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INFLATION DYNAMICS IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

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Inflation dynamics in Central and Eastern European countries

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Economic and Monetary Union (EMU) raises important questions about policy context and design within member states. As EMU membership rises, so it embraces an increasingly diverse range of countries notwithstanding, the qualifying convergence criteria. Given the importance of convergent inflation to the sustainability of EMU with a common monetary policy, understanding the dynamics of inflation is of particular policy importance. This study uses fractional integration methods to analyse inflation dynamics in 12 Central and Eastern European countries. We find evidence of mean-reversion in only seven countries, with different speeds of reversion across countries. Furthermore, employing a recently developed time-series approach, we uncover the existence of multiple statistically distinct $I(0)/I(1)$ regime states in almost all the countries. This raises the possibility that, as and when these countries join EMU, ECB monetary policy aimed at euro wide price stability could potentially transmit quite differently through these economies, resulting in heterogeneous and diverging inflation outcomes.

JEL Codes: C22, E31, E61

Keywords: Inflation, Fractional integration, Multiple changes in persistence.

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1. Introduction

Interest rates signal the stability of an existing inflation regime (with changes in long-term rates reflecting changes in inflationary expectations), but price stability is widely accepted as the best indicator of sound monetary policy. In practice, two important features are commonly observed in inflation rates: the persistence of inflation across time (see, for example, Baum *et al.,* 1999; Coleman, 2010; Cuestas and Harrison, 2010), and breaks in inflation behaviour (see example Noriega and Ramos-Francia, 2009).

For many emerging and transition economies, price stability is increasingly a major policy issue. Since the early 1990s, analyses of inflation dynamics have become very popular, partly because of the increase in the number of countries adopting inflation targeting (IT) and, partly, bolstered by the academic evidence backing IT's superiority over other strategies to control inflation.[1] Across Europe and other OECD countries and, more recently, developing economies in Africa and South America (such as Brazil, Chile, Ghana and South Africa), IT has been adopted as the basis for monetary policy-making.

Analyses of price stability and inflation dynamics are particularly topical and important for emerging and transition economies. First, these economies are usually exposed to myriad shocks (both internal and external). In the context of, in particular, an exogenous shock, different country-level policy interventions may be required, depending on the degree of shock persistence. Second, breaks, which are often present in inflation rate data, imply the need to model inflation according to the specific

[1] See, for example, Mishkin (1998, 2000, 2004) and the references cited therein.

characteristics of the data. Third, the volume of investment and foreign portfolio flows into emerging markets have increased significantly in recent years, which may have contributed, at least in part, to lower inflation and improving price stability. For example, the Institute of International Finance (June, 2011) forecasts private capital inflows to emerging economies to increase to US$1,041 billion in 2011 and US$1,056 billion in 2012. Against this background, the macroeconomic conditions in these destination countries become relevant for investors and, in particular, the dynamics of inflation in these countries have become more important in the investment decision process.

This group of countries includes several of the Central and Eastern European Countries (CEECs) that have recently been admitted to the EU, or have been granted candidate status.[2] Our sample of 12 CEECs includes three countries already in EMU (Estonia, Slovakia and Slovenia), seven in the EU and working towards EMU (Bulgaria, the Czech Republic, Hungary, Latvia, Lithuania, Poland and Romania), and two candidate countries, working towards EU accession (Croatia and Macedonia). Inflation dynamics in these countries are of particular importance, because the terms of EU accession commit countries to work towards membership of EMU. To this end, the Maastricht Treaty lays down a series of accession criteria all of which are, in some way, related to a country's current and possible future inflation profile.[3] Indeed, we note that, since 2001 or so, inflation in many CEECs has declined to below 10 percent and remained there (see Tables 1a and 1b, below).

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[2] The Czech Republic, for example, is considered to be an important market in the FTSE Emerging Market indices (part of the FTSE Global Equity Index Series (GEIS)).

[3] For more detail on the macroeconomic, or convergence, criteria, see Article 109(j) of the Maastricht Treaty (http://www.eurotreaties.com/maastrichtec.pdf).

Research on the CEECs is limited, but growing, with the current focus primarily on the behaviour of exchange rates (see Gil-Alana and Nazarski, 2007, Candelon *et al*., 2007; Dufrénot *et al*., 2008; and Barros *et al*., 2011, Cuestas *et al.*, 2011). To the best of our knowledge, only Cuestas and Harrison (2010) have investigated inflation persistence in the CEECs. Their main findings are based on the nonlinear unit root test proposed by Kapetanios *et al*. (2003) [KSS] and tests the assumption of linearity in the data generating process. Specifically, the KSS test, under the alternative hypothesis, allows for the possibility of a globally stationary exponentially smooth transition autoregressive (ESTAR) process, thereby allowing for a two-regime process. Although the method allows for the possibility of a smooth change in regimes, say from $I(0)$ to $I(1)$, it does not allow for the possibility of multiple breaks.

This paper contributes to this sparse extant literature in three main ways: *(i)* by investigating the specific possibility of fractionally integrated (FI) inflation rates; *(ii)* by employing an additional test that allows for multiple changes in the order of integration across time; and *(iii)* including more recent data in our analyses. Our results indicate that some countries' inflation rates are better characterised as an FI process. Allowing for the possibility of multiple breaks in the data series, moreover, provides valuable information for policy formulation in these transition economies, which will have important policy implications. Notably, first, some degree of policy intervention would be required in these countries to return inflation to the mean following an inflationary shock. Second, although ECB monetary policy cannot target individual member country performance, the clarification of relative weights associated with each member, recognising differing degrees of the mean-reversion of inflation, matters profoundly for the effectiveness of monetary policy across the countries of the euro area.

The remainder of the paper is organised as follows. Section 2 provides a brief background to macroeconomic developments in the CEECs, while Section 3 describes the data and econometric strategies we employ. Section 4 presents the empirical results and Section 5 discusses some policy implications and concludes.

2. A brief background of macroeconomic/monetary policy developments in the CEECs

From late 1989, the communist regimes of central and eastern Europe collapsed – and, with them, their economic systems based on central planning. Through the transition period that followed, as they all sought to establish functioning market economies, the CEECs adopted different approaches to marketisation. For example in central Europe, Hungary, Poland and the Czech Republic went ahead with rapid transformation processes, while several countries further east entered much slower and less constructive cycles of economic reform. These differences notwithstanding, EU membership was established early on as a primary economic and political goal; a move that implied, at a later date, adoption of the euro. Such different policy approaches taken at the outset of the transition process have, subsequently been mirrored in different dates of accession to the EU, and an even-wider time-span for countries to join EMU (with several countries still an undefined, but considerable, way away from EMU accession).

That said, there has been significant convergence around inflation targeting as the primary approach to monetary policy-making. The monetary authorities in the Czech Republic, Hungary and Poland resorted, initially, to targeting of the exchange rate, but by the late 1990s and early years of the new millennium had adopted inflation targeting (in 1998, 2001 and 1999, respectively). Slovakia also began by targeting the exchange rate, but their move subsequently was to an implicit inflation target. Slovakia became the second CEEC to enter the euro area, in January 2009. Bulgaria's monetary policy, initially, was based on the multiple objectives of discretionary control of money supply and a floating exchange rate. Following a severe banking and currency crisis in 1996, however, Bulgaria adopted a currency board in 1997. In Romania, monetary policy was based on monetary targeting, where the monetary base was set as an operational objective, and money supply (M2) as an intermediate objective. However, in circumstances closely related to the Bulgarian situation, Romania experienced hyperinflation in 1996/97 and underwent a serious financial crisis in 1999, when it was close to default on external debt. In August 2005, the National Bank of Romania adopted inflation targeting.

Monetary reforms in Estonia started in 1992 with the introduction of a currency board and the convertibility of the Estonian *kroon*. This ceased when Estonia became the third CEEC to join the euro area, in January 2011. Latvia, since 1993, also adopted a crude exchange-rate targeting programme but, in February 1994, the Bank of Latvia pegged the national currency, the *lats*, to the special drawing rights (SDR) basket of currencies. Lithuania also opted for a nominal monetary anchor by introducing a currency board in 1994 until 2002 when, in line with other Europeanisation policies, the *littas* was re-pegged from the US dollar to the euro. Slovenian policy involved setting an intermediate target that focused on money supply measured in terms of M1, and base money became an operating target. In 2007, Slovenia became the first of the CEECs to enter the euro area, and the only one not to have done so with an explicit inflation target already in place.

Macedonia, the least developed of the Yugoslav republics, produced only about 5% of total federal output of goods and services. Several factors hindered economic growth until 1996, including the collapse of Yugoslavia and the loss of markets in a de facto free trade area, limited infrastructure, UN sanctions on the downsized Yugoslavia, and Greece’s economic embargo stemming from a dispute about the country's constitutional name and flag. More recently, with the denar pegged to the euro, prudent fiscal and monetary policies have delivered a sound financial system. The resulting macroeconomic stability has thus seen falling interest rates. In contrast, Croatia, once one of the wealthiest of the Yugoslav republics, suffered a severe and virtual collapse of output owing to the 1991-1995 civil war. More recently, however, due to increasing tourism and credit-driven consumer spending, the country experienced steady GDP growth of between 4%-6% (over 2000-2007). Inflation over the same period remained under control, on average under 2.5% over the last decade. The currency, the *kuna*, has also remained stable. Interestingly, high unofficial *euro-ization* remains one of the most striking features of the monetary policy environment in Croatia. Foreign currency deposits in Croatia comprise close to 90% of total deposits, while two-thirds of broad money is denominated in foreign currency. A stubbornly high unemployment rate, a growing trade deficit and uneven regional development are still prevalent, though and the state retains a large role in the economy. Attempts at privatization are still challenging, often meeting stiff public and political resistance. While macroeconomic stabilization has largely been achieved, structural reforms lag because of deep resistance on the part of the public and lack of strong support from politicians.

Table 1a: Summary inflation statistics, 1994m1 – 2011m4 (Pre- and Post- joining EU, excluding candidate states)

Country	Observations		Mean		Standard deviation		Minimum		Maximum	
	Pre-	Post-	Pre-	Post	Pre-	Post-	Pre-	Post-	Pre-	Post-
Bulgaria	156	52	124.04	6.40	362.26	4.76	-2.23	-0.25	2019.04	15.27
Czech Rep.	124	84	5.88	2.67	3.88	1.84	-0.40	-0.17	13.44	7.55
Estonia	124	84	13.27	4.72	14.54	3.29	0.32	-2.16	51.62	11.44
Hungary	124	84	13.97	5.22	7.65	1.81	3.39	2.28	31.02	9.03
Latvia	124	84	10.25	6.77	11.38	5.26	0.60	-4.13	43.11	17.92
Lithuania	124	84	15.84	4.51	28.68	3.29	-1.92	-0.46	176.51	12.52
Poland	124	84	13.02	2.97	10.57	1.29	0.07	0.51	37.05	5.02
Romania	156	52	49.81	6.22	55.40	1.64	4.62	3.65	272.02	9.04
Slovak Rep.	124	84	8.39	3.29	3.45	1.88	1.97	0.40	16.54	8.49
Slovenia	124	84	9.52	2.84	4.61	1.68	3.45	-0.58	22.50	6.95

Note: Pre- and Post- refers to summary statistics on inflation data before and after EU accession:

Table 1b: Summary inflation statistics (1994m1 – 2011m4, including candidate states)

Country	Observations	Mean	Standard deviation	Minimum	Maximum
Bulgaria	208	94.634	317.619	-2.236	2019.480
Croatia	208	18.369	88.158	0.603	839.545
Czech Rep.	208	4.588	3.578	-0.404	13.446
Estonia	208	9.820	12.151	-2.160	51.629
Hungary	208	10.444	7.394	2.287	31.023
Latvia	208	8.8480	9.544	-4.134	43.108
Lithuania	208	11.270	22.899	-1.925	176.517
Macedonia	208	11.263	35.006	-4.063	253.538
Poland	208	8.968	9.570	0.078	37.056
Romania	208	38.910	51.547	3.655	272.023
Slovak Rep.	208	6.335	3.846	0.402	16.545
Slovenia	208	6.8273	4.958	-0.588	22.505

Note: Croatia and Macedonia are EU candidate countries.

Given the importance of inflation targeting in the CEECs monetary policy, analyses of inflation persistence in these countries will provide insights into possible problems as they converge on EMU membership, and thus any consequent policy implications.

3. Data and econometric methods

3.1 Data

Monthly CPI-based inter-annual inflation rates for the 12 CEECs in our sample have been obtained from the International Financial Statistics (IFS) database of the International Monetary Fund, for 1994*m*1-2011*m*4. Table 1a and 1b display summary statistical information about the inflation rates for our focus countries. Over this period, significant differences can be seen in some of the statistical measures reported across this sample of countries which, from the policy point of view, is interesting given the importance of convergence in inflation as a pre-requisite for EMU accession.

3.2 Econometric methods

In this paper, we adopt a two-pronged approach: First, we test for the order of fractional integration in the full sample period for each country. Specifically, we employ the *Modified Log Periodogram Regression estimator* of Phillips (1999a, 1999b), which addresses a major criticism of the widely-used Geweke and Porter-Hudak (1983) estimate of the long memory (fractional integration) parameter, d. The Geweke and Porter-Hudak estimator is inconsistent against $d>1$ alternatives: in those circumstances, distinguishing unit-root behaviour from fractional integration may be problematic. Phillips proposes a modified form of the long memory parameter, d, in which the dependent variable is modified to reflect the distribution of d under the null hypothesis that $d=1$. The estimator gives rise to a test statistic for $d=1$, which is a standard normal variate under the null. Phillips suggests removal of the deterministic trends from the series before application of the estimator.[4] Evidence of fractional integration in the inflation series will imply that an *a priori* assumption that inflation rates possess a unit root may be misleading; and, in terms of technique fractional differencing, where needed, will be more appropriate than taking first differences.

Second, we apply a test proposed by Leybourne *et al*. (2007) [hereafter, LKT] for changes in the order of integration of a time series. The LKT test allows consistent estimation of the change dates, and is robust to the presence of (multiple) level breaks. It thus has advantages over similar tests proposed by Harvey *et al*. (2006) and Leybourne *et al*. (2006), which are inconsistent against processes which display multiple changes in persistence. The data generation process (DGP) consists of the following time-varying AR(p):

$$y_t = d_t + u_t \qquad (1)$$

Where y_t is the inflation rate, $d_t = z'_t \beta$ being the deterministic component. LKT allow for two alternatives: (i) $z_t = 1$ and $\beta = \beta_0$, the (possibly non-constant) level of inflation, and (ii) $z_t = [1,t]$ and $\beta = [\beta_0, \beta_1]'$, and ε_t is a martingale difference sequence.

In Equation 1, u_t is taken to be a time-varying AR(p) process, which can be rewritten as $u_t = \rho_i u_{t-1} + \sum_{j=1}^{k_i} \vartheta_{ij} \Delta u_{t-j} + \varepsilon_t, \quad t = 1,2,\ldots,T$, where $k_i = p_i - 1, i=1,\ldots, m+1$, and m is the number of changes in persistence. In this form, Equation 1 permits the estimation of separate ρ_i [the dominant AR root], and ϑ_{ij} [the lag coefficients] differ across the m+1 regimes. In other words, the AR coefficients and orders are regime-dependent. There are two hypotheses: the null, H_0: $y_t \sim I(1)$ throughout, that is, $\rho_i = 1 \forall t$, versus the alternative, H_1: y_t undergoes one or more regime shifts between $I(1)$ and $I(0)$ behaviour.

[4] See Phillips (1999a, 1999b) for a more detailed description.

Therefore, under the alternative, ρ_i may undergo $m\geq1$ unknown persistence changes, giving rise to $m+1$ segments with change point fractions given by $\tau_1<\tau_2<\ldots<\tau_{m-1}<\tau_m$. LKT's procedure partitions the time series, $y_t, t=1,\ldots T$ into its separate $I(0)$ and $I(1)$ regimes, and consistently estimates the associated change point fractions. LKT define the fraction $\tau\in(\lambda,1)$, for a given λ in (0,1), and base their test H_0 vs. H_1 on the local GLS de-trended ADF unit root statistic (see Elliot *et al*., 1996) that uses the sample observations between λT and τT, called $DF_G(\lambda,\tau)$, obtained as the standard *t*-statistic associated with $\hat{\rho}_i$ in the fitted regression:

$$\Delta y_t^d = \hat{\rho}_i y_{t-1}^d + \sum_{j=1}^{k_i} \hat{b}_{i,j}\, \Delta y_{t-j}^d + \hat{\varepsilon}_i, \qquad t=\lambda T;\ \lambda T+1;\ \ldots;\ \tau T \tag{2}$$

where $y_t^d = y_t - z'_t y_t^d = y_t - z_t'\hat{\beta}$, with $\hat{\beta}$ the OLS estimate of β [obtained from regressing $y_{\lambda,T}$ on $z_{\lambda,T}$, where $y_{\lambda,T} \equiv (y_{\lambda,T}, y_{\lambda,T+1}-\hat{\alpha}y_{\lambda,T},\ldots, y_{\tau T}-\hat{\alpha}y_{\tau T-1})'$ and $z_{\lambda,T} \equiv (z_{\lambda,T}, z_{\lambda,T+1}-\hat{\alpha}z_{\lambda,T},\ldots, z_{\tau T}-\hat{\alpha}z_{\tau T-1})'$, with $\hat{\alpha}=1+\bar{c}/T$, and $\bar{c}=-10$.

In our analysis, we set $\lambda=1/T$ and explore the subsamples along two fronts: First, as in LKT, we use $\tau=0.20$, and employ the modified Akaike Information Criterion (MAIC) for determining the value of k_i, as suggested by Ng and Perron (2001), using a maximum lag order of 12.

The test statistic proposed by LKT is based on doubly-recursive sequences of DF type unit root statistics:

$$M = \inf_{\lambda\in(0,1)} \inf_{\tau\in(\lambda,1)} DF_G(\lambda,\tau) \tag{3}$$

The corresponding estimators are $(\hat{\lambda},\hat{\tau}) \equiv \arg \inf_{\lambda\in(0,1)} \inf_{\tau\in(\lambda,1)} DF_G(\lambda,\tau)$ and give the start and end points, i.e. the interval $[\hat{\lambda},\hat{\tau}]$, of the first $I(0)$ regime over the whole sample. Any further $I(0)$ regimes are then detected sequentially by applying the M statistic to each of the resulting subintervals $[0,\hat{\lambda}]$ and $[\hat{\tau},1]$. We continue in this fashion for all temporal dimensions exceeding 20 observations, which is the minimum for which LKT (p. 13) report finite sample critical values until, for each period considered, the 'most prominent' *I*(0) regime, together with their start and end points, have been identified. We note that the period between the end point of one *I*(0) regime and the start point of the next *I*(0) regime must represent an *I*(1) regime.

4. Empirical results

The results in column 3 of Table 2 reveal evidence of fractionally integrated inflation rates in six countries (Bulgaria, Croatia, Lithuania, Macedonia, Poland and Slovakia); i.e. both the null of d=0 and d=1 are rejected at the standard significance levels. Of the remaining 6 countries, we are unable to reject the null of d=1 (unit root) in five, and the null of d=0 (stationarity) in just one, Romania. The implication is that shocks to inflation are mean-reverting in the first six countries and Romania. Only in Romania, however, is the reversion immediate. The remaining countries exhibit some degree of inflation persistence, although inflation does revert to the mean eventually. For the other five countries, however – the Czech Republic, Estonia, Hungary, Latvia and Slovenia – the implication is that the impacts of a shock to inflation are permanent. The FI test sheds more light on the order of integration of the series compared to the tests that give knife-edge *I*(0) vs. *I*(1) outcomes. In fact, several authors (for example Taylor (1985); McCallum (1988)) argue that central banks' monetary policy is often designed under the assumption that the main economic target, inflation, is a stationary process. However, our results indicate that for some countries, this is not the case. Therefore, for these EU members and candidate countries, particularly those who are aiming to adopt (or have already adopted) the euro and be under the jurisdiction of the European

Central Bank (ECB), this information is crucial since they would all be subject to common monetary policy formulated by the ECB, and common policy transmitting heterogeneously within any union is likely to be a policy concern.

Second, a visual inspection of the time series plots of the datasets suggests a general long-term decline in inflation rates across the CEECs, which is unsurprising given the IT policies adopted by these countries and described in Section 2. We therefore apply the LKT procedure over the sample period and allow the possibility of both a constant and a trend i.e., the deterministic component, $z_t=(1,t)'$. Results of the *M* test for each country are reported in Table 2 and show, for each (sub-)period tested, the 'most prominent' *I*(0) regime.[5] With the exception of Estonia we find, for each country, the incidence of at least one *I*(0) sub-period, for which we are able to reject the unit root null [i.e. an *I*(1) to *I*(0) then back to *I*(1) regime change]. A few points are worthy of note: first, the results from the LKT procedure are largely complementary to the FI test results. For example, the implication for Estonia is that, at the standard significance levels, there is no prominent *I*(0) sub-period over the sample period under investigation, which corroborates the result of the FI test that the null of *d*=0 is rejected.

[5] See Leybourne *et al*. (2007) for a more detailed description.

Table 2: Results of fractional integration and multiple persistence changes for CEECs

Country	Sample	d	k_i	M	I*(0) start*	I*(0) end*
Bulgaria	1994*m*1-2011*m*4	0.294(0.117)$^{++,***}$	0	-15.123$^{\wedge\wedge\wedge}$	1996*m*12	2009*m*7
Croatia	1994*m*1-2011*m*4	0.183(0.020)$^{+++,***}$	0	-4.835$^{\wedge\wedge}$	1994*m*9	1999*m*6
	1999*m*7-2011*m*4		1	-6.417$^{\wedge\wedge\wedge}$	2002*m*9	2005*m*5
	2005*m*6-2011*m*4		0	-5.092$^{\wedge\wedge}$	2008*m*12	2010*m*4
Czech Rep.	1994*m*1-2011*m*4	0.832(0.241)$^{+++}$	1	-3.796	2004*m*1	2007*m*7
	1994*m*1-2003*m*12		1	-3.344	1994*m*1	1996*m*6
	1996*m*5-2003*m*12		1	-5.387$^{\wedge\wedge\wedge}$	2000*m*2	2001*m*9
Estonia	1994*m*1-2011*m*4	0.954(0.149)$^{+++}$	0	-3.416	1998*m*12	2010*m*4
	1994*m*1-1998*m*11		1	-4.176	1995*m*3	1996*m*3
Hungary	1994*m*1-2011*m*4	1.204(0.277)$^{+++}$	0	-3.211	2002*m*10	2011*m*2
	1994*m*1-2002*m*9		0	-3.777	1999*m*1	2000*m*4
	1994*m*1-1998*m*12		3	-8.106$^{\wedge\wedge\wedge}$	1995*m*1	1997*m*1
Latvia	1994*m*1-2011*m*4	1.047(0.148)$^{+++}$	4	-4.485$^{\wedge}$	2001*m*2	2002*m*12
	1994*m*1-2001*m*1		3	-5.255$^{\wedge\wedge}$	1994*m*4	1997*m*7
	2003*m*1-2011*m*4		4	-4.177	2003*m*6	2009*m*1

Lithuania	1994*m*1-2011*m*4	0.648(0.031)$^{+++,**}$	0	-3.742	2003*m*7	2008*m*12
	1994*m*1-2003*m*6		0	-4.650$^{\wedge}$	1999*m*6	2001*m*7
	1994*m*1-1999*m*5		1	-7.415$^{\wedge\wedge\wedge}$	1995*m*4	1996*m*5
Macedonia	1994*m*1-2011*m*4	0.524(0.066)$^{+++,***}$	0	-4.073	2004*m*11	2008*m*8
	1994*m*1-2004*m*10		0	-3.996	2000*m*8	2003*m*4
	1994*m*1-2000*m*7		0	-6.294$^{\wedge\wedge\wedge}$	1997*m*1	1998*m*5
Poland	1994*m*1-2011*m*4	1.364(0.157)$^{+++,**}$	3	-4.569$^{\wedge}$	1994*m*12	1999*m*4
	1999*m*5-2011*m*4		0	-2.874	2008*m*5	2010*m*11
Romania	1994*m*1-2011*m*4	0.375(0.288)***	0	-5.702$^{\wedge\wedge\wedge}$	1996*m*11	2011*m*4
Slovak Rep.	1994*m*1-2011*m*4	0.588(0.232)$^{++,**}$	0	-3.901	2004*m*9	2010*m*11
	1994*m*1-2004*m*8		1	-3.644	1996*m*7	1999*m*4
	1999*m*5-2004*m*8		0	-8.213$^{\wedge\wedge\wedge}$	1999*m*12	2001*m*11
Slovenia	1994*m*1-2011*m*4	1.263(0.350)$^{+++}$	3	-4.329	2000*m*11	2005*m*8
	1994*m*1-2000*m*10		1	-3.834	1995*m*9	1998*m*12
	2005*m*9-2011*m*4		3	-4.812$^{\wedge\wedge}$	2006*m*7	2007*m*9

Notes: In column 3, the numbers in parentheses refer to the standard error for the *d* estimate. $^{+,++,+++}$ and *,**,*** imply rejection of the null of *d*=0 and *d*=1 respectively. For *M* statistic, critical values for LKT for *T*=200 are -4.48, -4.751 and -5.323 at the 10%, 5% and 1% levels respectively. $^{\wedge,\wedge\wedge,\wedge\wedge\wedge}$ imply rejection of the unit root null at the 10%, 5% and 1% levels respectively).

The agreement is also evident for Bulgaria and Romania, where the *I*(0) sub-period identified spans almost the entire period investigated, and the FI test also rejects the null of d=1.[6] The implication is that, while the FI approach offers rich information, the LKT approach arguably provides even richer and more time-specific information on the dynamics of the data. For policy formulation and academic purposes, this is relevant, not least because it can inform policymakers of specific points in time as to which prevailing policies yielded the observed behaviour in the inflation rates.

Finally, we are unable to identify a consistent pattern of sub-periods for *all* countries over which the regime switches occur. From the policy perspective, this observation is significant since some of these CEECs (Estonia, Slovakia and Slovenia) have adopted the euro and are therefore subject to the common monetary policy of EMU. In other words, ECB monetary policy aimed at euro wide price stability could potentially transmit quite differently through these economies, and result in heterogeneous and diverging inflation outcomes.

5. Policy implications and conclusions

In this paper, we contribute to the literature on inflation persistence, by analysing the dynamics of inflation in 12 CEECs, including Estonia, Slovakia and Slovenia already in EMU, seven more in the EU and working towards EMU membership, and a further two countries looking to join the EU. Finding different rates of mean reversion in different countries' inflation, or even the absence of mean reversion, would have important

[6] The FI tests suggest mean-reversion for Bulgaria; whereas for Romania the null of d=0 is not rejected.

policy implications for countries who, in joining the EU, are also committing themselves to enter EMU at some point.

Our results, based on the nonparametric methods proposed by Phillips (1999a, 1999b), indicate that inflation rates in Bulgaria, Croatia, Lithuania, Macedonia, Poland, Romania and the Slovakia are mean-reverting; whilst, in the Czech Republic, Estonia, Hungary, Latvia and Slovenia, orders of integration are, at standard levels, not significantly different from 1. The implication is that inflation shocks in the former group would see inflation revert to the mean, even without any policy intervention, over a period of time dependent on the degree of persistence. That said, this would happen rapidly only in Romania. On the other hand, shocks to the latter group are permanent i.e., non mean-reverting.

On the demand side, in countries with significant levels of persistence in the response to inflation shocks, the resulting decrease in the real value of income will depreciate borrowers' liquidity, and have a direct impact on households' ability to borrow. Furthermore, for these countries, non-mean reverting inflation would undermine competitiveness and thus affect negatively the balance of trade. Given their greater vulnerability to shocks, policymakers in these countries may need to pay more attention to measures aimed at smoothing aggregate demand, even following a symmetric shock. On the supply side, the likelihood of higher price instability is increased with higher inflation persistence. For example, with inflation persistence, it is likely that households will negotiate for higher nominal wages, which in turn will create a vicious circle and raise firm costs, reflected in higher prices. Therefore, price inflation will be higher and, with inflation persistence, for longer. Against this background, policymaking in the EU, but especially in EMU, should therefore allow for asymmetries in responses to inflationary shocks.

Specifically, our results show that, to some degree, inflation persistence is present in the majority of CEECs in our sample. Some notable questions and implications emerge for policy formulation, particularly for the countries in EMU. Evidence from Franta et al (2007) suggests inflation persistence is lower in the euro area ‘heavyweights’ than in the new entrants. How much will policymakers from economically larger EMU states, therefore, endorse policies that benefit countries which make up the majority share of euro area GDP, but are less favorable to economically smaller countries such as Estonia and Slovenia where, as the present study has shown, there is evidence of notable inflation persistence? Bressimis and Skotida (2007) suggest that an optimal monetary policy reaction function should attach more weight to countries where aggregate demand is relatively steep, however we also suggest that same should apply for countries where inflation is more persistent (non mean reverting). To this end, although ECB monetary policy cannot target individual member country performance, the clarification of relative weights to be associated with each member is crucial, and matters profoundly for the effectiveness of monetary policy across the countries of the euro area.

For almost all the CEECs analysed, with the exception of Romania, some degree of policy intervention would be required to return inflation to the mean following an inflationary shock. Even in the countries which demonstrate mean-reversion, a more proactive policy may be adopted if a more speedy reversion of the inflation rate is required. In Bulgaria, for example, although the regime state is predominantly mean-reverting, there is still some indication of persistence in the series.

The finding of distinct regime states over the period considered, for almost all countries in our sample, demonstrates that allowing for the possibility of multiple breaks in inflation is imperative in empirical work. Our results, therefore, suggest that an *a priori* assumption that inflation rates possess a unit root may be misleading and, in terms of technique, fractional differencing will be more appropriate, where needed, instead of taking first differences. Specifically, the finding of separate regime states over the period investigated suggests that, in empirical work, the error of over-differencing can easily be made.

Furthermore, from the policy formulation perspective, the country-level economic outcome of policies aimed at facilitating trade across the Single European Market will be affected by the prevailing inflationary characteristics of the regime state in different countries. Given the well-documented empirical links between monetary policy and economic welfare, improved understanding of the duration of a shock should better inform policymakers' projections about macroeconomic aggregates, economic growth, and welfare of the population.

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