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GDP-INFLATION CYCLICAL SIMILARITIES IN THE CEE COUNTRIES AND THE EURO AREA

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Abstract

In this paper we look at business cycles *similarities* between CEE countries and the euro area. Particularly, we uncover GDP-inflation cycles by adopting a trend-cycle decomposition model which allows the trend to be either stochastic or deterministic i.e. of the non-linear type. Once cyclical components are derived, we test for *ex post* restrictions at both with-in (GDP-to-inflation) and cross-country (CEECs vs. euro area) levels. Allowing for different degrees of cyclical *similarity*, we find that a *similar* inflation vs. GDP cycle is not rejected only for Poland, Lithuania, Romania and Estonia (with Latvia and the euro area being at the boundary). Looking at cross-country results, almost all countries feature a fair degree of *similarity* with respect to the euro area. Exceptions are Poland, Hungary, Latvia and Slovenia because of lack of a *similar* cycle either occurring in GDP or inflation, yet not in both. Finally, observing how concurrence between each CEECs cycle and the euro area evolved over time, we find that inflation conditional correlation increased stemming from the EU accession of most CEECs and as a result of the commodity price shock preceding 2008. Further, inflation and GDP conditional correlations receded during the course of 2009-2010, possibly resulting from more idiosyncratic adjustments in the aftermath of the crisis on the monetary/fiscal side. Interestingly, Slovenia, Slovakia, Estonia and Bulgaria display a conditional correlation pattern in GDP and inflation which roughly suggest a strong out-of-phase recovery starting from 2005.

JEL Classification Codes: C51, E31, E32, F43, F44.

Keywords: Inflation-GDP gaps, CEECs, Euro-Area, Business Cycle, Convergence.

Non-Technical Summary

This paper raises a number of questions relating to inflation and GDP dynamics in 10 Central Eastern EU countries (hereafter CEECs). The discussion about inflation developments in those countries has gained momentum, not only in light of a growing interest in the link between inflation and the catching-up process in GDP, but also in light of the recent financial crisis - where a steep increase in GDP/inflation cyclical correlation stemming from the global slowdown in 2008 is expected to be followed by a marked hump-down in correlation whenever adjustments have been more idiosyncratic.

In this paper we document with-in and cross country variability and persistence in both inflation and GDP at each country level and across-countries. Because it has been long recognized that cyclical dynamics are not robust to the particular detrending procedure adopted (e.g. Canova, 1998), we derive a measure of each country GDP and inflation cycles by means of a loose trend-cycle decomposition model which allows the trend to be either stochastic or deterministic (i.e. of the non-linear type, e.g., Gallant, 1984). Hence, we "tickle" the optimal specification in a general-to-specific modeling approach.

From the outset, this allows addressing the issue of considering possible dissimilarities leading to asymmetric GDP vs. inflation cyclical patterns over time, and across countries. In fact, while it would be natural to hypothesize upfront that some groups of countries - such as those already part of the EMU - feature strong cyclical *similarities* with respect to the euro area, this is less than straightforward. Especially for inflation, where differentials across regions are, in principle, a normal feature of any currency union (ECB, 2011a).

Compared to the existing literature, our approach adds methodological value to the analysis as it - first - allows for accurate modeling of the persistence properties of the time series investigated, where the novelty relative to previous approaches is in allowing for a trend component not necessarily conforming with stochastic non-stationarity. Secondly, it does not impose restrictions *a priori*. Restrictions are rather imposed *ex post* as the framework is extended for evaluating GDP and inflation cyclical *similarities* both with-in and cross countries. Particularly, in the former case we aim at capturing GDP-to-inflation cyclical adjustments in each country, whereas in the latter case we look at cyclical CEECs *similarities* benchmarking the euro area. In all cases, the tests are performed by means of a constrained vs. unconstrained trend-cycle decomposition model, accounting for different degrees of cyclical restrictions (*phase-in*, *similar* persistence and *similar* cycles).

To preview some of the results in the paper, the estimated inflation cycles are found to be in line with purely *demand*-driven episodes, with a positive gap in 2003-2005 followed by a peak-to-trough in 2008-2009. Those swings - being more pronounced in Estonia, Latvia and Lithuania, and most moderate in Poland - need being interpreted in light of the EU accession of most CEECs in 2004 (with the only exception of Romania and Bulgaria whose accession occurred in 2007) and the international turmoil started in 2008.

Looking at inflation vs. GDP cycles we find evidence of a *similar* inflation vs. GDP cycle only for Poland, Lithuania, Romania and Estonia (with Latvia and the euro area being at the boundary) in line with the idea of quantities presenting more sluggish adjustments than prices. Moreover, almost all countries feature a fair degree of *similarity* in GDP and inflation with respect to the euro area. Only for Poland, Hungary, Latvia and Slovenia we fail to capture a *full* degree of cyclical *similarity*, because of lack of *similarity* either occurring in GDP or inflation

cycles, yet not in both.

The robustness of these results is finally assessed by means of a time-varying correlation analysis. The results suggest that distinguishing features, possibly relating to the different policy interventions carried out, as well as structural differences, may explain the observed variability in GDP/inflation cyclical correlation. Overall, correlations are overall found to increase as of 2007/2008 under the global economic slowdown, and - particularly for inflation - under the impulse of supply side shocks. Those are, alternatively, found to recede after 2009, suggesting that adjustments in the aftermath of the crisis have been indeed idiosyncratic. Interestingly only Slovenia, Slovakia, Estonia and Bulgaria display an inflation and GDP conditional correlation pattern which roughly suggests a strong out-of-phase recovery since 2005.

1 Introduction

In recent years, more and more attention has been given to the next step of the process of European integration for the central eastern EU countries (hereafter CEECs): their entry in the Eurozone. When considering the appropriate time schedule, the question which naturally arises is whether business cycles are sufficiently in line relatively to the euro area, so the costs of transferring monetary and exchange rate policies are minimized.[1]

The literature on the economic performance of the euro area peripherals has mainly focused on two lines of investigation. (i) On the one hand, there are studies belonging to the *cycles* analysis focusing on GDP (or industrial production indexes) (see Artis *et al.*, 2005) and its main components (Darvas and Szapary, 2007). Particularly, reference is made to *business cycle* theories, looking at the sequence of booms and busts periods characterizing the level of each variable, and *growth cycle* theories, understanding fluctuations relative to a trend (see Minz, 1969). (ii) On the other hand, there are bivariate *structural-VARs* (SVAR) analyses aimed at identifying demand and supply side shocks (Blanchard and Quah, 1989). In this respect, comparing the economic developments of the CEECs with that of the euro area has been recognized to suffer from some methodological drawbacks. In fact, the years of the economic transformation in those countries limit the existence of a stable relationship amongst the variables (GDP, inflation...), and reduce the time span sensible for the analysis. Such caveats make VARs less rigorous than other approaches (e.g. Frenkel *et al.*, 1999; Korhonen, 2001; Fidrmuc and Korhonen, 2003; Süppel, 2003), as a short sample would either require a looser specification to leave sufficient degrees of freedom in the estimation (see Süppel, 2003; Korhonen, 2001), or force considering a sample which dates back further, by capturing the years of the economic transition.[2] In the latter case, the economic interpretation of shocks is rather difficult (being many output losses related to structural changes).

In this paper, we focus on a *growth cycle* analysis in 10 CEE countries: Poland, Hungary, Czech Republic, Latvia, Lithuania, Bulgaria and Romania, Slovenia, Slovakia, Estonia and the euro area; where, in our sample, Slovenia (January 2007) and Slovakia (January 2009) represent early episodes of EMU convergence, while Estonia - given our pre-2011 data structure - is not yet part of the euro area (i.e. the country successfully joined the EMU in January 2011). As we are interested in documenting with-in and cross-country regularities in macroeconomic fluctuations, we carry out the investigation at a country-specific standpoint. To isolate cyclical components, we adopt a *dynamic*

[1] In fact, retaining monetary/exchange rate independence is used as countervailing argument for which each country can better face asymmetric shocks (e.g. Frenkel and Nickel, 2002).

[2] For a survey see Fidrmuc and Korhonen (2003), Backé (2002). For a discussion see also Frenkel (2004).

latent factor model entailing a trend-cycle decomposition in both GDP and inflation. Particularly, we start from a univariate identification strategy which allows for stochastic or deterministic non-linear trends. A univariate framework is more than appropriate in this setting, as the special targeting regime adopted by some CEECs may invalidate a linear GDP-to-inflation cyclical adjustment (i.e. by a lack of inflationary pressure *vis-à-vis* an increase in output, to restore competitiveness).

Once cyclical components are derived, we look at with-in countries cyclical *similarities.* In a second step we look at the cross-country *similarities* in GDP and inflation cycles, by testing for cross-country restrictions where the benchmark is the euro area. In all cases the restrictions are performed allowing for different degrees of cyclical similarity (*phase-in*, *similar persistence*, *similar* cycles). Here, cyclical *similarity* is evaluated on the basis of whether two cycles share the same frequency and degree of persistence (see also Harvey, 1989). Our evaluation offers significant advantages over a standard business cycle analysis, allowing us to analyze different degrees of cyclical comparability *ex post.* In this way, we address from the outset the issue of considering possible dissimilarities leading to asymmetric GDP vs. inflation cycles over time and across countries.

To preview some of the results in the paper, the estimated inflation cycles are found to be in line with purely *demand*-driven episodes, with a positive gap in 2003-2005 followed by a peak-to-trough in 2008-2009. Those swings - being more pronounced in Estonia, Latvia and Lithuania, and most moderate in Poland - need being interpreted in light of the EU accession of most CEECs in 2004 and the international turmoil started in 2008.[3]

Looking at inflation vs. GDP cycles we find evidence of a *similar* inflation vs. GDP cycle only for Poland, Lithuania, Romania and Estonia (with Latvia and the euro area being at the boundary) in line with the idea of quantities presenting more sluggish adjustments than prices. Almost all countries feature moreover a fair degree of *similarity* in GDP and inflation with respect to the euro area. Only for Poland, Hungary, Latvia and Slovenia we fail to capture a *full* degree of cyclical *similarity*, because of lack of *similarity* either occurring in GDP or inflation cycles, yet not in both.

The robustness of these results is finally assessed by means of a time-varying correlation analysis. Here, we find that inflation conditional correlation series increased stemming from the EU accession of most CEECs in 2004 and as a result of the commodity price shock preceding the international turmoil in 2008. Further, inflation and GDP conditional correlations receded during the course of 2009-2010, possibly resulting from more idiosyncratic adjustments in the aftermath of the crisis on the monetary/fiscal side. Interestingly, Slovenia, Slovakia, Estonia and Bulgaria display inflation and GDP conditional correlation patterns which roughly suggest a strong out-of-phase recovery starting from 2005.

The reminder of the paper is organized as follows. Section 2 presents the econometric strategy. Section 3 outlines the main results. Section 4 concludes.

2 Business Cycles in CEECs

The analysis of the business cycles of the CEECs is usually rendered difficult by the existence of frequent regime shifts or non-linearities marking both the transition and the after-transition periods (i.e. Artis *et al.*, 2005; Benczúr

[3]The EU accession occurred in 2004 for all CEE countries, with the only exception of Romania and Bulgaria whose accession occurred in 2007.

and Rátfai, 2010). For this reason, we use a relatively comprehensive sample which focuses on the 1995Q1-2010Q2 period, where excluding data prior to 1995 is motivated by both the purpose of controlling for the transition phase, and overcoming major data missing which render comparisons with recent dynamics rather difficult. Data are collected in quarterly frequencies from Eurostat for the GDP in constant 2000 prices and the International Financial Statistics of the International Monetary Fund for the harmonized-*cpi* series.[4] All series are not seasonally adjusted and the GDP is in PPP with the euro.

2.1 Measuring Cycles

To provide an accurate measure of the *similarity* in the cyclical pattern of each CEECs *vis-à-vis* the euro area, we proceed by modeling cyclical components in both GDP and inflation. In order to avoid imposing *a priori* restrictions on the cyclical dynamics, we start fitting the data with a loose trend-cycle decomposition model for each country.[5] In the latter framework we allow for the trend component to be either stochastic or deterministic (possibly of the non-linear type).

2.1.1 Stochastic vs. Deterministic Non-Linear Trend-Cycle Decomposition

To document the variability and the persistence in the output-inflation co-movements, we start fitting the data with a standard univariate structural time-series model (Harvey, 1989).
For the country i, the level of each variable is described by a standard trend ($\bar{x}$) vs. cycle (φ) - plus seasonal (γ) and irregular component (ϵ) - model:

$$x_{i,t} = \bar{x}_{i,t} + \varphi_{i,t} + \gamma_{i,t} + \epsilon_{i,t}, \tag{1}$$

We first allow for a stochastic trend component, which - in the more general framework - is assumed to follow a *local linear trend* model:

$$\bar{x}_{i,t} = \mu_{i,t} + \bar{x}_{i,t-1} + \eta_{i,t} \tag{2}$$

and

$$\mu_{i,t} = \mu_{i,t-1} + v_{i,t}, \tag{3}$$

with x alternatively being GDP (y) or the quarter-on-quarter *cpi*-inflation (Δp). The errors (η_i, v_i) are assumed to be serially and mutually uncorrelated with zero mean and variance σ^2, i.e. $\eta_{i,t}, v_{i,t} \sim NID(0, \sigma^2_{\eta,v})$, where the notation NID stands for normally and independently distributed (see Koopman *et al.*, 2009). Equations (1) to (3) are denoted as Model 1. The latter encompasses the following special cases, by posing restrictions on the transition equations innovations:

- a *smooth level* model, under $\sigma^2_\eta = 0$ (i.e. Model 2);
- a *local level* model with drift, under $\sigma^2_v = 0$ (i.e. Model 3);
- and a *global linear trend* model, with $\sigma^2_v = 0$ and $\sigma^2_\eta = 0$ (i.e. Model 3a).

[4] The series for the HCPI for the Euroland aggregates is extended back to 1995Q1 using data from the Euro Wide Model made available from the Euro-Area Business Cycle Network's (EABCN) website.
[5] Particularly, peaks and trough are meant here in the level of each detrend series, so that any phase is understood as a period where GDP (inflation) is below (above) its trend.

As an alternative specification, we detail a more general form of the trend by means of a Gallant (1984) flexible functional form. This is obtained by replacing the stochastic trend in equation (1) with a time-dependent function which is a $sin - cos$ expansion of a deterministic trend. As shown by Enders and Lee (2004), regardless of the form of the *level*, we can approximate a deterministic nonlinear trend - which is not known *a priori* - by means of a Chebishev polynomials (see also Bierens, 1997) of the type:

$$\bar{x}_{i,t} = \sum_{h=0}^{2} \delta_{i,h} t^h + \sum_{k=1}^{n} \alpha_{i,k} sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \beta_{i,k} cos\left(\frac{2\pi kt}{T}\right), \tag{4}$$

where $n < \frac{T}{2}$ and n represents the number of frequencies contained in the approximation, k is the frequency under consideration and $t = \{1, ..., T\}$ is a linear trend.[6]

We let the non-linear trend in (1) being first described by a $k = 1$ Fourier approximation with no linear trend (i.e. $h = 0$), and denote this specification as Model 4. Henceforth, we repeatedly estimate equation (4) - alongside with (1) - by unrestricting additional parameters in (4). In light of the idea that a low order approximation can successfully capture the behavior of an unknown functional form (see Gallant, 1984; Gallant and Souza, 1991; Becker *et al.*, 2004), we set the maximum order in this *specific-to-general* exercise to $k = 2$. Hence, five additional models for each country are derived, where - *ceteris paribus* - the trends are nested versions of the more general form in equation (4). In details:

· Model 4 approximates the trend with a Fourier approximation of the first order;

· Model 5 equals Model 4 plus a time trend;

· Model 6 equals Model 5 plus a quadratic trend;

· Model 7 consists of a trend estimated by a Fourier approximation of the second order;

· Model 8 equals Model 7 plus a time trend;

· Model 9 equals Model 8 plus a quadratic trend.

Common to the stochastic and the non-linear specification, the cycle φ is modeled as a stochastic process by means of a generalization of a deterministic cycle with a *sin-cos* wave within a given period.[7] The generalization occurs by introducing a dumping factor ρ_φ and by shocking the deterministic cycle with a set of two mutually uncorrelated disturbances. Disregarding the i subscript to simplify notation:

$$\begin{bmatrix} \varphi_t \\ \varphi_t^* \end{bmatrix} = \rho_\varphi \begin{bmatrix} cos\lambda_c & sin\lambda_c \\ -sin\lambda_c & cos\lambda_c \end{bmatrix} \begin{bmatrix} \varphi_{t-1} \\ \varphi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix}. \tag{5}$$

The innovations are assumed to be zero mean and common variance processes, $k_t, k_t^* \sim NID(0, \sigma_k^2)$, and the dumping factor is assumed to belong to the interval $0 < \rho_\varphi \leq 1$, ensuring that the representation in equation (5) is a mean-reverting process. The term λ_c represents the frequency in radians - being in the range $0 \leq \lambda_c \leq \pi$ - with

[6] In the specification Engle and Lee (2004) propose the linear trend is missing. We include it in order to account for the high trends in inflation in most CEECs after 1995.

[7] The order of the cycle is set to equal 1.

the *period* being $p = 2\pi/\lambda_c$. Importantly, this specification of the cycle is a reduced ARMA(2,1) model, which has an AR(1) cycle as its limiting case under $\lambda_c = 0$ or $\lambda_c = \pi$ (see Harvey, 1989).[8]

Concerning the seasonal component, we do not restrict it to be deterministic from the outset. Similarly to the cycle, we allow for a stochastic effect according to a trigonometric representation. Disregarding the i subscript:

$$\gamma_t = \sum_{j=1}^{[s/2]} \gamma_{j,t}$$

where, for each $j = 1, .., [s/2]$ and $t = 1, ..., T$ (see Harvey, 1989; Koopman *et al.*, 2009):[9]

$$\begin{bmatrix} \gamma_{j,t} \\ \gamma^*_{j,t} \end{bmatrix} = \begin{bmatrix} cos\lambda_j & sin\lambda_j \\ -sin\lambda_j & cos\lambda_j \end{bmatrix} \begin{bmatrix} \gamma_{j,t-1} \\ \gamma^*_{j,t-1} \end{bmatrix} + \begin{bmatrix} w_{j,t} \\ w^*_{j,t} \end{bmatrix} \tag{6}$$

and $\lambda_j = 2\pi j/s$ is the frequency in radians whilst the innovations ($w_{j,t}$, $w^*_{j,t}$) are assumed to be mutually uncorrelated NID disturbances with zero mean and common variance σ^2_w (see Harvey, 1989; Koopman *et al.*, 2009). All disturbances in each component - equation (1) - are further modeled to be among them mutually uncorrelated (see Koopman *et al.*, 2009).

As the structural vulnerabilities of the *post*-reforms have exposed those economies to global economic and financial shocks (1998 Russian crisis, 2001 World recession, 2008 crisis...), together with some hyperinflation episodes in the late 90s (i.e. Bulgaria and Romania), we further augment the specification in (1) with some selected interventions. With the purpose of detecting large residuals we draw on Harvey and Koopman's (1992) two steps *auxiliary* regression procedure. The procedure requires the model being estimated twice, with the first pass being concerned with outliers/break detection, and the second step estimating the model with the interventions found significant in the the first step.[10]

All structural models (Model 1 to 9) are estimated by mean of a Quasi-ML approach based on the Kalman filter.[11] Once all models are estimated, for each variable in each country a model is uniquely selected based on residuals' diagnostic and the *information criteria*.[12] This provides a rationale/robust measure of the cyclical dynamics behind each variable, in line with the concern that the cyclical pattern may strongly depend on the particular detrending procedure adopted (e.g. Canova, 1998). Detailed results on the model selection procedure are reported in the Appendix (Tables 7 to 17)

[8]Based on the *information criteria*, this specification of the cycle is found to be preferable to a simple AR(2) in all the cases we considered.

[9]With s being the data frequency, i.e. quarterly.

[10]The procedure records standardized residuals and level shifts exceeding 2.3 and 2.5 respectively (in absolute value). For level breaks, residuals within a distance of 3 with respect to large residuals are removed, in line with the idea of level residuals to be correlated over time (see Harvey and Koopman, 1992).

[11]Table 18 in the Appendix shows the Jarque-Bera test of normality for the standardized residuals in each model. Owing to the well-known low power of the test under fat-tailed alternatives and in small samples, for each selected model several alternative normality tests based on the comparison between the empirical distribution and a normal distribution function (Anderson-Darling's, Cramer-von Mises', Lilliefors' and Watson's empirical distribution tests) are reported. While normality is decisively rejected only in a few cases, fat tails are a symptom of the higher volatility marking the post-transition period in some CEE countries. In many cases, however, excluding data prior to 1999, sensitively reduces the number of rejections.

[12]Whenever the AIC and the BIC are not congruous, we rely by default on the BIC criterion which is known to have better asymptotic properties. Only exception are Latvia and Poland - for which we rely on the AIC - as the corresponding optimal specification offers a better approximation of the cycle.

2.2 Constrained Trend-Cycle Decomposition

An attempt to formally test for within or cross-countries regularities comes by imposing individual restrictions on the estimated cycles.

In details, considering two cycles (φ^a, φ^b) both described by the specification in (5), and taking φ^b as a benchmark, we test whether the cyclical properties in φ^a are consistent with those estimated for the benchmark φ^b. Here, we posit three different degrees of cyclical *similarities*: (i) a *phase-in* model, (ii) a model with *persistence* restrictions, and (iii) a *similar* cycle model.[13] In particular, the first model features cyclical fluctuations in φ^a with the same *period* as the benchmark cycle. The second model features instead cycles with the same degree of *persistence*, by restricting φ^a to have the same dumping factor as the benchmark, φ^b. Finally, the *similar* cycle model features the two above properties (common *period* and *persistence*) jointly. The latter model clearly embodies much stronger restrictions, as it casts φ^a to have the same statistical properties as φ^b.

More formally, *phasing-in* implies:[14]

$$\begin{bmatrix} \Phi_t \\ \Phi_t^* \end{bmatrix} = \begin{bmatrix} I_N \otimes P_\Phi \begin{pmatrix} cos\lambda_c^b & sin\lambda_c^b \\ -sin\lambda_c^b & cos\lambda_c^b \end{pmatrix} \otimes I_N \end{bmatrix} \begin{bmatrix} \Phi_{t-1} \\ \Phi_{t-1}^* \end{bmatrix} + \begin{bmatrix} K_t \\ K_t^* \end{bmatrix} \tag{7}$$

where, differently from Section 2.1.1 and using the notation in Harvey and Koopman (1997), we let each element to be a (2×1) vector, with $\Phi_t^{'} = [\varphi_t^a, \varphi_t^b]$ and P_Φ is a (2×2) diagonal matrix in (ρ_φ^a, ρ_φ^b). For K_t and K_t^* being the multivariate counterpart of the disturbances in φ, each innovation has a 2-dimensional variance-covariance matrix with $E(K_t K_t^{'}) = E(K_t^* K_t^{*'}) = \Sigma_K$ and $E(K_t K_t^{*'}) = 0$. Importantly, the variance-covariance matrix considered here is diagonal, given that the two cycles are estimated separately (i.e. restrictions are imposed *ex post*) and not jointly as in Harvey and Koopman (1997).

A similar reasoning applies to the test for *similar* persistence, where ρ_φ^a is fixed at the benchmark value ρ_φ^b.

Finally, modeling *similar* cycles requires both ρ and λ_c in φ^a to be fixed at the benchmark levels, thus requiring cyclical movements in φ^a to be centered around the same period as φ^b (see also Harvey and Koopman, 1997; Carvalho *et al.*, 2007; Koopman *et al.*, 2009). All other things being equal, this implies:

$$\begin{bmatrix} \Phi_t \\ \Phi_t^* \end{bmatrix} = \begin{bmatrix} \rho_\varphi^b \begin{pmatrix} cos\lambda_c^b & sin\lambda_c^b \\ -sin\lambda_c^b & cos\lambda_c^b \end{pmatrix} \otimes I_N \end{bmatrix} \begin{bmatrix} \Phi_{t-1} \\ \Phi_{t-1}^* \end{bmatrix} + \begin{bmatrix} K_t \\ K_t^* \end{bmatrix} \tag{8}$$

Assessing the above properties requires a constrained trend-cycle decomposition, by fixing (*ceteris paribus*) the cycle's parameters in φ^a to the corresponding values found for the unconstrained estimation of the benchmark cycle. To assess the validity of the model restrictions detailed above, the results from a LR test, $LR = -2logL(\tilde{\psi}_0)/L(\tilde{\psi})$, where $L(\tilde{\psi}_0)$ is the maximized likelihood function under the null of, e.g., *phasing-in*, *similar* persistence or cyclical *similarity*, are complemented by some *information criteria*. The latter conveniently allow to penalize each models' log-likelihood to reflect the number of parameters being estimated (see also Vuong, 1989; Sin and White, 1996), being less prone to model mis-specifications (see White, 1982; Vuong, 1989).

[13] For further discussion see also Engle and Kozicki (1991); Carvalho et al. (2007).

[14] Here, we disregard the countries subscript we used before to simplify the notation.

Importantly, *similarity* is meant on a purely statistical ground. In other words, and consistent with our assumptions, our tests look at ”weak” forms of cyclical ”comparability”. In so far, our analysis is not able to distinguish whether two cycles, albeit *similar*, are idiosyncratic or share a common cycle/feature (see Koopman *et al.* 2007; Engle and Kozicki, 1991).

3 Results

In Table 1 and 2 we report details on the model selected for each country. As a large fraction of the change in GDP and prices since 1995 is due to idiosyncratic restructuring reforms, we clearly do not expect a clear pattern on the evolution of the series across country. Still, some general features may be discussed.

We find that for 5/10 countries (Poland, Latvia, Bulgaria, Romania, Slovakia) a Fourier approximation with a first order component together with a time trend provide a good approximation of the properties of (trend) GDP. For Hungary and the Czech Republic we find instead a ”smooth level model” to provide a reliable approximation. This is consistent with the early results in Boone and Maurel (1999), confirming that an anchored monetary policy has strengthened the degree of shocks symmetry, together with stabilizing growth in those countries. Other interesting insights can be gouged by investigating earlier episodes of convergence, i.e. Slovenia and Slovak Republic, together with Estonia and the euro area. The GDP of the euro area and Slovenia is found to be consistent with a global linear trend model. This is corroborated by the fact that Slovenia was the first country in the region entering the Eurozone (Jan. 2007). Analogously, Estonia is found to be described by a second order Fourier approximation and no, either linear or quadratic, trend. This reasonably deals with the fact that the country benefited from stable growth in the process of economic convergence since the years preceding its entry. An exception is the Slovak Republic, whose GDP is modeled by means of a first order Fourier approximation and a linear time trend; the latter diverging specification may be possibly related to its latter accession. In all cases the variance of the seasonal is found to be different from zero, indicating that a stochastic seasonal pattern is accepted by the data. The significance of the seasonal component is assessed by means of a $\chi^2(3)$ test reported at the top of Table 2, confirming the significance of the adjustment in almost all quarters. Based on the selected interventions, we moreover find that many outliers belong to the *post*-reform and to the 2008-financial crisis cycle. Real GDP seems to have suffered from a hump down in the aftermath of the crisis for almost all countries. Notable exceptions are Poland, Lithuania and Estonia for which a level break in 2008 or 2009 does not appear.[15] This confirms the results in Epstein and Macchiarelli (2010), suggesting that for Poland the crisis spillovers appear not to have been as severe as for other countries in the region.[16] More detailed information on the results for the cycles is finally found in Table 3, reporting the estimated period (frequency) and dumping factor. The results confirm that the average *period* duration is about 5/6 years, although Hungary and Estonia seem more in line with a 2-year cycle. As for inflation, we find a non-linear deterministic trend *à la* Gallant to be preferable to a modeling approach were a stochastic trend appears instead (10/10 countries).[17] In 5/10 cases k is kept equal to one (Poland, Hungary,

[15]All countries are found to be consistent with a level break in 2009.1, whilst for Romania the break is already in 2008.4 (see Table 2).

[16]The relative good performance of Polish GDP can be interpreted in terms of the role of the automatic stabilizers which the government let operate when the crisis hit, and the one-year precautionary arrangement approved under the Flexible Credit Line by the International Monetary Fund. The latter particularly reduced the risk of financial vulnerability and that associated to exchange rate pressures. See ECB (2010) for further insight.

[17]In this context, this may owe to sample selection or the particular time span considered.

Czech Republic, Bulgaria, Slovakia), albeit there is no clear pattern of a dominant specification for all countries. Differently, Latvia and Lithuania feature a second order Fourier approximation and a linear time trend. Moreover, Romania is found to be well described by a second order Fourier approximation, yet featuring a quadratic trend as well, consistent with its large inflation swings of the late 90s. Once again, the euro area, Slovenia and Estonia are found to be conveniently described by a similar specification (a first order Fourier approximation with no linear/quadratic trend), which is consistent with a steady inflation outlook from 1995. Focusing on the results for the seasonal, we find that allowing for a stochastic component is accepted only in 4/10 countries, whilst for Poland, Czech Republic, Latvia, Lithuania, Bulgaria, Romania and Slovenia a deterministic pattern is found to more appropriately describe the data. Looking at the selected interventions, the most important outliers reflect the large shocks associated with the hyper-inflation period of 1997 (followed by the 1998 crisis) in Bulgaria, and the inflation surge of 1997 in Romania (see Benczúr and Rátfai, 2010). Finally, at the bottom of Table 3 we present the results of the fit for the inflation cycles. Those confirm the cycle in inflation to show a higher frequency than what found for GDP (with the exception of Lithuania and Romania), displaying an average period duration of about 3 years.

3.1 Within Country Restrictions

Based on the results of the trend-cyclical decomposition, we then aim at assessing within country inflation vs. GDP cyclical *similarities* (Figure 1). The findings for the euro area are reported in a separate plot (see Figure 2). The relation between inflation and GDP cycles is normally estimated in the context of a Phillips curve relationship. This specification is supported in modern micro-founded models in the context of a New-Keynesian Phillips Curve, where demand shocks are assumed to reduce the costs of production by pushing wages and inflation lower. While in this linear set up the relation between inflation and the GDP cycle (i.e. normally, between inflation and the so called "output gap") is significant, it is also quantitatively small and tend to vary across countries (e.g., for Poland see Macchiarelli and Epstein, 2010; for the euro area see ECB, 2011b; for other EU non-euro area countries see Denis *et al.*, 2002).

From a visual inspection of our results, we confirm a positive relation amongst inflation and GDP for almost all countries. Such a feature characterizes however more recent years, being the cyclical dynamics in the aftermath of the transition more volatile.[18] During the last decade, inflation cycles are found to be in line with purely *demand*-driven episodes, with a positive gap in 2003-2005, followed by a peak-to-trough in 2008-2009. Those swings - being more pronounced in Estonia, Latvia and Lithuania, and most moderate in Poland - need being interpreted in light of the EU accession of most CEECs in 2004 (except for Romania and Bulgaria whose accession occurred in 2007) and the recent international turmoil started in 2008. Exceptions are Bulgaria and Latvia: the inflation of the former being dominated by the large price swings mentioned above, and that of the latter looking fairly out of phase.

From a preliminary *column-wise* inspection of the results in Table 3, point estimates suggest that GDP cycles

[18] More generally, it can be argued that the presence of *post*-reform years render difficult any attempt of modeling a *demand*-type relation from the outset. The reforms implied a high unemployment rate in the departure from the planned full-employment state equilibrium. Together with price liberalizations, this contributed to a budget deficit financing *via* a dramatic increase in the money supply and hence "rocketing prices" (see Ruggerone, 1996). Prices start to trend lower in most countries from 1995, clearly not responding to the GDP gap logic.

feature a lower frequency than inflation cycles, a part from Lithuania and Romania. Analogously, the persistence in output (dumping factor) is found to be higher than the persistence in inflation (with a significant exception for Poland and Lithuania); with the latter feature being consistent with the standard assumption of a different degree of sluggishness in quantities and prices, i.e. with prices showing more flexible adjustments.

Here, assuming a *demand*-type function where GDP determines the inflation cycle in each country, we follow the methodology in Section 2.2 and posit three different degrees of cyclical *similarity* (a *phase-in* model, a model with *persistence* restrictions, and a *similar* cycle model). In other words, assuming GDP as a benchmark cycle in each country, a constrained maximization of the trend-cycle decomposition for inflation is performed, where the tested parameters are fixed to the corresponding values found for the unconstrained estimation of the GDP cycle. The results are shown in Table 4.[19]

Consistent with our graphical analysis, the null of *phasing-in* for inflation is not rejected for all countries (i.e. at least two *criteria* and the LR test support the restriction), with Poland and Lithuania being at the boundary (i.e. the hypothesis is rejected at the 10% critical level using the LR test, and only one criterion supports the restriction). Excluding these latter, a decisive rejection is not supported by the data in all cases, also corroborating standard theories on inflation-GDP adjustments not only for those countries inside (Slovenia and Slovakia) or forthcoming (Estonia) to the EMU, but also for countries normally found to better adjust to euro area dynamics, i.e. Hungary and the Czech Republic (Artis *et al.*, 2005; Fidrmuc and Korhonen, 2003; Süppel, 2003).

Imposing the restriction of similar *persistence* is not rejected for the Czech Republic, Latvia, Lithuania, Bulgaria, Romania, Estonia and the euro area, with Poland being at the boundary. The further *similar* cycles restriction is non-rejected only for Poland, Lithuania, Romania and Estonia, with Latvia and the euro area being at the boundary. As quantities are normally found to adjust more slowly than prices - reflecting a different speed of mean reversion in the two series - concluding against a synchronous cycle for those countries for which we do not find a inflation vs. GDP *similar* cycle (but simply *phasing-in*) is indeed not correct.

3.2 Cross-Country Restrictions

Additional insights can be gleamed by looking at the cross-country evidence on inflation and GDP cyclical *similarities*. As in the previous section, we compare three different models (*phase-in*, similar *persistence* and *similar cycles*), albeit the current exercise aims at assessing whether the cyclical properties of both GDP and inflation for the CEECs are consistent with those found for the euro area.

A *row-wise* inspection of the results in Table 3 gives some preliminary insight. The results suggest the GDP gaps in Poland, Czech Republic, Romania, Bulgaria, Slovakia and Slovenia to be fairly in line with that of the euro area on a *frequency* basis. The cyclical GDP pattern in Estonia seems to feature instead a higher frequency than what found for the euro area, somehow phasing-in with Hungary. Looking at persistence, we further find that almost all countries seem to feature a degree of mean reversion similar to that of the euro area.

The results for inflation indicate instead that only 4/6 countries, for which we expect to have GDP-synchronization, are expected to *phase-in* (Czech Republic, Romania, Slovenia and Slovakia). Estonia and Hungary are once again

[19] We do not expect the results to change dramatically using inflation as a benchmark. Nonetheless, our restrictions are in line with the business cycle theories considering inflation to fall during recessions and to increase through recoveries.

recognized in the common situation of looking fairly *phasing-in* in inflation but not for GDP. With the exception of inflation for Poland - being more persistent - and for Hungary and Slovakia - displaying a lower persistence - all other series seem to be in line with the degree of sluggishness observed for the euro area inflation. Proceeding to test all those assumptions, we report the results of the restrictions in Table 5.

Looking at the results for GDP, we find three cases:

· A first group - Poland, Czech Republic, Lithuania, Bulgaria, Romania, Slovenia and Slovakia and Estonia - for which we can not reject the null of *similar* cycles benchmarking the euro area (for Romania the dumping restriction is rejected alone).

· Latvia, not being yet characterized by a *similar* cycle, but simply *phasing-in*.

· Finally, Hungary featuring cyclical GDP fluctuations not yet *similar* to those of the Euro aggregates, nor *phasing-in*.

As discussed earlier, it should be borne in mind that featuring a *similar* cycle implies the two reference countries to be characterized by the same degree of cyclical periodicity and persistence, without necessarily being *common* (see Harvey, 1989; Engle and Kozicki, 1991). Also, it should be distinguished whether the rejection of a *similar* cycle stems from the lack of *phasing-in* or the lack of *similar* persistence (or both). In the case of Latvia, the rejection of a similar cycle suggest that the Latvian and the euro area cycles feature the same period while they clearly display a different wavily pattern. Conversely, the lack of a *similar* cycle for Hungary is of particular interest here as it stems from a rejection of *phasing-in*. This rejection can be thought to reconcile with a strong idiosyncratic behavior, also in the light of the economic slowdown the country experienced from 2006, which turned into a recession in 2008 (i.e. ECB, 2010).

As for inflation, we find that (see Table 5):

· We can not reject a *similar* euro area pattern for the Czech Republic, Latvia, Bulgaria, Romania, Slovakia and Estonia, whereas Lithuania is found to be at the boundary of the rejection area.[20]

· For Hungary and Slovenia the *similar cycle* restriction is rejected by the data but we can not reject the countries to *phase-in*.

· Finally, Poland featuring cyclical dynamics not yet *similar* with the euro area. The country is moreover found to be at the boundary of the rejection area for the similar *persistence* and *phasing-in* restrictions.

Importantly, Slovenia and Hungary feature a cycle which is not found to be *similar* with that of the euro area but only *phasing-in*. For the reasons outlined before, rejection of *similar* persistence simply suggests a different wavily behavior, possibly stemming from more (or less) accentuated business cycle fluctuations. These result are very different from the one for Poland. In the latter case, the results point to a more idiosyncratic inflation cycle with respect to the euro area, possibly owing to a different inflation profile in more recent years.

In interpreting the overall results, it should be observed that inflation and output differentials may stem from differences in demographic trends or long term catching up processes. Further, as stressed in ECB (2011a),

[20] The hypothesis is rejected at the 10% critical level.

inflation differentials across regions are, in principle, a normal feature of any currency union. The fact that some economies are catching-up might imply their inflation or GDP growth rates to be higher than the average, naturally resulting into more accentuated cyclical swings; i.e. in our terminology, cycles may display the same period - or *phasing-in* - but feature different degrees of persistence.

3.3 Conditional Correlation Analysis

As our analysis was primarily directed towards the understanding of the cyclical properties in each country's GDP and inflation, in this Section we look at how correlation of each CEECs cycle evolved against the corresponding euro area benchmark. This is crucial in order to understand how cyclical patterns changed over time.[21]

Here, we conduct a conditional correlation analysis which entails recovering the estimated innovations for the cycles in each country, allowing to measure correlation after cyclical features are controlled for. The results are detailed by means of the *exponential smoother* used by $RiskMetrics^{TM}$, i.e.

$$\hat{\rho}_t = \frac{(1-\varpi)\sum_{q=1}^{\infty}\varpi^{q-1}k_{EA,t-q}^2 k_{i,t-q}^2}{[(1-\varpi)\sum_{q=1}^{\infty}\varpi^{q-1}k_{EA,t-q}^2][(1-\varpi)\sum_{q=1}^{\infty}\varpi^{q-1}k_{i,t-q}^2]}$$

with $(i = country, EA = euroarea)$. Compared to a standard rolling window (i.e. *moving correlation*) this methodology is still a moving average model for changing conditional variance, but it uses exponential (declining) weights based on a parameter ϖ which we set equal to 0.94, following the standard practice in the literature.[22]

The results for GDP (Figure 4) reveal that co-movements present a mixed evidence with a clear-cut upward trend for the Czech Republic. For Bulgaria, Romania and Slovenia we find a U-shaped pattern with increasing correlation from 2005 only. Hungary, Lithuania and Latvia, moreover display a rather even GDP correlation, which is positive in the former two cases, while negative in the latter one (the pattern of GDP correlation holds steady at a high level in Slovenia, i.e. 0.6, whereas has been quite sustained in Hungary, i.e. roughly 0.4).

From the overall results, correlation seems to have fallen after the 2001 and 2008 busts, where stronger adjustments from the side of monetary and fiscal policy were likely. Particularly, the steep increase in conditional correlation in 2008 shows the global slowdown affected GDP and inflation dynamics in the *pre*-crisis scenario, whilst adjustments in the crisis aftermath were more idiosyncratic. This is consistent with the results in ECB (2011a), suggesting that - already for euro area countries - the dispersion in output growth and inflation increased after 2010, reflecting differences in timing and the extent of the hit of the recession and the adjustments on the fiscal side.

While analyzing the effects of the sovereign crisis on correlation patterns between euro area and CEE countries is beyond the scope of this analysis, a high degree of heterogeneity in GDP growth is observed to persist in the few quarters following the end of our sample or, even, to increase during 2011. Such divergences - which emerge by simply looking at the unweighted standard deviation of real GDP growth for the euro area aggregates vs. CEE countries - are, however, decreasing during 2012.

An initial high level of heterogeneity stems from sluggish GDP growth in some euro area countries after 2010, and,

[21]This is important especially as regards theories on the optimality of a Currency Area (OCA). These theories have stressed the importance of economic factors such as the external openness, productivity differentials and mobility in the production factors as driving forces behind real convergence. According to this literature, the implementation of a single European market is likely to led business cycles synchronization *ex post* rather than *ex ante*, in line with the idea of an OCA to present some endogenous self-fulfilling *criteria* (see Frankel and Rose, 1997).

[22]This simply prevents past events to affect current and future estimates of $\hat{\rho}$ with unchanged weight.

in particular, as the result of spillovers of country-specific sovereign risk, highlighting the need for idiosyncratic policy adjustments. Relevant adjustments occurred mainly on the fiscal side to tackle previously accumulated imbalances.

Against this backdrop, the ensuing correlation between the euro area aggregates and each CEE country is *expected* to decrease further during 2011, also in the light of a stronger GDP rebound in some CEECs over the same period (see National Bank of Poland, 2011; 2012).

Heterogeneities are, however, observed to decrease again (i.e. correlation patterns would *possibly* increase) during 2012, reflecting - among the others - a weakening of external demand in both the euro area and CEE countries (on the latter see National Bank of Poland, 2012; 2013), and the stabilization policies adopted in many CEECs to downsize the effects of a contagion from the euro area.[23]

Our results for inflation are analogously mixed, showing rather even dynamics for Poland, Latvia, Lithuania and Romania, yet an upward trend in Slovakia (see Figure 5). Moreover, Hungary, Czech Republic, Slovenia and Estonia show an U-shaped correlation with concurrence increasing since 2005 (and since 2007 in Romania). A part from the Czech Republic, for Slovakia, Estonia, Latvia and Romania we find a high GDP correlation but low correlation in prices, suggesting a de-synchronization between the two series at even points in time (i.e. whenever a weakening of the economic activity does not have a dampening effect on inflation, or *vice versa*). The swings in the inflation conditional correlation between 2004 and 2008 would need moreover being interpreted in the light of (i) the EU accession of most CEECs in 2004 (with the only exception of Romania and Bulgaria whose accession occurred in 2007), where a U-shape correlation pattern could be understood either in terms of the dis-inflationary policy adopted in those years (i.e. Romania) or in light of the EU entry and the related process of economic integration; (ii) the international turmoil started in 2008, with inflation correlation picking higher under the effect of the global supply shocks in 2007-2008 (see Figure 3). Overall, only Slovenia, Slovakia, Estonia and Bulgaria are found to display a U-pattern in the evolution of the inflation conditional correlation over time which roughly mirror that of GDP. Being Bulgaria the only EMU "outsider" (among the above group of countries), this result is particularly interesting in terms of the out-of-phase recovery the country undertook since 2005. More detailed country results are delegated to the Appendix.

4 Conclusions

In this paper we detail an analysis on inflation and GDP dynamics for 10 central eastern EU countries (Poland, Hungary, Czech Republic, Latvia, Lithuania, Bulgaria, Romania, Slovenia, Slovakia and Estonia) and the euro area. Based on previous empirical analysis, we deepen the investigation on two main grounds.

From the outset, we address the issue of considering possible dissimilarities leading to asymmetric GDP vs. inflation cyclical patterns over time, and across countries. Without imposing restrictions *a priori*, we let the data to be fit with a loose trend-cycle decomposition model which allows the trend to be either stochastic or deterministic (possibly of the non-linear type).

Secondly, we test for *ex post* within and cross-country restrictions; where in the former case we aim at capturing GDP-to-inflation cyclical *similarity* in each country, and in the latter case we look at cyclical CEECs *similarity*

[23] Correlation patterns for inflation/GDP and the consequences of the sovereign debt crisis are difficult to quantify here.

benchmarking the euro area. In all cases, tests are performed by means of a constrained trend-cycle decomposition model and accounting for different degrees of similarity (*phase-in*, *persistence* and *similar* cycle restrictions) which involve restricting each estimated cycle's period, dumping factor, or both.

The overall results show that a non-linear specification for inflation, where the trend is described by a Fourier approximation, is found to always be preferable to a modeling approach where a stochastic trend appears instead. For GDP the evidence is rather mixed. Overall, Slovenia and the euro area are found to be described by the same specification in both GDP and inflation dynamics, supporting the early EMU accession of Slovenia in January 2007.

Based on the constrained estimation results, we find evidence of a *similar* inflation vs. GDP cycle restriction only for Poland, Lithuania, Romania and Estonia (with Latvia and the euro area being at the boundary), in line with the idea of quantities presenting more sluggish adjustments than prices.

In documenting cross-country dynamics, almost all countries feature a fair degree of *similarity* with the euro area. Only for Poland, Hungary, Latvia and Slovenia we fail to capture a *full* degree of cyclical *similarity*, because of the lack of co-movements either occurring in GDP or inflation cycles, yet not in both.

The above results deserve further discussion, as it should be borne in mind that countries featuring a *similar* cycle do not necessarily share a *common* cycle (see Harvey, 1989) or can have, anyway, an idiosyncratic behavior. To partially address this issue, we looked at the evolution of covariation between each CEECs cycle, in both GDP and inflation, and the corresponding euro area cycle. Overall, the inflation correlation series are found to increase stemming from the EU accession of most CEECs in 2004 and as a result of the commodity price shock preceding the international turmoil in 2008. Together with GDP, inflation conditional correlations are alternatively found to recede during the course of 2009-2010, possibly resulting either from idiosyncratic adjustments in the aftermath of the crisis, or from a yet stronger economic slowdown compared to the euro area cycle.

Finally, only Slovenia, Slovakia, Estonia and Bulgaria interestingly display an inflation and GDP conditional correlation pattern roughly suggesting a strong out-of-phase recovery since 2005.

The snapshot we provide confirms that co-movements of the CEECs cycles against the euro area has changed radically in the course of 2005-2010, and partially explains divergence with early results (*inter alia* Kocenda, 1999; Artis *et al.*, 2005; Frenkel and Nickel, 2005; Korhonen, 2003). Changes in the GDP and inflation dynamics in those countries are still on-going and this naturally provides incentives for further research in this direction.

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Table 1: Model Results: GDP

	Poland	Hungary	Czech Rep.	Latvia	Lithuania	Bulgaria	Romania	Slovenia	Slovakia	Estonia	EA
Log-likelihood	5.647	97.291	91.784	124.98	103.24	98.517	166.2	129.054	126.569	21.957	-141.24
Seasonal χ^2test	492.2	861.49	353.64	101.35	625.27	152.608	175.25	177.27	235.32	475.04	366.58
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Period 1	-3.688*	-1.356*	-0.854*	-0.473*	-0.959*	-0.636*	-0.150*	-0.380*	-0.429*	-4.005*	-30.281*
Period 2	-3.390*	0.024	0.380*	-0.01	-0.094**	-0.105	0.053*	0.215*	0.01	-1.521*	11.855*
Period 3	-1.503*	0.421*	0.256*	0.139*	0.507*	0.514*	-0.01	0.164*	0.355*	2.203*	-15.729*
Period 4	6.581*	0.911*	0.178*	0.35	0.547*	0.226**	0.107*	0.000	0.060	3.323*	34.155*
Outlier 1995:4	–	–	-0.591*	–	–	–	–	–	–	–	–
			[0.108]								
Outlier 1996:4	-2.04	–	–	–	–	–	–	–	–	–	–
	[0.466]										
Outlier 1997:4	–	–	–	–	–	-0.414*	–	–	–	–	–
						[0.090]					
Outlier 2007:1	–	–	0.304**	–	–	–	–	–	–	–	–
			[0.088]								
Level 1995:4	–	–	–	–	0.317*	–	–	–	–	–	–
					[0.095]						
Level 1996:3	–	–	–	–	-0.386*	–	–	–	–	–	–
					[0.088]						
Level 1997:2	–	–	–	–	0.323*	–	–	–	–	–	–
					[0.089]						
Level 2001:1	–	–	–	–	–	–	–	–	–	–	52.119*
											[10.999]
Level 2008:4	–	–	–	–	–	–	-0.128*	–			
							[0.036]				
Level 2009:1	–	-0.564*	-0.706*	-0.242*	–	-0.732*	–	-0.504*	-0.670*	–	-50.831*
		[0.132]	[0.133]	[0.090]		[0.093]		[0.075]	[0.070]		[11.251]
Level 2010:1	–	–	–	-0.299*	–	–	–	–	–	–	–
				[0.115]							
δ_1	0.823*	–	–	0.021*	0.020*	0.083*	0.022*	–	0.049	–	–
	[0.144]			[0.007]	[0.003]	[0.002]	[0.002]		[0.002]		
δ_2	-0.004	–	–	–	–	–	–	–	–	–	–
	[0.002]										
α_1	1.505*	–	–	-0.506**	-0.552*	0.175*	-0.179*	–	-0.218	-2.147*	–
	[0.411]			[0.223]	[0.057]	[0.045]	[0.043]		[0.060]	[0.090]	
β_1	3.163*	–	–	-0.15	0.326*	0.589*	0.02	–	0.238	1.809*	–
	[0.958]			[0.121]	[0.034]	[0.025]	[0.024]		[0.033]	[0.103]	
α_2	–	–	–	–	-0.173*	–	–	–	–	-0.417*	–
					[0.026]					[0.107]	
β_2	–	–	–	–	0.078*	–	–	–	–	0.387*	–
					[0.027]					[0.079]	
Level (σ^2_η)	–	–	–	–	–	–	–	–	–	–	–
Slope (σ^2_v)	–	0.001	0.001	–	–	–	–	–	–	–	–
		(0.853)	(0.153)								
Seasonal (σ^2_w)	0.020	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.013	0.090
	(0.206)	(0.891)	(0.066)	(0.099)	(0.352)	(1.000)	(0.039)	(0.731)	(0.215)	(0.355)	(0.014)
Cycle (σ^2_κ)	0.092	0.000	0.006	0.002	0.001	0.001	0.001	0.002	0.000	0.035	79.208
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(0.721)	(1.000)	(7.062)	(1.000)	(1.000)	(12.760)
Irregular (σ^2_ϵ)	–	–	–	–	–	–	–	0.000	–	–	6.210
								(1.000)			(1.000)

Notes: [Standard errors] and (p-values) in brackets. (*) denotes significance at 1%, (**) at 5% and (***) at 10 % respectively. The seasonal $\chi^2(3)$ assess the importance of the seasonal adjustment. Seasonal effects for periods 1 to 4 refer to each period adjustment (i.e. period 4 means winter). *Outlier* means a blip intervention in a given quarter(q) for the year(yy), *19yy-q*. *Level* is a break in level (i.e. a dummy is defined for all quarters > 19*yy-q*). The coefficients α_k, β_k and δ_k are those associated to a Fourier approximation of order $k = 1, 2$. Reported values are derived under an optimal selection procedure as shown in Table 7 to 17. In the last section of the Table values in brackets are q-ratios, i.e. signal-to-noise ratios. Normalization occurs on higher variance values. The variances are those associated to that of a stochastic level (σ^2_η) with stochastic drift, i.e. slope (σ^2_v). Seasonal (σ^2_w) and cycle (σ^2_κ) are the variances associated to both a trigonometric seasonal and cyclical component. Irregular refers to the irregular component in the measurement equation. A value of 0.000 in the corresponding variance implies a deterministic adjustment.

Table 2: Model Results: Inflation

	Poland	Hungary	Czech Rep.	Latvia	Lithuania	Bulgaria	Romania	Slovenia	Slovakia	Estonia	EA
Log-likelihood	-63.294	-67.396	-59.698	-66.056	-80.847	-176.291	-129.609	-68.453	-70.105	-72.154	-22.572
Seasonal χ^2test	54.973	13.107	76.063	83.447	25.73	5.147	9.711	35.185	0.139	4.964	37.144
	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.161)	(0.021)	(0.000)	(0.987)	(0.174)	(0.000)
Period 1	1.792*	2.383***	.3.741*	2.703*	2.328*	2.694	3.411***	0.027	0.091	1.337	-1.848*
Period 2	1.519*	2.730**	-0.879***	0.943**	0.538	-6.723**	-2.356	3.322*	-0.434	0.879	3.292*
Period 3	-3.882*	-1.023	-0.31	-3.888*	-3.153*	-0.708	-3.854**	-2.035**	0.101	-0.11	-1.595**
Period 4	0.572	-4.090*	-2.551*	0.242	0.288	4.737	2.799	-1.314**	0.242	-2.106	0.151
Outlier 1995:3	-9.206*	–	–	-7.727*	–	–	–	–	–	–	–
	[2.676]			[2.235]							
Outlier 1996:3	–	–	–	10.571*	–	–	–	–	–	–	–
				[2.231]							
Outlier 1997:1	–	–	–	–	–	460.691	101.728*	–	–	–	–
						[16.578]	[8.091]				
Outlier 1997:3	–	–	12.849*	–	–	–	-115.361*	–	–	–	3.606
			[2.369]				[7.811]				[1.225]
Outlier 1998:1	11.956*	–	8.798*	–	–	–	–	–	–	–	–
	[2.571]		[2.363]								
Outlier 1999:3	–	–	–	–	–	–	–	–	23.662*	–	–
									[2.401]		
Outlier 2003:1	–	–	–	–	–	–	–	–	10.134*	–	–
									[2.395]		
Break 1995:3	–	-9.566*	–	–	–	–	–	–	–	–	–
		[3.120]									
Break 1996:2	–	–	–	–	-22.035*	–	–	–	–	-14.680*	–
					[4.326]					[2.478]	
Break 2009:1	–	–	–	–	–	–	–	–	–	-9.500*	–
										[2.191]	
δ_1	-0.264*	-0.297*	-0.111*	-0.420*	0.158	-1.885*	1.289*	–	-0.060***	–	–
	[0.034]	[0.038]	[0.035]	[0.076]	[0.188]	[0.455]	[0.397]		[0.034]		
δ_2		–	–	–	–	–	-0.020*	–	–	–	–
							[0.006]				
α_1	-0.587	-1.276	-0.828	-9.683**	2.91	-18.728***	17.525*	3.147*	0.658	0.633*	-0.406**
	[0.803]	[0.895]	[0.829]	[1.602]	[4.149]	[10.744]	[4.119]	[0.663]	[0.798]	[0.727]	[0.198]
β_1	3.977*	3.839*	1.940*	4.280*	1.722	26.481*	4.153	-0.588	-0.921*	3.908*	-0.444**
	[0.481]	[0.538]	[0.496]	[0.640]	[1.914]	[6.231]	[3.298]	[0.669]	[0.469]	[0.930]	[0.205]
α_2	–	–	–	-2.318**	3.265–	0.453		–	–	–	–
				[1.126]	[3.935]		[1.878]				
β_2	–	–	–	0.696	-4.166	–	-3.880***	–	–	–	–
				[0.845]	[3.273]		[2.208]				
Level (σ_η^2)	–	–	–	–	–	–	–	–	–	–	–
Slope (σ_v^2)	–		–	–	–	–	–	–	–	–	–
Seasonal (σ_w^2)	0.000	0.152	0.000	0.000	0.000	0.000	0.000	0.000	0.626	0.032	0.025
		(0.040)							(0.491)	(0.001)	(0.303)
Cycle (σ_κ^2)	0.063	3.751	0.628	3.360	1.768	205.137	0.238	7.364	1.276	3.329	0.098
	(0.012)	(1.000)	(0.171)	(2.357)	(0.220)	(2.694)	(0.004)	(1.000)	(1.000)	(0.902)	(0.117)
Irregular (σ_ϵ^2)	5.32	–	3.661	1.426	8.032	76.159	61.607	–	–	3.69	0.835
	(1.000)		(1.000)	(1.000)	(1.000)	(1.000)	(1.000)			(1.000)	(1.000)

Notes: [Standard errors] and (p-values) in brackets. (*) denotes significance at 1%, (**) at 5% and (***) at 10 % respectively. The seasonal $\chi^2(3)$ assess the importance of the seasonal adjustment. Seasonal effects for periods 1 to 4 refer to each period adjustment (i.e. period 4 means winter). *Outlier* means a blip intervention in a given quarter(q) for the year(yy), *19yy-q*. *Level* is a break in level (i.e. a dummy is defined for all quarters $> 19yy$-q). The coefficients α_k, β_k and δ_k are those associated to a Fourier approximation of order $k = 1, 2$. Reported values are derived under an optimal selection procedure as shown in Table 7 to 17. In the last section of the Table values in brackets are q-ratios, i.e. signal-to-noise ratios. Normalization occurs on higher variance values. The variances are those associated to that of a stochastic level (σ_η^2) with stochastic drift, i.e. slope (σ_v^2). Seasonal (σ_w^2) and cycle (σ_κ^2) are the variances associated to both a trigonometric seasonal and cyclical component. Irregular refers to the irregular component in the measurement equation. A value of 0.000 in the corresponding variance implies a deterministic adjustment.

Table 3: Model Results: Cycles

	Poland	Hungary	Czech Republic	Latvia	Lithuania	Bulgaria	Romania	Slovenia	Slovakia	Estonia	Euroland Aggregates
Cycles properties: GDP											
Period	23.429	7.788	21.288	38.025	12.868	18.720	23.163	31.488	22.760	10.027	25.651
Period in years	5.857	1.947	5.322	9.506	3.217	4.680	5.791	7.872	5.690	2.507	6.413
Frequency	0.268	0.807	0.295	0.165	0.488	0.336	0.271	0.200	0.276	0.627	0.245
Damping factor	0.902	0.946	0.971	0.990	0.823	0.958	0.982	0.956	0.969	0.804	0.929
Cycles properties: Inflation											
Period	16.940	7.944	12.402	11.727	25.330	12.107	41.871	7.871	11.659	11.198	10.399
Period in years	4.235	1.986	3.101	2.932	6.332	3.027	10.468	1.968	2.915	2.800	2.600
Frequency	0.371	0.791	0.507	0.536	0.248	0.519	0.150	0.798	0.539	0.561	0.604
Damping factor	0.991	0.649	0.887	0.845	0.968	0.919	0.801	0.450	0.808	0.753	0.881

Notes: The Table reports the period in years (second row), the period and the frequency in radians (first and third row) and the dumping factor of the estimated cycles.

Table 4: Within Country Results

			Log(L)	BIC	HQ	AIC	H_1 to $H_0/H_{0'}/H_{0''}$
Poland	*Unrestricted*	H_1	-63.294	2.308	2.225	2.171	
	Phase-in	H_0	-65.098	2.300	2.237	2.197	3.607
	Persistence	$H_{0'}$	-64.745	2.288	2.226	2.185	2.902
	Similar cycles	$H_{0''}$	-65.100	2.233	2.192	2.165	3.612
Hungary	*Unrestricted*	H_1	-67.396	2.440	2.357	2.303	
	Phase-in	H_0	-67.399	2.374	2.311	2.271	0.006
	Persistence	$H_{0'}$	-73.866	2.583	2.520	2.480	12.939
	Similar cycles	$H_{0''}$	-73.930	2.518	2.476	2.449	13.068
Czech Rep.	*Unrestricted*	H_1	-59.698	2.192	2.109	2.055	
	Phase-in	H_0	-60.639	2.156	2.093	2.053	1.882
	Persistence	$H_{0'}$	-59.865	2.131	2.068	2.028	0.333
	Similar cycles	$H_{0''}$	-63.966	2.197	2.155	2.128	8.536
Latvia	*Unrestricted*	H_1	-66.057	2.397	2.314	2.260	
	Phase-in	H_0	-67.500	2.311	2.269	2.242	2.886
	Persistence	$H_{0'}$	-66.859	2.356	2.294	2.254	1.605
	Similar cycles	$H_{0''}$	-68.980	2.358	2.317	2.290	5.847
Lithuania	*Unrestricted*	H_1	-80.847	2.874	2.791	2.737	
	Phase-in	H_0	-82.621	2.865	2.802	2.762	3.549
	Persistence	$H_{0'}$	-81.420	2.826	2.764	2.723	1.147
	Similar cycles	$H_{0''}$	-82.069	2.781	2.739	2.712	2.444
Bulgaria	*Unrestricted*	H_1	-176.291	5.953	5.870	5.816	
	Phase-in	H_0	-177.964	5.874	5.832	5.805	3.346
	Persistence	$H_{0'}$	-176.610	5.897	5.834	5.794	0.639
	Similar cycles	$H_{0''}$	-180.396	5.952	5.911	5.883	8.209
Romania	*Unrestricted*	H_1	-129.609	4.447	4.364	4.310	
	Phase-in	H_0	-129.613	4.381	4.318	4.278	0.008
	Persistence	$H_{0'}$	-129.607	4.381	4.318	4.278	-0.004
	Similar cycles	$H_{0''}$	-129.656	4.316	4.274	4.247	0.094
Slovenia	*Unrestricted*	H_1	-68.453	2.408	2.345	2.305	
	Phase-in	H_0	-68.711	2.350	2.308	2.281	0.517
	Persistence	$H_{0'}$	-81.093	2.749	2.707	2.680	25.280
	Similar cycles	$H_{0''}$	-79.598	2.634	2.613	2.600	22.291
Slovakia	*Unrestricted*	H_1	-70.105	2.528	2.444	2.391	
	Phase-in	H_0	-70.852	2.485	2.423	2.382	1.494
	Persistence	$H_{0'}$	-72.520	2.539	2.477	2.436	4.830
	Similar cycles	$H_{0''}$	-76.406	2.598	2.556	2.529	12.601
Estonia	*Unrestricted*	H_1	-72.154	2.660	2.556	2.489	
	Phase-in	H_0	-72.225	2.596	2.513	2.459	0.143
	Persistence	$H_{0'}$	-72.195	2.595	2.512	2.458	0.083
	Similar cycles	$H_{0''}$	-72.288	2.532	2.469	2.429	0.268
Euroarea	*Unrestricted*	H_1	-22.572	1.061	0.957	0.889	
	Phase-in	H_0	-23.512	1.025	0.941	0.887	1.881
	Persistence	$H_{0'}$	-22.657	0.997	0.914	0.860	0.171
	Similar cycles	$H_{0''}$	-24.948	1.005	0.942	0.902	4.753

Notes: H_1 to $H_0/H_{0'}/H_{0''}$ refers to the value of the statistics of imposing the restrictions of phasing-in and similar persistence [$\chi^2(1)$] and similar cycle [$\chi^2(2)$], respectively. Critical values for a $\chi^2(1)$ are 3.84 (5%) and 2.71 (10%), and for a $\chi^2(2)$ are 5.99 (5%) and 4.61 (10%).

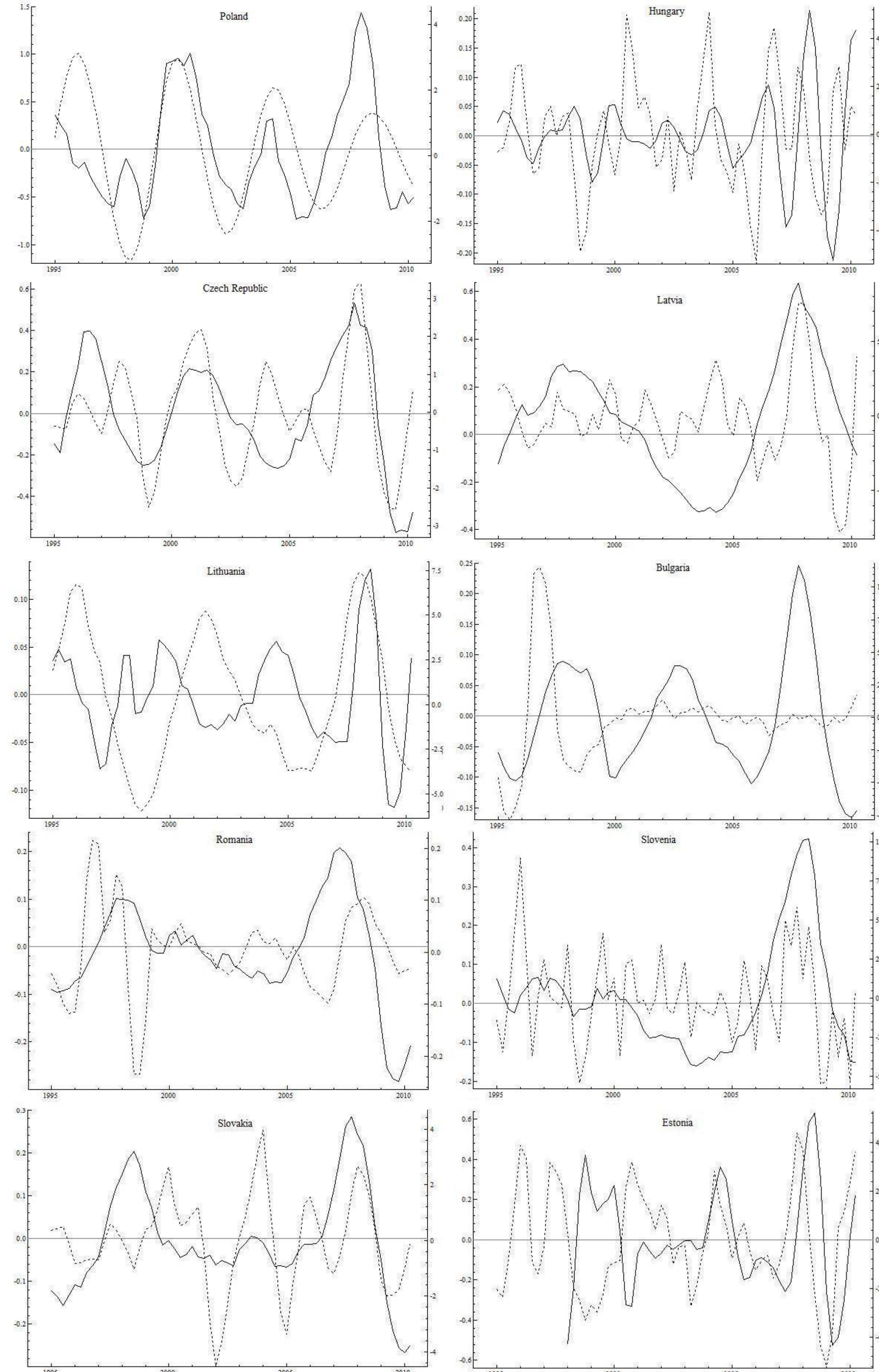

Figure 1: CEECs. Inflation vs. GDP Cycles

Notes: Inflation (dotted, right scale) and GDP (black line) cycles. Reported values are derived under an optimal selection procedure as shown in Table 7 to 17.

Table 5: Cross-Country Results: GDP

			Log(L)	BIC	HQ	AIC	H_1 to $H_0/H_{0'}/H_{0''}$
Poland	*Unrestricted*	H_1	5.647	0.084	0.001	-0.053	
	Phase-in	H_0	5.618	0.018	-0.044	-0.084	0.057
	Persistence	$H_{0'}$	5.497	0.022	-0.040	-0.081	0.300
	Similar cycles	$H_{0''}$	5.474	-0.043	-0.085	-0.112	0.346
Hungary	*Unrestricted*	H_1	97.292	-2.806	-2.910	-2.977	
	Phase-in	H_0	94.368	-2.776	-2.860	-2.913	5.812
	Persistence	$H_{0'}$	97.260	-2.871	-2.955	-3.008	0.063
	Similar cycles	$H_{0''}$	93.231	-2.805	-2.868	-2.908	8.122
Czech Rep.	*Unrestricted*	H_1	91.784	-2.628	-2.732	-2.800	
	Phase-in	H_0	91.399	-2.682	-2.765	-2.819	0.771
	Persistence	$H_{0'}$	91.200	-2.676	-2.759	-2.813	1.169
	Similar cycles	$H_{0''}$	90.981	-2.735	-2.798	-2.838	1.607
Latvia	*Unrestricted*	H_1	124.983	-3.765	-3.849	-3.903	
	Phase-in	H_0	123.735	-3.791	-3.854	-3.895	2.495
	Persistence	$H_{0'}$	122.200	-3.742	-3.805	-3.845	5.565
	Similar cycles	$H_{0''}$	121.592	-3.789	-3.831	-3.858	6.782
Lithuania	*Unrestricted*	H_1	103.243	-3.064	-3.148	-3.201	
	Phase-in	H_0	102.928	-3.121	-3.183	-3.223	0.631
	Persistence	$H_{0'}$	102.657	-3.112	-3.174	-3.215	1.173
	Similar cycles	$H_{0''}$	102.234	-3.165	-3.206	-3.233	2.018
Bulgaria	*Unrestricted*	H_1	98.517	-2.912	-2.995	-3.049	
	Phase-in	H_0	98.081	-2.964	-3.027	-3.067	0.872
	Persistence	$H_{0'}$	98.402	-2.975	-3.037	-3.078	0.229
	Similar cycles	$H_{0''}$	97.961	-3.027	-3.067	-3.095	1.112
Romania	*Unrestricted*	H_1	166.200	-5.095	-5.178	-5.232	
	Phase-in	H_0	165.894	-5.152	-5.214	-5.255	0.612
	Persistence	$H_{0'}$	163.969	-5.090	-5.152	-5.193	4.462
	Similar cycles	$H_{0''}$	163.969	-5.156	-5.198	-5.225	4.462
Slovenia	*Unrestricted*	H_1	129.054	-3.830	-3.934	-4.002	
	Phase-in	H_0	128.684	-3.951	-4.014	-4.054	0.741
	Persistence	$H_{0'}$	128.786	-3.955	-4.017	-4.058	0.537
	Similar cycles	$H_{0''}$	128.467	-4.011	-4.053	-4.080	1.174
Slovakia	*Unrestricted*	H_1	126.569	-3.817	-3.900	-3.954	
	Phase-in	H_0	126.434	-3.879	-3.941	-3.982	0.271
	Persistence	$H_{0'}$	125.851	-3.860	-3.923	-3.963	1.435
	Similar cycles	$H_{0''}$	125.851	-3.927	-3.968	-3.995	1.436
Estonia	*Unrestricted*	H_1	21.958	-0.442	-0.525	-0.579	
	Phase-in	H_0	21.076	-0.480	-0.543	-0.583	1.764
	Persistence	$H_{0'}$	21.304	-0.488	-0.550	-0.590	1.308
	Similar cycles	$H_{0''}$	20.199	-0.518	-0.560	-0.587	3.517

Notes: H_1 to $H_0/H_{0'}/H_{0''}$ refers to the value of the statistics of imposing the restrictions of phasing-in and similar persistence [$\chi^2(1)$] and similar cycle [$\chi^2(2)$], respectively. Critical values for a $\chi^2(1)$ are 3.84 (5%) and 2.71 (10%), and for a $\chi^2(2)$ are 5.99 (5%) and 4.61 (10%).

Table 6: Cross-Country Results: Inflation

			Log(L)	BIC	HQ	AIC	H_1 to $H_0/H_{0'}/H_{0''}$
Poland	*Unrestricted*	H_1	-63.294	2.308	2.225	2.171	
	Phase-in	H_0	-66.125	2.266	2.225	2.198	5.662
	Persistence	$H_{0'}$	-64.972	2.296	2.233	2.193	3.355
	Similar cycles	$H_{0''}$	-74.510	2.470	2.449	2.436	22.432
Hungary	*Unrestricted*	H_1	-67.396	2.440	2.357	2.303	
	Phase-in	H_0	-67.705	2.384	2.321	2.281	0.617
	Persistence	$H_{0'}$	-70.845	2.485	2.423	2.382	6.897
	Similar cycles	$H_{0''}$	-71.344	2.435	2.393	2.366	7.895
Czech Rep.	*Unrestricted*	H_1	-59.698	2.192	2.109	2.055	
	Phase-in	H_0	-60.085	2.138	2.075	2.035	0.775
	Persistence	$H_{0'}$	-59.699	2.126	2.063	2.023	0.003
	Similar cycles	$H_{0''}$	-60.160	2.074	2.032	2.005	0.924
Latvia	*Unrestricted*	H_1	-66.057	2.397	2.314	2.260	
	Phase-in	H_0	-66.235	2.336	2.274	2.233	0.357
	Persistence	$H_{0'}$	-66.083	2.331	2.269	2.229	0.052
	Similar cycles	$H_{0''}$	-66.400	2.275	2.233	2.207	0.687
Lithuania	*Unrestricted*	H_1	-80.847	2.874	2.791	2.737	
	Phase-in	H_0	-84.003	2.909	2.847	2.807	6.313
	Persistence	$H_{0'}$	-81.268	2.821	2.759	2.718	0.843
	Similar cycles	$H_{0''}$	-83.179	2.816	2.774	2.748	4.665
Bulgaria	*Unrestricted*	H_1	-176.291	5.953	5.870	5.816	
	Phase-in	H_0	-177.536	5.927	5.864	5.824	2.490
	Persistence	$H_{0'}$	-176.464	5.892	5.830	5.789	0.345
	Similar cycles	$H_{0''}$	-177.737	5.867	5.825	5.798	2.893
Romania	*Unrestricted*	H_1	-129.609	4.447	4.364	4.310	
	Phase-in	H_0	-129.610	4.381	4.318	4.278	0.002
	Persistence	$H_{0'}$	-129.613	4.381	4.318	4.278	0.008
	Similar cycles	$H_{0''}$	-129.634	4.315	4.273	4.246	0.050
Slovenia	*Unrestricted*	H_1	-68.453	2.408	2.345	2.305	
	Phase-in	H_0	-68.526	2.344	2.302	2.275	0.146
	Persistence	$H_{0'}$	-76.680	2.607	2.565	2.538	16.455
	Similar cycles	$H_{0''}$	-78.238	2.590	2.570	2.556	19.570
Slovakia	*Unrestricted*	H_1	-70.105	2.528	2.444	2.391	
	Phase-in	H_0	-70.287	2.467	2.405	2.364	0.364
	Persistence	$H_{0'}$	-70.348	2.469	2.407	2.366	0.486
	Similar cycles	$H_{0''}$	-70.662	2.413	2.371	2.344	1.114
Estonia	*Unrestricted*	H_1	-72.154	2.660	2.556	2.489	
	Phase-in	H_0	-72.185	2.595	2.511	2.458	0.062
	Persistence	$H_{0'}$	-72.526	2.606	2.523	2.469	0.745
	Similar cycles	$H_{0''}$	-72.653	2.543	2.481	2.440	0.999

Notes: H_1 to $H_0/H_{0'}/H_{0''}$ refers to the value of the statistics of imposing the restrictions of phasing-in and similar persistence [$\chi^2(1)$] and similar cycle [$\chi^2(2)$], respectively. Critical values for a $\chi^2(1)$ are 3.84 (5%) and 2.71 (10%), and for a $\chi^2(2)$ are 5.99 (5%) and 4.61 (10%).

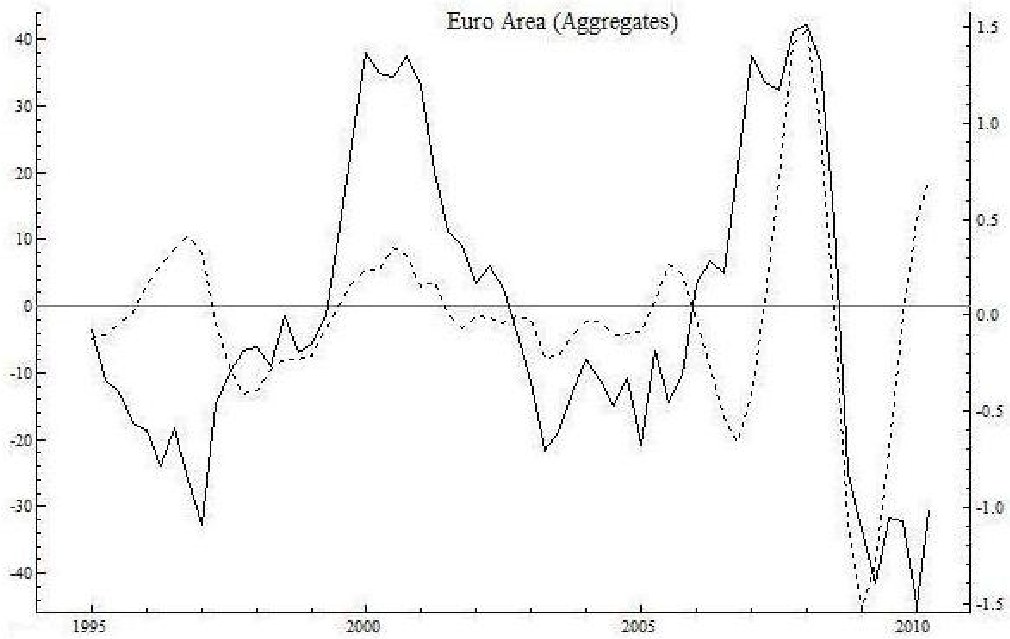

Figure 2: Euroland Aggregates. Inflation vs. GDP Cycles

Notes: Inflation (dotted, right scale) and GDP (black line) cycles. Reported series are derived under an optimal selection procedure as shown in Table 7 to 17.

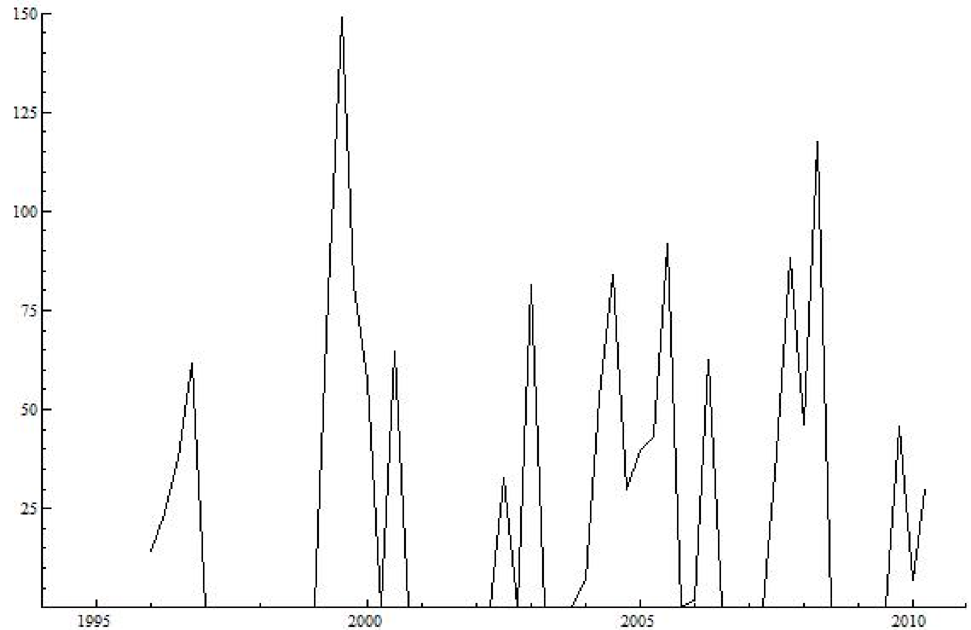

Figure 3: Net Oil Price Increase

Notes: The net oil price increase is computed as in Hamilton (1996), i.e. considering the price of oil price in the current quarter, relative to the maximum value for the level achieved during the previous four quarters.

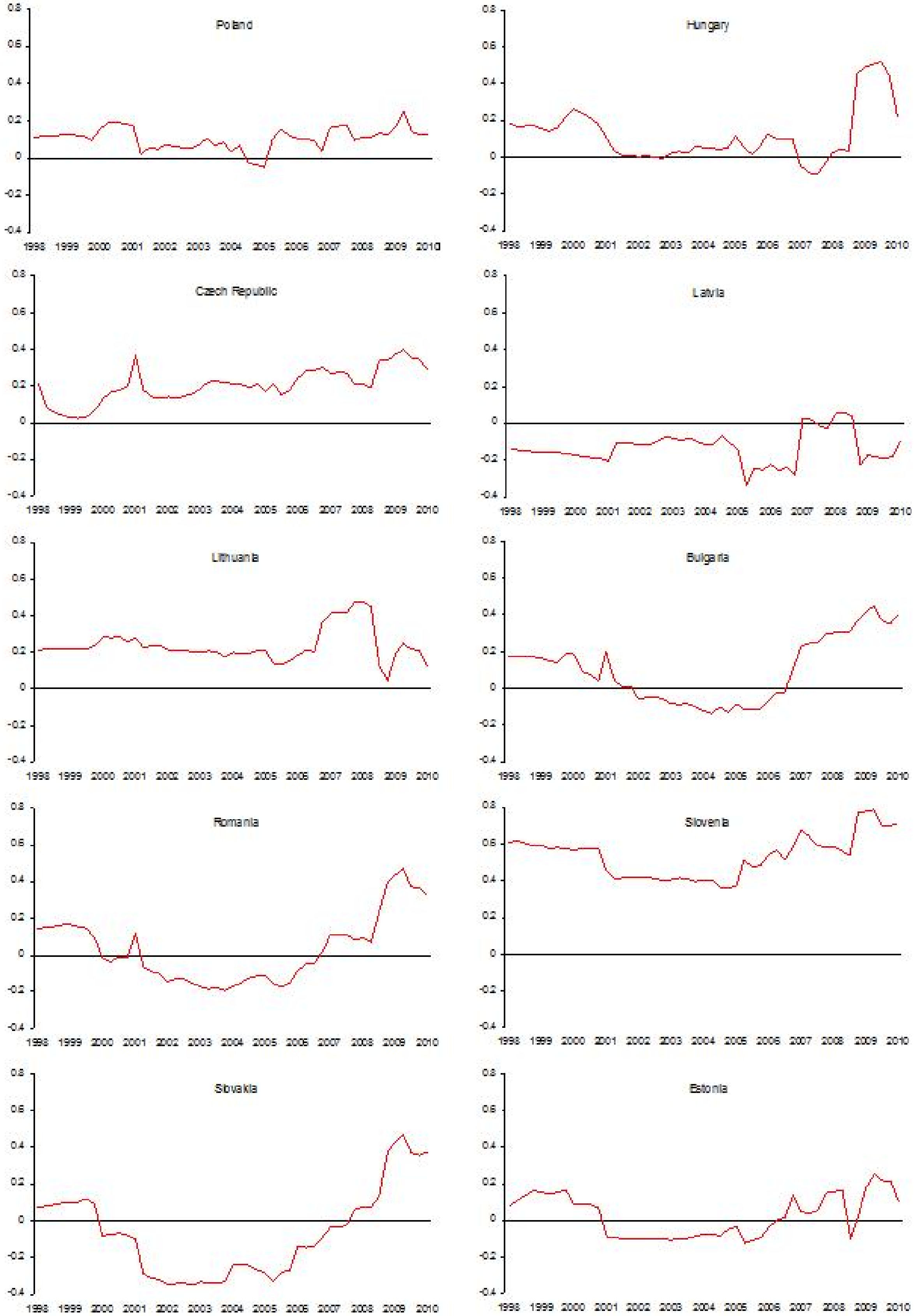

Figure 4: Conditional Correlation: GDP Cycles

Notes: Conditional correlation series are derived using the estimated innovations for the cycles in each country. Correlation is each time *vis-à-vis* the euro area. Results are detailed by means of the *exponential smoother* used by RiskMetrics^{TM}.

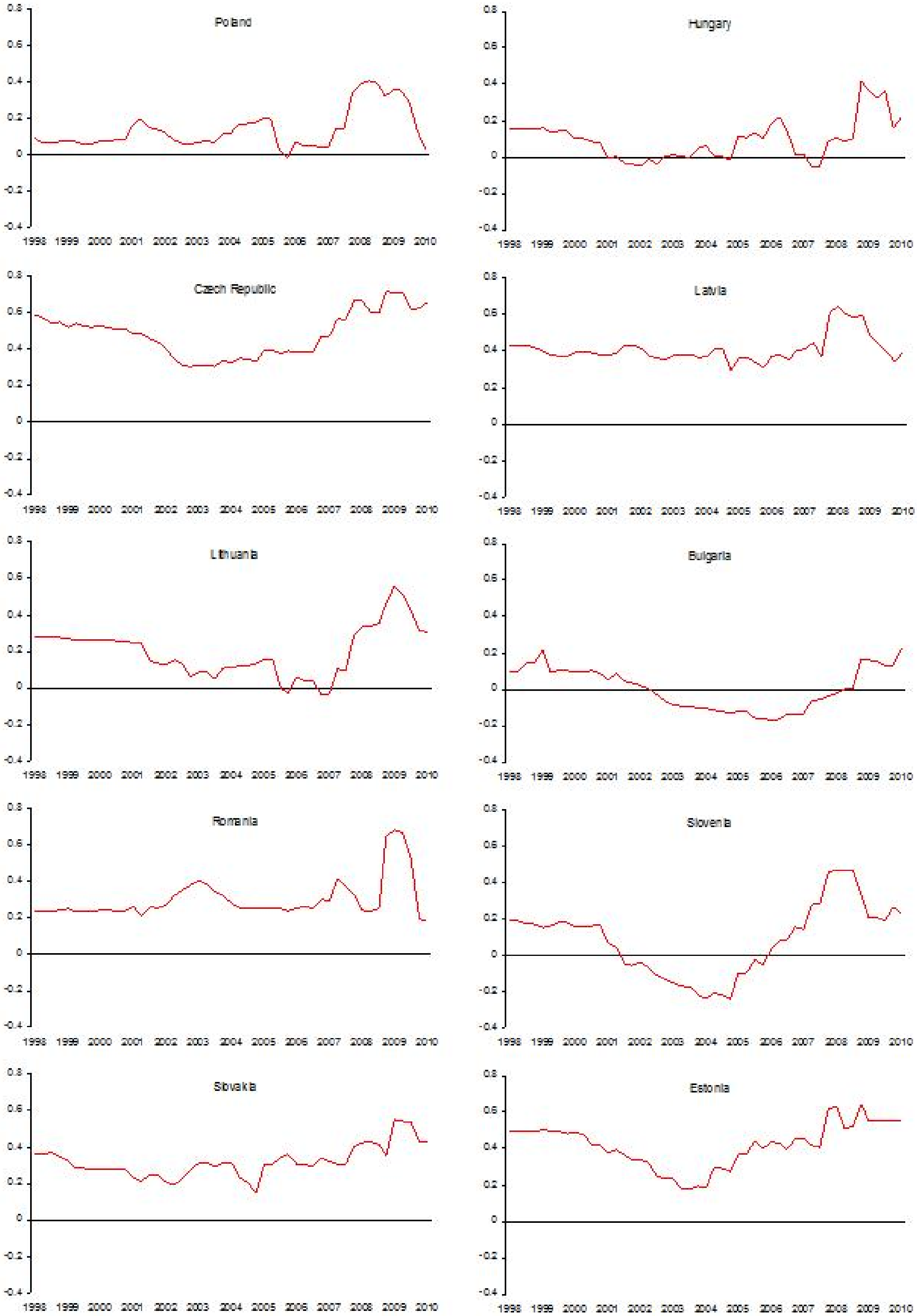

Figure 5: Conditional Correlation: Inflation Cycles

Notes: Conditional correlation series are derived using the estimated innovations for the cycles in each country. Correlation is each time *vis-à-vis* the euro area. Results are detailed by means of the *exponential smoother* used by RiskMetrics^{TM}.

Annex A - Model selection results and Diagnostic Tests

Table 7: Goodness-of-fit based on Residuals: Poland

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Poland: *GDP*				
Skewness	0.274	0.212	0.294	0.246	0.442	0.496	0.121	0.285	0.287
Excess kurtosis	0.023	-0.064	0.264	0.716	1.170	1.380	0.037	0.772	0.297
Prediction error variance	0.457	0.514	0.446	0.685	0.393	0.355	0.851	0.439	0.468
AIC	-0.557	-0.440	-0.581	-0.055	-0.609	-0.680<	0.226	-0.467	-0.370
BIC	-0.317	-0.199	-0.341<	0.287	-0.266	-0.302	0.637	-0.089	0.041
Durbin-Watson	1.763	1.791	1.731	2.438	1.797	1.858	2.206	1.853	1.855
					Poland: *Inflation*				
Skewness	–	0.495	0.128	0.028	0.034	0.133	-0.207	0.270	0.349
Excess kurtosis	–	-0.660	-0.550	-0.741	0.345	0.178	-0.710	-0.460	0.499
Prediction error variance	–	9.166	8.685	9.808	4.119	5.025	10.138	6.991	3.886
AIC	–	2.412	2.358	2.541	1.738<	1.969	2.638	2.331	1.777
BIC	–	2.620	2.566	2.816	2.081<	2.347	2.981	2.743	2.223
Durbin-Watson	–	1.897	1.811	1.876	1.754	1.828	1.752	1.815	1.856

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 8: Goodness-of-fit based on Residuals: Hungary

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Hungary: *GDP*				
Skewness	–	-1.050	-1.547	-0.183	-0.980	-1.066	-1.221	-0.867	-1.072
Excess kurtosis	–	1.993	3.583	0.462	1.209	1.232	1.398	1.559	1.640
Prediction error variance	–	0.024	0.027	0.065	0.028	0.089	0.047	0.031	0.071
AIC	–	-3.510<	-3.383	-2.436	-3.285	-2.095	-2.705	-3.077	-2.222
BIC	–	-3.270<	-3.143	-2.127	-2.976	-1.752	-2.328	-2.666	-1.777
Durbin-Watson	–	1.805	1.687	2.569	1.428	2.616	2.143	1.390	2.580
					Hungary: *Inflation*				
Skewness	0.284	0.136	0.385	0.319	-0.053	0.349	0.325	0.233	0.112
Excess kurtosis	-0.895	-0.272	-0.975	-0.242	-0.268	-0.520	-0.766	-0.726	-0.420
Prediction error variance	10.251	10.522	9.674	16.065	7.031	11.121	11.672	10.463	7.273
AIC	2.524	2.550	2.499	2.940	2.240<	2.699	2.747	2.670	2.371
BIC	2.732	2.758	2.741	3.113	2.549<	3.007	3.056	3.013	2.783
Durbin-Watson	1.809	1.664	1.709	2.187	1.838	1.863	1.870	1.827	1.875

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 9: Goodness-of-fit based on Residuals: Czech Republic

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Czech Republic: *GDP*				
Skewness	–	-0.813	-0.698	-0.334	-1.402	-1.470	-0.350	7.716	-2.096
Excess kurtosis	–	1.461	0.797	2.776	5.735	5.446	1.398	-4.428	7.029
Prediction error variance	–	0.021	0.028	0.021	0.028	0.027	0.027	0.029	0.027
AIC	–	-3.551<	-3.298	-3.510	-3.255	-3.243	-3.233	-3.121	-3.171
BIC	–	-3.243<	-3.023	-3.167	-2.912	-2.865	-2.821	-2.675	-2.691
Durbin-Watson	–	1.751	1.636	1.969	1.669	1.670	1.578	1.584	1.596
					Czech Republic: *Inflation*				
Skewness	0.417	0.417	0.508	0.148	0.242	0.345	0.250	-0.099	0.159
Excess kurtosis	1.481	1.477	1.711	0.448	0.264	0.719	-0.127	-0.479	-0.433
Prediction error variance	9.047	9.047	10.032	6.942	4.685	5.632	4.647	5.086	4.532
AIC	2.399	2.399	2.502	2.195	1.867<	2.051	1.891	2.014	1.930
BIC	2.607	2.607	2.710	2.470	2.210<	2.394	2.268	2.425	2.376
Durbin-Watson	1.949	1.947	2.149	2.091	2.113	2.266	2.235	2.156	2.213

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 10: Goodness-of-fit based on Residuals: Latvia

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Latvia: *GDP*				
Skewness	–	-0.515	-0.949	-0.733	-0.272	0.612	-0.637	-2.094	0.214
Excess kurtosis	–	4.471	3.118	1.726	2.575	1.363	3.037	6.512	2.186
Prediction error variance	–	0.010	0.006	0.006	0.006	0.006	0.010	0.016	0.007
AIC	–	-4.357	-4.796	-4.784	-4.832<	-4.686	-4.234	-3.741	-4.463
BIC	–	-4.151	-4.556<	-4.475	-4.489	-4.308	-3.890	-3.330	-4.017
Durbin-Watson	–	1.685	1.694	2.319	1.633	1.758	1.468	2.297	1.727
					Latvia: *Inflation*				
Skewness	–	-0.091	-0.049	0.035	-0.104	0.059	-0.122	0.101	-0.150
Excess kurtosis	–	0.325	0.094	0.735	0.338	0.600	0.417	0.309	0.381
Prediction error variance	–	13.008	12.401	8.371	6.200	7.911	8.255	0.560	7.830
AIC	–	2.795	2.747	2.415	2.147	2.391	2.466	2.103<	2.477
BIC	–	3.037	2.989	2.724	2.490	2.734	2.843	2.514<	2.923
Durbin-Watson	–	1.888	1.889	1.800	1.960	1.874	1.860	1.901	1.884

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 11: Goodness-of-fit based on Residuals: Lithuania

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
				Lithuania: *GDP*					
Skewness	–	-0.591	-0.563	0.795	-0.864	-0.365	0.556	-0.325	-0.667
Excess kurtosis	–	0.707	1.832	2.293	3.235	1.103	1.755	1.871	2.087
Prediction error variance	–	0.013	0.009	0.015	0.009	0.046	0.031	0.007	0.026
AIC	–	-4.051	-4.376	-3.878	-4.337	-2.712	-3.118	-4.567<	-3.254
BIC	–	-3.777	-4.067	-3.569	-3.960	-2.335	-2.741	-4.087<	-2.842
Durbin-Watson	–	2.079	1.872	1.772	1.953	2.719	2.112	1.975	2.295
				Lithuania: *Inflation*					
Skewness	–	-0.343	-0.496	0.046	0.057	0.178	0.221	-0.026	-0.009
Excess kurtosis	–	0.757	0.941	-0.208	-0.209	-0.532	0.216	-0.469	-0.410
Prediction error variance	–	12.205	11.533	9.714	8.977	11.012	7.627	7.548	10.878
AIC	–	2.764	2.707	2.564	2.517	2.721	2.418	2.408<	2.778
BIC	–	3.041	2.984	2.873	2.860	3.065	2.830	2.820<	3.224
Durbin-Watson	–	2.181	2.176	1.948	1.930	1.847	2.110	1.819	1.937

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 12: Goodness-of-fit based on Residuals: Bulgaria

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Bulgaria: *GDP*				
Skewness	-0.173	-0.202	0.198	-0.513	-0.318	-0.561	-0.458	-0.512	0.008
Excess kurtosis	0.561	0.565	0.514	0.220	1.465	1.891	0.243	1.821	0.782
Prediction error variance	0.018	0.018	0.017	0.041	0.009	0.029	0.044	0.029	0.021
AIC	-3.747	-3.751	-3.811	-2.909	-4.288<	-3.135	-2.726	-3.146	-3.431
BIC	-3.473	-3.477	-3.537	-2.600	-3.945<	-2.723	-2.314	-2.735	-2.985
Durbin-Watson	1.752	1.694	1.804	2.130	1.759	1.713	2.197	1.692	1.918
					Estonia: *Inflation*				
Skewness	–	-1.894	-1.943	-3.572	-2.069	-1.495	-3.531	-1.253	-2.728
Excess kurtosis	–	8.091	8.162	18.801	10.158	8.683	18.184	8.289	13.074
Prediction error variance	–	4897.100	4767.800	451.330	372.440	362.440	405.29	352.890	353.350
AIC	–	8.726	8.699	6.370	6.210<	6.215	6.327	6.221	6.255
BIC	–	8.968	8.941	6.645	6.519<	6.558	6.670	6.598	6.666
Durbin-Watson	–	2.146	2.145	1.941	2.225	1.743	1.651	1.744	1.731

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 13: Goodness-of-fit based on Residuals: Romania

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
				Romania: *GDP*					
Skewness	–	-1.580	-1.592	0.227	-0.976	-0.461	-0.614	-1.238	-1.116
Excess kurtosis	–	5.261	3.862	1.070	1.367	0.587	2.695	3.266	2.834
Prediction error variance	–	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.002
AIC	–	-6.122	-6.250	-6.065	-6.386<	-6.227	-5.653	-5.604	-5.611
BIC	–	-5.882	-6.010	-5.756	-6.077<	-5.849	5.276	-5.192	-5.165
Durbin-Watson	–	1.725	1.711	2.354	1.885	1.855	1.847	2.088	2.158
				Romania: *Inflation*					
Skewness	–	-1.380	-1.943	-0.323	1.517	0.939	0.253	0.673	0.304
Excess kurtosis	–	4.621	8.162	3.913	4.945	3.186	5.041	5.973	4.585
Prediction error variance	–	290.410	4767.800	74.203	103.990	59.185	68.892	57.721	50.191
AIC	–	5.900	8.699	4.629	4.966	4.435	4.619	4.442	4.335<
BIC	–	6.143	8.941	4.972	5.310	4.813	5.031	4.854	4.781<
Durbin-Watson	–	1.758	2.145	1.973	2.812	2.131	1.892	1.749	1.716

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 14: Goodness-of-fit based on Residuals: Slovenia

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
					Slovenia: *GDP*				
Skewness	–	–	-1.099	-0.746	-0.929	-1.071	-0.858	-1.602	-0.853
Excess kurtosis	–	–	2.551	5.049	2.097	3.688	3.729	4.543	2.631
Prediction error variance	–	–	0.007	0.009	0.006	0.013	0.012	0.011	0.013
AIC	–	–	-4.781	-4.361	-4.792<	-3.994	-4.053	-4.150	-3.912
BIC	–	–	-4.541<	-4.053	-4.483	-3.651	-3.676	-3.772	-3.501
Durbin-Watson	–	–	2.162	2.127	2.125	1.807	1.584	1.410	1.849
					Slovenia: *Inflation*				
Skewness	–	0.825	0.467	0.707	0.896	-0.131	0.121	0.007	0.231
Excess kurtosis	–	1.939	0.648	1.191	-0.086	-0.413	-0.321	0.040	0.018
Prediction error variance	–	7.768	7.363	6.615	6.148	5.626	9.170	7.260	6.018
AIC	–	2.247	2.226	2.147	2.139	2.082<	2.506	2.369	2.182
BIC	–	2.454	2.468	2.422<	2.482	3.460	2.815	2.781	2.594
Durbin-Watson	–	1.814	2.012	2.138	1.896	1.895	1.311	2.068	2.040

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 15: Goodness-of-fit based on Residuals: Slovakia

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
				Slovakia: *GDP*					
Skewness	–	-0.015	-0.050	0.018	0.273	-0.257	-1.790	-1.117	-0.941
Excess kurtosis	–	0.387	0.192	0.386	0.899	1.918	8.363	5.652	5.160
Prediction error variance	–	0.007	0.009	0.012	0.005	0.010	0.020	0.015	0.014
AIC	–	-4.691	-4.524	-4.177	-4.926<	-4.229	-3.593	-3.827	-3.863
BIC	–	-4.451	-4.284	-3.903	-4.617<	-3.852	-3.250	-3.415	-3.417
Durbin-Watson	–	1.768	1.944	2.425	1.793	1.832	2.062	1.603	1.731
				Slovakia: *Inflation*					
Skewness	–	1.050	1.115	1.581	-0.401	0.223	0.259	0.388	0.150
Excess kurtosis	–	4.027	3.707	5.121	0.900	2.915	2.972	3.095	2.671
Prediction error variance	–	24.014	21.827	23.923	7.758	10.138	10.831	13.795	10.085
AIC	–	3.375	3.279	3.338	2.371<	2.671	2.737	3.011	2.730
BIC	–	3.583	3.487	3.512	2.714<	3.048	3.115	3.423	3.176
Durbin-Watson	–	2.119	2.039	1.934	1.876	2.031	2.070	2.038	2.059

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 16: Goodness-of-fit based on Residuals: Estonia

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
				Estonia: *GDP*					
Skewness	–	-0.479	-0.428	-0.301	0.466	0.008	0.613	0.044	0.182
Excess kurtosis	–	1.354	0.969	0.916	1.096	1.230	1.880	1.593	1.438
Prediction error variance	–	0.276	0.246	0.275	0.201	0.178	0.176	0.222	0.156
AIC	–	-1.007	-1.121	-1.011	-1.241	-1.363	-1.375	-1.024	-1.379<
BIC	–	-0.740	-0.853	-0.743	-0.897	-1.019	-1.030<	-0.565	-0.920
Durbin-Watson	–	1.446	1.438	1.521	1.598	1.370	1.330	1.424	1.359
				Estonia: *Inflation*					
Skewness	–	-0.089	0.294	0.253	-0.121	-0.187	-0.204	-0.130	-0.206
Excess kurtosis	–	0.158	1.190	-0.555	0.192	0.127	0.482	0.020	0.506
Prediction error variance	–	16.772	17.842	9.395	11.187	10.987	12.128	9.529	11.957
AIC	–	3.016	3.078	2.530<	2.705	2.719	2.850	2.609	2.901
BIC	–	3.224	3.286	2.839<	3.014	3.062	3.228	2.986	3.347
Durbin-Watson	–	1.994	1.959	2.098	2.107	2.090	2.118	2.200	2.130

Notes: The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 17: Goodness-of-fit based on Residuals: Euro Area (Aggregates)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
			Euro Area (Aggregates): *GDP*						
Skewness	–	–	-0.580	-0.190	-0.349	-0.856	-0.380	-0.109	0.037
Excess kurtosis	–	–	1.285	0.904	0.661	2.049	0.799	1.549	1.527
Prediction error variance	–	–	104.480	125.740	104.580	152.460	107.660	191.470	209.440
AIC	–	–	4.907<	5.125	4.973	5.382	5.034	5.577	5.764
BIC	–	–	5.181<	5.433	5.316	5.759	5.411	5.920	6.210
Durbin-Watson	–	–	1.990	1.841	1.949	1.605	1.879	1.860	1.813
			Euro Area (Aggregates): *Inflation*						
Skewness	–	–	-0.155	0.031	0.000	0.142	-0.104	-0.489	-0.069
Excess kurtosis	–	–	-0.274	0.401	-0.140	-0.085	0.523	1.049	-0.223
Prediction error variance	–	–	1.580	1.504	1.284	1.638	1.456	1.617	1.300
AIC	–	–	0.687	0.666	0.605<	0.815	0.731	0.900	0.714
BIC	–	–	0.929	0.940<	0.982	1.159	1.108	1.346	1.195
Durbin-Watson	–	–	2.055	2.170	2.103	2.294	2.229	2.237	2.422

Notes:The Table reports the estimated models for each country (Model 1 to 9). In the second half of the Table AIC and BIC are the Akaike Information Criterion and the Bayesian Information Criterion respectively. Durbin-Watson refers to the value of the Durbin-Watson statistics for no residuals autocorrelation. [Standard errors] and (p-values) in brackets. Model 1 is a local linear trend model; Model 2 is a smooth level model; Model 3 is a local level model; Model 4 approximate the trend with a Fourier approximation of the first order; Model 5 equals Model 4 plus a time trend; Model 6 equals Model 5 plus a quadratic trend; Model 7 consists of a trend estimated by a Fourier approximation of the second order; Model 8 equals Model 7 plus a time trend; Model 9 equals Model 8 plus a quadratic trend. Whenever values for Model 1 or 2 are missing it means a stochastic level, slope (or both) not to be accepted by the model.

Table 18: Normality Tests

GDP				Inflation			
	Method	Value	p		Method	Value	p
Poland	Jarque-Bera	6.383	(0.041)	Poland	Jarque-Bera	0.268	(0.874)
	Lilliefors	0.140	(0.011)		Lilliefors	0.082	> 0.1
	Cramer-von Mises	0.143	(0.029)		Cramer-von Mises	0.073	(0.254)
	Watson	0.136	(0.025)		Watson	0.072	(0.223)
	Anderson-Darling	0.837	(0.029)		Anderson-Darling	0.416	(0.321)
Hungary	Jarque-Bera	19.562	(0.000)	Hungary	Jarque-Bera	0.184	(0.911)
	Lilliefors	0.091	> 0.1		Lilliefors	0.073	> 0.1
	Cramer-von Mises	0.096	(0.126)		Cramer-von Mises	0.034	(0.776)
	Watson	0.074	(0.213)		Watson	0.033	(0.753)
	Anderson-Darling	0.668	(0.077)		Anderson-Darling	0.265	(0.683)
Czech Rep.	Jarque-Bera	10.757	(0.005)	Czech Rep.	Jarque-Bera	0.660	(0.718)
	Lilliefors	0.150	(0.004)		Lilliefors	0.057	> 0.1
	Cramer-von Mises	0.203	(0.005)		Cramer-von Mises	0.023	(0.937)
	Watson	0.188	(0.004)		Watson	0.022	(0.932)
	Anderson-Darling	1.249	(0.003)		Anderson-Darling	0.156	(0.952)
Latvia	Jarque-Bera	15.299	(0.000)	Latvia	Jarque-Bera	0.290	(0.865)
	Lilliefors	0.101	> 0.1		Lilliefors	0.091	> 0.1
	Cramer-von Mises	0.099	(0.113)		Cramer-von Mises	0.065	(0.321)
	Watson	0.099	(0.091)		Watson	0.063	(0.305)
	Anderson-Darling	0.747	(0.049)		Anderson-Darling	0.394	(0.363)
Lithuania	Jarque-Bera	8.173	(0.017)	Lithuania	Jarque-Bera	0.464	(0.793)
	Lilliefors	0.114	> 0.1		Lilliefors	0.087	> 0.1
	Cramer-von Mises	0.113	(0.072)		Cramer-von Mises	0.060	(0.367)
	Watson	0.113	(0.056)		Watson	0.060	(0.329)
	Anderson-Darling	0.705	(0.062)		Anderson-Darling	0.337	(0.492)
Bulgaria	Jarque-Bera	5.632	(0.004)	Bulgaria	Jarque-Bera	256.660	(0.000)
	Lilliefors	0.073	> 0.1		Lilliefors	0.142	(0.010)
	Cramer-von Mises	0.057	(0.402)		Cramer-von Mises	0.331	(0.000)
	Watson	0.057	(0.362)		Watson	0.314	(0.000)
	Anderson-Darling	0.423	(0.310)		Anderson-Darling	2.096	(0.000)
Romania	Jarque-Bera	12.775	(0.002)	Romania	Jarque-Bera	44.651	(0.000)
	Lilliefors	0.119	(0.053)		Lilliefors	0.142	(0.013)
	Cramer-von Mises	0.151	(0.022)		Cramer-von Mises	0.274	(0.001)
	Watson	0.124	(0.038)		Watson	0.273	(0.000)
	Anderson-Darling	0.961	(0.014)		Anderson-Darling	1.832	(0.000)
Slovenia	Jarque-Bera	26.446	(0.000)	Slovenia	Jarque-Bera	7.685	(0.021)
	Lilliefors	0.100	> 0.1		Lilliefors	0.059	> 0.1
	Cramer-von Mises	0.081	(0.195)		Cramer-von Mises	0.033	(0.793)
	Watson	0.063	(0.297)		Watson	0.026	(0.880)
	Anderson-Darling	0.636	(0.092)		Anderson-Darling	0.286	(0.612)
Slovakia	Jarque-Bera	2.488	(0.288)	Slovakia	Jarque-Bera	3.150	(0.207)
	Lilliefors	0.106	> 0.1		Lilliefors	0.133	(0.023)
	Cramer-von Mises	0.109	(0.082)		Cramer-von Mises	0.155	(0.019)
	Watson	0.108	(0.065)		Watson	0.152	(0.014)
	Anderson-Darling	0.665	(0.078)		Anderson-Darling	0.791	(0.038)
Estonia	Jarque-Bera	8.821	(0.012)	Estonia	Jarque-Bera	1.247	(0.536)
	Lilliefors	0.127	(0.089)		Lilliefors	0.067	> 0.1
	Cramer-von Mises	0.118	(0.061)		Cramer-von Mises	0.032	(0.807)
	Watson	0.112	(0.057)		Watson	0.029	(0.826)
	Anderson-Darling	0.721	(0.056)		Anderson-Darling	0.281	(0.627)
Euro area	Jarque-Bera	6.872	(0.032)	Euro area	Jarque-Bera	0.372	(0.830)
	Lilliefors	0.074	> 0.1		Lilliefors	0.062	> 0.1
	Cramer-von Mises	0.036	(0.747)		Cramer-von Mises	0.024	(0.921)
	Watson	0.033	(0.765)		Watson	0.024	(0.911)
	Anderson-Darling	0.301	(0.567)		Anderson-Darling	0.144	(0.968)

Annex B - Conditional correlation results by country

Poland	In Poland inflation and GDP correlation *vis-à-vis* the euro area remained around 0.1 until the mid-2008. In 2004 we observe a temporary rise in inflation correlation mainly stemming from Poland's accession to the EU. Following a period of low inflation, price pressure started to pick up again at the end of 2006 causing a fall in conditional correlation. The same fall is observed in GDP correlation, pointing out that inflation developments appear to have roughly mirrored the output performance with some lag, as also suggested by ECB (2010).[24] For inflation, correlation is however low (below 0.2). In 2008-09 inflation correlation remained at a higher value, picking up at 0.4 in 2008, and mainly reflecting inflation shocks (a sharp depreciation of the zloty in 2008 contributed to keep inflationary pressure high). The very low correlation at the end of sample suggests that the inflation adjustment to the 2008 downswing has not truly matched what observed for the euro area, partially explaining the Polish GDP growth performance in the aftermath of the crisis. Indeed, the introduction of a precautionary arrangement, approved under the Flexible Credit Line by the International Monetary Fund, reduced exchange rate pressures, letting a bigger room for corrective manoeuvres. A part from the latter episode, the overall low average correlation for inflation (roughly 0.15) is consistent with the rejection of the *similar* cycle restriction reported in Section 3.2. A more stable GDP correlation can justify a *similar* cycle instead.
Hungary	In Hungary, inflation sharply declined from 1998 to 2003, and accelerated again in 2004. It moderated in 2005 but peaked out in 2007. All those swings are consistent with the very low inflation correlation, relatively to the euro area, until 2005, increasing up to 0.2 thereafter, and followed by a hump down as inflation peaked in 2007. As inflation started receding since 2007, we observe increasing correlation over time, further reinforced by the 2008 commodity price shock. From the side of GDP, although the country experienced robust growth at the beginning of the 2000s, since the end of 2006 the aforementioned inflation developments took place against the background of a strong economic slowdown, which turned into a recession in 2008. This is shown in the correlation downturn from 0.3 to zero in 2001, following a steep pattern since 2008, matching the euro area economic slowdown. The above findings are consistent with the very low synchronism found over the full sample in both GDP and inflation, and may justify the rejection of the *similar* cycle restriction relatively to the euro area in both cases (see Section 3.2).
Czech Rep.	In Czech Republic, inflation followed a downward trend until 2003. This helped the country to keep inflation safely at a subdue level, displaying an overall degree of correlation with the euro area. Price pressure started to pick up in 2007, mainly as result of an increase in food and energy prices, which also led to increasing correlation. Between 2003 and 2007 GDP developments were characterized by some upswings, followed by a slowdown in 2008. Since 2008 the country seemed to stay fairly synchronized with the euro area cyclical dynamics. Overall, the pattern of GDP and inflation seems to provide robust evidence of a *similar* cycle relative to the euro area (Section 3.2) as the inflation correlation oscillates around 0.3 while GDP correlation is never below 0.35.
Latvia	Latvia's inflation and inflation correlation remained broadly stable in the early 2000s. Inflation started increasing in 2003, before peaking up in 2007, driven by the increase in import prices (and the depreciation of the lats against the euro). Excessive demand and subsequent hikes in food and energy prices contributed to the latter increase, as well as to the upswing in conditional correlation since 2007. Moreover, during the booming years (2005-2007) the Latvian economy exhibited very low correlation with respect to the euro area GDP. Such a low GDP correlation and high inflation seem to be consistent with the rejection of a *similar* cycle relative to the euro area in GDP but not in inflation, as discussed in Section 3.2. The deep Latvian recession observed recently (see ECB, 2010), is moreover reflected into a serious turnaround in the conditional GDP correlation which started since 2009. The drop in GDP was more substantial than for the euro area, bringing correlation back to the *pre*-crisis value of about -0.2.
Lithuania	In Lithuania inflation remained largely under control in the early 2000s, as a result of the Russian crisis and the appreciation of the litas. This also resulted in a stable conditional correlation (around 0.3) until 2001. Inflation correlation started falling since 2002. Correlation increased gradually in 2007 and 2008, as the result of food and energy prices increasing. Inflation also trended higher following the increased domestic demand and a robust GDP growth. The latter developments help explain the large conditional correlation in GDP, relative to the euro area. Followed by a pronounced turnaround in both the euro area and the Lithuania's economic cycles, correlation also raised in 2008 and fell in 2009, possibly as an effect of the idiosyncratic adjustment process in the country. The relatively steady correlation in both GDP and inflation over the full sample (around 0.3) seem to be consistent with the hypothesis of *similar* GDP and inflation cycles, relatively to the euro area.
Estonia	Looking at Estonia (appearing here as EMU candidate), we find that the overall high inflation conditional correlation over the sample period can be explained by the process of disinflation started in 2003 and mainly oriented to price stability. During 2005-2007 an increased domestic demand boosted economic growth, hence leading to an uprising correlation *vis-à-vis* the euro area GDP cycle. The lack of inflationary pressure in those years is explained by the adjustment process of an economy with fixed exchange rate to restore early losses in competitiveness (see ECB, 2010). After strong economic expansion, output growth started to decelerate in 2007 and turned negative in the first quarter of 2008 causing a steep fall in correlation. During the course of 2009 correlation in both GDP and inflation overall increased. The fall in output, together with the on-going adjustment process, contributed to the maintenance of a relative high level of inflation correlation over time, which - together with GDP dynamics - help explain the non-rejection of a *similar* cycle relatively to the euro area (see Section 3.2).
Bulgaria	In Bulgaria during 2004-08, monetary policy conditions - together with a currency board arrangement of pegging with the euro (since 1997) - became expansionary, leading to strong GDP growth. Overall, this meant sustained GDP and inflation correlation with the euro area since 2008. Like Estonia and two EMU insiders (Slovenia, Slovakia), Bulgarian inflation conditional correlation is found to broadly mirror the evolution of GDP correlation, featuring a U-shaped pattern as well. Being Bulgaria the only EMU "outsider" (among the above group of countries), this result is particularly interesting in terms of the out-of-phase recovery the country undertook since 2005. In light of those dynamics, featuring a *similar* GDP and inflation cycle relatively to the euro area is hence not surprising for the country.
Romania	In Romania, GDP dynamics are similar than what found for Bulgaria. Inflation correlation is on the contrary very different, displaying a fair degree of cyclical co-movement, mainly due to the disinflation process during the 2000-2004 period in preparation of the EU accession in 2007. In 2007 inflation picked up fueled by the commodity price shock and increasing demand pressure, to slow down again since 2008 due to lower commodity prices and the contraction in the economic activity. Overall, this led to strong correlation in GDP and inflation, relatively to the euro area, in 2008 and 2009. Interestingly in 2010 inflation correlation fell more than output correlation (inflation correlation reduced from 0.7 in 2009 to 0.2 in 2010) consistent with strong prices - rather than output - flexibility. Based on these developments, conditional correlations seem to be consistent with the non-rejection of a *similar* cycle relative to the euro area in both GDP and inflation.