in the outer regime. In other words, the autoregressive parameter gets smaller and the variable tends to revert faster to its fundamental equilibrium the further it deviates from the equilibrium. The unit root hypothesis can be tested against the alternative of a globally stationary ESTAR process using the following ESTAR-modified auxiliary ADF regression:-

$$\Delta y_t = \alpha y_{t-1} + \phi y_{t-1}\left(1 - \exp\left\{-\theta y_{t-1}^2\right\}\right) + \varepsilon_t \qquad (4)$$

KSS assume that the variable is a unit root process in the central regime so that $\alpha = 0$, although the process is globally stationary. The null hypothesis $H_0 : \theta = 0$ that the process is a unit root in the outer regime is then tested against the alternative $H_1 : \theta > 0$ of stationarity. However, this test cannot be performed directly over θ, since in practice the parameter ϕ cannot be identified under the alternative. KSS propose the use of a Taylor approximation for equation (4) of the form:-

$$\Delta y_t = \beta y_{t-1}^3 + error \qquad (5)$$

Testing $H_0 : \beta = 0$ against $H_1 : \beta < 0$ is equivalent to testing for unit roots in the outer regime in equation (4). Of course, equation (5) may incorporate lags in order to control for autocorrelation in the residuals. KSS consider three possibilities regarding the deterministic components in their test: applying the test to the raw data, to the demeaned data and to the demeaned and detrended data. Since we are analysing inflation persistence against convergence to the equilibrium value, we apply the KSS test to the demeaned data. The results are reported in the last column of Table 3. Although KSS provided the critical values for these tests for different sample sizes, in this paper we have computed the critical values for each test given the number of observations we have used. These computations are based on Monte Carlo simulations with 50,000 replications.

The empirical analysis shows that after taking into account the possibility of nonlinear dynamics in the series of inflation for the CEECs, the inflation rate turns out to be a stationary process for 6 up to 12 countries. These results contrast with the results obtained with the Ng and Perron (2001) test (only Bulgaria's inflation appears to be stationary), but corroborates the findings obtained in the previous section, that is, inflation rates are mean reverting processes in some of the countries. From a statistical perspective, the fact that the inflation rate is a unit root process for some of these countries implies that prices are I(2) processes, something that has been already documented as a factual possibility in the literature (Johansen, 1992, among others). Moreover, this finding highlights the importance of taking into account nonlinearities when testing for unit roots, in particular in countries that have been in transition during the last decades and that, where political instabilities are frequent, affecting the rest of the economy and preventing the linear framework from being completely appropriate.

3. Conclusions

Aiming at contributing to the literature of inflation persistence in those Central and Eastern European Countries that have recently joined the EU, this paper tests for the order of integration of monthly inflation rates for this group of countries by applying several unit root tests. Our panel unit root tests corroborates our individual unit root testing analysis, taking into account the possibility of nonlinearities in the inflation dynamics. That is, the inflation rate turns out to be stationary for a total of 7 out to 12 countries. This shows the success these countries have had in stabilising their inflation rates as a prelude to joining the Euro area.

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Table 1: Summary statistics

Country	Mean	Standard error	Mininum	Maximum
Bulgaria	115.7858042	350.2852010	-2.2363167	2019.4854837
Croatia	22.0094388	97.7897681	0.6512315	839.5453795
Czech Republic	5.0101679	3.6702928	-0.4045746	13.4460506
Estonia	11.0781409	13.0341175	0.3285592	51.6297233
Hungary	11.7550231	7.7018501	2.2860563	31.2850396
Latvia	9.5702318	9.8926617	0.6868775	43.1090175
Lithuania	12.6723314	25.2069427	-1.9436346	176.5163101
Macedonia	13.2006053	38.6904291	-4.0633559	253.5377795
Poland	10.2269783	10.2512491	0.0775416	37.0557796
Romania	46.5946498	54.6272503	3.6549109	272.0220101
Slovak Republic	7.2496544	3.6489157	1.9578765	16.5449505
Slovenia	7.8130960	4.9206962	1.4812070	22.5056290

Table 2: Panel unit root tests

Method	Statistic	Prob.
Levin, Lin & Chu	24.1054	1.0000
Im, Pesaran and Shin	-5.41465	0.0000
ADF - Fisher Chi-square	83.7332	0.0000
ADF - Choi Z-stat	-5.47791	0.0000
PP - Fisher Chi-square	238.034	0.0000
PP - Choi Z-stat	-9.51714	0.0000

Note: The order of lags has been determined by the MAIC (Ng and Perron, 2001). Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 3: Ng and Perron (2001) and KSS tests

Country	MZa	MZt	MSB	MPT	KSS
Bulgaria	-20.1893**	-3.17615**	0.15732**	1.21735**	-2.23292
Croatia	0.51386	50.7396	98.7419	54.7480	-18.92223**
Czech Republic	-0.48795	-0.41026	0.84078	36.7963	-2.56956(*)
Estonia	0.18720	0.28121	1.50217	123.406	-3.80127**
Hungary	-1.17016	-0.64971	0.55523	17.0440	-1.86488
Latvia	-0.70606	-0.51794	0.73357	28.0386	-0.07452
Lithuania	0.48598	2.00677	4.12931	957.791	-14.12783**
Macedonia	0.51226	5.73472	11.1950	7041.46	-3.52693**
Poland	0.30261	0.34179	1.12949	74.8429	-1.56796
Romania	0.30311	0.34159	1.12696	74.5473	-5.19054**
Slovak Republic	-0.13172	-0.08909	0.67633	28.5336	-2.98841**
Slovenia	0.01622	0.01506	0.92819	49.3685	-1.97886

Note: The order of lag to compute the tests has been chosen using the modified AIC (MAIC) suggested by Ng and Perron (2001). The Ng and Perron tests include an intercept, whereas the KSS test has been applied to the demeaned data. The symbols * and ** mean rejection of the null hypothesis of unit root at the 10% and 5% respectively. The critical values for the Ng and Perron tests have been taken from Ng and Perron (2001), whereas those for the KSS have been obtained by Monte Carlo simulations based upon 50,000 replications:

	MZa	MZt	MSB	MPT	KSS
5%	-8.10000	-1.98000	0.23300	3.17000	-2.906833
10%	-5.70000	-1.62000	0.27500	4.45000	-2.636264

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