EUROPEAN ECONOMY

Occasional Papers 50 | July 2008

What drives inflation in the New EU Member States?
Proceedings of the workshop held on 22 October 2008

Directorate-General for Economic and Financial Affairs

Economic and Financial Affairs
DIRECTORATE-GENERAL

EUROPEAN COMMISSION

Occasional Papers are written by the Staff of the Directorate-General for Economic and Financial Affairs, or by experts working in association with them. The "Papers" are intended to increase awareness of the technical work being done by the staff and cover a wide spectrum of subjects. Views expressed do not necessarily reflect the official views of the European Commission. Comments and enquiries should be addressed to:

European Commission
Directorate-General for Economic and Financial Affairs
Publications
B-1049 Brussels
Belgium
E-mail: mailto:Ecfin-Info@ec.europa.eu

This paper exists in English only and can be downloaded from the website
http://ec.europa.eu/economy_finance/publications

A great deal of additional information is available on the Internet. It can be accessed through the Europa server (http://europa.eu)

ISBN 978-92-79-11264-5
DOI: 10.2765/49687

European Commission

Directorate-General for Economic and Financial Affairs

What drives inflation in the New EU Member States?

Proceedings of the workshop held on 22 October 2008

TABLE OF CONTENT

Introduction

by Géraldine Mahieu and Massimo Suardi[1]

BACKGROUND

Better understanding the determinants of inflation in the new EU Member States (NMS) was the aim of the workshop organized by the Directorate-General for Economic and Financial Affairs (DG ECFIN) of the European Commission on 22 October 2008 in Brussels. The workshop brought together participants from academia, central banks, ministries of finance and permanent Member States' representations to the European Commission.

The surveillance of the EU and national economies is at the core of DG ECFIN's responsibility. Before the financial crisis hit Europe, high inflation had emerged as one major economic challenge in several Member States, even before the most recent energy and food price shock. Inflation had increased most visibly in countries with fixed exchange rate regime, in a context of buoyant domestic demand, largely fuelled by high rates of credit growth. Wage-price spirals had taken roots in a number of countries, leading to a visible deterioration in their international price and cost competitiveness. For new Member States with a fixed exchange rate regime, , inflation emerged as the main obstacle on their way to the euro in the boom period.

The workshop happened to take place during the possibly most acute phase of the financial crisis, following the Lehman Brothers' demise in mid-September 2008. By then, the crisis had dramatically changed the economic landscape and the priorities of policy-makers, including in the NMS. With respect to inflation, the deceleration of global economic activity, abrupt falls in commodity prices and rapidly decelerating credit growth (as a result of the global credit crunch) had already started to put a lid on inflation pressures in most NMS. While much of the public and policy-makers attention had started to focus on immediate measures to handle the crisis and pull these countries out of recession, the workshop provided a timely forum to discuss how persistent inflation in those NMS could be in this new environment, and to draw some lessons that will no doubt prove useful in the future.

The drivers of inflation dynamics in NMS are indeed arguably more complex to discern than those in the 'old' Member States. First, 'traditional' determinants (external price shocks, cyclical conditions, inflation expectations, etc.) of inflation interplay with transition effects and long-term catching up dynamics, as well as with ongoing factor and product market integration with the EU; second, relatively short statistical series and structural breaks complicate the statistical analysis; third, EU accession has required adjustments of excise duties and indirect taxes, which have temporary but substantial impact on inflation.

Against this background, the workshop discussed cross-country and quantitative analyses of the determinants of inflation in the NMS, focusing in particular on three broad questions. First, the workshop attempted to assess the relative importance of external versus domestic drivers of inflation. External shocks such as the increase in energy and food prices, globalization or EU accession have clearly significantly affected inflation in NMS. NMS are typically small and very open economies. As they are on average at a lower level of economic development than 'old' Member States, food and energy represent a higher share of consumer spending. At the same time, the diversity of countries' inflation performance suggests that endogenous, country-specific factors, notably strong domestic demand pressures and accelerating wages and unit labour costs, have also significantly contributed to inflationary pressures in some NMS.

A second question of interest was to ascertain more specifically the specific role of catching-up and transition-related effects in observed inflation developments. More specifically, it is important for policy-makers to know to what extent price developments are driven by equilibrium phenomena, reflecting their lower initial price level and their ongoing catching-up process, as opposed to demand-supply disequilibria. Replying to this question implies gauging the magnitude of the so-called "Balassa-Samuelson effect", but also the effect of other structural changes associated to real income catching-up (such as an increased weight for services in consumption and

[1] We thank Anton Jevcak for his help in reviewing and providing very useful comments on the papers contained in this volume.

rising demand for higher-quality goods and services,…). It also implies analysing the other elements driving price level convergence, including price deregulation, changes in the level of public subsidies and accession-related taxes.

The third question explored in the workshop was the role of policies in determining the dynamics of inflation in NMS. Differences in the stance of monetary and fiscal policy (including via the determination of public wages), as well as structural policies impacting on competition or markets flexibility are likely to have contributed to different inflation patterns in NMS. An issue of special interest in this context was to ascertain the impact of different exchange rate regimes.

THE PAPERS AND DISCUSSIONS

EXTERNAL VERSUS DOMESTIC DRIVERS OF INFLATION

In his paper **"Driving forces of inflation in the New EU 10 Members"**, Emil Stavrev decomposed inflation drivers between factors common to all NMS and factors specific to each country (by means of a generalized dynamic factor model). The decomposition was achieved via a panel estimation of the common factors driving inflation across countries and country-by-country estimations of the country-specific component. 65% of inflation was found to be ‘common‘, of which 40% (around ¼ of total inflation) could be explained by price level convergence, changes in interest rates (EU integration) and energy inflation. In the country-by-country estimations, the key variables were the output gap, real interest rates, and the nominal effective exchange rate. They explained between 30 and 84% of the country-specific inflation components (on average around 50%).

John Beirne, in his paper **"Vulnerability of inflation in the New EU Member States to country-specific and global factors"**, used a GMM-System panel estimator to assess the relative importance of country-specific and global factors in explaining inflation in NMS over the period 1998 to 2007 (quarterly data). By contrast to the previous paper, this paper suggested that country-specific factors (such as exchange rate, productivity growth, government consumption, capital growth, current account balance, stock market capitalization, domestic credit and reforms on price liberalization) dominate global influences on inflation in the CEECs. External factors having the largest impact included energy prices, food prices, and EU accession in the 2002-2007 period. Interestingly, the paper did not observe any statistical relationship between unemployment and inflation in the NMS.

In his paper **"Inflation in the New EU Countries from Central and Eastern Europe: Theories and Panel Data Estimations"**, Karsten Staehr discussed a number of theories of inflation, including some of particular importance for catching-up economies. The theories and explanations of inflation were grouped under four headings: (i) institutions and policies, (ii) structural factors, (iii) business-cycle factors and (iv) shocks. The explanatory power of the various theories was then assessed using, as in Beirne's paper, the GMM-System panel estimator but on annual (rather than quarterly) data for 10 CEE countries in 1997-2007. The results pointed to imported inflation, the Balassa-Samuelson effect, the size of the government and the current account balance as statistically significant drivers of inflation in the CEE countries. The inflation process was also found to have a substantial autoregressive component (of the size 0.3-0.5), suggesting possible inertia in price and wage setting and backward-looking price expectations.

In his discussion of the papers, Reiner Martin pointed out that these papers covering many aspects of inflation in the EU NMS were well-suited for the first session. Emil Stavrev paper's was however lacking some important aspects of inflation in these countries, notably the role of structural policies and public finances, while the second paper (initially the papers by J. Beirne and K. Staehr formed only one paper but was split into two following the discussants' comments) appeared overburdened with numerous variables and a range of somewhat eclectic estimations methods. Reiner Martin also stressed that, while cross-country studies were providing useful information, current key policy questions seemed to require more detailed country-specific information.

The second discussant, Tatiana Fic suggested that the determinants of inflation, the models and specifications in the papers of J. Beirne and K. Staehr could have been selected more carefully. She considered Emil Stavrev's modelling strategy as elegant and transparent, but noted that the criteria for selecting the drivers of common and country-specific components should be specified and the numbers of variables considered could be extended.

In the subsequent discussions, it was stressed that the different conclusions of the two papers regarding the importance of common versus country-specific factors was largely semantic. Specifically, the Balassa-

Samuelson effect was considered as a country-specific shock in the paper of J. Beirne and K. Staehr but common in the E. Stavrev's paper.

CATCHING-UP AND TRANSITION-RELATED INFLATION

The paper **"Catching-up and transition-related inflation: the Balassa-Samuelson effect revisited"** by Dubravko Mihajlek and Marc Klau aimed at estimating the Balassa-Samuelson (BS) effect for eleven countries in Central and Eastern Europe (all NMS and Croatia) on a disaggregated set of quarterly data covering the period from the mid-1990s through the first quarter of 2008. The paper concluded that the BS effects were clearly present: 25% of inflation differential between new EU member states vis-à-vis the euro area and 50% of domestic relative price differentials between non-tradable and tradable industries could be explained by the BS effect. Nevertheless, the effect was found to decline in the more recent period observed, most probably due to real convergence process. Further, the authors claimed that the BS effect was stronger in the Central European countries (Slovakia, Slovenia, Lithuania, Hungary, Estonia, Poland) than in Southern European countries (Bulgaria, Croatia, Romania). They also argued that the Slovak and Slovenian experiences showed that it was possible to fulfil the Maastricht inflation criterion even in the presence of a relatively strong BS effect (larger that 1.5 percentage points). The authors however stressed that the large measurements errors and high room for discretion in transforming data and applying estimation procedures invited utmost caution in drawing policy implications based on estimates of the BS effect. Following suggestions from the discussants, the authors split the data into two sub-periods. However, results were mixed and did not provide any clear general indication on changes in the size of the B-S effect.

In his paper **"Catching-up and transition related inflation"**, Balázs Égert provided a detailed account of stylized facts regarding the determinants of inflation in NMS and used Bayesian model averaging techniques to assess the relative importance of these factors on observed inflation rate in the Central and Eastern Europe. By contrast with D. Mihajlek and M. Klau, Égert found that the BS effect was not an important inflation driver in either the old or the new member states. Other structural factors affecting goods and services prices, monetary aggregates and cyclical and external factors appeared to matter much more than the BS effect. Moreover, regulated prices, house prices, food prices, nominal exchange rate and the output gap were found to be important in explaining inflation developments in Europe.

In the subsequent discussion, Lina Bukeviciute argued that the difference in results between the two papers was related to different methodological approaches, data frequency and definition of tradable and non-tradable sectors. She pointed to possible shortcomings in the methodology used in the two papers, notably regarding possible non-stationarity of variables and structural breaks in the first paper, the need to consider additional variables in both papers. Moreover, output gap estimates were not reliable. She suggested grouping data into various panels in order to study the cross-country differences (hard-peg versus floaters NMS, old MS). She concluded that, while the BS effect was an appealing economic theory, the estimates of this effect were surrounded by such a high degree of uncertainty that they seemed to be of limited use for practical economic policy making.

The general discussion mainly focused on the reasons behind the different conclusions of the two papers. The authors deemed that part of the differences could come from the different methodologies used, the classification between tradables and non-tradables and the time period considered. In addition, the results may vary largely from country to country, implying that country-specific studies are also needed to reach more reliable policy conclusions.

ROLE OF MACROECONOMIC AD STRUCTURAL POLICIES

In their paper **"Is persistence a driving force of inflation in the new EU Member States?",** Michael Franta Branislav Saxa and Katerina Smidkova compared inflation persistence between the countries that joined the European Union in 2004 and 2007 and selected current members of the euro area. Using two inflation persistence measures (one based on a simple univariate statistical model of inflation with time-varying mean and the other assuming that inflation follows a fractionally-integrated process and measuring inflation persistence within an ARFIMA model), the authors identified two different groups of countries within the New Member States. The first group (consisting of Bulgaria, Cyprus, the Czech Republic, Malta, Romania, and Slovakia) displayed a very similar degree of inflation persistence compared to the current euro area members, suggesting a comparable reaction to inflationary shocks. By contrast, the second group (the Baltics, Hungary, Poland and Slovenia) exhibited a very high level of inflation persistence, which would make it more difficult to fulfil the Maastricht inflation criterion for these countries.

The paper **"Inflation forecasting in the New EU Member States"** by Olga Arratibel, Christophe Kamps and Nadine Leiner-Killinger presented stylized facts on monetary versus non-monetary (economic and fiscal) determinants of inflation in NMS as well as formal econometric evidence on the forecasting performance (for inflation) of a large set of monetary and non-monetary indicators. In line with previous research for the euro area, monetary indicators were found to contain useful information for predicting inflation at longer horizons (three years). It was, however, difficult to find models that significantly outperform simple benchmarks at shorter time horizons.

In the subsequent discussion, Alf Vanags criticised the blind use of statistical techniques and emphasized the importance of taking full account of country-specific information. For the Baltics, in particular, the inclusion of national or regional characteristics would have led to significantly different conclusions on inflation persistence, he argued. Massimo Suardi also pointed out the need to account for countries' heterogeneity and emphasized the promising results of the inflation forecasting paper which suggested that, depending on the time horizon, different "drivers of inflation" may be at work in the New Member States.

The general discussion mainly centred on the possible policy conclusions which could be drawn from the papers. While some participants argued that the tools available to policymakers were limited (e.g. because monetary aggregates or credit are not fully controllable, especially in countries with fixed exchange rate regimes), it was generally deemed that the stylized facts presented may serve as a useful benchmark for policymakers.

CONCLUSIONS

The workshop confirmed the challenges posed by the analysis of inflation in NMS, notably because of short data series and structural breaks. It also confirmed the need to look carefully at the statistical properties of data series, something that was emphasised in some papers but not all. Finally, while cross-country studies were useful as they notably allowed exploiting larger data bases and looking for common factors, country-specific studies remained indispensable to inform the policy debate and actions at national level.

Notwithstanding these challenges, the workshop confirmed the complex nature of the inflationary process in NMS. First, both structural and transition-related drivers (relative price level, changes in regulated prices, quality and demand effects…) and the business cycle appear to play a significant role. From an empirical point, it is not obvious to determine clearly the relative weight of these two sets of factors during a fast catching-up process as the one that characterised NMS before the financial crisis. Second, estimates of BS effects are subject to large measurements errors and seem to have, at best, a relatively limited impact on inflation in NMS, and thus to explain only a fraction of the observed empirical correlation between income and price-level convergence. Third, monetary variables and financial deepening (interest rate, money growth) were also identified to be important determinants of inflation. However, none of the papers provided robust econometric evidence on a significant effect of the exchange rate regime. Finally, several authors stressed the importance of structural reforms in labour and product markets, in particular to reduce inflation persistence.

Forces Driving Inflation in the New EU10 Members

Prepared by Emil Stavrev

ABSTRACT

The paper analyzes the forces driving inflation in the new EU10 member countries. A significant part of headline inflation in these countries is due to common factors, such as price level convergence and EU integration. However, idiosyncratic factors have also played a role in the inflation process. These factors are related to the country-specific financial conditions, pass-through from foreign prices, and demand-supply situation in each country, although administered price adjustments and increases of indirect taxes associated with EU accession are also likely to have played a role.

JEL Classification Numbers: C13, C33, E31, F15

Keywords: inflation, generalized dynamic factor model, price convergence

Author's E-Mail Address: estavrev@imf.org

1 INTRODUCTION

The new EU10 member states from Eastern Europe (NMS) are under the obligation to adopt the euro some time in the future.2 The Maastricht inflation criterion requires that inflation in a member state applying for euro entry should not exceed the average inflation rate of the three countries with the lowest inflation rate in EU plus 1½ percentage points. However, over the past ten years, with some exceptions, inflation in the NMS has exceeded the Maastricht inflation criterion most of the time.3 Also, following a disinflation trend since the mid-1990s, over the past couple of years, inflation in most NMS has trended up and with the exception of Poland and Slovakia is currently above the inflation criterion.

A better understanding of the inflation process is important from a broader policy standpoint. In particular, for policy makers it is useful to know the degree to which inflation has been driven by common factors that affect all NMS as opposed to country-specific factors related to domestic aggregate demand/supply conditions. In that regard, the integration in the EU increased the confidence of investors and allowed the NMS to borrow in the international capital markets, stimulating an economic boom, which may have affected inflation beyond the country-specific cyclical factors. Beyond these considerations, inflation is also costly. High inflation results in a redistribution of wealth from those with fixed incomes to those with flexible incomes (from lenders to borrowers) and reduces real returns on savings and investments.

The factors driving inflation dynamics vary depending on the time horizon. Over the short term, the structure of the consumption basket plays an important role for headline inflation. For example, for given commodity price shocks, headline inflation will be higher in countries with higher energy and food price shares in the consumer basket. Over the medium term, business cycle fluctuations are important determinants of inflation. Administered prices and indirect tax changes may also contribute to country-specific inflation over the medium-term, as NMS policies are synchronized with the EU requirements. Over the longer term, factors such as convergence of price levels across countries become a more important driving force.

This paper analyzes the forces driving inflation in the 10 NMS. The analysis suggests that a significant part of headline inflation in the NMS is driven by common factors, such as price level convergence and EU integration. Country-specific factors however, have also played a role in the inflation process. These factors are related to the financial conditions, pass-through from foreign prices, and demand-supply situation in each country, although administered price adjustments and increases of indirect taxes associated with EU accession are also likely to have played a role.

The remainder of the paper is organized as follows. Section II briefly summarizes related literature. Section III provides background information about inflation dynamics in the new NMS. Section IV describes the methodology and the data. Section V discusses the results, while Section VI concludes.

2 RELATED LITERATURE

There is an ongoing debate in the literature on the importance of common versus country-specific determinants of inflation. Rogoff (2003) for instance, argues that as a result of globalization the level of inflation has declined, partly through increased competition, but also through the political economy process that drives long-term inflation trends. He maintains that competition tends to make factor and output prices more flexible, reducing the real effects of monetary policy surprises. Thus , central banks have less incentives to inflate, which enhances their anti-inflationary credibility. According to Borio and Filardo (2007) and Razin and Binyamini (2007), global economic slack has significant explanatory power for domestic inflation and its role has been growing over time, especially since the 1990s. However, Ihrig and others (2007) find no evidence that the trend decline in the sensitivity of inflation to the domestic output gap observed in many countries owes to globalization.

[2] Slovenia already adopted the euro in January 2007 and Slovakia is scheduled to adopt it in January 2009.
[3] Exceptions are Poland from August 2002 to August 2004 and from January 2006, Slovenia from January 2006 to July 2007; Lithuania from January 2000 to December 2004, Latvia from January 2001 to December 2003, and Czech Republic from August 2002 to November 2007, when inflation was strictly below the Maastricht criterion.

Several studies have dealt with the relative importance of domestic versus common determinants of inflation of the EU countries. For example, Stavrev (2006), applying a GDFM framework, separates country-specific and common components of inflation in NMS8 and estimates the factors driving country-specific inflation. Mody and Ohnsorge (2007), using a sample of EU25 countries, identify common time and sectoral trends and find that the common, cross-border sources of inflation increase, reducing the extent of domestically-generated inflation. They show that country-specific inflation in the NMS is higher than that in the old EU members and find evidence that a lower initial price level is associated with higher subsequent inflation. Choueiri and others (2008) in a panel of EU25 countries separate common from idiosyncratic components of inflation and find that cross-country differences in common inflation within the EU depend on gaps in the initial price level, changes in the nominal effective exchange rate, the quality of institutions, and the flexibility of the economies.

This paper utilizes a two-step approach in analyzing the forces driving inflation in the NMS. In the first step, it decomposes inflation into common and idiosyncratic components, using a generalized dynamic factor model due to Forni and others (2000). By allowing for autocorrelation of the dynamic factors, GDFM is better suited to isolate the unobserved common component of inflation than other filtering methods. In the second step, the paper identifies the driving forces of common and country-specific inflations by regressing them on a set of macroeconomic variables that capture the common and country-specific shocks.

3 INFLATION DYNAMICS IN MNS: BACKGROUND

The NMS countries are more energy intensive and have a significantly higher share of food prices in their consumer baskets than the old EU members (Table 1). In terms of energy intensity, measured by the CPI weight of energy consumption, the NMS, on average, consume about 50 percent more energy than the old EU countries. Regarding the share of food prices, it ranges from 50-60 percent higher in Czech Republic, Slovakia, Estonia, Poland, Slovenia, and Hungary to about 100 percent in Latvia and Lithuania, and to over 120 percent in Bulgaria and Romania.

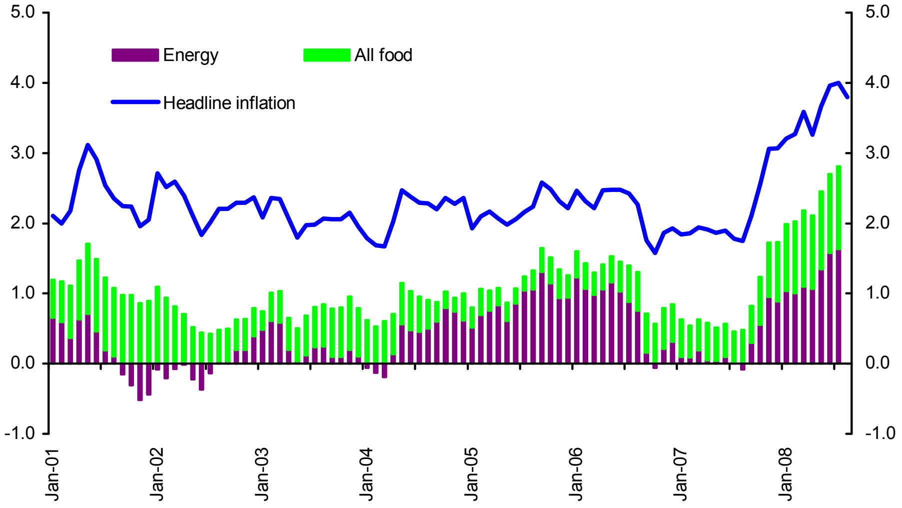
Table 3.1 NMS and Euro Area: Energy and Food Intensity 1/

	Energy	Liquid fuel	Food
	Share in CPI basket, in percent		
Bulgaria	14.7	4.9	31.6
Czech Republic	13.9	3.9	17.7
Estonia	13.9	6.1	21.4
Hungary	13.0	5.2	18.7
Latvia	12.9	3.6	28.5
Lithuania	14.0	4.7	28.1
Poland	14.9	4.6	22.8
Slovak Republic	16.7	3.4	18.8
Slovenia	12.7	8.0	17.3
Romania	14.7	4.9	31.6
Euro Area	8.8	4.8	14.4

Sources: Eurostat; and IMF staff calculations.
1/ Average for 2000-2008.

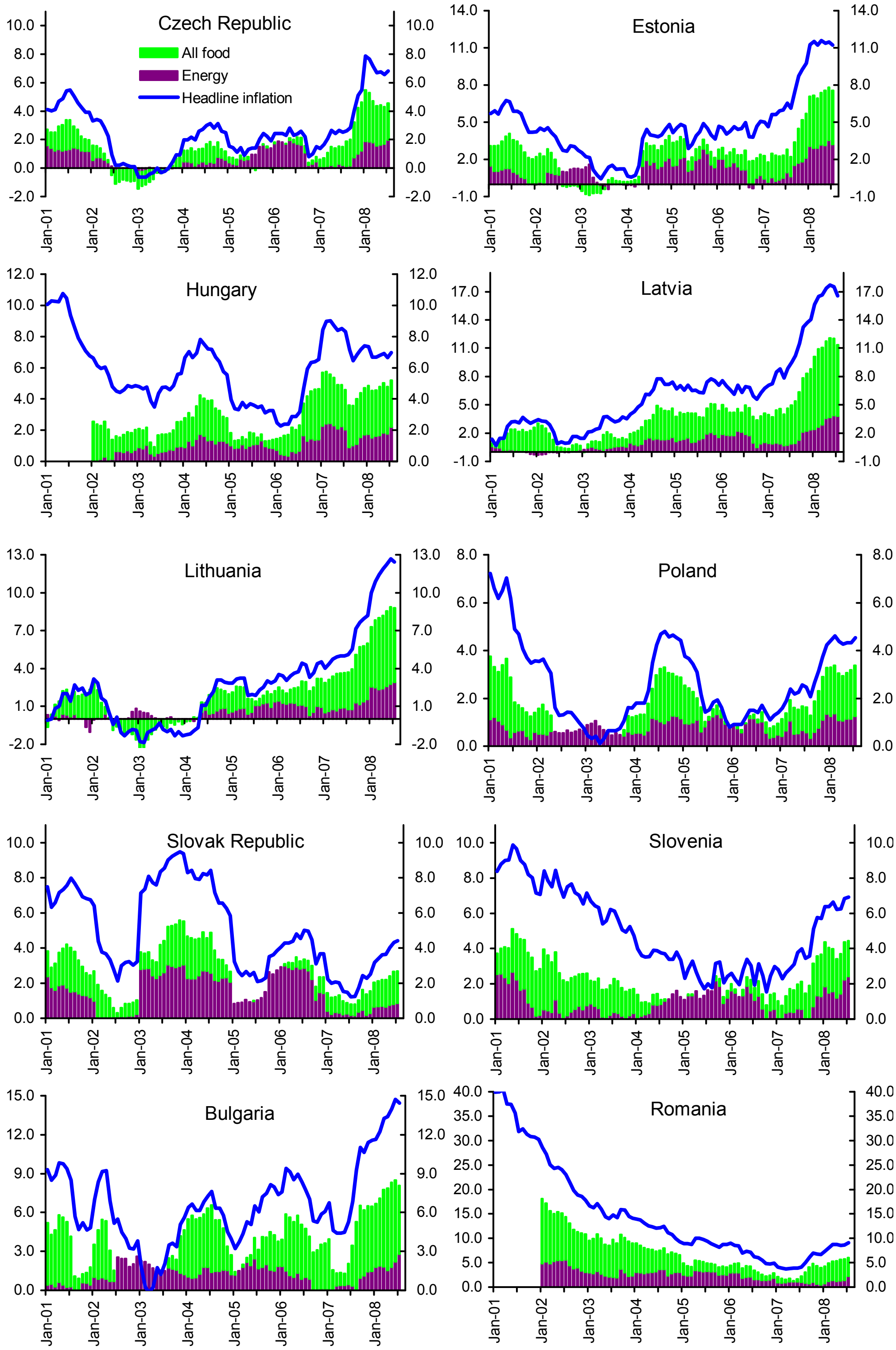
Consequently, commodity price shocks have a much more pronounced effect on headline inflation in the NMS compared to the old EU countries (Figures 1 and 2). In particular, over the past several years food and energy inflation contributed slightly less than 40 percent to headline inflation in the euro area, while it contributed close to 60 percent in the NMS.

Figure 3.1 Euro Area: Contribution of Energy and Food to Headline Inflation
(Inflation in percent; energy and food in percentage points)



Sources: Eurostat; and IMF staff calculations.

Figure 3.2 NMS: Contribution of Energy and Food to Headline Inflation
(Inflation in percent; energy and food in percentage points)



Sources: Eurostat; and IMF staff calculations.

From a policy standpoint however, of interest is the degree to which commodity prices trigger an indirect impact on underlying inflation. To gauge the importance of food and energy as potential sources of indirect (second-round) effects to underlying inflation, a tri-variate vector autoregressive model (VAR) comprising food, energy, and core inflation (HICP excluding energy and all food) for each country is used.4 The results suggest that commodity prices seem to impact core inflation in most of the NMS, either through domestic energy or food prices or both, but the effects are not large. Exceptions are Estonia and Slovenia, where, as in the euro area, commodity prices seem to have little impact on underlying inflation. In Bulgaria food prices seem to be the cause of the indirect effects, in Lithuania, Latvia, Hungary, and Slovakia energy prices are responsible, while in the Czech Republic, Poland, and Romania both food and energy prices are behind the indirect effects on underlying inflation.

Also, the stability of inflation expectations plays an important role in inflation dynamics. To determine how well anchored inflation expectations in the NMS are and the factors that affect them, a pooled regression is used. In particular, inflation expectations (measured by the EC consumer surveys) are regressed on energy, food, and core inflation. The results suggest that inflation expectations in the NMS are in general well anchored. Energy and core inflation have little impact on inflation expectations, while food inflation has a significant but relatively small effect (one percentage point higher food inflation increases inflation expectations by 0.1 percentage points).

4 METHODS AND DATA

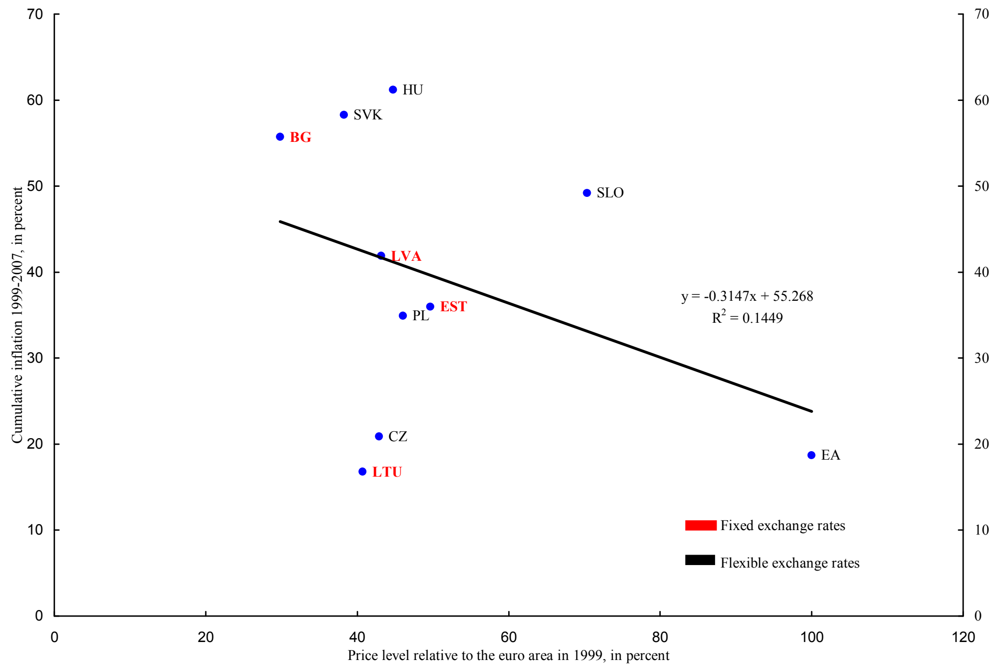
Inflation in the NMS may be driven by both common and country-specific forces. Common inflation may be a result of common shocks hitting the global economy. Commodity price increases is an example of such global shocks. However, there may be other common factors at play in the NMS. In particular, as all of these countries started their transition to market economy with significantly lower price levels compared to the old EU members, the process of convergence to their new equilibrium level would affect inflation. Also, while not fully orthogonal to the price level convergence, the economic boom associated with the EU membership is also expected to play a role, which may go beyond the impact of the normal cycle.

The analysis of the determinants of inflation in the NMS is carried out in two steps. First, inflation is decomposed into a component common to all NMS and a component which is specific to each country. The separation into a common and country-specific components is done using the generalized dynamic factor model (GDFM). In the next step, the determinants of common inflation are estimated in a panel setup, by regressing the common factor on variables that capture the effects of common driving forces. Specifically, commodity prices, initial price levels of NMS, and proxies for the role of EU integration.

The NMS differ considerably in their exchange rate regimes. In particular, the Baltics and Bulgaria are at the one extreme with the most rigid exchange rate regimes (currency boards or a peg with a very narrow band in Latvia), while the rest are at the other end with fully floating (or managed, as in Hungary for most of the sample period) exchange rates. Therefore, before proceeding with the analysis, it is worthwhile looking whether the differences in exchange rate regimes could potentially dampen the effects of the common factors discussed above on inflation. As the number of the NMS is small (10 countries), an econometric estimate of the impact of the exchange rate regime on inflation is not feasible. Nevertheless, the role of the exchange rate regime could be assessed by looking whether it is correlated with inflation after controlling for the income level. The results in Figure 3 suggest that the exchange rate regime does not seem to be a significant driver of inflation in the NMS, as given the income level, countries are randomly distributed around inflation-income line.

[4] The VAR model is estimated using monthly seasonally adjusted data for the period January 2000 to June 2008. The indirect effects on core inflation are estimated using domestic energy and food prices. This is done with a view of filtering the effect of short-term volatility of international energy prices that are not passed onto domestic energy prices. The pass-through from international commodity prices into domestic energy and food retail prices is determined by several factors. In particular, exchange rate movements, as domestic prices are priced in local currency, taxes and subsidies on fuels and food, and the cost structure of domestic production of energy and food, as labor costs account for a large share of their production.

Figure 4.1. NMS: Price level, Inflation, and Exchange Rate Regime



Source: IMF staff estimates.

4.1 GENERALIZED DYNAMIC FACTOR MODEL

As a first step, to separate inflation in NMS on a common and country-specific components, the paper applies the GDFM methodology developed by Forni and others (2000).

The GDFM is well suited to macroeconomic that are driven to a considerable degree by common shocks. For example, among others, Stock and Watson (1988, 1989) find factor models useful in disentangling a small number of common shock that are behind the covariation of the major macroeconomic time series (output, prices, interest rates, yields, etc.). Cristadoro and others (2005), using inflation and financial variables for the euro area countries, apply the GDFM model to estimate the underlying inflation. What the GDFM does is to extract this smaller number of orthogonal common shocks by maximizing the part each additional shock explains in the variation that remains unexplained by the previous shock.

Consequently, inflation in each country is represented as the weighted sum of the common shocks and a variable/country-specific, or idiosyncratic component. The common component is driven by a small number of common shocks, which are the same for all the cross section, but possibly translated into the common-component inflation in each country with different coefficients and/or lag structures. By contrast, the country-specific (idiosyncratic) component is driven by country-specific shocks. As a result, overall inflation in each country is the sum of the common and the idiosyncratic component as in:

$$x_{i,t} = x_{i,t}^{c} + \theta_{i,t} = b_i(L)\nu_t + \theta_{i,t} \tag{1}$$

where $x_{i,t}$ is individual country's inflation, $x_{i,t}^{c}$ is the common component, $\theta_{i,t}$ is the mean zero country-specific component, ν_t is a vector of size q of common unobservable dynamic factors driving the common component, b_i is a vector of loading factors, which are specific to each country and shock *q*. Note also that the country-specific component, $\theta_{i,t}$, is orthogonal to each element of the vector of common factors, ν_t, for all *i* and *t*.

The above assumptions are crucial for the decomposition of a country's inflation into common and country-specific components. They mean that covariation of inflation among countries is due to the effect of q common unobservable factors, while variation of inflation in each individual country is due to the variation of the country-specific factors plus the variation of the common factor.

4.2 MODELING COMMON AND COUNTRY-SPECIFIC COMPONENTS

In the second stage, the common and the country-specific components derived from the first step are modeled.

4.2.1 Common component

Several common factors (shocks), which can be global or regional in nature, can drive the common component of inflation in the NMS. In particular, such factors include differences in initial positions at the beginning of the transition process (price and income levels), commodity price shocks, EU integration process, and policies.

The effects of the common factors on common inflation in the NMS is analyzed using a pooled regression. In particular, the common component estimated from the first stage is regressed on several variables that are used as proxies for the common shocks discussed above. In particular,

$$x^c_{i,t} = \alpha + \beta_1 P_{i,1998} + \beta_2 \Delta r_{i,t-1} + \beta_3 \pi^e_{i,t-1} + \varepsilon_{i,t} \qquad (2)$$

where $x^c_{i,t}$ is the common component of inflation estimated in the fist step, $P_{i,1998}$ is the price level of NMS relative to EU15 in 1998, $\Delta r_{i,t-1}$ is the change in interest rates, and $\pi^e_{i,t-1}$ is energy inflation.

As a proxy for the effect of the initial price levels, the 1998 level of relative prices is used. This variable measures the gap between an individual country's price level and the EU15. It is supposed to capture the effects of price adjustments that are required to achieve the price level of EU15 countries over the medium to longer term (this variable could also capture to some degree effects of real income convergence). The forces behind price level adjustments may be different, for example, due to Balassa-Samuelson effect or quality convergence of consumer goods as a result of product market integration.[5] The change in interest rates is used as a proxy for the effect of EU integration of the NMS, while energy prices are intended to capture the effects of global commodity price shocks.

4.2.2 Country-specific component

The idiosyncratic component of inflation is modeled separately for each NMS by regressing the country-specific component from the first stage on variables intended to capture shocks specific to each country. In particular,

$$\theta_t = \delta + \gamma_1 y_{t-1} + \gamma_2 \Delta neer_{t-1} + \gamma_3 rr_{t-1} + \beta_3 \pi^f_{i,t-1} + \nu_t \qquad (3)$$

where θ_t is country-specific inflation, y_{t-1} is output gap, $\Delta neer_{t-1}$ is percent change of nominal effective exchange rate, rr_{t-1} is real interest rate, and $\pi^f_{i,t-1}$ is foreign inflation.

In this specification, the country-specific inflation is modeled as depending on domestic cyclical conditions, which are proxied by the output gap and real interest rates as well as on the openness of the economies which are captured by the nominal effective exchange rate and foreign inflation. Notice also that the idiosyncratic component of inflation in the NMS may be partially driven by changes in regulated prices and indirect taxes. For example, Choueiri and others (2008) note, such policy-induced price changes may have significant contribution to country-specific inflation in the NMS. In the above specification however, these effect are not explicitly modeled and therefore are captured by the residual term.

[5] Depending on the monetary policy setup in a particular country, the real effective exchange rate appreciation implied by the Balassa-Samuelson theory will be split between nominal exchange rate appreciation and higher inflation.

4.3 DATA DESCRIPTION

For the first stage GDFM estimates, the data set comprises 955 predominantly four-digit level HICP series for the NMS over the period January 1998 till June 2008 at monthly frequency. Where four-digit level series are not available, they are replaced with the next level of aggregation (about ¼ of the total data set). All HICP data are from Eurostat.

The following data transformations were done before applying the GDFM model. As the GDFM methodology requires stationary series, first- and twelve-month difference of the HCIP components were used. Prior to calculating the month-on-month percent changes, all HICP components were seasonally adjusted using the U.S. Bureau of Labor Statistics X12 procedure. Finally, to ensure that the estimation results are not contaminated by variables with high-volatility, the data for both month-on-month and year-on-year regressions were normalized by subtracting their means and dividing by their standard deviations.

In the second stage of the estimation the following non-HICP data are used: industrial production (seasonally adjusted), interest rates, nominal effective exchange rates (all three at monthly frequency), and price levels of the NMS relative to EU15 (at annual frequency). In addition to using monthly data, the models for the determinants of the common and country-specific components were estimated with quarterly (country-specific component) and annual data (common component) as well. In that case, the corresponding monthly data were averaged over the respective periods to obtain quarterly or annual figures. In the quarterly models, industrial production was replaced with real GDP figures. Nominal effective exchange rates, industrial production data for the majority of the countries, and price levels are from Eurostat. The remaining industrial production data are from Haver Analytics database.

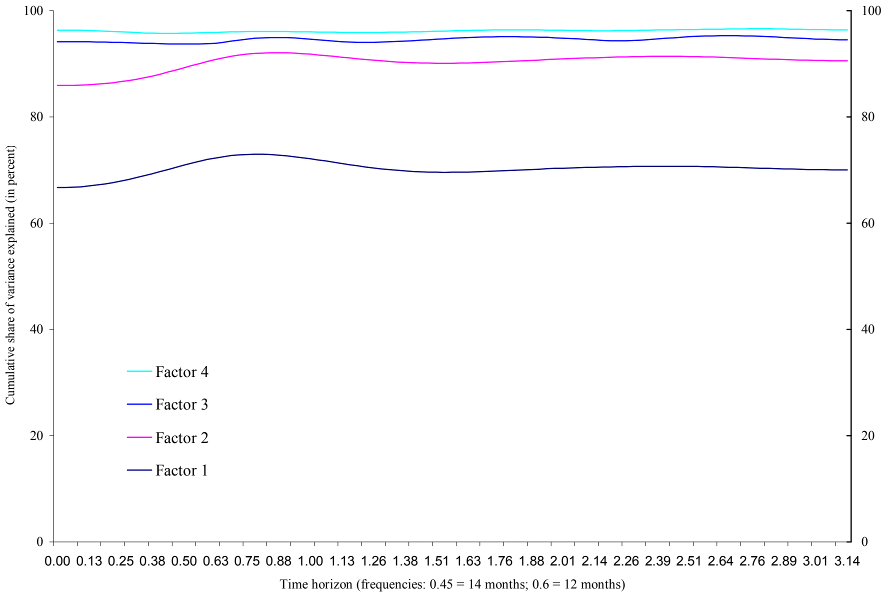
5 DISCUSSION OF THE RESULTS

5.1 GDFM RESULTS

The number of common factors is determined by analyzing the spectral density matrix of the data. On Figure 4, the cumulative share of the data variability explained by the largest four eigenvalues is plotted over the interval $[0, \pi]$. Note that in the time domain, the frequency of 0.52 on the horizontal axis corresponds to twelve months. The region to the left of that point correspond to periods greater than, while the region to the right to less than twelve months. On the vertical axis, the area below the eigenvalues indicates the cumulative share of the variance of the data set explained by each consecutive common factor.

As can be seen from Figure 3, the first common factor, corresponding to the largest eigenvalue, explains most of the variation of the data over the medium to longer term in the frequency domain. In particular, the first common factor explains about 65 percent of the data variability at a medium-term horizon and a slightly higher share, about 70 percent, at shorter horizons. Notice the fast decline of the marginal contribution of each additional common factor—the marginal contribution of the third principal component is considerably smaller than the second. Following Cristadoro and others (2005) the threshold for identifying common shocks is chosen at about 50 percent, to avoid bias from excessive noise at the higher frequencies. Thus, the first factor is chosen as the single dynamic common factor of inflation in the NMS. The remaining factors are assumed to contribute to the country-specific components.

Figure 5.1 Cumulative Share of Data Variance Explained by Common Factors
(In percent)

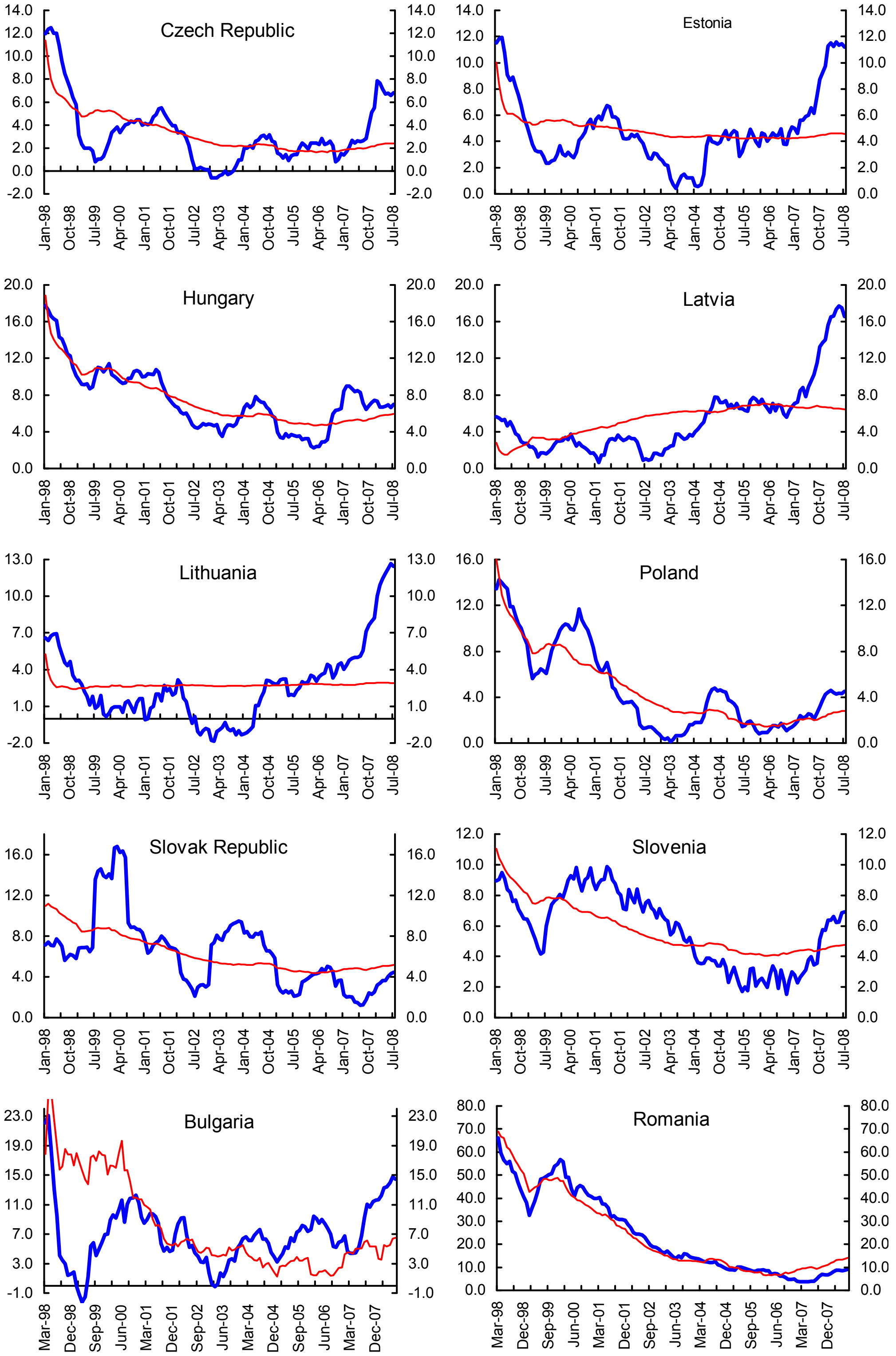


Source: IMF staff estimates.

The number of static factors is chosen using the algorithm proposed by Bai and Ng (2002). The algorithm minimizes the sum of squared errors from the regression of the data on the static factors, subject to a penalty for the sample size. The criterion reaches a minimum at 7 static factors. Given the selection of one common shock from the spectral density analysis, this implies six lags for the dynamic common factor in equation (1).

Figure 5 plots headline and common component inflation derived from the GDFM model using one common dynamic factor. In the time domain, the share of inflation variation explained by one dynamic factor varies significantly across NMS. In particular, it explains about 15 percent in the Baltics, around 45 percent in the Czech Republic and Slovakia, 75 percent in Hungary and Poland and over 80 percent in Bulgaria and Romania. Adding a second dynamic factor increases the share of explained inflation variation to above 80 percent on average for the NMS, suggesting that the two common factors are of different importance for each NMS.

Figure 5.2 NMS: Headline and One Common Factor Inflation
(Percent)



Sources: Eurostat and IMF staff estimates.

5.2 DETERMINANTS OF COMMON AND COUNTRY-SPECIFIC INFLATION

5.2.1 Drivers of common inflation

The estimates from the pooled regression discussed in Section IV B, suggest that the relative price level, EU integration forces (proxied by the convergence of nominal interest rates), and energy prices explain over 40 percent of the variability of common inflation in the NMS.

Price convergence forces are found to play a significant role in explaining common inflation (Table 2). In particular, half of the variability explained by the above factors is accounted for by the initial relative price level. Consistent with price convergence, the estimated coefficient of the initial relative price level is negative and significant. The estimated coefficient implies that in a NMS with a price level 30 percent below the level observed in the EU15 countries, common inflation would be about 1½ percentage points. This result is in line with findings elsewhere in the literature about the impact of the relative price level on inflation in the NMS. For example, Ashoka and Ohnsorge (2007) estimate the impact to be 1 percentage point.

Table 5.1. NMS10: Determinants of Common Component 1/

	Relative price level in 1998	Change in interest rates	Energy inflation	Adjusted R-squared
Coefficient	-0.05 (0.02)	-0.35 (0.05)	0.12 (0.01)	0.44

Source: IMF staff calculations.
1/ Dependent variable: common inflation derived from the GDFM model.
Interest rate change in percentage points; relative price level and energy inflation in percent.
Standard errors in parenthesis.

The effect of EU integration on common inflation, captured by the convergence of interest rates, is also found to be significant. The estimated coefficient implies that a country that experiences a 1 percentage point decline in interest rates would have about 1/3 of a percentage point higher. Finally, energy prices are also an important determinant to common component inflation, with the estimated coefficient implying that a 1 percent increase in energy prices accounts for 0.12 percentage points common inflation.

5.2.2 Determinants of country-specific inflation

In most NMS the idiosyncratic component is driven by cyclical factors, financial conditions, and openness (Table 3). Overall, these factors explain about half of the variation of the country-specific inflation. Cyclical factors, captured by the output gap are statistically significant in most NMS. Financial conditions, captured by the real long-term interest rate are also a significant determinant of the idiosyncratic component.

Table 5.2 NMS: Determinants of Country-specific Component 1/

	Output gap	Real interest rates	Nominal effective exchange rate	EU inflation	Adjusted R-squared
Czech Republic	0.08 (0.03)	-0.90 (0.05)	-0.04 (0.01)	n.s.	0.84
Estonia	0.16 (0.05)	-0.38 (0.10)	-0.08 (0.02)	n.s.	0.40
Hungary	0.12 (0.06)	-0.40 (0.07)	n.s.	n.s.	0.40
Latvia	0.1 (0.07)	-0.70 (0.05)	0.50 (0.05)	1.8 (0.50)	-0.70
Lithuania	0.05 (0.03)	-0.65 (0.06)	0.16 (0.05)	n.s.	0.70
Poland	0.20 (0.04)	-0.05 (0.03)	-0.03 (0.01)	0.60 (0.20)	0.30
Slovak Republic	n.s.	-0.45 (0.05)	-0.20 (0.05)	n.s.	0.55
Slovenia	n.s.	n.s.	-0.11 (0.04)	1.30 (0.40)	0.40
Bulgaria	n.s.	n.s.	-0.40 (0.12)	3.00	0.35
Romania	n.s.	-0.35 (0.07)	-0.16 (0.02)	1.00 (0.06)	0.45

Source: IMF staff calculations.
1/ Dependent variable: country-specific component of inflation, defined as headline inflation minus common component inflation. Long-term interest rate in percent; the other variables year-on-year, in percent. Standard errors in parenthesis. Statistically significant variables reported; n.s.—not statistically significant at 1 percent, 5 percent, or 10 percent.

6 CONCLUDING REMARKS

This paper decomposes inflation in the NMS on a common and country-specific components. The estimation results suggest several conclusions. First, a significant part (about 65 percent) of inflation in the NMS over the medium term is driven by common factors. Second, among the common factors, price level convergence and convergence of real interest rates are significant determinants common inflation, as are commodity prices.

However, idiosyncratic factors have also played a role in the inflation process. Domestic cyclical conditions and financial conditions play an important role for country-specific inflation in the NMS. Finally, pass-through effects from foreign prices have also played a role.

REFERENCES

Bai, Jushan, and Serena Ng, 2002, "Determining the Number of Factors In Approximate Factor Models," Econometrica, Vol. 70 (1), pp. 191–221.

Borio, Claudio, and Andrew Filardo, 2007, "Globalization and Inflation: New Cross-Country Evidence on the New Global Determinants of Domestic Inflation," BIS Working Paper No. 227.

Choueiri, Nada, Franziska Ohnsorge, and Rachel van Elkan, 2008, "Inflation Differentials in the EU: A Common (Factors) Approach with Implications for EU8 Euro Adoption Prospects," IMF Working Paper No. 08/21 (Washington: Internationals Monetary Fund).

Cristadoro, R., M. Forni, L. Reichlin, and G. Veronese, 2005, "A Core Inflation Index for the Euro Area," Journal of Money, Credit and Banking, Blackwell Publishing, Vol. 37 (3), pp. 539–60, June

Forni, Mario, Marc Hallin, Marco Lippi, and Lucrezia Reichlin, 2000, "The Generalized Factor Model: Identification and Estimation," Review of Economics and Statistics, Vol. 82, No. 4, pp. 540−54

Ihrig, Jane, Steven B. Kamin, Deborah Lindner, and Jaime Marquez, 2007, "Some Simple Tests of the Globalization and Inflation Hypothesis," Board of Governors of the Federal Reserve System Finance Discussion Paper No. 891.

Mody, Ashoka and Franziska Ohnsorge, 2007, "Can Domestic Policies Influence Inflation?," IMF Working Paper, WP/07/257.

Rogoff, Kenneth, 2003, "Globalization and Global Disinflation," Federal Reserve Bank of Kansas City Economic Review vol. 88 (4), pp. 45–78.

Quah, Danny and Shaun P. Vahey, 1995, "Measuring Core Inflation," The Economic Journal, Vol. 105, 86 (1), pp. 1130−44.

Stavrev, Emil, 2006, "Driving Forces of Inflation in New EU Countries," Czech Journal of Economics and Finance, Vol. 56 (Nos. 5–6), pp. 246–57.

Stock, James. H., and Mark. H. Watson, 1988, "Testing for Common Trends" Journal of the American Statistical Association, Vol. 83, No. 404 (Dec., 1988), pp. 1097–1107.

Stock, James. H., and Mark. H. Watson, 1989, "New Indexes of Coincident and Leading Economic Indicators," NEBR Macroeconomic Annual Report 1989, pp. 351−94.

Vulnerability of inflation in the new EU Member States to country-specific and global factors [6]

John Beirne [7]

Brunel University, London, UK
European Central Bank, Frankfurt am Main, Germany

ABSTRACT

This empirical paper uses a GMM-System panel estimator to assess the vulnerability of inflation in the new EU Member States to country-specific and global factors over the period 1998 to 2007, including an assessment of the more recent 2002 to 2007 period. Using a large dataset of macroeconomic, financial and structural reform indicators, the results suggest that country-specific factors such as exchange rate movements, productivity growth, government consumption expenditure, capital growth, the current account balance, and reforms on price liberalisation have strong effects on inflation. Global factors that have a notable effect include energy prices, and particularly in the more recent period, food prices. Furthermore, inflationary effects of EU accession are apparent in the 2002 to 2007 analysis. The magnitudes of the coefficients suggest that country-specific effects dominate global influences on inflation in the CEEs. This holds across the full-period sample and the more recent 2002 to 2007 period. These results have important policy implications for the group of countries examined.

JEL codes: E31, E42, E63, F31, P24

Keywords: Inflation, EU transition economies.

---

[6] This paper has its foundations in a joint project with Karsten Staehr in a paper entitled "Determinants of Inflation in the New EU Countries from Central and Eastern Europe: A Panel Data Approach", which was presented on October 22nd 2008 at the DG-ECFIN workshop on 'What Drives Inflation in the New EU Member States?'.

[7] Contact details: John Beirne, Brunel University, Department of Economics and Finance, Uxbridge, West London, UB8 3PH, United Kingdom; email: John.Beirne@brunel.ac.uk. European Central Bank, Kaiserstraße 29, 60311, Frankfurt am Main, Germany; email: John.Beirne@ecb.int. The views expressed in this paper are those of the author and do not necessarily represent those of the European Central Bank.

1 INTRODUCTION

This paper provides empirical evidence for the causes of inflation in the new EU Member States. The specific countries incorporated into the analysis are as follows: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia, and Romania. Using a rich data source over the period 1998 to 2007, the methodology is based on the GMM-System panel estimator, helping to ensure econometrically efficient results. A sub-sample analysis is also carried out for the period 2002 to 2007 to provide an insight into the dynamic driving inflation more recently. The latter period also, of course, represents the period where all of the economies are members of the EU.

This paper provides a comprehensive assessment of the causes of inflation using a quarterly dataset constructed from a range of sources. Thus, the paper adds to the literature in three key respects. Firstly, the range of indicators used ensures that all possible inflation determinants are taken into account (including country-specific and common factors comprised of macroeconomic, financial and structural variables). Secondly, the econometric technique is highly sophisticated and provides confidence in the magnitude and significance of the estimation coefficients. And, thirdly, the estimation is undertaken simultaneously not only across a wide range of indicators per country, but also across all ten CEE countries. In these three respects, the paper goes beyond previous work carried out on this issue.

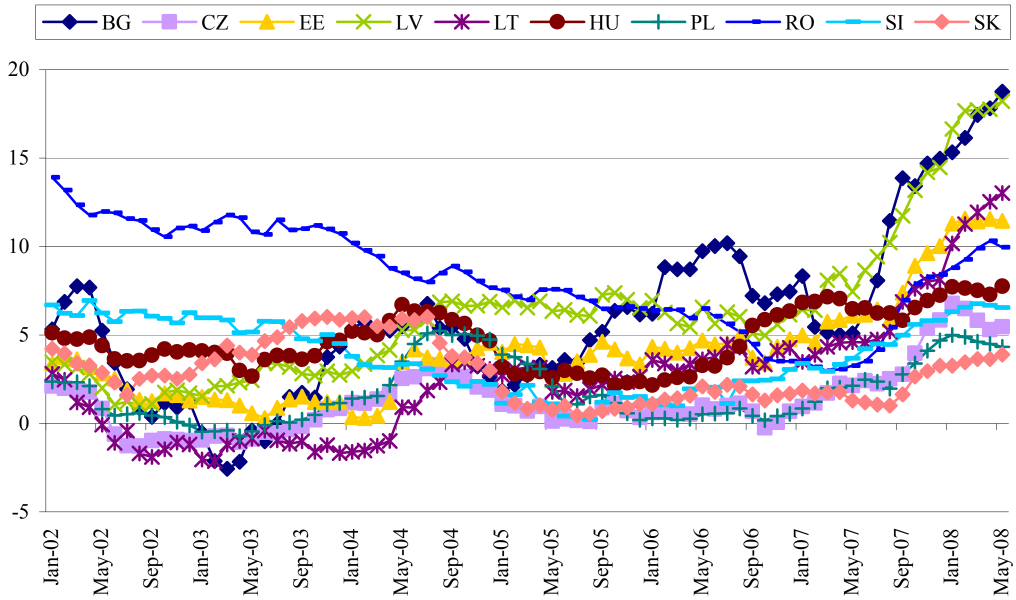
The remainder of the paper is structured as follows: Section 2 provides an overview of the context and description of findings from some previous empirical studies on the issue. Section 3 provides a description of the data and methodology. Section 4 sets out some preliminary analysis. Section 5 presents the main empirical results. Finally, Section 6 concludes.

2 INFLATION IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

This empirical paper is set against the context of a rising rate of inflation in many of the former Central and Eastern European (CEE) economies. The recent trajectory of inflation in the CEEs has been upwards. An important policy issue remains as regards the causes of the inflation surge. A better understanding of the causes of inflation in these countries helps to ensure that appropriate policy responses are implemented. Given the aim of the CEE economies to become members of EMU, high inflation has become a major obstacle given the requirement in the Maastrict criteria for low inflation. More broadly, however, it is commonly understood that high inflation can be detrimental to economies in terms of competitiveness losses. There exists a wide range of possible reasons for the rise in inflation. These include reasons that could be considered to be country-specific and other reasons that would be common to all countries. Country-specific effects, for example, would include exchange rate developments, economic growth, the size of the government, the current account balance, the tightness of the labour market, the exchange rate regime, and the degree of structural reform. Common shocks would include global rises in energy prices, global rises in food, shifts in global monetary policy, and EU accession.

While inflation has declined substantially from the relatively high levels of the late 1990s, since the period 2003 to 2005, inflation has started to rise again, particularly in Bulgaria, Estonia, Latvia, and Lithuania. In addition, the downward trend in inflation in Romania and Slovakia appears to have reversed since around the middle of 2007. Graph 1 illustrates the evolution of the HICP inflation rate in the CEE countries since 2002 (monthly annualised data).

Graph 1 HICP Inflation in the CEE Countries, 2002-2008 (monthly annualised)



Source: ECB, 2008

The movement in inflation is closely linked to exchange rate developments. The conventional view is that fixed regimes are most beneficial for developing economies with weak institutions. Crocket and Goldstein (1976) note that the combination of a commitment to exchange rate stability and monetary growth helps to ensure the control of inflation. On the other hand, where institutions are strong and central banks have independence, flexible regimes in combination with inflation targeting frameworks can be appropriate (Calvo and Mishkin, 2003). Across all of the CEE economies, there was a trend appreciation of the real exchange rate. In countries with a fixed exchange rate regime (Bulgaria, Estonia, Latvia, Lithuania), this appreciation was driven by inflation. Where a more flexible regime was in place (the Czech Republic, Hungary, Poland, Romania, Slovakia), the combination of inflation and nominal appreciation caused the real appreciation. This issue is examined in the empirical work by incorporating a variable to reflect the exchange rate regime.

A further common reason cited for inflation in emerging economies is the Balassa-Samuelson effect, whereby non-productivity related wage inflation takes place in the non-traded sector due to the mobility of labour between the more productive tradable sector and the less productive non-tradable sector. There remains a lack of consensus as to whether this holds for the CEE countries given that the services sector constitutes a much smaller proportion of overall consumption in these economies and also that the non-traded sector has experienced some productivity gains in recent years (e.g. Egert, 2002).[8]

In addition, the economies in the study have experienced strong levels of economic growth throughout the past six years or so. Strong credit growth and increasing degrees of openness have also been characteristics of the CEE economies, as well as associated widening current account deficits. All of these factors have been accompanied by a process of structural reform, including measures to develop the banking sector, measures to develop the infrastructural base, and an on-going process of price liberalisation. The combination of all of these country-specific factors could make the economies more vulnerable to certain types of global price shocks, such as energy price rises or food price rises. Previous studies on inflation in the CEE countries have tended to focus either on only a few of the countries considered in this paper, or else a few of the inflation determinants, or some combination of both. Some exceptions include de Grauwe and Schnabl (2004) who examine a large sample of 18 Central European economies across a number of macroeconomic variables only (using annual data). Their

[8] Moreover, as argued by de Broeck and Sløk (2001) in a study of the Baltic countries, the real exchange appreciation caused by productivity growth in the tradable sector may not lead to competitiveness losses given that the national currencies were undervalued at the outset. A similar argument is put forward in Caporale et al (2008).

focus was on the impact of the exchange rate regime on inflation and output, and making the overall finding that exchange rate stability is linked with low inflation in a low inflation environment, although this appears to break down when inflation is already at a high level. Egert (2007) also provides a comprehensive assessment of the drivers of the price level and inflation in the CEE countries, again focussing on macroeconomic variables at an annual frequency. He finds a strong role played by cyclical factors and the exchange rate in driving inflation in the transition economies. Notably, he also finds no evidence of Balassa-Samuelson effects. A further issue highlighted by Bhagwati (1984) relates the rise in the price of non-tradables as being due to a capital deepening effect whereby the capital-labour ratio rises.

The present paper amalgamates and expands the types of indicators used in previous studies in a simultaneous framework, enabling a comparative analysis to be made across the indicators as regards the impact upon the price level and inflation. The following section describes the data used, and the methodology, in more detail.

3 DATA AND METHODOLOGY

The data period runs from 1998 to 2007, using quarterly data[9] for the following ten EU transition countries: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia, and Romania. The variables gathered for each country are as follows: HICP, nominal effective exchange rate, current account deficit (%GDP), real GDP per capita, gross fixed capital formation, government consumption expenditure, relative prices (CPI/PPI), unemployment rate(%), stock market capitalisation (%GDP), domestic credit to private sector (%GDP), exchange rate regime arrangement, index of economic freedom, EBRD index of infrastructure reform, and EBRD index of price liberalisation. The main source for the macroeconomic and financial data is the IMF's IFS dataset. Stock market capitalisation, domestic credit to private sector, and various EBRD reform indices were attained from the EBRD Structural Indicators dataset. The exchange rate regime indicator was sourced from the Reinhart and Rogoff classification (coded as 1 for fully fixed, 2 for crawling peg, 3 for managed float, and 4 for free float). The index of economic freedom was sourced from the Heritage Foundation. All of these variables are predominantly 'country-specific'. As a measure of some form of global or common shocks impacting upon inflation, the following variables were constructed: energy price shock, food price shock, interest rate shock, and EU accession. The energy and food price shock variables are constructed as taking a value of 1 where the spreads of the respective energy and food price inflation rates relative to EU-27 average rates for these items are one standard deviation above mean. The interest rate shock is measured as the spread between the 3 month rate and the US Treasury Bill rate (as a proxy for global monetary policy), taking a value of 1 where the spread is one standard deviation above mean. The EU accession variable is represented as a dummy taking the value of 1 after EU entry and 0 prior to EU entry. In total, therefore, the data covers 18 variables (14 country-specific and 4 global factors) across 10 countries over 10 years.

The empirical methodology to be pursued is based on the GMM-System panel estimator. The GMM approach overcomes problems with more traditional forms of panel estimation (e.g. OLS) where there is a strong likelihood the dynamic approaches will suffer from problems relating to autocorrelation, specifically that the lagged dependent variable is correlated with the error term. This would, of course, mean that the least squares estimator is inconsistent (even asymptotically).[10] Since the bias in least squares estimation tends to zero over time, our large number of cross-sections and relatively short time range makes it more of an issue of concern.

Using GMM, the cross-section specific fixed effects are eliminated with first-differencing. This leads to a correlation between the first-differenced error term and the lag of the dependent variable. As a result, the lagged level of the dependent variable is used as an instrumental variable. Arellano and Bond (1991) make the point that lags of the dependent variables for two and more periods are also appropriate as instruments. This approach is known as the GMM-Difference. This dynamic panel estimator uses the following specifically as instruments: levels of the dependent variables lagged two and more periods, levels of the endogenous variables lagged two and more periods, and first difference of the strictly exogenous covariates. This approach was criticised by Blundell and Bond (1998) and Arellano and Bover (1995) on the grounds that levels may be poor instruments for first differences if variables are highly persistent. They then propose a GMM-System estimator, where lagged

[9] Due to the availability of some of the variables at an annual frequency only, these have been interpolated to a quarterly frequency using either the quadratic-match average or quadratic-match sum technique, as appropriate. Also, there are some missing observations at the start of the data period, making the panel unbalanced for the 1998 to 2007 analysis.
[10] The bias associated with least squares estimators in dynamic panels was perhaps first noticed by Nickell (1981).

differences of the independent and dependent variables are used as instruments for the levels equation. The empirical work is based on the following type of generalised equation:

$$Y_{it} = \alpha Y_{i,t-1} + X'_{i,t}\beta_1 + \upsilon_i + \varepsilon_{it} \qquad i = 1,\ldots,N \qquad t = 1,\ldots,T_i \qquad (1)$$

where Y is the dependent variable, X represents a vector of covariates, υ are country specific effects and ε is the error term.

Therefore, the empirical model pursued sets the HICP level (in logarithmic form) in the EU transition economies as a function of both the typical macroeconomic factors as well as indicators of structural reform. The added value of this type of approach lies mainly in the simultaneous nature of the estimation across a wide variety of macroeconomic and structural reform indicators. As described above, first-differencing (1) eliminates υ, leading to the following Arellano and Bond GMM estimation:

$$DY_{it} = \alpha DY_{i,t-1} + DX'_{i,t}\beta_1 + DW'_{i,t}\beta_2 + D\varepsilon_{it} \qquad (2)$$

where D is the first difference operator.

The key difference between the GMM-Difference and the GMM-System lies in the treatment of instruments. Whereas the former approach uses lagged levels in the difference equations, the latter estimator goes further by using lagged differences in the level equations. Blundell and Bond (1998) note that this approach is preferable particularly when T is relatively short. Moreover, when explanatory variables are persistent, the authors explain that this approach is more efficient.[11] In terms of model specification, the GMM estimator is subjected to tests to examine the validity of the instruments used. Specifically, the Sargan test for over-identifying restrictions (which tests the null hypothesis that the over-identifying restrictions are valid) is conducted as well as a test of second order autocorrelation (null of no autocorrelation). As well as this, the various estimations are based upon heteroskedasticity-robust standard errors. The GMM-System models estimated are based on the one-step method due to the poor small sample properties of the two-step estimation method.[12] In addition, time-invariant country-specific effects are controlled for in these models.

4 PRELIMINARY ANALYSIS

Prior to analysing the main GMM-System results, the headline GMM-System estimations were compared with three alternative panel estimations as a means to validate the results.[13] To this end, pooled OLS, least squares dummy variable (LSDV), and GMM-Difference panel estimations were performed, and compared to the baseline GMM-System estimates.[14] The rationale for the pooled OLS and LSDV estimations this was to provide an upper and lower bound within which the GMM-System estimates should lie, while the comparison of the GMM-System and GMM-Difference results provides an indication of the presence of weak instruments.

Across both the pooled OLS (common constant) and LSDV (which allows for country fixed effects) approaches, it is known that the results are biased upwards in the case of the former approach (Hsiao, 1986) and biased downwards in the case of the latter (Nickell, 1981; Kiviet, 1995). Whilst it is understood that this bias recedes as the time dimension of the panel approaches infinity, it cannot be ignored in our sample of 12 years. From this preliminary analysis, where parameter significance is evident, the GMM-System estimates do indeed lie within the pooled OLS and LSDV boundary. The GMM-System parameter estimates are generally slightly larger than those of the GMM-Difference. But as the GMM-Difference results also lie within the pooled OLS and LSDV boundary, there is an indication that the instruments used are not weak. As a result, there is confidence in the robustness and efficiency of the GMM-System estimates. In the following section, the main results based on the GMM-System are provided and analysed. An iterative approach is followed to attain parsimony using a General-to-Specific framework.

[11] For example, Blundell and Bond (1998) show that by applying the additional assumption of no correlation in the differences, more efficient estimates are attained.
[12] As recommended by Arellano and Bond (1991).
[13] Furthermore, analysis of the correlation matrix of all variables led to the exclusion of the FDI and IBSR variables due to potential multicollinearity issues.
[14] These results are not reported but are available from the author upon request.

5 EMPIRICAL RESULTS

Having established that the GMM-System estimates are efficient, this section focuses on the results using this approach. Moreover, a sub-sample analysis is also carried out. Table 1 sets out the results for the full sample, as well as the more recent 2002 to 2007 period, in the case where the log of HICP is the dependent variable. While the price level is used as the dependent variable, the logarithmic transformation ensures that the interpretation of the coefficients is in terms of the elasticity with respect to the price level. As a result, these results can be interpreted in terms of the rate of change in the price level, e.g. in the double-log model with the log of HICP as the dependent variable, an explanatory variable coefficient of *x* implies that a 1% change in the relevant explanatory variable changes the HICP level by *x*%, or equivalently, that the HICP inflation rate changes by *x* percentage points.[15]

Table 1 GMM-System Panel Output (Dependent Variable = Log HICP)

Regressors	**1998 to 2007**	**2002 to 2007**
Country-Specific Factors: Macroeconomic and Financial Indicators		
Lagged Log (HICP)	0.304*** [0.065]	0.683*** [0.028]
Log (nominal effective exchange rate)	-0.405*** [0.141]	-0.307*** [0.052]
Log (real GDP per capita)	-0.138*** [0.026]	-0.068** [0.030]
Current account deficit (%GDP)	0.221*** [0.066]	0.143*** [0.032]
Log (government consumption expenditure)	0.119*** [0.026]	0.112*** [0.062]
Log (relative prices)	0.327** [0.130]	0.205*** [0.095]
Domestic credit to private sector (%GDP)	0.003*** [0.001]	0.005*** [0.001]
Exchange rate arrangement	-0.009 [0.008]	-0.009** [0.004]
Log (nominal effective exchange rate) x Exchange rate arrangement	0.268** [0.134]	0.127** [0.064]
Unemployment rate	0.001 [0.001]	0.000 [0.000]
Log (gross fixed capital formation)	0.018* [0.011]	0.021*** [0.006]
Stock market capitalisation (%GDP)	0.004*** [0.001]	0.005*** [0.001]
Country-Specific Factors: Structural Reform Indicators		
Index of economic freedom	0.005*** [0.002]	0.000 [0.000]
Index of infrastructure reform	0.110*** [0.017]	0.049** [0.023]
Index of price liberalisation	-0.126 [0.087]	-0.105* [0.048]
Global Factors		
Interest rate shock	0.001*** [0.000]	0.001* [0.000]
Food price shock	0.088* [0.025]	0.108*** [0.036]
Energy price shock	0.125***	0.126***

[15] A separate analysis was also carried out using the first difference of the log of HICP as the dependent variable, which is of course a more direct means by which to infer implications for the rate of inflation. These results are not reported however given the failure to satisfy instrumentation. It is likely that the information lost through differencing (as opposed to using levels variables) may have contributed to the weakness of these results).

	[0.025]	[0.024]
EU accession	0.004 [0.003]	0.019** [0.010]
Countries	10	10
Observations	292	218
Country fixed effects	yes	yes
Period fixed effects	no	no
Sargan test (p-value)	0.593	0.498
Second order serial correlation (p-value)	0.334	0.297

(Notes: Robust standard errors in square parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and * respectively. Instruments comprise the lagged levels of dependent and independent variables in the difference equations, and lagged differences in the level equations).

Firstly, across both sets of results, it is clear that the validity of the instruments would appear to be satisfied, based on the Sargan test of overidentifying restrictions and the test for second order serial correlation. On analysis of the full-sample results, it is clear that the price level is strongly influenced by the nominal effective exchange rate, real GDP per capita, and the current account balance (%GDP). The signs associated with the coefficients of these variables accord with priors. In relation to the structural reform indicators, the index of economic freedom and the index of infrastructure reform appear to be exerting a positive affect on the price level. As well as country-specific factors, however, there is also a significant role played by global or common shocks. Most notable of these are energy price shocks and food price shocks.

Overall, it appears that country-specific macroeconomic indicators have the most notable effects on the price level relative to other indicators (in terms of the magnitude of the coefficients). For example, a 1% fall in the exchange rate (i.e. a depreciation) is associated with a 0.405% rise in the price level. In addition, the current account deficit relative to GDP is positively related to inflation. Specifically, a one percentage point rise in the current account deficit/GDP ratio increases the price level by 0.221% (equating to a 0.221 percentage point rise in the inflation rate). This makes sense intuitively as a rise in the current account deficit implies a rise demand for imported goods, and an associated rise in inflation. In addition, a 1% rise in government consumption expenditure is associated with a 0.119% rise in the price level. In relation to the financial system, the share of stock market capitalisation has a marginal positive impact upon inflation. Also, there exists a positive relationship between the share of domestic credit to the private sector and the price level. The effect of real GDP per capita on the price level also accords with priors in terms of the direction of the effect, whereby a 1% rise in real GDP per capita is associated with a 0.138% fall in the price level. There is also some weaker evidence to suggest that a rise gross fixed capital formation results in a rise in the price level.

As regards Balassa-Samuelson effects, relative prices have a significant effect on the HICP price level. Whilst this is to be expected, the fact that the magnitude of the effect is just 0.327, this could be an indication that Balassa-Samuelson effects are evident and contributing the rising price levels in the CEE countries. Structural reform has also had a notable impact on inflation in the CEE countries. Reforms linked to a shift towards a more market-oriented economy (proxied by the index of economic freedom) and those aimed at infrastructure reform appear to have positive effects on the price level (e.g. each additional unit of reform of infrastructure is linked with a 0.11% rise in the price level). A possible explanation for this is that reforms of this nature tend to encourage a flow of inward investment and economic activity. Interestingly, we do not observe any statistical relationship between unemployment and the price level. This outcome is robust across a range of alternative estimation specifications. This could suggest that Phillips-curve based explanations for inflation are not applicable to the CEE countries. Finally, an interaction term for the exchange rate and the exchange rate regime suggests that there is a greater impact on prices via the exchange rate when the regime is more fixed. Whilst there is no consensus on this issue in the literature, it is reasonable to observe a stronger link between nominal variables (i.e. the exchange rate and prices) under a fixed exchange rate regime.

Turning to the global factors, it is clear that all four common shock variables considered in Table 1 for the 1998 to 2007 period have an impact on the price level. In terms of scale and significance, the most notable effect comes from energy price shocks, and, to a lesser extent, food price shocks. For example, when the spread of local energy price inflation and that of the EU-27 is one standard deviation above mean, this causes a rise in the price level by 0.125%.

The results for the more recent period of 2002 to 2007 provide some different results, although the overall drivers of inflation in the CEE countries appear to be broadly the same. The differences evident largely relate to the scale of the effect. For example, it is clear that country-specific macroeconomic and financial indicators dominate inflation movements in the more recent sub-period. Food and energy price shocks are also notable global factors however. Lagged HICP affects current HICP by twice the magnitude compared to that of the 1997 to 2008 period. In addition, the Bhagwati-type effect where capital growth affects inflation is more apparent in the more recent period, both in terms of scale and significance. Of the structural reform indicators, measures aimed at price liberalisation have resulted in dampening effects on inflation (a one unit rise in the price liberalisation index is associated with a 0.105% decline in the price level).

The exchange rate regime indicator in the 2002 to 2007 period is significant and negative, suggesting that a fall in the price level is associated with a shift towards a more flexible regime. However the magnitude of the effect is not very substantial, where a shift in the regime to a less fixed/more flexible category is associated with a 0.009% decline in the price level.[16] In terms of preparations for EMU, the result in terms of sign may be unexpected, certainly as far as it pertains to fixed exchange rate regime countries. However, it could be argued that it is not inconsistent with the preparation of these countries for euro adoption as the exchange rate stability criterion oscillates around a +/- 15% range. The result could be related to a requirement for an appropriate lever to manage capital flows (i.e. the exchange rate), certainly over the past 3-4 years. Of course, the sample of ten countries considered in the panel is comprised of four CEEs with fixed regimes, and six with flexible regimes, which makes the interpretation somewhat difficult. Specifically, the result could be driven by the greater number of flexible regime countries in the panel (i.e. the inflation-targeting countries). Also, the effect is marginal.

Nonetheless, further discussion is warranted. For the period 2002 to 2007 (see Graph 1), the rate of HICP inflation has been broadly similar across all ten countries. However, for the fixed exchange rate regime countries, it has been consistently somewhat higher. This period was also associated with a surge in capital inflows to the CEE countries which are not always consistent with maintaining a given level of stability in the nominal exchange rate. For example, a greater level of exchange rate regime flexibility may be required to enable intervention to manage the capital flows and reduce pressure on prices.[17] Indeed, from Graph 1, it is clear that the current surge in inflation in the period since the end of 2007 is dominated by the fixed exchange rate regime countries, which would lend further support to the view that the nature of this regime, or the degree to which it is fixed, may no longer be entirely appropriate for controlling inflation in these economies.[18] Therefore, while fixed regimes can be useful at early stages of economic development, as economies become more developed and integrated into global trade and capital markets, a degree of greater flexibility in the exchange rate regime can be necessary.

Regarding the global factors in the 2002 to 2007 period, while the global interest rate and energy price shock effects do not change compared to the full-period results, it is apparent that the magnitude of food price shocks has increased in the most recent period. It is also more significant in the recent sub-period analysis. This would be in line with the greater relative volatility of food prices for the current period compared to the 'smoothening' effect of considering the entire ten year period. EU accession appears to exhibit this same sort of effect, whereby the restriction of the sample to the 2002 to 2007 period reveals that accession to the EU has had some (positive) impact on the price level.

[16] This does not imply that the fixed exchange rate regime countries should abandon fully their exchange rate management arrangements, which would be detrimental to their euro adoption plans. In any case, their institutions are arguably not strong enough to freely float in conjunction with inflation targeting. Rather, the proposition is that there may be some scope to shift to a looser form of fixed exchange rate regime arrangement. Similarly, it must be borne in mind that the result pertains to the panel as a whole, and not any one individual country. Thus, it does not necessarily imply that flexible exchange rate regime countries should be more flexible. Rather, on average, considering all of the CEEs as a whole, a degree of flexibility may be appropriate.

[17] As noted by Markiewicz (2006), many of the CEE countries had high inflation rates in the early 1990s and thus many opted for pegged exchange rate policies against an external anchor. As a result, the economies stabilized throughout the 1990s with inflation under control. This attracted a flow of foreign capital, which in a sense challenged the fixed exchange rate arrangements. Thus, towards the mid-1990s, some of the countries opted for more flexibility in their regimes (notably the Czech Republic, Poland, Hungary, and the Slovak Republic). Under a fixed exchange rate regime, large capital inflows oblige the Central Bank to maintain the nominal fix, which can lead to a rise in the money supply, which increases inflation and appreciates the real exchange rate (e.g. Athukorala and Rajapatirana, 2003; and Sorsa et al, 2007).

[18] Data constraints meant that the 2008 period was not part of the empirical analysis however. In addition, more conclusiveness on this issue would require a more comprehensive analysis on a country-by-country basis.

6 CONCLUSIONS

This empirical paper uses the GMM-System estimator to assess the vulnerability of inflation in the new EU Member States to country-specific and global factors over the period 1998 to 2007. In terms of common shocks (i.e. global factors affecting inflation), the variables examined included interest rate shocks, food price shocks, energy price shocks, and EU accession. While all of the global factors appear to exert some influence over the price level and inflation, the results are most pronounced for energy price shocks, and, to a lesser extent, food price shocks. As regards country-specific factors, exchange rate dynamics affect movement in the price level. The exchange rate pass-through to prices is about 40% over the 1998 to 2007 period.

The current account deficit is also found to exert upward pressure on inflation. Other country-specific variables with highly significant effects on inflation include the rate of capital growth, productivity growth in the traded compared to the non-traded sector, government consumption expenditure, and reforms on price liberalisation. The direction of the effect of these variables on inflation accords with priors. In terms of the financial system, stock market development and domestic credit to the private sector appear to significantly affect the price level. Regarding structural reform indicators, measures implemented to foster price liberalisation have helped to control inflationary pressure. However, measures aimed at infrastructure reform do not appear to have the expected effects in terms of reducing inflation. This expectation is based on the perceived competitiveness gain that such reforms are associated with. It could be the case that there may be a time threshold for the effectiveness of the reforms. Alternatively, the reforms may have led to higher levels of investment and economic activity, which would have an inflationary effect.

Overall, it is clear that the main determinants of inflation in the CEE countries are country-specific. However, there also exists a role played by energy and food price shocks in particular. Of course, it must be borne in mind that the panel approach adopted may to some extent camouflage recent events regarding global food prices. For example, the modelling of a subset of countries over the period 2007 to 2008 would be of interest in this respect. Data availability, however, does not allow such an analysis to be carried out in a robust manner, certainly across the variety of variables used in this study. Given the findings, which are valid for the full-period results as well as the results for 2002 to 2007, the policy implication would appear to be that sound macroeconomic policy in conjunction with sensible structural reforms should help economies to control inflation. This may involve some fiscal tightening as well as more flexibility in exchange rate regimes where appropriate. In addition, the openness of the economies needs to be monitored in terms of exchange rate effects given the exposure of prices to exchange rate movements. As regards implications to reduce exposure to energy and food price shocks, it is difficult to prescribe active policy measures. As the CEE economies develop further, their reliance on energy and food as a share of overall GDP should decline. This may help to alleviate the extent of the exposure at least.

Going forward, it would be of interest to analyse the determinants of inflation in more detail on a country-by-country basis in order to derive more specific policy implications. Data availability makes this an arduous task however, certainly in terms of the coverage of indicators used in this paper, as many variables are only available from the mid-1990s at a quarterly frequency or lower.

Acknowledgements

I am very grateful for comments received from participants at the DG-ECFIN workshop on "What drives inflation in the new EU Members States?" (European Commission, Brussels, October 22nd 2008). In particular, I would like to acknowledge valuable and detailed comments received from Reiner Martin (OeNB/ECB) and Tatiana Fic (NIESR).

REFERENCES

Arellano, M. & Bond, S. (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, vol. 58, no. 2, pp. 277-297.

Arellano, M. & Bover, O. (1995), "Another Look at the Instrumental Variable Estimation of Error-Components Models", *Journal of Econometrics*, 68, pp. 29-52.

Athukorala, P-C & Rajapatirana, S. (2003), "Capital Inflows and the Real Exchange Rate: A Comparative Study of Asia and Latin America", *The World Economy*, 26(4), pp. 613-637.

Bhagwati, J. (1984), "Why Are Services Cheaper in Poor Countries?", *Economic Journal*, 94(374), pp. 279-286.

Blundell, R. & Bond, S. (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models", *Journal of Econometrics*, 87(1), pp. 115-143.

Calvo, G. & Mishkin, F. (2003), "The Mirage of Exchange Rate Regimes for Emerging Market Countries", *Journal of Economic Perspectives*, 17, 4, pp. 99-118.

Caporale, G.M., Ciferri, D. & Girardi, A. (2008), "Are the Baltic Countries Ready to Adopt the Euro? A Generalised Purchasing Power Parity Approach", CESifo Working Paper No. 2359.

Crocket, A. & Goldstein, M. (1976), "Inflation under Fixed and Flexible Exchange Rates", *IMF Staff Papers*, 23, pp. 509-544.

De Broeck, M. & Sløk, T. (2001), "Interpreting Real Exchange Rate Movements in Transition Countries", BOFIT Discussion Papers, 7.

De Grauwe, P. & Schnabl, G. (2004), "Exchange Rate Regimes and Macroeconomic Stability in Central and Eastern Europe", CESifo Working Paper no. 1182.

Egert, B. (2007), "Real Convergence, Price Level Convergence and Inflation Differentials in Europe", CESifo Working Paper no. 2127.

Egert, B. (2007), "Investigating the Balassa-Samuelson Hypothesis in the Transition Economies: Do We Understand What We See? A Panel Study", *Economics of Transition*, 10(2), pp. 273-309.

Hsiao, C. (1986), *Analysis of Panel Data*, Cambridge: Cambridge University Press.

Kiviet, J.F. (1995), "On Bias, Inconsistency, and Efficiency of Various Estimators in Dynamic Panel Data Models", *Journal of Econometrics*, 68, pp. 53-78.

Markiewicz, A. (2006) Choice of Exchange Rate Regime in Central and Eastern European Countries: An Empirical Analysis, *Journal of Comparative Economics*, Vol. 34(3), pp. 484-498.

Nickell, S. (1981), "Biases in Dynamic Models with Fixed Effects", *Econometrica*, 49, pp. 1417-1426.

Sorsa, P, Bakker, B., Duenwald, C., Maechler, A. & Tiffin, A. (2007), "Vulnerabilities in Emerging Southeastern Europe – How Much Cause for Concern", IMF Working Paper 07/236.

Inflation in the New EU Countries from Central and Eastern Europe: Theories and Panel Data Estimations

by Karsten Staehr*

March 2009

ABSTRACT

This paper seeks to identify factors driving consumer price inflation in the new EU member countries from Central and Eastern Europe. Different theories are discussed, including some of particular importance to economies experiencing high economic growth and rapid structural change. The explanatory power of the theories is tested using panel data estimations based on annual data from 1997 to 2007. Convergence-related factors, including the Balassa-Samuelson and the Bhagwati capital-deepening effects, are important drivers of inflation. Import inflation and, by implication, exchange rate developments have an important impact, while the exchange rate regime is unimportant. Higher government debt and larger revenues are associated with higher inflation. The cyclical position as measured by unemployment, employment changes or the current account balance is found to affect inflation. Food price shocks have large but short-lived effects, while energy price shocks have longer-lasting effects on the inflation rate. Multicollinearity across the explanatory variables makes it difficult to identify the effect of each individual factor.

JEL codes: E31, E42, E63, P24

Keywords: Inflation, inflation theories, real and nominal convergence, inflation determinants

---

* Tallinn University of Technology and Bank of Estonia. This paper is part of earlier joint work with John Beirne presented at the ECFIN workshop "What Drives Inflation in the New EU Member States?". The author would like to thank the discussants Reiner Martin and Tatiana Fic as well as other workshop participants for useful comments. At various stages Aurelijus Dabusinskas, Martin Lindpere, Martti Randveer, Krista Talvis, Lenno Uusküla and Lena Vogel have also contributed to the paper through discussions, comments or other forms of inputs. Any errors remain the responsibility of the author. The views expressed are those of the author and not necessarily those of the institutions with which he is affiliated.

1 INTRODUCTION

This paper seeks to analyse and explain the inflation developments in the decade 1997-2007 in the CEE countries, i.e. the 10 countries from Central and Eastern Europe that joined the European Union in 2004 and 2007. By the mid-1990s, the first round of inflationary pressure from price liberalisations and under-valued exchange rates had abated and other factors gained importance.

A better understanding of the factors driving inflation in the new EU countries is important for many reasons. First, households and businesses are usually averse to inflation, and even anticipated inflation is likely to affect welfare negatively when it exceeds a certain threshold.19 The relatively high inflation rates in Eastern Europe may thus directly reduce social welfare. Second, high inflation may affect the international competitiveness of a country negatively with possible knock-on effects on output and employment. Third, as part of the conditions of EU membership, each of the CEE countries has committed to joining the European Monetary Union subject to the country satisfying the Maastricht criteria. One of the criteria is the price stability criterion stipulating, inter alia, that the inflation rate must be below a certain reference value. By early 2009, Slovenia and Slovakia had joined the EMU, but for most of the other eight CEE countries, their relatively high inflation rates have been one of the main obstacles for fulfilling the Maastricht criteria and gain entry to the EMU (Staehr, 2008).

Table 1 shows the annual percentage change in the Harmonised Index of Consumer Prices (HICP) for the 10 CEE countries. We notice several points. First, Bulgaria and Romania stabilised inflation relatively late in the transition process. Bulgaria introduced a currency board in July 1997, which had an almost immediate effect on the inflation rate, while Romania pursued monetary targeting as a disinflationary policy from around 2000, but only succeeded in bringing annual inflation below 20 percent in 2003.

Table 1: Annual HICP inflation, percent per year

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Bulgaria	..	18.7	2.6	10.3	7.4	5.8	2.3	6.1	6.0	7.4	7.6
Czech Rep.	8.0	9.7	1.8	3.9	4.5	1.4	-0.1	2.6	1.6	2.1	3.0
Estonia	9.3	8.8	3.1	3.9	5.6	3.6	1.4	3.0	4.1	4.4	6.7
Latvia	8.1	4.3	2.1	2.6	2.5	2.0	2.9	6.2	6.9	6.6	10.1
Lithuania	10.3	5.4	1.5	1.1	1.6	0.3	-1.1	1.2	2.7	3.8	5.8
Hungary	18.5	14.2	10.0	10.0	9.1	5.2	4.7	6.8	3.5	4.0	7.9
Poland	15.0	11.8	7.2	10.1	5.3	1.9	0.7	3.6	2.2	1.3	2.6
Romania	154.8	59.1	45.8	45.7	34.5	22.5	15.3	11.9	9.1	6.6	4.9
Slovenia	6.0	6.7	10.4	12.2	7.2	3.5	8.4	7.5	2.8	4.3	1.9
Slovakia	8.3	7.9	6.1	8.9	8.6	7.5	5.7	3.7	2.5	2.5	3.8
Average[a]	26.5	14.7	9.1	10.9	8.6	5.4	4.0	5.3	4.1	4.3	5.4

[a] Unweighted average of countries for which data is available.
Source: Eurostat (2008a).

Second, in the years 2005-07 inflation increased markedly in the Baltic countries and in Bulgaria, which all had currency boards or a tight peg (Latvia). Meanwhile, inflation remained subdued in the Visegrad countries which pursued inflation targeting and experienced a substantial nominal appreciation of their currencies in the period. It may be concluded that the “traditional” disinflationary policy instrument, a fixed exchange rate, proved unable to restrain inflation in 2005-07.

Third, in most CEE countries the HICP inflation has been over inflation levels in the euro area, with only a few and short-lived exceptions when countries have experienced rapid nominal appreciation. This tendency to high trend inflation (at least if measured in foreign currency terms) may in part be related to catch-up process where income levels and economic structures gradually convergence to West European averages. Finally, inflation has

[19] Welsch & Bonn (2007) show in an empirical study that life satisfaction has converged in the old European Union countries in large part because of inflation rates having converged.

exhibited considerable variability in almost all of the CEE countries, suggesting that the inflation processes have been sensitive to different kinds of shocks.

This paper seeks to test the importance of a number of theories which can explain inflationary developments in the CEE countries. The theories or explanations have all been proposed in the academic or policy-oriented literature. Some of the explanations are specific to fast-growing economies subject to rapid structural change, while others are more standard explanations usually considered of particular relevance for “mature” economies.

The importance of the different theories in explaining inflation in the CEE countries is assessed in panel data estimations using annual data from 1997 to 2007. The inflation rate is taken as the dependent variable, while a number of variables “capturing” or reflecting different theories are used as explanatory variables. The possibility of reverse causality and mutual interdependence across the explanatory variables – in combination with a short sample and many missing observations – necessitate a careful modelling approach. The potential endogeneity of explanatory variables is addressed using panel data GMM estimation methods. The multicollinearity is addressed by undertaking estimations in two steps. First, each theory is assessed by the inclusion of only one or a few variables reflecting the specific theory along with a set of control variables. Second, a general-to-specific approach is used to pin down the variables with more explanatory power.

A large number of studies have examined the effect of one or a few explanatory factors on inflation in (typically a subset of) the CEE countries (see the survey in Subsection 2.1). Only few studies have sought to assess the importance of many different factors simultaneously – with the panel data studies in Egert (2007) and Hammermann & Flanagan (2007) as prime examples. The main contribution of this paper is to include a large number of variables (including several that hitherto have not been examined) in panel data regressions using a uniform dataset and employing estimation techniques seeking to address endogeneity and multicollinearity issues.

The rest of the paper is organised as follows: Section 2 presents a comprehensive set of explanations of inflation in economies subject to real convergence. Section 3 discusses the dataset and the empirical methodology. Section 4 contains the first part of the empirical analysis in which explanatory factors are included separately. Section 5 present the results of a general-to-specific approach. Section 6 concludes.

2 THEORIES OF INFLATION AND EMPIRICAL RESULTS FOR THE CEE COUNTRIES

It is challenging to pinpoint the drivers of low or moderate inflation levels, since numerous, mutually interconnected, factors contribute to the inflation (Dornbusch & Fischer, 1993). Subsection 3.1 discusses a range of theories and factors explaining low or moderate inflation, with a special focus on theories linking inflation and fast structural change. Subsection 3.2 surveys a number of empirical studies examining the importance of different factors on inflationary trends in the CEE group of countries.[20]

It is useful to distinguish between structural inflation and fluctuations in inflation or temporary changes in inflation. Structural inflation is the average or typical inflation over an extended period of time, while fluctuations in inflation consist of deviations from structural inflation. Some factors may be important for structural inflation, other factors for fluctuations in inflation, and others again for both structural inflation and fluctuations in inflation. Moreover, there may be linkages between structural inflation and fluctuations in inflation; e.g., because of indexing schemes or the formation of expectations.

2.1 EXPLAINING INFLATION

The authorities have a number of policy instruments with which they can influence the inflation rate. This can be monetary policy instruments, but also other policies such as fiscal policy, direct and indirect taxation, income policy and price controls. The monetary policy instruments include the choice of exchange rate regime, exchange

[20] Slightly different lists of factors (including theories not discussed here) are provided in Wood (1988), the OECD (2007, pp. 45-47) and Egert (2007, 2008).

rate targets, the interest rate and/or the stock of money. The different policy instruments may affect inflation directly or through inflationary expectations. The many instruments imply that the authorities can pursue any given inflation objective provided they are willing to accept the costs of the necessary policies. In other words, inflation is ultimately the result of economic policy (Hammermann & Flanagan, 2007).

These insights lie behind the literature on inflation determination in monetary and fiscal policy games as pioneered by Kydland & Prescott (1977).21 The main assumption of this literature is that policies affecting the inflation rate are determined in a game between the authorities and the public. There is a potential conflict between the objectives of the authorities and the objectives of the public – generally, as the authorities are taken to have an incentive to inflate the economy.

In monetary policy games the incentive to inflate derives from a Lucas-type Phillips curve where an inflation surprise lifts economic activity and employment. The incentive to create surprise inflation is taken into account by the public which sets inflationary expectations accordingly. The equilibrium outcome is an inflationary bias; i.e., structural inflation is above the authorities' preferred target. In fiscal policy games the authorities have an incentive to create surprise inflation in order to reduce the real value of outstanding (domestic, non-indexed) debt. This is carried into inflationary expectations by the public, which may lead to higher inflation depending on the monetary policy setup.22 This link from fiscal policy to inflation is frequently called the "weak form" fiscal theory of inflation (Carlstrom & Fuerst 1999).

In the policy games literature, structural inflation is the result of interaction between authorities and the public. The inflation rate is determined as the point where the marginal benefits of inflation equals its marginal costs, which again will depend on the authorities' preferences, the policymaking setup, the structure of the economy, the cyclical position, different shocks etc. The policy game framework makes clear that a large number of factors – directly or indirectly – determine the rate of inflation.

Monetary policy and other economic policies affect inflation. The choice and application of different policies is likely to depend on, inter alia, the inflation rate.23 The policy game theory underscores the importance of the formation of expectations, which may produce self-perpetuating forces in the inflationary process. The structure and overall functioning of the economy and the financial system will influence the effectiveness and costs of economic policies. Variables depicting the economic and financial structure may thus help explain inflation. A number of theories explaining structural inflation in fast-growing economies with rapid structural change are discussed below.

The most celebrated theoretical explanation of high inflation in rapidly growing economies is the Balassa-Samuelson effect (Egert et al., 2003). The baseline model assumes that the economy has a traded and a non-traded sector, and that the production in both sectors employs labour using a constant returns to scale technology. The price of the traded good is determined from abroad, labour is paid its marginal product, and the wage is equalised across the two sectors. The Balassa-Samuelson effect refers to the case where (total factor) productivity growth is higher in the traded than in the non-traded sector. Productivity growth in the traded sector drives wage growth in that sector, which is carried into wage growth in the non-traded sector. Under the assumption that productivity growth is lower in the non-traded than in the traded sector, the result is higher inflation in the non-traded than in the traded sector. The consumer price index is a weighted average of prices in the two sectors and it consequently increases more than the traded good price.24

The Balassa-Samuelson effect is based on the assumption of exogenous productivity growth in the two sectors. Bhagwati (1984) has presented a theory which endogenises the labour productivity changes based on capital accumulation changing the economy-wide capital stock. It is assumed that the low-income country is endowed with so little capital that the capital-output ratio in the two sectors is outside the (factor) price equalisation cone; in particular, the return to labour is lower than in high-income (capital abundant) countries. If real convergence is associated with capital deepening, labour becomes relatively less abundant and the return on labour therefore increases in both sectors. Under plausible assumptions, including that the non-traded sector is more labour

[21] Their work sparked off an extensive amount of literature which has come to constitute the backbone of theories explaining low and moderate inflation (Romer, 2007, ch. 10).
[22] The size of the government (or other fiscal policy proxies such as a high debt ratio) may thus be inflationary in so far as the public forms inflation expectations based on these variables.
[23] This suggests that the inclusion of policy variables in an econometric model may lead to endogeneity and multicollinearity issues.
[24] More elaborate specifications of the Balassa-Samuelson model, in which output is a function of both labour and capital, give rise to additional channels from productivity growth to non-traded inflation. The results depend on, inter alia, the degree of international mobility of capital and the factor intensities in the two sectors (Motonishi, 2002; Holub & Cihak, 2003). The theoretical results are, however, sensitive to the concrete specifications and we will not pursue these versions of the Balassa-Samuelson model in this paper.

intensive than the traded sector, the result is price increases in the non-traded sector and, hence, inflationary pressure (Bhagwati, 1984; Samuelson, 1994; Motonishi, 2002).

The real convergence process is in many cases accompanied by deeper cross-border integration. Sectors that see little trade may gradually open to foreign competition with possible effects on the prices of the affected commodities (Lein-Repprecht et al., 2007). International goods markets' integration is likely to lower the prices of products with prices that are initially below international levels, and increase the prices of products with prices that are initially above international levels.[25] The integration of factor markets may similarly affect domestic prices; for instance, emigration might lead to an upward pressure on wages which may spill over into higher prices of non-traded products.

A number of explanations can link real convergence to inflation in both non-traded and traded goods. Higher income in a country might make demand for many products less price elastic. To the extent sellers of traded and non-traded products have market power and employ "pricing to market", higher income will lead to increasing margins and consequently an upward pressure on prices.[26]

Structural changes concomitant with higher income can also affect inflation. Higher income may lead private demand to switch towards goods and services of higher quality. Statistics authorities make adjustments to the price index to account for changes in quality, but such changes are generally rudimentary and applied only to a limited range of products (Wynne & Rodriguez-Palenzuela, 2004). The result of a gradual switch to higher-quality products may then be higher measured inflation. This is further aggravated in economies with high income growth as consumption switches away from food and other basic products and toward manufactured products and services (Engel's Law). Quality adjustment issues are limited in food and other basic products, but widespread in manufactured products and services (Dornbusch, 1998).

High-income countries tend to have bigger governments relative to GDP than low-income countries (Wagner's Law). High economic growth may thus lead to a gradual increase in tax pressure with a resulting upward pressure on the inflation rate (Beck, 1979). This applies most directly to indirect taxes such as value added and excise taxes, but possibly also to other types of taxes depending, inter alia, on the incidence of these taxes (see also Gordon, 1985).

Cyclical factors can also play a role in the formation of inflation as traditionally captured by the Phillips curve. The unemployment rate, the gap between the actual and natural unemployment rate, the output gap and the labour income share are commonly used proxies for capacity utilisation in the labour and goods markets.

Economies undergoing fundamental structural change are particularly exposed to different inflationary shocks (Zoli 2009). Changes in import, energy and food prices will affect inflation directly and indirectly. Other price shocks emerge from changes in the rates or the coverage of indirect taxes such as value added and excise taxes. Likewise, changes in controlled prices (incl. the prices of government-produced goods and services) may also affect overall inflation.

The many theories of inflation may be assembled under four headings (see also Table 2 in Section 3). The category Institutions and policies includes factors such as the regulatory framework, the financial system, labour market relations, indexation schemes, expectations formation, the monetary policy regime, and monetary and fiscal policies. The category Structural factors comprises the Balassa-Samuelson effect, the Bhagwati effect, cross-border integration, pricing to market, consumption composition effects, consumption quality effect (and insufficient quality adjustments of price indices) and Wagner's Law. The Business cycle factors comprise various measures of capacity utilisation in product or labour markets. The Shocks include energy and food price shocks, import price shocks, regulated price changes and changes in indirect and direct taxes (rates and coverage).

Some of the theories are applicable to all economies, while others (in particular those under the heading Structural factors) are particularly relevant for fast-growing economies. Some of the shocks might be particularly relevant for the CEE countries as they have experiences which are related to the accession to the EU (and the preparation for the accession). This includes the harmonisation of agricultural prices and harmonisation of excise taxes and regulated prices.

[25] Cihak & Holub (2001) point out that the convergence of relative price structures may lead to higher inflation if prices are downward rigid and they find some empirical support for the channel for countries in Central and Eastern Europe.
[26] Market opening may also affect competitive pressure in the affected sectors and hence change the mark-ups.

2.2 SOME EMPIRICAL RESULTS FOR THE CEE COUNTRIES

It is outside the scope of this paper to provide a comprehensive survey of empirical studies dealing with inflation in the CEE countries (see instead Egert 2008). The focus here is on the specific factors under each of the headings in Box 1. Most studies have examined the effect of one or a few explanatory factors on CEE inflation, while only a few studies have assessed the (relative) importance of a larger number of factors. Diverging results may reflect different empirical methods, control variables, and country and time samples.

The impact of the choice of exchange rate regime has been examined in De Grauwe & Schnabl (2008), who find that greater exchange rate stability is associated with lower inflation in South-Eastern and Central European countries even when controls for a number of other factors are employed. Measures of de facto exchange rate stability have more explanatory power than de jure measures.

Hammermann & Flanagan (2007) explain inflation differentials across the transitions by institutional factors such as political stability, progress in liberalisation, financial sector reform and central bank independence. However, the main emphasis of their study is on explaining why inflation is on average higher in the CIS countries than in the CEE countries.

An important issue concerning the effectiveness of economic policies on inflation in the CEE countries relates to the degree of exchange rate pass-through. The general result is that the exchange rate has a significant effect on the inflation rate, but that the pass-through is substantially below one in most countries, even in the longer term (Zorzi et al., 2007). Egert & MacDonald (2008) survey a number of studies and find that the mean pass-through from exchange rate changes to consumer price inflation is a bit above 0.3 in both the short and the ling term.

Hammermann & Flanagan (2007) examined the importance of fiscal sustainability and found that higher public debt as a percentage of GDP explains – or coincides with – higher inflation in a broad sample of post-communist transition countries. This may be seen as a confirmation of the weak version of the fiscal theory of inflation, but other interpretations of their result are also possible.

The most intensively examined theory linking structural change and inflation is the Balassa-Samuelson effect. The overall picture is that the Balassa-Samuelson effect may explain some of the CEE countries' real appreciation towards the old EU countries since the mid-1990s, but that the effect is likely to be rather small, in part because non-traded products constitute a relatively small share of private consumption and in part because the non-traded sector has also seen substantial productivity growth in these countries (Egert, 2002; Egert et al., 2003; Egert & Podpiera, 2008).27 Egert (2007) takes it to the point of issuing an "obituary notice" for the Balassa-Samuelson effect.

Empirical work confirms that also the price inflation of traded products is higher in the new EU countries than in the euro area (Egert et al., 2003). Fabrizio et al. (2007) show that the quality of export products – and also presumably of domestically consumed products – has increased substantially in the CEE countries since the mid-1990s. This may suggest that a part of both traded and non-traded inflation results from an inadequate correction of the price index to improved product quality (Cincibuch & Podpiera, 2006; Egert et al., 2006; Egert & Podpiera, 2008).

Another possible explanation for the high inflation of traded products may be that traded products in almost all cases "contain" a substantial amount of non-traded components. The price paid by a consumer for an imported product will often include payments for domestic transportation, warehousing, packaging, marketing, retail sale, warranty provisions, etc. Most of the additional components are essentially non-traded and their costs might be affected by the Balassa-Samuelson effect or other structural factors. Data limitations make it notoriously difficult to test this hypothesis.

Lein-Rupprecht et al. (2007) show that deeper cross-border integration (more trade) has reduced inflation in the CEE countries, possibly reflecting lower mark-ups because of increased competition. It has also been found that productivity increases inflation (interpreted as a Balassa-Samuelson effect) and this effect is, interestingly, strongest in the most open economies.

[27] Miyajima (2005) shows for a large set of high-growth economies that higher productivity growth in the tradable than in the non-tradable sector is related to real exchange-rate appreciation. However, he also shows that growth spurts are not systematically coinciding with productivity growth being higher in the traded than in the non-traded sector.

There is empirical support in favour of a Phillips-curve relationship affecting inflation in the CEE countries. Different measures of demand pressure or capacity utilisation, including the share of total production appropriated by labour, enter significantly (Arratibel et al., 2002; Masso & Staehr, 2005; Egert, 2007). Darvas & Szapary (2008) suggest the current account balance as a measure of excess capacity in highly open economies with labour migration; they find that the current account balance has explanatory power in price-level estimations for the CEE countries.

Different studies have found that shocks such as changes in import prices, regulated prices, and energy and food prices affect inflation in important ways. The estimated coefficients and their statistical significance level vary across different studies (Egert, 2007, 2008; Hammermann & Flanagan, 2007).

3 DATA AND EMPIRICAL METHODOLOGY

The inflation rate is taken as the dependent variable, while variables "capturing" or proxying many of the inflation theories discussed in Section 2 are used as explanatory variables. The aim is to cover a large number of the theories, which necessitates the use of annual data as more variables capturing productivity growth, structural change and public finances are available at an annual frequency than at higher frequencies.

3.1 INFLATION THEORIES AND VARIABLES

The primary data source is the web-based statistical indicators produced by Eurostat (Eurostat 2008b). The main advantage of using data from Eurostat is that the data is collected according to uniform guidelines and therefore is comparable across countries. The main drawbacks are that many of the series only start in 1995 or (frequently) later, and that there are many missing data points for some of the series. Indices of structural reforms from the European Bank for Reconstruction and Development (EBRD 2008a, 2008b) have also been used.[28] The data panel for the 10 CEE countries generally starts in 1997 and ends in 2007. The short time dimension implies that the number of observations in the panel dataset is relatively low.

The dependent variable is the annual percentage change in the HICP consumer price index. HICP inflation is a headline inflation measure, including spending components with volatile price developments such as food and energy. HICP inflation is the main inflation measure in most European Union countries and its development attracts substantial interest from policymakers and the public alike. The HICP inflation variable is only available from 1997, so this year constitutes the first year in the panel data sample.[29] Eurostat also produces a HICP price index where energy, food, alcohol and tobacco are excluded. It emerges that the econometric results are rather similar whether the headline or the volatility-reduced HICP inflation series is used as the dependent variable, and we therefore focus on the headline inflation variable.

A number of monetary policy instruments may affect inflation. We include the annual percentage change in the nominal effective exchange rate index. An increasing nominal effective exchange rate is synonymous with a depreciation of the domestic currency. We also include a dummy variable for the exchange rate regime based on Frommel (2007). The exchange rate dummy is 1 if the government has an exchange rate target; otherwise 0. The interest rate is the three month interest rate; the Eurostat database also contains data on the twelve month interest rate, but many observations are missing.

The Balassa-Samuelson effect is captured as the difference in annual percentage labour productivity growth in the manufacturing sector (epitomising the traded sector) and in annual percentage labour productivity growth in private services (epitomising the non-traded sector). We also include the annual percentage change in economy-wide labour productivity provided by Eurostat to compare the explanatory power of the two variables.

The Bhagwati effect links the capital stock per worker with the price level – or the relative change in the capital stock per worker with the inflation rate. Data for the capital stock is generally not available for the CEE countries, but data for investment in fixed capital is available in the Eurostat database. We employ the investment rate as a (rough) measure through which the inflation effect of capital deepening can be assessed.

[28] A list of detailed references for each of the variables is available from the author upon request.
[29] The HICP inflation series can be extended backwards using data from the EBRD, but very few additional degrees of freedom are gained in the estimations as many observations for the years 1995-98 are also missing for other variables.

We account for possible inflationary effects of integration in world markets by including variables for import and export, both as a percentage share of GDP. The variables are summed to give a proxy of the overall openness of the economy.

The Eurostat database contains a large number of variables concerning the (consolidated) finances and taxes of the general government. We have chosen variables depicting the consolidated government's debt, total revenue, tax revenue, value-added tax revenue and budget balance, all as a percentage share of GDP. Evidently, some of these variables are closely correlated. The series for tax revenue and value-added tax revenue are compromised by many missing observations (and no data is available for 2007). Eurostat also produces a series for excise tax revenue, but there were so many missing observations that we decided against using it.

Among the structural reform indices from the EBRD, we have chosen to focus on three indices where a relatively direct link between reforms and inflationary performance may be expected. These variables are an index of price liberalisation, an index of foreign exchange and trade liberalisation and an index of competition policy. The indices range from 1 to 4.33, and a higher index signifies that reforms have been implemented moving the country closer to best practice in developed market economies. There is relatively little variability in all three indices.

A number of variables may proxy the business cycle position. In the dataset we have included the percentage unemployment rate, the percentage growth in the employment rate (of the working-age population) as well as the percentage growth of real GDP. Following Darvas & Szapary (2008), we have also included the current account balance as a percent of GDP, based on the argument that demand fluctuations in small and very open economies may show up in changes in the current account balance. In line with this argument, the trade balance as a percent of GDP has also been included.

Variables for food and energy price inflation may capture supply shocks. Each variable is simply the percentage price change of the particular spending component of the HICP index. Unfortunately, there are many missing observations in these series. Finally, we have included a dummy variable which is meant to pick up any price spike stemming from accession to the EU. The dummy is 1 for a country being a member of the EU (0.67 if the country acceded on 1 May), and 0 otherwise.

The variables, their sample availability and some summary statistical measures are provided in Table A.1 in the Appendix. Table 2 lists the inflation theories discussed in Section 3 together with the associated variables. Some of the theories do not have any corresponding explanatory variable, while others have several possible "candidates". It has not been possible to find proxies for all the suggested theories; this applies in particular to the some of the structural factors involving the composition and quality of consumption.

Table 2. Linking variables and theories

Theory / explanation	Variable(s)
Institutions and policies	
Expectations formation	Lagged endogenous variable
Indexation	
Inflation rigidities	
Institutions (financial system, regulation, labour market institutions, political system)	EBRD index of forex and trade liberalisation, EBRD index of price liberalisation, EBRD index of competition policy
Monetary policy regime	Exchange rate system dummy
Monetary policy	Nominal effective exchange rate, import price, interest rate
Fiscal policy stance	Government debt, budget balance
Structural factors	
Balassa-Samuelson effect	Difference between labour productivity growth in manufacturing and private services
Bhagwati effect	Investment as share of GDP
Openness / cross-border integration	Import plus export as share of GDP
Pricing to market	..
Consumption composition (“Engle’s Law”)	..
Quality improvements not in price index	..
Government size (“Wagner’s Law”)	Government revenues, tax revenues
Business cycle	
Phillips curve explanations	Unemployment rate, employment rate, GDP growth, current account balance, trade balance, nominal wage growth
Shocks	
Price shocks	Energy inflation, food price
Tax shocks	Value-added tax revenue
EU membership price shock	Accession dummy
Institutional shocks	Changes in EBRD institutional indices

Note: The theories or explanations are discussed in more detail in Section 3.

3.2 METHODOLOGICAL ISSUES

As outlined above the dataset is relatively shallow with most series starting around 1997 and ending in 2007 (or even in 2006 in some cases). There are also many missing variables especially for the tax variables, employment, the labour earnings variable and the inflation shocks. Because of the missing observations, the panel dataset will generally be unbalanced.

Bulgaria and Romania had very high inflation at the end of the 1990s. To avoid the situation where such outbursts of very high inflation affect the results unduly all observations with HICP inflation in excess of 20 percent per year have been trimmed. Very few observation points are lost because of this trimming, since data for other variables are frequently missing for the same years as for the two affected countries.

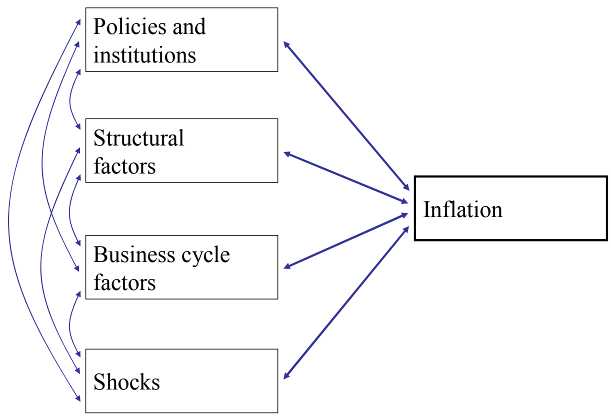
Testing of the time series properties of variables in panels often produce inconclusive results with different tests producing contradictory results. We have generally pursued a strategy where all explanatory variables entered in the empirical model are stationary. This is generally attained by calculating the absolute or the percentage change of a variable or as a share of GDP.30 This reduces the risk of a spurious correlation between trending variables.

[30] The exceptions are the structural variables which are entered in both non-differenced and differenced form.

The explanatory variables are entered in contemporaneous form or with a lag of one year. The choice is based on theoretical and econometric considerations. In many cases, it is reasonable to assume that the explanatory variable only works through the economic system to inflation with a lag of one year. For instance, changes in the exchange rate may only gradually affect the price setting of enterprises and hence inflation. A one-period lag will also, in many cases, reduce the risk of reverse causality or, more generally, endogeneity bias affecting the results. In many cases, it is difficult to determine the lag structure a priori and consequently we have experimented with different lag structures.

The main issues from an econometric viewpoint are the identification problems stemming from mutual interdependence between different explanatory variables as well as possible reverse causality where changes in inflation bring about changes in the explanatory variables. These issues are illustrated in Figure 1, but an example may also be useful: a government may seek to combat high inflation by changing the exchange rate regime and allowing the currency to appreciate; this may affect the business cycle and also for instance the price of imported energy.

Figure 1. Inflation determinants – interaction and causality



Source: Author's composition

The identification of the different inflation driving factors is bound to be complex. Evidently, such identification problems are present in many (or most) areas of economics where essentially one endogenous variable is explained by a large range of factors, which in many cases are also endogenous. Moreover, it is possible to introduce an almost infinite list of explanatory factors which reduce the power of the tests used – particularly in small datasets. These problems are prevalent in this particular case, but also in e.g. growth regressions where a range of methods have been used to address the problems (Barro & Sala-i-Martin, 2003, ch. 12).

The identification problems (multicollinearity and reverse causality) in combination with the dataset containing less than 100 observations call for a careful choice of modelling approach. The econometric investigation is undertaken using two approaches. In the first approach, the HICP inflation rate is regressed on its one-year lagged value, the contemporaneous and one-year lagged import price inflation, and one variable (or a small set of variables) of interest. Thus, each variable (or set of variables) pertaining to a specific theory is included separately with controls only for the auto-regressive dynamics of the inflation rate as well as the impact of import prices. In the second approach, the HICP inflation rate is regressed on a very large set of explanatory variables, which is subsequently reduced using a general-to-specific procedure.

This methodology is chosen for two reasons. First, the low number of observations implies that if all explanatory variables are included at the same time, very few explanatory variables are likely to be statistically significant at even the 10 percent level. Second, many of the explanatory variables are correlated leading to potential multicollinearity problems which lead to large standard errors of the estimated coefficients.31

The panel data specification brings up some additional issues. We have decided to include country-fixed effects and the lagged dependent variable. These choices imply that the results reflect only within effects, i.e. are based

[31] Variables such as unemployment, employment and real economic growth are highly correlated. This also applies to the government finance variables.

on the variations within the countries. Moreover, any possible autoregressive components of the inflation process will be swept away by the lagged dependent variable.

The choice of both fixed effects and control for the lagged endogenous has the advantage of reducing the risk of biased coefficient estimates because of omitted variables. It reduces the probability of Type II errors, i.e. the rejection of the null hypothesis that a variable has no effect on inflation when in fact the null is correct. However, the choice increases the probably of Type I errors, i.e. the failure to reject the null hypothesis when in fact the variable is of importance. In other words, using country effects and controlling for the lagged dependent variables amounts to a "conservative" approach, where too few, rather than too many factors, are likely to be found of statistical significance.

A final issue pertains to the choice of estimation method. The sample is small with generally less than 100 sample points and this introduces a number of difficult trade-offs. Since the panel estimations include the lagged dependent variable, the estimated coefficient to the lagged dependent variable will be downward biased if the model is estimated using ordinary least squares with country-specific fixed effects. The Nickell bias will be particularly large for highly autoregressive processes, i.e. processes where the coefficient to the lagged dependent variable is close to 1. A potentially more important issue is the possible endogeneity of many of the explanatory variables, in particular the contemporaneous (unlagged) variables.

The Nickell bias and the endogeneity bias can be addressed using a GMM approach to estimate the dynamic panel (Bond, 2002; Roodman, 2006). Both the Difference GMM method developed by Arellano and Bond and the System GMM method by Arellano, Bover, Blundell and Bond are applicable. Bond (2002) shows that the coefficients are generally estimated more precisely using System GMM than using Difference GMM.[32] System GMM combines estimates from a differenced version of the model using level instruments and a level version using differenced instruments. It is also customary to use expanding GMM instruments in order to improve the precision of the coefficient estimates.

We employ the System GMM methodology to estimate the dynamic panel models using the xtabond2 command in Stata (Roodman, 2006). To avoid correlation between the GMM instruments and the residuals, the instruments are lagged at least two years (given that contemporaneous and one-year lagged variables enter as explanatory variables). Some experimentation with other methods showed that the results were generally not very sensitive to the choice of estimation method. The System GMM estimations generally produced models with better statistical properties (especially with respect to the validity of the instruments) and also resulted in estimation results which were more robust to sample changes.

4 SEPARATE TESTING OF EXPLANATORY FACTORS

This section presents the results of the System GMM estimations where the HICP inflation rate is explained by its one-year lagged value, the contemporaneous and one-year lagged import price inflation along with one (or occasionally two or three) of the explanatory variables mentioned in Subsection 3.1. The control variables are meant to account for the inflationary impact of imported inflation as well as the auto-regressive component of the inflation rate. (In addition, the System GMM method removes the country-fixed effect.)

The limited number of explanatory variables beyond the variable(s) of interest reduces the likelihood that other explanatory variables pick up variation stemming from the variable(s) of interest. The drawback is that the variable(s) of interest risks picking up variation stemming from variables that are not included in the regression. The risk of such omitted variable bias is reduced by the use of controls for import inflation impulses, auto-regressive inflation and country fixed effects.

Table 3 shows the results of these "parsimonious" models for the variables reflecting institutions and policies. As a starting point, Column (3.1) shows the results when only lagged inflation and contemporaneous and one-year lagged inflation are included. As required for the validity of the System GMM method, there is first order, but second order autocorrelation in the residuals. The null hypothesis of the Sargan test of over-identification is that the instruments are not correlated with the residuals. The null cannot be rejected. The estimated autoregressive

[32] Judson & Owen (1999) show that the Difference GMM performs well in small unbalanced panels. Another estimator, a modified least squares estimator, also produces satisfactory results in small panels, but this method is not available for unbalanced samples.

coefficient is around 1/3 and the sum of the contemporaneous and one-year lagged import inflation is also 1/3. Broadly similar results emerge when additional variables are included (in Tables 3-5). Thus, the pass-through from import price inflation to domestic HICP inflation is around 0.33 in the short term and around 0.5 in the longer term. As discussed in Subsection 2.2, other studies have produced pass-through estimates for the CEE countries of similar magnitudes.

Table 3. The impact of institutions and policies on annual HICP inflation; one-step System GMM

	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)
HICP (-1), % change	0.341^{***} (0.101)	0.360^{***} (0.097)	0.355^{***} (0.098)	0.222 (0.138)	0.451^{***} (0.054)	0.341^{***} (0.101)
Import price, % change	0.169^{***} (0.051)	0.161^{***} (0.048)	0.173^{***} (0.052)	0.168^{***} (0.054)	0.149^{***} (0.045)	0.157^{***} (0.055)
Import price (-1), % change	0.177^{**} (0.083)	0.088 (0.102)	0.177^{**} (0.081)	0.189^{**} (0.079)	0.127 (0.085)	0.194^{**} (0.085)
Nominal effective exchange rate (-1), % change	..	0.110^{**} (0.046)	..	..	..	..
Non-floating exchange rate (-1)	..	..	0.112 (0.479)	..	..	..
3-month interest rate (-1), %	..	..		0.130 (0.095)	..	..
Government budget balance (-1), % of GDP	..	..	..	..	-0.027 (0.067)	..
Government debt (-1), % of GDP	..	..	..	..	..	0.011 (0.011)
AR(1) in first differences	-2.54 [0.011]	-2.31 [0.021]	-2.47 [0.014]	-2.38 [0.017]	-2.42 [0.016]	-2.36 [0.018]
AR(2) in first differences	-0.74 [0.457]	-0.62 [0.538]	-0.74 [0.457]	-0.86 [0.390]	-1.31 [0.189]	-0.71 [0.478]
Sargan over-identification test	84.37 [0.087]	109.44 [0.314]	112.65 [0.062]	114.65 [0.203]	105.76 [0.406]	106.80 [0.379]
Observations	94	94	94	90	91	90

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. Robust standard errors are shown in round brackets; p-values are shown in square brackets. Superscripts ***, **, * denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent level of significance, respectively.

Column (3.2) includes the lagged percentage change of the nominal effective exchange rate along with the control variables. The coefficient to the lagged percentage change of the nominal effective exchange is statistically significant, while the coefficient to the lagged import price inflation loses significance. The sum of the two coefficients is around 0.2, which is of the same magnitude as the estimated coefficient to the lagged import price in (3.1). The conclusion is that policies which affect import price inflation (e.g., exchange rate changes) are import drivers of inflation in the CEE countries.

The choice of exchange rate regime has in itself no effect on inflation in the CEE countries; cf. (3.3). This contradicts the finding in De Grauwe & Schnabl (2008), but may be related to the fact that the dummy variable exhibits relatively little variability in the sample. The lagged interest rate (which could also be replaced by the lagged real interest rate as the lagged inflation rate already enters as an explanatory variable) attains a positive but insignificant estimated coefficient; cf. (3.4). A similar result emerges if the contemporaneous interest rate is used. The result suggests that there is no discernable link from interest rate changes to inflation in the following year.

Columns (3.5) and (3.6) show the results when the government budget balance and government debt as a percentage of GDP are included as explanatory variables, respectively. None of them appear to matter, although the coefficient to the lagged debt stock has the sign predicted by theory. The absence of a link from these measures of government budget sustainability to inflation is contradictory to the results found in Hammermann & Flanagan (2007); their sample, however, also includes the CIS countries.

The estimations using the EBRD indices of institutional development are not presented in order to save space. Only the index for exchange and trade liberalisation attain significance, but the positive estimated coefficient is unreasonable large. Inspection shows that there is a very little variation in the variable (see Table A.1 in the

Appendix) and the variable effectively functions as a dummy variable. Overall, the institutional variables have little explanatory power.

Table 4 shows the results of estimations including variables proxying for structural factors. The estimated coefficient to the difference between labour productivity growth in manufacturing and private services is positive and statistically significant at the 1 percent level, cf. Column (4.1). The quantitative importance of the Balassa-Samuelson effect is moderate. During the sample period 1997-2007, labour productivity in the CEE countries has on average grown 3.4 percent faster in the manufacturing than in the private services sector, implying a short-term effect at around 0.2 percentage points and a long-term effect of roughly twice as large.

Table 4. The impact of structural factors on annual HICP inflation; one-step System GMM

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)	(4.7)
HICP (-1), % change	0.486^{***} (0.048)	0.374^{***} (0.088)	0.349^{***} (0.124)	0.475^{***} (0.053)	0.368^{***} (0.094)	0.437^{***} (0.061)	0.446^{***} (0.058)
Import price, % change	0.149^{***} (0.044)	0.175^{***} (0.053)	0.171^{***} (0.047)	0.136^{***} (0.043)	0.184^{***} (0.049)	0.147^{***} (0.047)	0.150^{***} (0.042)
Import price (-1), % change	0.123^{*} (0.070)	0.174^{**} (0.073)	0.184^{**} (0.084)	0.129^{*} (0.071)	0.177^{**} (0.077)	0.133 (0.085)	0.128^{**} (0.079)
Difference in labour productivities (-1), % change	0.056^{***} (0.011)	..	..	0.068^{***} (0.010)	..	..	
Gross fixed capital formation (-1), % of GDP	..	0.142^{**} (0.063)	..	0.150^{**} (0.070)	..	..	..
Total labour productivity (-1), % change	..		-0.043 (0.064)	-0.025 (0.073)	..	..	..
Import (-1) + export (-1), % of GDP	..	..	..	..	0.011 (0.070)	..	..
Government revenue (-1), % of GDP	..	..	..	..	..	0.089^{*} (0.050)	..
Total tax revenue (-1), % of GDP	..	..	..	..	..	..	0.111^{**} (0.054)
AR(1) in first differences	-2.46 [0.014]	-2.55 [0.011]	-2.55 [0.011]	-2.56 [0.011]	-2.45 [0.014]	-2.46 [0.014]	-2.52 [0.012]
AR(2) in first differences	-1.25 [0.221]	-0.81 [0.418]	-0.72 [0.470]	-1.22 [0.222]	-0.74 [0.458]	-1.39 [0.165]	-1.27 [0.205]
Sargan over-identification test	105.76 [0.353]	104.91 [0.484]	110.13 [0.347]	98.92 [0.959]	108.77 [0.381]	105.23 [0.421]	105.11 [0.451]
Observations	89	94	93	89	94	90	92

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. Robust standard errors are shown in round brackets; *p*-values are shown in square brackets. Superscripts ***, **, * denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent level of significance, respectively.

The coefficient to investment in fixed capital is statistically significant at the 5 percent level. This would be consistent with the Bhagwati effect. The estimated coefficient in (4.2) seems to be of a reasonable magnitude if compared with results in Miyajama (2005). A 1 percentage point increase in investment as a share of GDP is followed by an inflation increase equal to 0.1-0.2 percent the next year and more in the longer term. The effect is clearly large enough to be of economic significance.

The coefficient to lagged labour productivity growth in the whole economy is statistically insignificant when included alone; cf. (4.3). When included along with the proxies for the Balassa-Samuelson and Bhagwati effects in (4.4), then the labour productivity growth variable is still statistically insignificant, while the estimated coefficients to the two other variables are essentially unchanged. This illustrates that a broad-based measure of economic growth cannot replace variables capturing the Balassa-Samuelson and Bhagwati effects.

The estimated coefficient to the lagged openness variable (the sum of the import and export shares of GDP) is statistically insignificant; cf. Column (4.5). The same result applies if the contemporaneous openness variable or the absolute change in the openness variable is used (not shown).

The estimated coefficient to government size (lagged government revenue) is positive and statistically significant at the 10 percent level, while the estimated coefficient to the total tax intake is slightly larger and significant at the 5 percent level. The correlation coefficient between the total revenue intake and tax intake variables is 0.96, so the rather similar estimated coefficients are not surprising. Overall, the estimations in (4.6)-(4.7) provide support for the notion that the financing of government activities has affected inflation in the CEE countries.

Table 5 provides the results for the business cycle indicators. A negative effect from lagged unemployment to inflation is discernable; cf. Column (5.1).33 Lagged employment changes attain statistical significance at the 1 percent level and affects inflation positively; the size of the coefficient is comparable to the one found for the unemployment variable. The estimated coefficient to lagged GDP growth is not statistically significant. Moreover, experiments with different lag structures reveal that contemporaneous and two-year lagged GDP growth also attain statistically insignificant coefficient estimates (not shown).34

Table 5. The impact of business cycle factors on annual HICP inflation; one-step System GMM

	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)
HICP (-1), % change	0.442*** (0.067)	0.457*** (0.051)	0.349*** (0.124)	0.381*** (0.090)	0.368*** (0.094)
Import price, % change	0.150*** (0.047)	0.168*** (0.061)	0.175*** (0.049)	0.176*** (0.048)	0.168*** (0.047)
Import price (-1), % change	0.120 (0.092)	0.126* (0.071)	0.175** (0.087)	0.161** (0.079)	0.166** (0.083)
Unemployment (-1), %	-0.099** (0.047)	..	..	..	..
Employment (-1), %-point change	..	0.127*** (0.036)	..	..	..
GDP (-1), % change	..		0.018 (0.079)	..	..
Current account balance (-1), % of GDP	..	..	..	-0.133*** (0.050)	..
Trade balance (-1), % of GDP	..	..	..	..	-0.069 (0.049)
AR(1) in first differences	-2.53 [0.011]	-2.48 [0.013]	-2.47 [0.014]	-2.50 [0.013]	-2.46 [0.014]
AR(2) in first differences	-1.26 [0.208]	-1.51 [0.130]	-0.74 [0.461]	-0.79 [0.429]	-0.76 [0.448]
Sargan over-identification test	101.28 [0.474]	91.45 [0.526]	113.09 [0.278]	113.76 [0.263]	113.64 [0.266]
Observations	89	82	94	94	94

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. Robust standard errors are shown in round brackets; p-values are shown in square brackets. Superscripts ***, **, * denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent level of significance, respectively.

The estimated coefficient to the current account balance is negative and statistically significant, implying that a larger deficit is followed by higher inflation. As discussed in Subsection 2.2, Darvas & Szapary (2008) find a corresponding result in their price level regressions. Remarkably, the trade balance does not attain statistical significance although the sign is negative as expectedly and the magnitude comparable to the estimate for the current account balance.

Finally, turning to the impact of various shocks, the results are provided in Table 6. Column (6.1) shows the results when the contemporaneous energy and food price inflation components of the HICP index are included as explanatory variables. Unsurprisingly, the estimated coefficients are statistically significant; the coefficients reflect to a large extent the importance of the two components of the HICP price index. The CEE countries have very large spending shares on food and energy, and price changes in these two consumption components affect inflation substantially. Interestingly, the results in (6.2) show that while food price changes have no lasting effects, energy price changes spill over into the following year (and affect the entire regression in the process).

[33] Given that country fixed effects have been eliminated, the unemployment variable can also be associated with an unemployment gap calculated as the difference between the unemployment rate and a time-invariant natural rate of unemployment.
[34] The two-year lagged GDP growth was included since the one-year lagged unemployment rate attained statistical significance and unemployment generally lags the growth cycle. The correlation coefficient between GDP growth and the unemployment rate is -0.135, while the correlation coefficient between lagged GDP growth and the unemployment rate is -0.231.

Table 6. The impact of economic shocks on annual HICP inflation; one-step System GMM

	(6.1)	(6.2)	(6.3)	(6.4)	(6.5)
HICP (-1), % change	0.398*** (0.047)	0.121 (0.107)	0.493*** (0.058)	0.325*** (0.115)	0.355*** (0.098)
Import price, % change	0.080** (0.039)	0.052* (0.030)	0.182*** (0.040)	0.163*** (0.051)	0.167*** (0.052)
Import price (-1), % change	-0.097 (0.061)	0.255*** (0.067)	0.067** (0.082)	0.186** (0.084)	0.184** (0.079)
Food inflation, % change	0.497*** (0.067)	..	..	..	..
Energy inflation, % change	0.070*** (0.016)	..	..	..	..
Food inflation (-1), % change	..	0.038 (0.072)	..	..	..
Energy inflation (-1), % change	..	0.212*** (0.024)	..	..	..
Value added taxes, % of GDP, %-point change	..		0.105 (0.293)	..	..
EU entry	..	..	..	-0.398 (0.580)	..
Index of price liberalisation, change	..	..	..	..	-2.057 (1.945)
AR(1) in first differences	-2.19 [0.029]	-2.06 [0.040]	-2.46 [0.014]	-2.61 [0.009]	-2.54 [0.011]
AR(2) in first differences	-0.72 [0.474]	0.14 [0.885]	-1.25 [0.221]	-0.72 [0.473]	-0.75 [0.453]
Sargan over-identification test	92.27 [0.473]	98.77 [0.544]	87.93 [0.512]	86.87 [0.061]	103.16 [0.088]
Observations	71	77	80	94	94

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. The EU entry dummy is used as standard instrument in (6.4). Robust standard errors are shown in round brackets; *p*-values are shown in square brackets. Superscripts ***, **, * denote that the coefficient estimate is different from 0 at the 1, 5 and 10 percent level of significance, respectively.

The coefficient to the changes of the value-added tax (as percent of GDP) is positive but very small and statistically insignificant in model (6.3). One explanation for this surprising result might be the limited number of observations available. The dummy indicating that a country is a member of the European Union is not statistically significant. The same applies if the dummy is lagged one period. Finally, when changes of the structural reform variables are included as proxies for reform shocks, none of them attain statistical significance. The case of changes to the price liberalisation index is shown in (6.5).

The results in Tables 3-6 can be summarised in the following way: The lagged inflation rate affects current inflation, but the degree of inflationary persistence is relatively small. Changes in import prices (or the effective exchange rate) are important determinants of domestic inflation, although the pass-through is far from complete in both the short and the long term. Higher productivity growth in traded than in non-traded sectors puts upward pressure on inflation as captured by the Balassa-Samuelson effect. Investment may likewise be of importance for inflation in the CEE countries. Contrary to this, increased openness does not seem to play a major role. A bigger government as measured by tax revenues or overall revenues is generally associated with higher inflation, which may work through the public's expectation of the government's policy priorities. Several business-cycle measures seem to affect the inflation rate; in particular, the unemployment rate, employment growth and the current account deficit. Food and energy price changes affect contemporaneous inflation, but only energy price changes have longer lasting effects. Surprisingly, variables capturing VAT changes and EU accession seem to be unimportant for inflation in the CEE countries.

The fact that relatively few explanatory variables are included at the same time may affect the results discussed above. Nevertheless, it should be recalled that the model contains controls in the form of the lagged inflation rate and import price inflation in addition to the time-invariant country effects. The next subsection examines the results when more explanatory variables are included at the same time.

5 MORE EXPLANATORY VARIABLES

5.1 FULL SAMPLE

Only few estimated coefficients are statistically significant if all the variables in Table 2 are included in the inflation regression at the same time. This is hardly surprising given the small number of observations, multicollinearity across different explanatory variables and the inclusion of both the lagged dependent variable and country fixed effects. This section seeks to pinpoint factors of importance for CEE inflation by first undertaking a general-to-specific procedure and afterwards examining specific issues in more detail.

The general-to-specific approach entails the successive removal of variables with no explanatory power until only variables with statistically significant coefficient estimates remain. Many of the problems hampering estimation with all explanatory variables included also affect the general-to-specific approach. For instance, the limited number of observations and the correlated explanatory variables imply that the standard errors of coefficients to other variables may change markedly when a variable is removed. Issues like the specific choice of robust standard errors and the use of GMM instruments are also of importance. These factors have led us to experiment with many different possible specifications.

Some variables were left out of the general-to-specific procedure as their inclusion reduced the number of observation points substantially. This applies to the percentage change in food and energy prices, which anyway almost per construction have an effect on overall HCIP inflation.

A number of coefficients never attained statistical significance irrespective of the choice of estimation method and reduction strategy. These variables to a large extent correspond to the insignificant variables in Section 4 and comprise the exchange rate regime dummy, the interest rate, productivity growth in the whole economy and the EBRD reform indices. These variables were eliminated at an early stage of the general-to-specific procedure.

In all cases the import price inflation enters in contemporaneous form and the nominal effective exchange rate change enters one period lagged. This pattern is consistent across all specifications examined. It might signify that the two variables affect HICP inflation in the CEE countries through different channels in spite of the variables being closely correlated.

The difference between labour productivity growth in the manufacturing and private services entered significantly in all specifications during the general-to-specific procedure. The estimated coefficient was in all cases in the vicinity of 0.05. This robust result provides support in favour of the Balassa-Samuelson effect.

Finally, the large number of variables capturing the cyclical position implies that none of them are significant in specifications with many explanatory variables. Still, the removal of insignificant variables generally implied that the current account balance and/or the trade balance attained statistical significance at an early stage.

Columns (7.1)-(7.3) in Table 7 shows the last successive steps of the general-to-specific estimation procedure. Model (7.1) includes only variables significant at the 15 percent level or better, model (7.2) only variables significant at the 10 percent level or better, and (7.3) only variables significant at the 5 percent level or better.

Table 7. The impact of selected explanatory variables on annual HICP inflation; one-step System GMM

	(7.1)	(7.2)	(7.3)	(7.4)	(7.5)	(7.6)
HICP (-1), % change	0.454^{***} (0.039)	0.444^{***} (0.046)	0.476^{***} (0.038)	0.478^{***} (0.039)	0.504^{***} (0.048)	0.483^{***} (0.041)
Import price, % change	0.107^{***} (0.031)	0.101^{***} (0.030)	0.119^{***} (0.024)	0.120^{***} (0.024)	0.142^{***} (0.035)	0.123^{***} (0.034)
Nominal effective exchange rate (-1), % change	0.131^{***} (0.024)	0.146^{***} (0.019)	0.134^{***} (0.018)	0.131^{***} (0.020)	0.117^{***} (0.027)	0.112^{***} (0.029)
Government budget balance (-1), % of GDP	-0.110^{*} (0.057)	-0.087^{*} (0.045)	..	..	..	..
Government debt (-1), % of GDP	..	..	..	..	..	0.022^{***} (0.008)
Total tax revenue (-1), % of GDP	0.163^{***} (0.056)	0.217^{***} (0.070)	0.177^{***} (0.060)	0.166^{***} (0.048)	0.054 (0.067)	..
Difference in labour productivities (-1), % change	0.088^{***} (0.032)	0.061^{***} (0.016)	0.052^{***} (0.012)	0.053^{***} (0.013)	0.040^{***} (0.013)	0.046^{***} (0.012)
Gross fixed capital formation (-1), % of GDP	..	..	..	0.031 (0.056)	0.130^{**} (0.058)	0.172^{***} (0.053)
Unemployment (-1), %	-0.052^{+} (0.036)	..	..	..	..	..
Current account balance (-1), % of GDP	-0.090^{+} (0.059)	-0.113^{*} (0.062)	-0.225^{***} (0.041)	-0.210^{***} (0.029)	..	..
***Non-investment* current account balance (-1), % of GDP**	..	..	..	..	-0.113 (0.142)	..
Trade balance (-1), % of GDP	-0.160^{*} (0.083)	-0.153^{*} (0.085)	..	..	..	..
AR(1) in first differences	-2.50 [0.013]	-2.57 [0.010]	-2.51 [0.012]	-2.52 [0.012]	-2.40 [0.016]	-2.51 [0.012]
AR(2) in first differences	-1.02 [0.307]	-1.10 [0.273]	-1.23 [0.218]	-1.23 [0.220]	-1.48 [0.140]	-1.62 [0.106]
Sargan over-identification test	85.90 [1.000]	93.50 [1.000]	95.97 [0.827]	94.56 [0.986]	99.97 [0.963]	88.87 [0.921]
Observations	86	89	89	89	89	85

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. Robust standard errors are shown in round brackets; *p*-values are shown in square brackets. Superscripts ***, **, *, $^{+}$ denote that the coefficient estimate is different from 0 at the 1, 5, 10 and 15 percent level of significance, respectively.

A number of results emerge from the gradual elimination of insignificant explanatory variables. First, the investment rate never attains statistical significance in the general-to-specific procedure, not even at the 15 percent level. Second, the unemployment variable is eliminated at a relatively early stage. Third, the close correlation of the trade balance and current account balance implies that the two variables possess similar explanatory power; the trade balance is eliminated from (7.2), but the difference between the t-values of the two variables in (7.2) is marginal.

Overall, model (7.3) entails that imported inflation, the Balassa-Samuelson effect, the size of the government and the current account balance are statistically significant drives of inflation in the CEE countries. The estimated coefficient values are generally of reasonable size and comparable to those estimated in Section 4. One issue of particular interest is that the coefficient to the current account balance is (numerically) large and precisely estimated, while the investment rate does not attain significance. The two variables are, however, closely correlated with a correlation coefficient equal to -0.497. A fixed effect panel estimation "explaining" the current account deficit by the investment rate gives an estimated coefficient of the investment rate equal to -0.984, i.e. after controlling for country specific effects there is essentially a one-to-to relationship between the two variables. This would be consistent with the fact that foreign direct investments play a very significant role in the CEE countries

The importance of the correlation between investment and the current account balance can be assessed by removing the variation in the current account attributable to investment. Estimation (7.4) repeats (7.3) but includes the lagged investment rate. The coefficient to the lagged investment rate is insignificant and very small, while the coefficient to the current account balance retains its size and statistical significance. Estimation (7.5) shows the results when the current account balance variable is replaced by a variable containing only the part of its variation that cannot be explained by the investment rate. Following the approach in Fidrmuc (2003), the variable is the residual from the above-mentioned fixed effect estimation where the current account balance is explained by the investment rate (and the country dummies). It follows from (7.5) that the investment rate attains significance while the current account balance with investment removed does not.

Another way to assess the importance of the correlation between investment and the current account balance is to undertake a general-to-specific procedure where the current account balance and the trade balance are excluded a priori. The resulting regression with only variables significant at the 5 percent level is shown in column (7.6). The investment rate is highly significant in this specification and the coefficient is comparable to the finding in (7.5) as well as (4.2) and (4.4) in Section 4. In (7.4) the lagged government debt enters, whereas the tax intake attained significance in columns (7.1)-(7.3). The two variables are closely correlated; governments with large debts have on average large tax revenues.

Although it is difficult to identify precisely the impact of investment on HICP inflation, it seems safe to conclude that both the Balassa-Samuelson effect and the Bhagwati capital-deepening effects rate have been drivers of inflation in the CEE countries during the years 1998-2007. In other words, the real convergence process has contributed to higher inflation in the CEE countries to the extent that real convergence has entailed higher productivity growth in traded than non-traded sectors and a higher investment share. The theories hypothesise that, respectively, productivity growth differentials and capital-deepening produce (real) wage increases which subsequently lead to inflationary pressure (see Subsection 3.1).

5.2 DIFFERENT SUBSAMPLES

The results have hitherto been based on the entire sample (where annual inflation rates above 20 percent have been removed). In this Subsection, results are reported for different subsamples. Overall the results from these robustness analyses suggest that the impact of the main factors identified as drivers of inflation in the CEE countries does not vary much across different subsample.

Column (8.1) in Table 8 shows the results when (7.3) is repeated but where inflation rates above 5 percent per year are excluded. In spite of a markedly lower number of data points in the truncated sample, the results are remarkably similar with one exception: the impact of import price inflation on HICP inflation is somewhat smaller when the sample comprises only datapoints for cases of relatively low inflation. This result is in accordance with findings elsewhere (Zorzi et al., 2007). Column (8.2) shows the results when only data for 2003-07 is included. Even in this small subsample the results are little changed – with the possible exception that the coefficient to contemporaneous import price inflation is somewhat lower than before.

Table 8. The impact of selected explanatory variables on annual HICP inflation, different subsamples; one-step System GMM

	(8.1)	(8.2)	(8.3)	(8.4)	(8.5)	(8.6)
HICP (-1), % change	0.415^{***} (0.024)	0.517^{***} (0.059)	0.464^{***} (0.037)	0.520^{***} (0.056)	0.430^{***} (0.029)	0.535^{***} (0.068)
Import price, % change	0.091^{**} (0.042)	0.059 (0.045)	0.108^{***} (0.031)	0.165^{***} (0.040)	0.076^{*} (0.045)	0.116^{*} (0.065)
Nominal effective exchange rate (-1), % change	0.090^{***} (0.030)	0.132^{***} (0.041)	0.162^{***} (0.056)	0.090^{***} (0.015)	0.075^{**} (0.031)	0.134^{***} (0.049)
Government debt (-1), % of GDP	..	..	..	..	0.000 (0.014)	0.025^{**} (0.012)
Total tax revenue (-1), % of GDP	0.120^{***} (0.028)	0.118^{***} (0.036)	0.238^{**} (0.094)	0.046 (0.078)	..	..
Difference in labour productivities (-1), % change	0.066^{***} (0.017)	0.059^{**} (0.028)	0.060^{***} (0.016)	0.053^{+} (0.033)	0.061^{***} (0.012)	0.022 (0.021)
Gross fixed capital formation (-1), % of GDP	..	..	..	..	0.068^{*} (0.037)	0.146^{***} (0.055)
Current account balance (-1), % of GDP	-0.161^{***} (0.039)	-0.234^{***} (0.029)	-0.225^{***} (0.041)	-0.221^{***} (0.061)	..	..
AR(1) in first differences	-1.85 [0.064]	-2.31 [0.021]	-2.00 [0.045]	-1.90 [0.057]	-1.77 [0.077]	-2.17 [0.030]
AR(2) in first differences	-0.92 [0.359]	-1.07 [0.285]	-0.63 [0.597]	-1.24 [0.213]	-1.28 [0.200]	-1.37 [0.169]
Sargan over-identification test	45.64 [1.000]	46.27 [0.844]	56.44 [0.996]	35.68 [0.999]	46.45 [1.000]	51.74 [0.901]
Observations	48	48	50	39	48	48

Notes: Estimations without period fixed effects. The expanding GMM instruments are lagged 2-4 years. Robust standard errors are shown in round brackets; p-values are shown in square brackets. Superscripts ***, **, *, + denote that the coefficient estimate is different from 0 at the 1, 5, 10 and 15 percent level of significance, respectively.

Column (8.3) shows the results when only the Visegrad countries and Slovenia are included in the sample. Again the estimated coefficients obtained in the truncated sample are very similar to those obtained in the full sample shown in (7.3). Column (8.4) shows the results for the Baltic countries, Romania and Bulgaria. The main differences are that the size of the government plays no role in this subsample and the estimated coefficient to the productivity difference is only marginally significant.

Finally, we redo estimation (7.6) for observations with annual HICP inflation smaller than or equal to 5 percent. The result in column (8.5) suggest that the government debt has little impact on inflation in this subsample, while the impact from investment to inflation is imprecisely estimated and possibly rather small. Column (8.6) also repeats the estimation in (7.6) but includes observations only for 2003-07. The results are very similar to those for the entire sample.

6 FINAL COMMENTS

This paper has sought to pin down factors driving inflation in the new EU members from Central and Eastern Europe. To this end a large number of inflation theories were considered, including some with particular reference to economies experiencing high economic growth and rapid structural change. The empirical importance of the different theories was assessed in panel data estimations using annual data from 1997 to 2007. To address multicollinearity issues in combination with relative few observations in the dataset, we used separate inclusion of explanatory variables as well as a general-to-specific modelling approach. The results across the two methods were broadly consistent.

The autoregressive component of the inflation process was estimated to be in the interval 0.3-0.5, possibly reflecting backward-looking expectations and inertia in price and wage setting. Imported inflation has played an important role, but the pass-through has been far from complete; the short-term pass-through is estimated to approximately 0.3 and the long-term pass-through to approximately 0.5. The effect of the interest rate on inflation could not be estimated precisely. The exchange rate regime per se does not appear to have been of importance. On the other hand, fiscal policies seem to have affected the inflation in the CEE: countries with a large government debt and/or high fiscal revenues have experienced higher inflation than countries with a more cautious fiscal stance.

The effects of a number of structural explanatory factors were also analysed. The Balassa-Samuelson effect turned out to be very robust across different specifications and subsamples; higher productivity growth in the traded than in the non-traded sector has exerted upward pressure on inflation. The Bhagwati capital-deepening effect has also been present, although it is difficult to disentangle it from business cycle effects. The degree of openness does not appear to have played a role for inflation in the CEE countries in the sample period – except to the extent that openness has affected import price inflation and the trade and current account balances.

Variables reflecting the cyclical position have been important, although the effect of the unemployment variable could not be estimated precisely in many specifications. The current account balance (and to a lesser degree the trade balance) have been closely related to inflation developments in the new EU countries. The precise underlying mechanism is difficult to establish. One possibility is that the current account balance is a measure of the tightness of goods and labour markets. Another possibility emerges from the fact that the variable is closely correlated with investment in the economy and thus essentially depicts capital deepening. In any case, the current account balance in a given year is a powerful predictor of inflationary pressure the following year.

Unsurprisingly, various price shocks have affected the inflation rate, but only energy price shocks appear to have had longer-lasting effects. The effect on inflation of changes of indirect taxation proved impossible to detect, possibly because of data quality issues. EU entry does not appear to have affected inflation in the overall panel of CEE countries.

The discussion above recapitulated the large number of factors that have affected inflation in the CEE countries during the period 1997-2007. The analysis suggested that the relatively high inflation in many new EU countries is in part resulting from the catch-up process as high productivity growth in the traded sector, capital deepening and/or capital import drive up inflation. The analysis also showed that economic policies affecting import price inflation and/or the business cycle are effective in controlling inflation. Moreover, fiscal policy as reflected by for instance by the debt stock or tax revenues also seems to impact inflation. This means that the drivers of inflation in the CEE countries are essentially the same as those found in high-income countries.35 The generally higher inflation in the CEE countries is therefore likely the result of the different factors being more "extreme" in the CEE countries than in the rest of the European Union countries; in particular, convergence-related factors and in periods also business cycle developments and inflationary shocks have pushed up inflation, while economic policies have not fully counteracted this effect.

The analyses in this paper should be seen as exploratory as they were inhibited by the difficulty experienced in identifying precisely the effect of different factors on CEE inflation. First, it proved difficult to obtain precise coefficient estimates for many variables. This was in part the result of the few observation points in the dataset. Second, the relative importance of different factors may vary across different countries and across different time periods. Such heterogeneity is at variance with the need to employ panel data methodologies in order to attain sufficient degrees of freedom. Third, many of the explanatory variables are mutually interdependent and this complicates the identification of the specific factors driving inflation. Multicollinearity problems may in future work be addressed by using factor analysis to compute composite indices of different factors. Finally, more work should be devoted to separating trend and fluctuations of explanatory variables like unemployment and the current account balance in order to gain a clearer picture of the respective role of structural and cyclical factors.

[35] Motonishi (2002) show that differential productivity growth and capital deepening also drive inflation in high-income countries.

APPENDIX

Table A.1. Variables and summary statistics

Variable	Sample availability	Mean	Standard deviation
HICP, % change	1997-2007	5.760	3.887
HICP (-1), % change	1998-2007	5.973	4.431
Import price, % change	1995-2007	3.350	5.075
Nominal effective exchange rate, % change	1996-2007	2.414	6.223
Non-floating exchange rate dummy	1995-2007	0.606	0.485
3-month interest rate, %	1997-2007	7.809	5.232
Labour productivity in manufacturing, % change	1995-2007	7.045	4.965
Labour productivity in private service sectors, % change	1996-2007	3.585	3.695
Difference in labour productivities, % change	1997-2007	3.423	6.431
Overall labour productivity, % change	1995-2007	5.015	2.679
Gross fixed capital formation, % of GDP	1995-2007	24.663	4.274
Import, % of GDP	1997-2007	62.263	15.057
Export, % of GDP	1997-2007	56.378	15.502
Openness (import + export), % of GDP	1997-2007	118.641	30.085
Openness, %-point change	1997-2007	3.163	8.512
Government debt, % of GDP	1995-2007	30.523	19.272
Government budget balance, % of GDP	1995-2007	-2.848	3.085
Government revenue, % of GDP	1995-2007	38.691	3.747
Total tax revenue, % of GDP	1995-2007	33.478	3.499
Value added tax revenue, % of GDP	1995-2007	7.776	1.155
Index of price liberalisation	1995-2007	4.224	0.137
Index of price liberalisation, change	1995-2007	0.017	0.071
Index of forex and trade liberalisation	1995-2007	4.268	0.093
Index of forex and trade liberalisation, change	1995-2007	0.012	0.0718
Index of competition policy	1995-2007	2.810	0.376
Index of competition policy, change	1995-2007	0.068	0.145
Unemployment, %	1996-2007	10.479	4.431
Employment, % change	1998-2007	0.035	2.513
GDP, % change	1995-2007	5.441	2.728
Trade balance, % of GDP	1995-2007	-5.885	5.382
Current account balance, % of GDP	1995-2007	-6.896	4.638
Energy price inflation, % change	1997-2007	3.554	6.849
Food price inflation, % change	1997-2007	-1.129	3.192
EU entry dummy	1995-2007	0.304	0.443

Note: All summary statistics are for the trimmed sample where observations are excluded if the country has HICP inflation in excess of 20 percent.

LITERATURE

Arellano, Manuel & Stephen Bond (1991): “Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations”, *Review of Economic Studies*, vol. 58, no. 2, pp. 277-297.

Arratibel, Olga, Diego Rodriguez-Palenzuela & Christian Thimann (2002): “Inflation Dynamics and Dual Inflation in Accession Countries: A ‘New Keynesian’ Perspective”, ECB Working Paper, no. 132.

Barro, Robert & Xavier Sala-i-Martin (2003): *Economic growth*, 2nd ed., MIT Press.

Beck, Morris (1979): “Inflation, Government Spending, and Real Size of the Public Sector”, *Atlantic Economic Journal*, vol. 7, no. 3, pp. 25-34.

Bond, Stephen (2002): “Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice”, Portuguese Economic Journal, vol. 1, no. 2, pp. 141-162.

Carlstrom, Charles & Timothy Fuerst (1999): “Money Growth and Inflation: Does Fiscal Policy Matter?”, Economic Commentary, Federal Reserve Bank of Cleveland.

Cihak, Martin & Tomas Holub (2001): “Convergence of Relative Prices and Inflation in Central and Eastern Europe”, IMF Working Paper, no. 01/124.

Cochrane, Susan (1972): “Structural Inflation and the Two-Gap Model of Economic Development”, *Oxford Economic Papers*, vol. 24, no. 3, pp. 385-398.

Darvas, Zsolt & Gyorgy Szapary (2008): “Euro Area Enlargement and Euro Adoption Strategies”, European Economy / Economic Papers, no. 304.

De Grauwe, Paul & Gunther Schnabl (2008): “Exchange Rate Stability, Inflation and Growth in (South) Eastern and Central Europe”, *Review of Development Economics*, vol. 12, no. 3, pp. 530-549.

Dornbusch, Rudiger & Stanley Fischer (1993): “Moderate Inflation“, *World Bank Economic Review*, vol. 7, no. 1, pp. 1-44.

Dornbusch, Rudiger (1998): “Purchasing Power Parity”, in *The New Palgrave Dictionary of Economics*, Palgrave Macmillan, pp. 1075-84.

EBRD (2008a): *Transition Report 2007: People in Transition*, Selected economic indicators, http://www.ebrd.com/country/sector/econo/stats/sei.xls.

EBRD (2008b): *Transition Report 2007: People in Transition*, Structural change indicators, http://www.ebrd.com/country/sector/econo/stats/sci.xls.

Egert, Balazs & Jiri Podpiera (2008): “Structural Inflation and Real Exchange Rate Appreciation in Visegrad-4 Countries: Balassa-Samuelson or Something Else?”, CEPR Policy Insight 20, http://www.cepr.org/pubs/PolicyInsights/PolicyInsight20.pdf.

Egert, Balazs (2002): “Investigating the Balassa-Samuelson Hypothesis in the Transition: Do We Understand What We See? A Panel Study”, *Economics of Transition*, vol. 10, no. 2, pp. 273-309.

Egert, Balazs (2007): “Real Convergence, Price Level Convergence and Inflation Differentials in Europe”, CESifo Working Paper, no. 2127.

Egert, Balazs, Imed Drine, Kirsten Lommatzsch, & Christophe Rault (2003): “The Balassa-Samuelson Effect in Central and Eastern Europe: Myth or reality?”, *Journal of Comparative Economics*, vol. 31, no. 3, pp. 552-572.

Egert, Balazs, Kirsten Lommatzsch & Amina Lahreche-Revil (2006): “Real Exchange Rates in Small Open OECD and Transition Economies: Comparing Apples with Oranges?”, *Journal of Banking and Finance*, vol. 30, no. 12, pp. 3393-3406.

Egert, Balazs, Laszlo Halpern & Ronald MacDonald (2006): “Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues”, *Journal of Economic Surveys*, vol. 20, no. 2, pp. 257-324.

Egert, Balszs (2008): “Prices and Price Convergence in Emerging Europe: an Overview”, *National Institute Economic Review*, vol. 204, no. 1, pp. 66-84.

Egert, Balszs & Ronald MacDonald (2008): "Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Surveyable", OECD Economics Department Working Papers, no. 654.

Eurostat (2008a): http://ec.europa.eu/eurostat (Data → Prices → Harmonized indices of consumer prices (HICP) → Harmonized indices of consumer prices (2005=100) - Annual Data (average index and rate of change)).

Eurostat (2008b): http://ec.europa.eu/eurostat (Data → Economy and finance).

Fabrizio, Stefania, Deniz Igan & Ashoka Mody (2007): "The Dynamics of Product Quality and International Competitiveness", IMF Working Paper, no. WP/07/97.

Fidrmuc, Jan (2003): "Economic Reform, Democracy and Growth during Post-Communist Transition", *European Journal of Political Economy*, vol. 19, no. 3, pp. 583-604.

Frommel, Michael (2007): "Volatility regimes in Central and Eastern European Countries' exchange rates", Universiteit Gent, Faculteit Economie en Bedrijfskunde, Working paper no. 487.

Gordon, Robert (1985): "Understanding Inflation in the 1980s", *Brookings Papers on Economic Activity*, vol. 1985, no. 1, pp. 263-302.

Hammermann, Felix & Mark Flanagan (2007): "What Explains Persistent Inflation Differentials Across Transition Economies?", IMF Working Paper, no. WP/07/189.

Hofmann, Boris & Hermann Remsperger (2005): "Inflation Differentials among the Euro Area Countries: Potential Causes and Consequences", *Journal of Asian Economics*, vol. 16, no. 3, pp. 403-419.

Holmes Mark (2002): "Panel Data Evidence on Inflation Convergence in the European Union", *Applied Economics Letters*, vol. 9, no. 3, pp. 155-158.

Holub, Tomas & Martin Cihak (2003): "Price Convergence: What Can the Balassa-Samuelson Model Tell Us?", *Czech Journal of Economics and Finance*, vol. 53, nos. 7-8, pp. 334-355.

Judson, Ruth & Ann Owen (1999): "Estimating Dynamic Panel Data Models: A Practical Guide for Macroeconomists', *Economic Letters*, vol. 65, no. 1, pp. 9-15.

Kydland, Finn & Edward Prescott (1977): "Rules Rather Than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy*, vol. 85, no. 3, pp. 473-491.

Lein-Repprecht, Sarah, Miguel Leon-Ledesma & Carolin Nerlich (2007): "How is Real Convergence Driving Nominal Convergence in the New EU Member States?", ECB Working paper, no. 827.

Masso, Jaan & Karsten Staehr (2005): "Inflation Dynamics and Nominal Adjustment in the Baltic States", *Research in International Business and Finance*, vol. 19, no. 2, pp. 281-303.

Miyajima, Ken (2005): "Real Exchange Rates in Growing Economies: How Strong Is the Role of the Nontradables Sector?", IMF Working Papers, no. 05/233.

Motonishi, Taizo (2002): "Modifications of the Balassa-Samuelson Model: The Effects of Balanced Growth and Capital Accumulation", *Journal of the Japanese and International Economies*, vol. 16, no. 1, pp. 31-39.

OECD (2007): *Euro Area*, OECD Economic Surveys, Organisation for Economic Co-operation and Development.

Ohnsorge, Franziska, Nada Choueiri & Rachel van Elkan (2008): "Inflation Differentials in the EU: A Common (Factors) Approach with Implications for EU8 Euro Adoption Prospects", IMF Working Paper, no. 08/21.

Persson, Torsten & Guido Tabellini (1990): *Macroeconomic policy, Credibility and Politics*, Harwood Academic Publishers.

Romer, David (2007): *Advanced Macroeconomics*, McGraw-Hill, 3rd ed.

Roodman, David (2006): "How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata", Center for Global Development, Working Paper, no. 103.

Samuelson, Paul (1994): "Facets of Balassa-Samuelson Thirty Years Later", *Review of International Economics*, vol. 3, no. 3, pp. 201-226.

Staehr, Karsten (2008): "The Maastricht Inflation Criterion and the New EU Members from Central and Eastern Europe", Bank of Estonia Working Paper, no. 4/2008.

Welsch, Heinz & Udo Bonn (2008) “Economic Convergence and Life Satisfaction in the European Union”, *Journal of Socio-Economics*, vol. 37, no. 3, pp. 1153-1167.

Yi, Myung Hoon & Changkyu Choi (2005): “The Effect of the Internet on Inflation: Panel Data Evidence”, *Journal of Policy Modeling*, vol. 27, no. 7, pp. 885-889.

Zoli, Edda (2009): “Commodity Price Volatility, Cyclical Fluctuations, and Convergence: What is Ahead for Inflation in Emerging Europe”, IMF Working Paper, no. WP/09/41.

Zorzi, Michele Ca, Elke Hahn & Marcelo Sanchez (2007): “Exchange Rate Pass-through in Emerging Markets”, ECB Working paper, no. 739, European Central Bank.

Catching-up and transition related inflation

Balázs Égert[36]

ABSTRACT

This study analyses the long-run driving forces of inflation rates in Europe. We provide some stylised facts with a special focus on the new EU member states of Central and Eastern Europe and subsequently demonstrate the relative importance of these factors on observed inflation rates relying on Bayesian model averaging techniques. Our estimation results suggest that the Balassa-Samuelson effect is not an important driver in either the old or the new member states and that other structural factors affecting both goods and services prices matter a lot for inflation rates. We find strong evidence that regulated prices, house prices, food prices, the nominal exchange rate and the output gap are all important to explain inflation developments in Europe.

[36] OECD, Economics Department; CESifo; EconomiX at the University of Paris X; William Davidson Institute. Email: balazs.egert@oecd.org. The views expressed in this paper do not necessarily reflect the official position of the OECD.

1 INTRODUCTION

The driving forces of high inflation rates in the new EU member states of Central and Eastern Europe has been in the centre of research interest in academic and policy circles since the start of economic transition.37 One reason for this was the obligation of these countries to adopt the euro at some point in the future and thus to find out whether inflation rates are influenced by other factors in the new member states than in the more mature economies of the euro area, and thus lower initial price levels and the ongoing catching-up process would lead to substantially higher inflation rates in the longer run by increasing inflation dispersion within the euro area. Secondly, the recent acceleration of inflation in the Baltic countries sparked renewed interest in the topic. The questions usually raised are whether higher inflation rates in the fast growing economies of Central and Eastern Europe are due to real convergence and in particular to the Balassa-Samuelson effect and what role othe factors may have in explaining the higher inflation rates.

This study has a twofold objective. First, we discuss the possible causes of higher inflation related to economic transition and real convergence in Central and Eastern Europe and characterise them by provide some descriptive statistics. Among others, we give an update on the possible size of the Balassa-Samuelson effect in Europe and seek to disentangle the transmission from productivity to inflation. Furthermore, we describe other structural factors affecting goods, services and house prices. Second, we use a Bayesian averaging framework (Bayesian averaging of classical estimates) to shed light on the relative importance of each single factors (completed with some commonly used control variables).

The roadmap of this study is the following. Section 2 provides some stylised facts about price levels and inflation rates in Europe. Section 3 describes our estimation strategy, Section 4 touches upon data issues and Section 6 presents the estimation results. Section 7 gives the conclusions.

2 STYLISED FACTS

2.1 THE OVERALL PICTURE

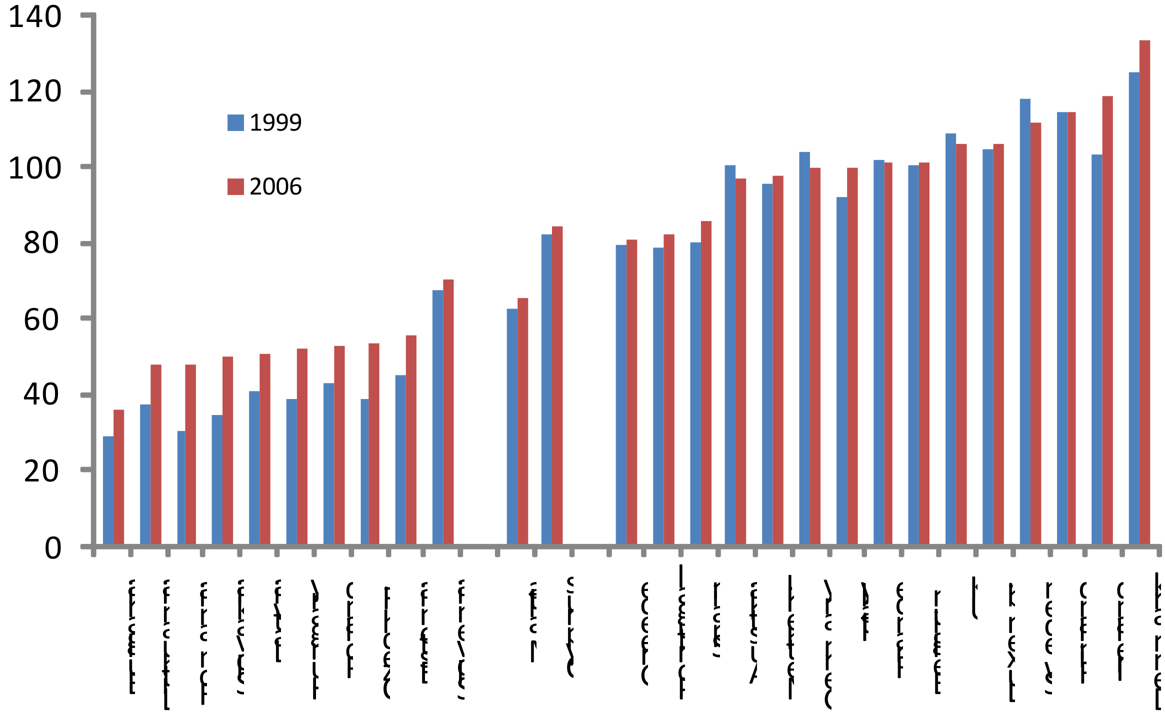
The consumer price level of the new EU member countries was considerably below that of the old member states both in 1999 and 2006: relative price levels ranged from 40 percent (Bulgaria) to 70 percent (Slovenia) of the average of the old EU-15 in 2006 (Figure 1). A significant reduction in these differences can be observed for most of these countries from 1999 to 2006, perhaps with the exception of Slovenia (which displayed more moderate differences than the other Central and Eastern European countries).

Price level convergence is usually thought to be due to real convergence. According to Figure 2, the rate of growth of per capita income (measured in Purchasing Power Standard terms) appear to be positively correlated to inflation rates.

Conventional view holds that lower price levels in less developed countries are a result of the lower price level of services. Consequently, price level convergence is due to service price inflation. Yet this view is not fuly supported by the data. Figure 3 shows that the price level of consumer goods in the new member states is by a significant margin lower than in the old EU countries. This is particularly true of Bulgaria, Lithuania and Romania but also the price level of consumer goods sold in Slovenia reached only about 80% of the corresponding price level in WesternEurope in 2006.

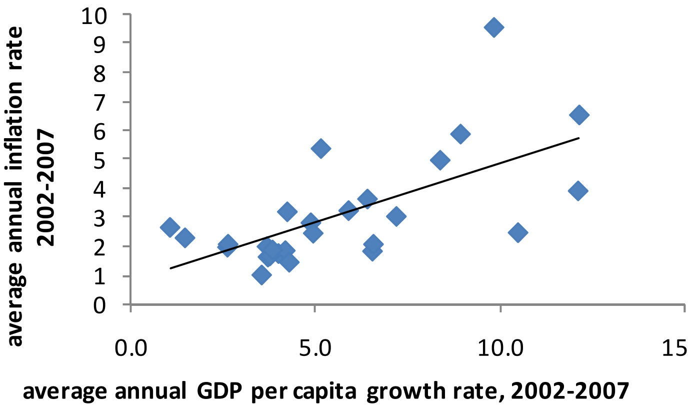
[37] See e.g. Backé et al (2003) and Hammermann (2007) for earlier attempt to quantify the effect of different factors in Central and Eastern Europe. See also Honohan and Lane (2004) and Hofmann and Remsperger (2005) for the euro area and Rogers (2001, 2002) for the US. This issue of European Economy contains a number of other studies aimed at analysing drivers of inflation rates.

Figure 1. Consumer price levels (EU-15 average=100), in 1999 and 2006



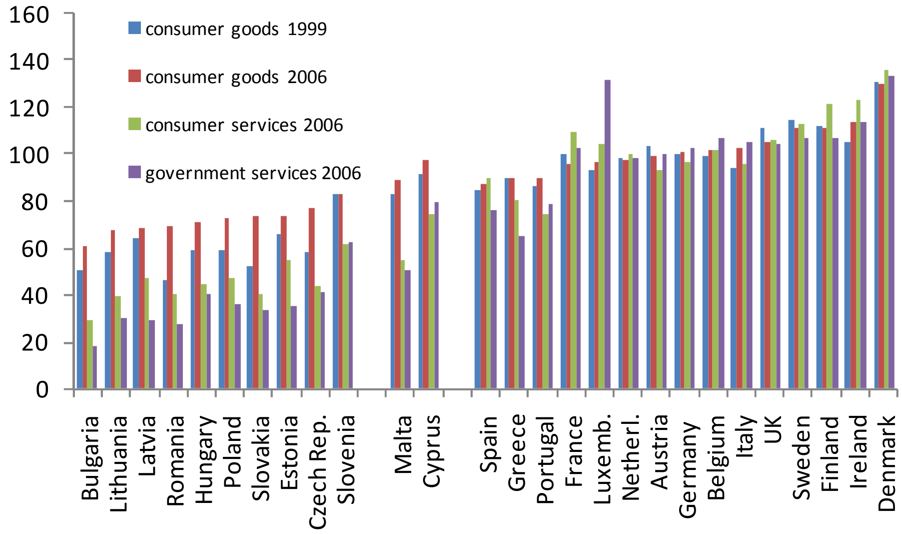
Source: NewCronos/Eurostat

Figure 2. Real GDP per capita growth and inflation in the EU-27, 1997-2007



Source: Author's calculations based on data obtained from NewCronos/Eurostat and AMECO/European Commission
Notes: Romania is not included in the figures because of its high triple and double digit inflation rates in the late 1990s.

Figure 3. Price level of consumer goods and services(100=EU-15 average), in 1999 and 2006



Source: NewCronos/Eurostat

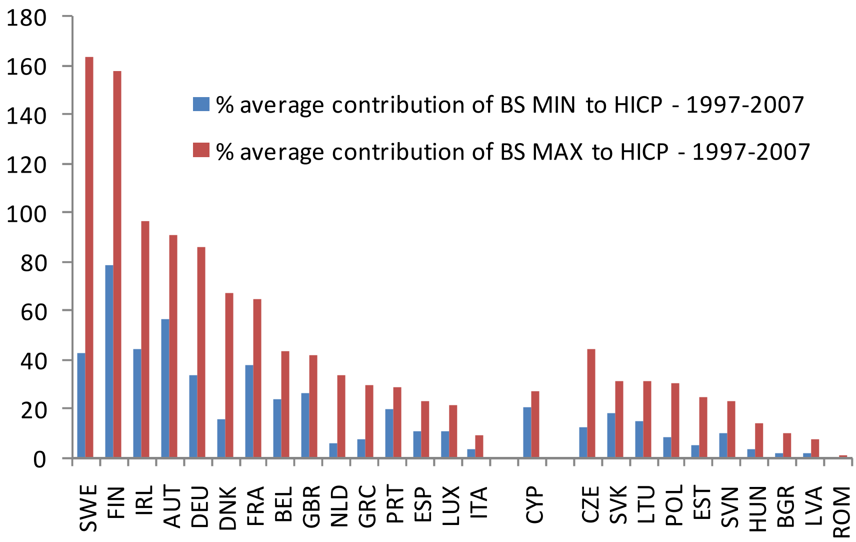
2.2 MARKET-BASED SERVICE PRICES: THE BALASSA-SAMULESON EFFECT

An array of papers provided estimates for the size of the Balassa-Samuelson effect both for transition countries and old EU member states over the last 10 years or so. While studies based on data for the 1990s found the Balassa-Samuelson effect of having a sizeable impact on inflation rates in Central and Eastern Europe, more recent studies came to the conclusion that the impact of the Balassa-Samuelson effect on the inflation rate was between zero and two percentage points annually.38 In this section we provide an update of these figures using a simple accounting framework, according to which the inflation rate that is attributable to the Balassa-Samuelson effect equals the growth rate of productivity in the tradable sector over that in the nontradable sector multiplied by the share of nontradables in the inflation rate. Using data drawn from the NewCronos database of Eurostat, we find the pattern described earlier in the literature (Figure 4):

1. First, the implied size of the balassa-Samuelson effect ranges between 0 and 2 p.p. in the new EU member states.
2. Second, the precise size of the Balassa-Samuelson effect is sensitive to alternative sectoral classifications (using manufacturing vs. industry for tradables, and market services vs. total services including all kind of public services) and, to some extent, to the fact whether labour productivity is measured in terms of number of workers, number of full-time equivalent workers or hours worked.
3. Third, the Balassa-Samuelson effect in the new EU member states are not higher than those found for the old member states.

[38] See e.g. Égert, Halpern and MacDonald (2006) for an overview and Mihaljek and Klau (2008) for a recent update.

Figure 4. The implied Balassa-Samuelson effect, 1997-2007



Source: Author's calculations based on data obtained from NewCronos/Eurostat and AMECO/European Commission
Notes: Min is calculated as the growth rate of labour productivity in market tradables multiplied by the share of market services in the HICP. Max refer to the case when all services are used (instead of market services).

2.3 REGULATED SERVICES

Regulated prices are important for inflation developments. First, they generally account for a considerable chunk of the HICP. Second, they tend to increase faster than market-based services or other components of the HICP.

A narrow definition proposed in ECB (2003) and extended by Lünneman and Mathä (2005) considers the following subcategories as regulated: 1.) refuse collection, 2.) sewerage collection, 3.) medical and paramedical services, 4.) dental services, 5.) hospital services, 6.) passenger transport by railway, 7.) postal services, 8.) education and 9.) social protection, 10.) cultural services and 11.) passenger transport by road. In addition, we also look at household energy including 1.) electricity, 2.) gas, 3.) liquid and solid fuels and 4.) heat energy, which falls under some sort of government regulation.

The share of narrowly defined regulated service prices in the HICP ranges from around 6 percent to roughly 10 percent, both in the new member states and in the old EU member states (Figure 5). By contrast, the share of household energy is substantially (by a factor of two) higher in the new member states.

Regulated prices matter for overall inflation because they usually exhibit above-average increases over time in all new member states. The reason for these above-average changes are twofold. First, it is the heritage of the transition process during which prices were converging to cost recovery levels. Second, another important reason for high price increases in these sectors is that in the new member states, network industries are regulated on a cost plus (or rate of return) basis. Such a regulatory regime does not put pressure on the incumbents to operate more efficiently as they can pass cost increases onto consumers. Therefore, introducing incentive regulation would help foster investment in cost efficient technologoies.

2.4 GOODS PRICES

Given that the price level of goods of new member countries is also way below the average of the old member countries, price level convergence and higher inflation rates can be expected to come from goods prices. Two main factors may explain why goods prices may increase during economic catching-up:

2.4.1 Improvement of the quality of goods if quality changes are not accounted for

Households in poorer countries tend to buy goods of lower quality simply because they are cheaper. By contrast, wealthier households pay more attention to the quality of the goods they purchase and are prepared to pay a correspondingly higher price. This can be thought of as an extension of Engel's Law according to which richer households spend less of their budget on food than poorer households do: Not only there is a shift away from food in private household spending as households grow richer but households also upgrade the quality of the goods (including foodstuff) included in their consumption basket. In other words, wealthier consumers are more quality sensitive, while poorer households are more sensitive to prices.

A shift towards higher goods prices can occur through a simple shift towards better quality goods. However, a special case of this shift may occur in fast catching-up transition economies, where this shift towards more quality goods on the consumer side is matched with a shift towards more quality goods on the producer side. Obviously, quality effects should not show up in inflation rates. In practice, however, filtering out quality effects is difficult even for developed countries, let alone the cases where those changes happen more rapidly. Most CEE countries do nothing to filter out systematically (using hedonic quality adjustments) quality effects (: Ahnert and Kenny, 2004).

2.4.2 Pricing-to-market practices

The prices of identical goods may differ across countries because producers may price their products in line with disposable income. At the same time, convergence in disposable income levels would eliminate these differences by generating higher inflation rates in the catching-up economies. This might be the case for instance in low-end cheap cars that are are generally cheaper in the new member countries than the euro area average. Price differences are around 10 percent for smaller cars but the difference vanishes for luxury cars. This might indicate that car manufacturers are setting prices deliberately lower for smaller cars in the new member states because of the lower disposable income of households in those countries.39

3 ESTIMATION FRAMEWORK: BAYESIAN AVERAGING OF CLASSICAL ESTIMATES (BACE)

Bayesian averaging provides a convenient framework to carry out a very comprehensive sensitivity analysis of a given explanatory variables with regard to other explanatory variables. More specifically, the approach advocated by Sala-i-Martin, Doppelhofer and Miller (2004) asks the question not whether any given explanatory variable is robust to the inclusion of other variables, but investigatse the probability with which any given variable would be included in the estimated model space. This approach requires the estimation of all possible combinations of the candidate explanatory variables (of number K) that is usually quantified as 2^K. If the number of models to be estimated is so high that currently available computer power cannot cope with the estimations, a subset of regressions can be estimated using for instance the Markov-Chain Monte-Carlo Model Composition or a stochastic search variable selection or other forms of model sampling such as the random sampling procedure employed in Sala-i-Martin, Doppelhofer and Miller (2004). We estimate the whole model space as the number of potential regressors at hand is limited and allows the estimation of all possible combinations.

Bayesian averaging of classical estimates (BACE) first determines the posterior probability attributed to each single model M_j that includes the given variable and conditioned on the underlying dataset ($P(M_j|y)$).

$$P(M_j|y) = \frac{P(M_j)T^{-k_j/2}SSE_j^{-T/2}}{\sum_{i=1}^{2^K} P(M_i)T^{-k_i/2}SSE_i^{-T/2}} \qquad (3)$$

where SSE is the sum of squared residuals, T is the number of observations, k denotes the number of explanatory variables included in the specific model and K is the number of all explanatory variables considered. Expression (3) shows the extent to which any given model contributes to explaining the dependent variable as compared to the other models.

[39] When looking at individual car manufacturer, a few of them do not discriminate between markets even for the small car segment.

Expression (3) is then summed up for the models that contain the variable of interest to obtain the posterior inclusion probability of this variable. The posterior inclusion probability are then compared to the prior inclusion probability, which is ½ if all possible combinations are considered. If the posterior inclusion probability is higher than the prior inclusion probability, one can conclude that the specific variable will be included in the model.

The posterior mean conditional on inclusion ($E(\beta|y)$) is the average of the individual OLS estimates weighted by $P(M_j|y)$. The unconditional posterior mean considers all regressions, even those without the variable of interest. Hence, the unconditional posterior mean of any given variable can be derived as the product of the conditional posterior mean and the posterior inclusion probability.

The posterior variance of β ($Var(\beta|y)$) can be calculated as follows:

$$Var(\beta|y) = \sum_{j=1}^{2^K} P(M_j|y) Var(\beta|y, M_j) + \sum_{j=1}^{2^K} P(M_j|y)(\hat{\beta}_j - E(\beta|y))^2 \tag{4}$$

The posterior mean and the square root of the variance (standard error) conditional on inclusion can be used to determine the significance of the individual variables upon inclusion.

4 VARIABLE SELECTION AND DATA ISSUES

We seek to cover comprehensively the determinants of structural inflation. For this purpose, we use the following variables:

- productivity differential growth: the difference of productivity growth in the tradable sector versus productivity growth in the nontradable sector to proxy the Balassa-Samuelson effect. If the Balassa-Samuelson effect were to hold, the estimated coefficient should be positive. Because the narrow and wide definitions of the productivity differential (in terms of market-based and all services) are very strongly correlated (correlation coefficient: 0.96), we only use the narrow definition.

- initial price level taken in natural logarithm: the use of initial price levels could provide and indirect insights with regard to the impact of price level convergence. The price level is used with one year lag and a lower price level in the previous year is expected to generate higher inflation in the following year. Such an effect should not be interpreted as evidence for the Balassa-Samuelson effect but more as evidence of levelling off price levels across the whole spectrum of prices (including goods, market and non-market services).

- the share of household energy in the HICP: this variables is meant to capture more directly quality effects in the spirit of the extension of Engel's. Recall that poorer household tend to spend relatively more on foodstuff and also on goods and services of lower quality. The share of household energy is highly correlated with the share of foodstuff in the HICP. A negative coefficient would indicate that a lower share of household energy in the final consumption basket (and thus a higher bias towards goods of better quality) is related to higher inflation rates.[40]

- the growth rate of regulated service prices: the narrow definition of regulated services are used that excludes household energy and rents, possibly correlated to some extent to oil prices and house prices.

On top of these variables, we add a number of other factors to the model space.

[40] The growth rate of GDP per capita might be also well capture the shift in private consumption to better quality goods and to more services as disposable income increases. Yet we choose not to use it because this variable tends to be correlated with other variables used in our sample and thus creates problems in terms of multicollinearity.

External factors:

- the growth rate of oil prices in dollar terms

- the growth rate of food prices multiplied by the share of foodstuff in the HICP to pick the recent rise in food prices

- changes in the nominal effective exchange rate multiplied by openness: as an increase in the exchange rate variable is an appreciation, a negative relation would indicate that nominal currency appreciation (depreciation) would bring down (spark) inflation.

Cyclical factors are measured with the output gap.

The impact of monetary policy on inflation is captured with the policy rate.[41]

Other factors:

- lagged inflation rate

- the rate of growh of nominal house prices

- growth rate of monetary aggregates

- growth rate of the private credit to GDP ratio (only for CEE countries)

- changes in the remittances over GDP ratio

The estimations are carried out for three country groups: a.) the European Union, b.) old EU member states, c.) new EU member states.[42]

For each panel, two different model spaces are investigated.

1.) First, remittances and monetarty aggregates are excluded because these series end in 2006 while the remaining series span until 2007.

2.) Second, remittances and monetary aggregates are added to the list of explanatory variables that reduces the sample size to 1998 to 2006.

The Bayesian model averaging exercise is conducted using annual data. Multicollinearity may be an issue when including a large number of explanatory variables at the same time. The bivariate correlation coefficients (not reported here) indicate that the number of highly correlated potential explanatory variables is fairly limited and thus multicollineary does not seem to be a major problem.[43]

[41] To avoid problems related to endogenity, a reaction function was estimated for non euro area countries with a float including the lagged policy rate, the price gap (the difference of inflation rate from its long-term target) and the output gap.

[42] The following countries are excluded from the analysis: Luxembourg because it tends to turn out as an outlier in empirical analyses, and Romania, Malta and Cyprus because house price data are not available for these countries.

[43] For the whole sample, the bivariate correlation coefficient is higher than 0.5 for the pairs regulated services – initial price level and share of household energy – initial price level. For the old EU-15 countries, the same holds true for the pair of share of household energy – initial price level. For new member states, credit growth is strongly correlated with the growth rate of monetary aggregates and with output gap.

5 RESULTS

The estimation results for the groups of countries (old EU-15 members, new EU member countries, and the whole European Union) are displayed in Tables 2 to 4. They show that lagged inflation rates, regulated prices, food prices, the nominal exchange rate and output gap have posterior inclusion probabilities exceeding the prior inclusion probability of 0.5 for the longest time span (1998-2007). The means conditional on inclusion all have the expected sign and have low standard errors. This result does not change when remittances and monetary aggregates are included (implying a reduction of the time span).

Importantly, the Balassa-Samuelson effect and other measures of structural inflation rates do not seem to matter for inflation in the old EU member states.

Looking at the new EU member states, beside output gap, the policy rate and regulated prices, initial price levels and the share of household energy in the HICP aimed at capturing structural factors beyond the Balassa-Samuelson effect are found to be always included in the model space, with the expected mean conditional on inclusion. By contrast, the Balassa-Samuelson effect does not appear to be robust driver of inflation rates in those countries. The inclusion of the exchange rate and house prices seem to be sensitive to the time period covered and to the starting set of potential explanatory variables. Two observations deserve further attention. First, monetarty aggregates are found to have a large posterior inclusion probability. At the same time, credit growth does not seem to matter, perhaps because it is highly correlated with monetary aggregates and output gap.

Finally, when considering the whole European Union - a panel that offers much more cross-country variation than the previous subpanels -, the two measures of structural factors (initial price level and the share of household energy) are important determinants of inflation rates, while the Balassa-Samuelson is not robust to all possible combination of the other explanatory variables. The policy rate, regulated prices, house prices, food prices and the exchange rate turn out to have very high posterior inclusion probabilities with the expected sign on the conditional mean. Lagged inflation and output gap also have posterior inclusion probabilities unless productivity growth in the distribution sector is added to the initial set of explanatory variables (that reduces both the time and cross-country dimension of the sample).

Table 2. Bayesian model averaging, old EU member states

	1998-2007			1998-2006		
	Incl. Prob.	Cond. mean	s.e.	Incl. Prob.	Cond. mean	s.e.
Lagged inflation	**1.000**	0.408	0.083	**1.000**	0.403	0.084
Policy rate	0.088	0.000	0.003	0.088	0.000	0.003
Prod_differential	0.083	0.000	0.002	0.084	0.000	0.002
Initial price level	0.228	-0.616	1.710	0.212	-0.555	1.554
Share of HH energy	0.084	0.083	1.082	0.086	0.186	1.474
Regulated services	**0.888**	0.093	0.041	**0.875**	0.090	0.041
House prices	0.147	0.002	0.002	0.137	0.002	0.002
Oil prices	0.171	0.000	0.000	0.168	0.000	0.000
Food prices*share	**0.997**	0.141	0.039	**0.998**	0.146	0.040
Neer*open	**0.986**	-0.089	0.028	**0.985**	-0.089	0.029
Output gap	**0.999**	0.166	0.047	**0.999**	0.166	0.047
Remittances/GDP				0.087	-0.013	0.039
Monetary aggregates				0.082	0.000	0.000
No. of regressions	2037			7817		
No. obs						
No. countries	14			14		

Notes: bold figures indicate that the estimated posterior inclusion probability is higher than the prior inclusion probability of 0.5

Table 3. Bayesian model averaging, new EU member states

	1998-2007			1998-2006			1998-2007		
	Incl. Prob.	Cond. mean	s.e.	Incl. Prob.	Cond. mean	s.e.	Incl. Prob.	Cond. mean	s.e.
Lagged inflation	0.182	-0.015	0.018	0.115	0.002	0.009	0.182	-0.015	0.018
Policy rate	**0.997**	0.316	0.082	**1.000**	0.345	0.072	**0.997**	0.317	0.082
Prod_differential	0.118	0.001	0.003	0.114	0.002	0.003	0.118	0.001	0.003
Initial price level	**0.638**	-4.846	18.70	**0.944**	-10.13	12.43	**0.654**	-5.021	18.61
Share of HH energy	**0.961**	-40.70	129.08	**0.988**	-44.52	59.75	**0.961**	-40.772	129.28
Regulated services	**1.000**	0.350	0.042	**1.000**	0.284	0.044	**1.000**	0.348	0.042
House prices	**0.630**	0.017	0.008	0.321	0.006	0.004	**0.619**	0.016	0.007
Oil prices	0.128	0.000	0.001	0.176	-0.001	0.001	0.127	0.000	0.001
Food prices*share	0.267	0.022	0.021	0.420	0.042	0.029	0.273	0.023	0.022
Neer*open	0.473	-0.032	0.019	**0.825**	-0.078	0.027	0.464	-0.031	0.019
Output gap	**0.551**	0.174	0.100	**0.811**	0.276	0.120	**0.529**	0.165	0.098
Remittances/GDP				0.096	-0.001	0.013			
Monetary aggregates				**0.856**	0.054	0.021			
credit							0.163	0.006	0.008
No. of regressions	2037			7817			4019		
No. obs									
No. countries	9			9			9		

Notes: bold figures indicate that the estimated posterior inclusion probability is higher than the prior inclusion probability of 0.5

Table 4. Bayesian model averaging, full sample

	1998-2007			1998-2006		
	Incl. Prob.	Cond. mean	s.e.	Incl. Prob.	Cond. mean	s.e.
Lagged inflation	**0.891**	0.147	0.061	**0.985**	0.210	0.063
Policy rate	**0.799**	0.089	0.054	**0.671**	0.075	0.048
Prod_differential	0.052	0.000	0.001	0.050	0.000	0.001
Initial price level	**0.934**	-5.261	4.166	**0.913**	-5.745	6.181
Share of HH energy	**0.857**	-19.80	80.97	**0.816**	-18.64	94.65
Regulated services	**1.000**	0.312	0.045	**1.000**	0.275	0.045
House prices	**0.947**	0.023	0.009	**0.941**	0.024	0.009
Oil prices	0.175	0.001	0.000	0.159	0.001	0.000
Food prices*share	**0.982**	0.124	0.037	**0.988**	0.129	0.038
Neer*open	**0.602**	-0.032	0.016	**0.753**	-0.052	0.020
Output gap	**0.992**	0.193	0.054	**0.995**	0.199	0.055
Remittances/GDP				0.034	0.001	0.004
Monetary aggregates				0.155	0.003	0.001
No. of regressions	2037			7817		
No. obs						
No. countries	23			23		

Notes: bold figures indicate that the estimated posterior inclusion probability is higher than the prior inclusion probability of 0.5

6 CONCLUSIONS

This study had a twofold objective. We first provided stylised facts regarding factors that could bring about higher inflation rates during economic catching up and then provided quantitative results concerning the relative importance of most of the factors possibly shaping inflation developments in the new EU members – by comparing them to the old member countries. We argued that the Balassa-Samuelson effect was not particularly important in the new member states for numerous reasons. Our estimation results strongly backed the stylised facts and highlighted that the Balassa-Samuelson does not seem to matter for inflation developments in Europe. We argued that advances in real convergence could lead to a shift in consumption patterns of households. Richer households tend to consume higher quality goods (quality effect), less energy and foodstuff and more services (composition and demand-side effect). In addition, higher wages could (but need not) increase the price of domestically produced and consumed goods and the prices of all goods and services via more expensive wholesaling and retailing. Our estimation results showed that initially lower prices and composition shifts in the inflation basket reflecting changes in household consumption patterns can lead to higher inflation rates possibly via the quality, composition and demand-side effects that affect both tradable and nontradalbe goods.

In addition, regulated prices and the output gap seem to be important determinants of inflation rates in the new member countries, and also the nominal exchange rate and house prices matter to some extent. Interestingly, the growth rate of monetary aggregates appear to bear a robust positive relationship in the new member countries but not in Western European countries. Finally, credit growth (capturing the recent credit boom in a number of CEE countries) does not show up in the estimation results, perhaps because its effect is captured by developments in the output gap (with which it is highly correlated).

REFERENCES

Ahnert, Henning and Geoff Kenny, 2004, Quality adjustment of European price statistics and the role for hedonics, ECB occasional paper series No. 15.

Backé, Peter, Jarko Fidrmuc, Thomas Reininger and Franz Schardax. 2002. Price dynamics in Central and Eastern European EU accession countries. Oesterreichische Nationalbank Working Paper No. 61.

Égert, Balázs, László Halpern and Ronald MacDonald, 2005, Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues. Journal of Economic Surveys. 20(2). 257-324.

European Central Bank, 2003, Direct impact of changes in administered prices and indirect taxes on euro area HICP developments. ECB Monthly Report March. 35-36.

Hammermann, Felix. 2007. Nonmonetary determinants of inflation in Romania: A decomposition. Kiel Working Paper No. 1322.

Hofmann, Boris and Hermann Remsperger. 2005. Inflation differentials among the euro area countries: potential causes and consequences. Journal of Asian Economics. 6(3). 403-419.

Honohan, Patrick and Philip Lane. 2004. Exchange rates and inflation under EMU: an update. CEPR Discussion Paper No. 4583.

Lünnemann, Patrick and Thomas Y. Mathä, 2005, Regulated and services prices and inflation persistence. ECB Working Paper No. 466.

Mihaljek, Dubravko and Marc Klau, 2008, Catching-up and inflation in transition economies: the Balassa-Samuelson effect revisited, BIS working paper no. 270.

Rogers, John H. 2001. Price level convergence, relative prices and inflation in Europe. Board of Governors of the Federal Reserve System. International Finance Discussion Papers No. 699.

Rogers, John H. 2002. Monetary union, price level convergence and inflation: how close is Europe to the United States? Board of Governors of the Federal Reserve System. International Finance Discussion Papers No. 740.

Sala-i-Martin, Xavier, Gernot Dopperhofer and Ronald I. Miller, 2004, determinants of long-run growth: a Bayesian averaging of classical estimates (BACE) approach, American Economic Review, 94(4), 813-835.

Catching-up and inflation in transition economies:
the Balassa-Samuelson effect revisited

Dubravko Mihaljek and Marc Klau[44]

ABSTRACT

This paper estimates the Balassa-Samuelson effects for 11 countries in central and eastern Europe on a disaggregated set of quarterly data covering the period from the mid-1990s to the first quarter of 2008. The Balassa-Samuelson effects are clearly present and explain around 24% of inflation differentials vis-à-vis the euro area (about 1.2 percentage points on average); and around 84% of domestic relative price differentials between non-tradables and tradables; or about 16% of total domestic inflation (about 1.1 percentage points on average). The paper presents mixed evidence on whether the Balassa-Samuelson effects have declined since 2001 compared with the second half of the 1990s.

JEL Classification Numbers: E31, F36, O11, P20
Keywords: Balassa-Samuelson effect, productivity, inflation, transition, convergence, European monetary union, Maastricht criteria

[44] Senior Economist and Head of Departmental Research Assistance, respectively, Monetary and Economic Department, Bank for International Settlements, CH-4002 Basel, Switzerland. Corresponding author: dubravko.mihaljek@bis.org The views expressed in this paper are those of the authors and do not necessarily represent those of the BIS. Helpful comments from Claudio Borio, Lina Bukeviciute, Andy Filardo, Roman Horvath, Richhild Moessner and participants of a BIS seminar and the European Commission DG ECFIN workshop "What drives inflation in the new EU member states?" (October 2008) are gratefully acknowledged.

1 INTRODUCTION

The purpose of this paper is to assess, as precisely and transparently as possible, the degree to which faster productivity growth in tradable versus non-tradable sectors of countries in central and eastern Europe (CEE) contributes to domestic inflation and to inflation differentials that these countries exhibit vis-à-vis the euro area. These two effects – the domestic and international versions of the Balassa-Samuelson effect – are part of the structural inflation phenomenon and as such are of key importance for economic policy. As observed by Padoa-Schioppa (2003), not all inflation in the catching-up economies is "pathological" – faster productivity growth in industries producing tradable goods and services is part of the "physiology" of economic development. If labour and capital markets are unencumbered, there is not much that economic policy could or should do to control this source of inflation.

The magnitude of the Balassa-Samuelson effect is therefore of considerable interest for policymakers in EMU candidate countries and relevant EU institutions. If the productivity growth differential between the traded and non-traded goods sectors is larger in an EMU candidate country than the euro area, the overall inflation will be higher in the candidate country. Under a fixed exchange rate regime, this will result in real exchange rate appreciation. Under a flexible exchange rate regime, it will result in some combination of nominal appreciation and CPI inflation. Both scenarios might create problems with the fulfilment of the Maastricht criteria for inflation and exchange rate stability.

Consider countries with a fixed exchange rate regime. If monetary policy were to keep inflation around the benchmark – average of three EU countries with lowest inflation – but the Balassa-Samuelson effect was greater than the 1½ percentage point margin allowed by the Maastricht treaty, the inflation criterion might be missed.[45] The authorities might therefore feel compelled to maintain, at least temporarily, relatively restrictive monetary and fiscal policies in order to meet the inflation criterion. This might dampen economic growth and job creation. In such circumstances, it might be difficult to explain to the public why the economy needs to slow down in order to adopt the common currency – reasonable observers might argue that the country is being "punished" for catching up too fast.

In countries with flexible exchange rate regimes, the policy dilemma resulting from the Balassa-Samuelson effect is somewhat less pronounced. If monetary policy were to keep inflation below the Maastricht ceiling but the Balassa-Samuelson effect was greater than 1½ percentage points, the optimal response would be to allow the exchange rate to appreciate. The resulting appreciation is not likely to be a major obstacle for the fulfilment of the exchange rate stability criterion: the Balassa-Samuelson effect would have to be truly large to exhaust the 15% band of the ERM II in two years, assuming that the exchange rate starts in the middle of the band.[46] However, rapid exchange rate appreciation might attract large and volatile capital inflows and through this channel negatively affect financial stability and external competitiveness (see Mihaljek, 2008).

Not surprisingly, there has been much discussion in the literature on the existence, size and policy implications of the Balassa-Samuelson effect in CEE, so much so that the first literature reviews have been published (see eg Égert, 2003; Égert et al, 2006). The early empirical literature (Golinelli and Orsi, 2002; Halpern and Wyplosz, 2001; Kovács and Simon, 1998; Rother, 2000) argued that the Balassa-Samuelson effect was relatively large. If inflation is structurally out of line with the benchmark value in the EU because of strong catching-up effects, the proposition to relax the inflation criterion becomes empirically plausible. Consequently, there have been calls both by academics (Begg et al, 2003; Buiter and Grafe, 2002; Buiter and Siebert, 2006; Darvas and Szapáry, 2008) and policy makers (Szapáry, 2000) to relax the Maastricht inflation criterion.[47]

(45) According to the Maastricht inflation criterion, EMU candidates have to show a price stability performance that is sustainable and an average rate of inflation (observed over a period of one year before the examination) that does not exceed by more than 1½ percentage points that of, at most, the three EU member states with the best price stability performance.

(46) The Maastricht exchange rate stability criterion requires EMU candidates to spend at least two years "without severe tensions" – in particular without devaluing against the euro – in the exchange rate mechanism of the European Monetary System, the so-called ERM II. ERM II is an exchange rate arrangement with fixed but adjustable central parities against the euro and a normal fluctuation band of ±15% around these parities. The assessment of exchange rate stability against the euro focuses on the exchange rate being close to the central rate while also taking into account factors that may have led to an appreciation. The width of the fluctuation band within ERM II does not prejudice the assessment of the exchange rate stability criterion.

(47) For overviews, see eg Deroose and Baras (2005); and Mihaljek (2006).

However, more recent empirical studies found the Balassa-Samuelson effect to be relatively small. For instance, in our earlier paper (Mihaljek and Klau, 2004) we found that the Balassa-Samuelson effect in central European countries explained on average only between 0.2 and 2.0 percentage points of annual inflation differentials vis-à-vis the euro area. We also argued that, as the pace of catching-up decelerates, these effects were likely to decrease and hence should not become a determining factor in the ability of these countries to satisfy the Maastricht inflation criterion. Other studies (including Cipriani, 2001; Coricelli and Jazbec, 2001; Égert, 2002a and 2002b; Égert et al, 2003; Flek et al, 2002; Kovács, 2002; Lojschova, 2003) similarly found these effects to be small.

The literature has also identified some puzzles related to the operation of the Balassa-Samuelson effect (see Égert and Podpiera, 2008). On the one hand, the evidence suggests that this effect is not the main driving force of the observed relatively high inflation rates of 3–6% per annum in most CEE countries. On the other hand, although productivity growth in the tradable sectors has indeed been high, it has not led to correspondingly high inflation rates. Several explanations of these puzzles have been elaborated, including a trend increase in tradable prices related, inter alia, to steady quality improvements (Cincibuch and Podpiera, 2006); the role of regulated price adjustments in overall inflation (MacDonald and Wojcik, 2004); a disconnection between productivity growth and real wages in the manufacturing sector (Égert, 2007); incomplete wage equalisation and substantial productivity gains in market non-tradables (Alberola-Ila and Tyrväinen, 1998); and the low share of market non-tradables in consumer price indices of CEE countries (Égert et al, 2006).

Any addition to this burgeoning literature therefore has to be justified. The main contribution of the present paper is the size and up-to-dateness of the sample – we analyse quarterly data from eleven CEE countries from the mid-1990s through the first quarter of 2008. For more than half of the countries in our sample – Bulgaria, Croatia, Estonia, Latvia, Lithuania and Romania – there are only a handful of empirical studies of the Balassa-Samuelson effect.[48] For these six countries as well as the remaining new member states from CEE included in our sample – the Czech Republic, Hungary, Poland, Slovakia and Slovenia – there have been hardly any estimates of the Balassa-Samuelson effect covering the period since 2004.[49] This period is relevant because, with the exception of Croatia, all countries in the sample have since joined the European Union. Several of them (including the Baltic states) have entered the exchange rate mechanism ERM II, and two of these – Slovenia and Slovakia – have already passed the Maastricht tests. Assessing the size of the Balassa-Samuelson effect for these countries is therefore of particular interest.

Another contribution of the present paper is greater precision of our estimates than in the past (eg, compared with Mihaljek and Klau, 2004). One reason is the much better quality of the data that have been released over the past few years by national statistical authorities and Eurostat, in particular for Poland, Slovakia, the Baltic states, Bulgaria and Romania. This has enabled us to extend the coverage of tradable sectors to agriculture, forestry and fishing, which are major sources of exports of several countries in the region; and to directly include one additional key variable, the share of non-tradables, in regression equations that are being estimated. We also examine whether productivity growth and the Balassa-Samuelson effects have diminished in recent years, an issue that has not been addressed systematically in the literature so far.

Finally, one advantage of our approach is the simple, transparent estimating framework that can be easily interpreted by policymakers and replicated by researchers with access to more disaggregated data.

Section 2 discusses the analytical framework and some relevant data issues.

Section 3 reviews historical developments in productivity and inflation differentials within CEE countries and between those countries and the euro area over the sample period. Section 4 discusses our econometric estimates of the Balassa-Samuelson effects.

Section 5 summarises the main results and briefly notes some of their policy implications.

[48] See Burgess et al (2003); Chukalev (2002); Égert (2005a) and (2005b); Égert et al (2003); Funda et al (2007); Mihaljek and Klau (2004) and (2007); Nenovsky and Dimitrova (2002); and Wagner and Hlouskova (2004).

[49] In Mihaljek and Klau (2007) we cover the period through 2005:Q1 for six central European countries.

2 ANALYTICAL FRAMEWORK

Using the distinction introduced in our 2004 paper, we discuss two versions of the Balassa-Samuelson effect, the "international" effect (equation 1) and the "domestic" effect (equation 2):[50]

$$\hat{p}_t - \hat{p}_t^* = const + \hat{e}_t + (1-\alpha_t)[\left(\frac{\delta}{\gamma}\right)\hat{a}_t^T - \hat{a}_t^{NT}] - (1-\alpha_t^*)[\left(\frac{\delta^*}{\gamma^*}\right)\hat{a}_t^{T*} - \hat{a}_t^{NT*}] \quad (1)$$

$$\hat{p}_t^{NT} - \hat{p}_t^{T} = \left(\frac{\delta}{\gamma}\right)\hat{a}_t^{T} - \hat{a}_t^{NT} \quad (2)$$

where circumflexes (^) stand for the growth rates; "*" denotes variables in the euro area; $\hat{p}_t - \hat{p}_t^*$ is the difference in consumer price inflation between a given CEE country and the euro area; $\hat{p}_t^{NT} - \hat{p}_t^{T}$ represents the difference in domestic inflation rates of non-tradables and tradables, ie the growth rate of the relative price of non-tradables; $\hat{e}_t$ is the rate of nominal exchange rate depreciation (units of domestic currency vis-à-vis the euro); α_t is the share of traded goods in the consumption basket; $\hat{a}_t^T$ and $\hat{a}_t^{NT}$ are the growth rates of average labour productivity in tradable and non-tradable sectors, respectively; γ and δ are production function coefficients (labour intensities in traded and non-traded sectors); and *const* is a term containing coefficients α, γ and δ.

Equation (1) states that the difference in rates of inflation between two countries can be expressed as the sum of changes in the exchange rate (of the home country's currency vis-à-vis the foreign currency) and productivity growth differentials between traded and non-traded industries at home and abroad, weighted by the respective non-tradables' shares.

Equation (2) states that the growth rate of the relative price of non-tradable goods can be expressed as the difference in average labour productivity growth between tradable and non-tradable sectors.

Both versions of the Balassa-Samuelson effect are thus hypotheses about the structural origins of inflation: in the international version, about the tendency for inflation in the catching-up economies to be higher than in the economies they are converging to; and in the domestic version, about the tendency for the domestic prices of non-tradables to rise faster than those of tradables.

The structural factor that explains the tendency in both cases is the relative productivity growth differential. Historically, productivity growth in the traded goods sector has been faster than in the non-traded goods sector. If the law of one price holds, the prices of tradables tend to get equalised across countries, while the prices of non-tradables do not. Higher productivity in the tradable goods sector will bid up wages in that sector and, with labour being mobile, wages in the entire economy will rise. Producers of non-tradables will be able to pay the higher wages only if the relative price of non-tradables rises. This will in general lead to an increase in overall inflation in the economy.

Graphs A1 and A2 in the Appendix verify two key assumptions of the Balassa-Samuelson hypothesis: first, that productivity growth in the tradable sector bids up wages in that sector; and second, that wage growth in the tradable sector spreads to the non-tradable sector. As shown in Graph A1, real wage growth in tradable industries generally closely follows productivity growth in tradables over the sample period. In some cases (Croatia, Latvia, Lithuania, Slovakia, Slovenia), strong productivity gains in tradables are not entirely passed onto real wages in that sector. Graph A2 provides clear evidence of wage equalisation between tradables and non-tradables in CEE countries – it is remarkable how closely together wages in the two sectors have moved over longer periods in virtually all the countries in the region.

Several analytical points about this model are worth noting. First, the size of the Balassa-Samuelson effect depends on the *relative* rather than the absolute productivity growth differential. For instance, let a^T = 3%, a^{NT} = 1%, a^{T*} = 4%, a^{NT*} = 3%.[51] Then productivity growth in both tradables and non-tradables is higher abroad, but with $(a^T – a^{NT}) > (a^{T*} – a^{NT*})$, higher inflation at home would still be an equilibrium phenomenon. Similar to the theory of comparative advantage in international trade, the importance of the *relative* instead of the absolute productivity differential is often ignored in empirical studies, which assume that productivity growth in non-

(50) The two equations are derived in Mihaljek and Klau (2004); see also Égert (2003) and Égert et al (2006).
(51) For ease of notation, circumflexes will be omitted in the text, graphs and tables and used only in equations.

tradables is the same across countries or equal to zero. If this were the case, the Balassa-Samuelson effect in the above example would be negative (–1 percentage point).

Second, the size of the Balassa-Samuelson effect depends on the relative shares of non-traded goods $(1-\alpha_t)$ at home and abroad. This is also typically ignored in empirical studies by assuming not only that $\alpha_t = \alpha_t^*$, but also that the shares are constant over time. These assumptions, however, may lead to large overestimates of the effect.[52] We avoid this bias by calculating different shares of non-traded goods for different countries for each quarterly observation in the sample. This allows a much greater precision of the estimates because the shares of non-tradables range over the sample from under 40% to over 80%. On average, the non-tradables' share in CEE increased from 58% in the mid-1990s to 69% in 2007–08.

One should also note that we derive the non-tradables' shares from national income accounts in constant prices rather than the weight of non-tradables in consumer price indices (usually proxied by the weight of services in the CPI). While the latter is analytically correct – equation (1) is derived from the expression for the CPI as a weighted average of tradables and non-tradables – the former is preferable in empirical work because of the downward bias in the CPI weights of services in CEE countries. For instance, market-based non-tradables account for only around 20–30% of the CPI basket in the Baltic states and south-eastern Europe, although they represent on average around two-thirds of the value added in the economy. Using the CPI weights for non-tradables would therefore seriously underestimate the "true" Balassa-Samuelson effects.

Third, the Balassa-Samuelson effect is sensitive to the classification of tradable and non-tradable sectors. There is no accepted criterion for this classification, and data do not always allow one to make a clear distinction. Consider for instance an often used benchmark for tradables proposed by De Gregorio et al (1994): tradable industries are those with a share of exports in value added of 10% or more. To take an extreme example, housing is usually considered a quintessential non-tradable. But much of the housing in coastal areas of Bulgaria, Croatia and some Baltic states has been constructed and sold to non-residents in recent years. Data on such sales are generally unavailable, so a substantial part of "exports" of the construction industry might be underreported. Business services are another example of an industry typically classified as non-tradable, even though many companies in this sector are providing their services to (ie, are outsourcing for) foreign companies.

The classification used in this paper nonetheless follows the traditional approach: agriculture, hunting and forestry; fishing; mining and quarrying; and manufacturing are classified as tradables (NACE branches A–D); while electricity, gas and water supply; construction; wholesale and retail trade; hotels and restaurants; transport, storage and communication; financial intermediation; and real estate, renting and business activities (NACE branches E–K) are classified as non-tradables.[53] Not considered because of their largely non-market content are public administration, defence and compulsory social security; education; health and social work; other community, social and personal services; and activities of households (NACE branches L–P).

We also estimated regressions with hotels and restaurants, and wholesale and retail trade, classified as tradables, but decided not to report these estimates because data for the euro area could not be disaggregated in the same fashion.[54] In other words, the classification used in this paper has a fairly generous share of non-tradables, and our estimates of the Balassa-Samuelson effect are probably upward-biased – first, because some ex ante low-productivity sectors are not among the tradables; and second, because the share of non-tradables (which, as noted above, has a big impact on the size of the effect) is higher than in the studies that derive this share from the weights of goods and services in the CPI basket.

Fourth, the Balassa-Samuelson effect is sensitive to the assumption about factor intensities in non-traded and traded sectors (δ and γ). Like the rest of the literature, we assume that $\delta/\gamma = \delta^*/\gamma^* = 1$, ie, that factor intensities in tradable and non-tradable sectors are the same and do not differ across countries. The reason is practical: very few countries publish income-based GDP data disaggregated for different sectors of the economy. We verified this assumption only for the case of Hungary –the assumption that factor intensities can be approximated by factor shares seems to hold there. In general, however, the labour share in non-tradable industries is higher and, moreover, the ratio of labour shares should be higher in the euro area because tradable industries in CEE are probably more labour-intensive than in the euro area. This effect would tend to reduce the contribution of

(52) For instance, data in Tables 1 and 2 imply (using the average for CEE) that $(1-\alpha)(a^T-a^{NT}) - (1-\alpha)(a^{T*}-a^{NT*})$ = 0.635x3.9 – 0.687x2.4 = 0.83. With $\alpha = \alpha^* = 0.635$, the Balassa-Samuelson effect would be equal to 1.03, ie about 25% higher.

(53) The Appendix provides a detailed description of all data used in the paper.

(54) It is not clear why Eurostat does not make available on its website the breakdown of all 16 branches of NACE for the euro area; currently, only a six-branch breakdown is available (A–B, C–E, F, G–I, J–K, and L–P).

productivity differentials to inflation differentials. In other words, it is likely that the "true" Balassa-Samuelson effects are lower than those estimated here under the assumption of equal factor intensities.

Finally, like other studies of the Balassa-Samuelson effect, this paper uses data on average labour productivity (ALP) rather than total factor productivity (TFP).[55] The reason is the lack of data on capital stocks for central European economies. While, in theory, one could construct these data from statistical series on capital investment, data on initial capital stocks are either unavailable (in particular at industry level) or so unreliable as to make the exercise of questionable empirical value. One consequence of using APL rather than TFP is that labour productivity differences exaggerate true differences in *total* factor productivity, since average labour productivity growth is a sum of TFP growth and capital deepening weighted by the share of non-tradables.[56] Therefore, the growth rate of labour productivity might be systematically higher or lower than total factor productivity, with capital intensity working as a sort of leverage. In particular, extra capital raises output, holding other factor inputs constant, and therefore raises measured output per worker. The resulting bias is likely to be greater for relatively capital-intensive tradables than for non-tradables as well as for economies with a relatively higher endowment of capital (ie the euro area).

3 PRODUCTIVITY AND INFLATION IN TRADABLE AND NON-TRADABLE SECTORS

Table 1 summarises developments in productivity growth and inflation in 11 CEE countries and the euro area from an initial observation in the 1996–98 period to the first quarter of 2008. In line with the Balassa-Samuelson hypothesis, productivity growth was higher in tradable sectors, and relative prices increased faster in non-tradable sectors, in all 12 economies considered.[57] However, no clear pattern between productivity differentials and relative price differentials seems to emerge at first sight: Slovakia, for instance, had the highest productivity differential and one of the lowest relative price differentials; while Bulgaria had the lowest productivity differential and one of the highest relative price differentials (Graph 1).

Yet when one looks at country averages, there seems to be strong support for the domestic Balassa-Samuelson hypothesis. More specifically, data in Table 1 suggest that the average productivity differential $(a^T - a^{NT})$ for 11 CEE countries (3.7 percentage points), corrected for the share of non-tradables (64%, shown in Table 2), was exactly equal to the sectoral price differential $(p^{NT} - p^T)$ of 2.3 percentage points.

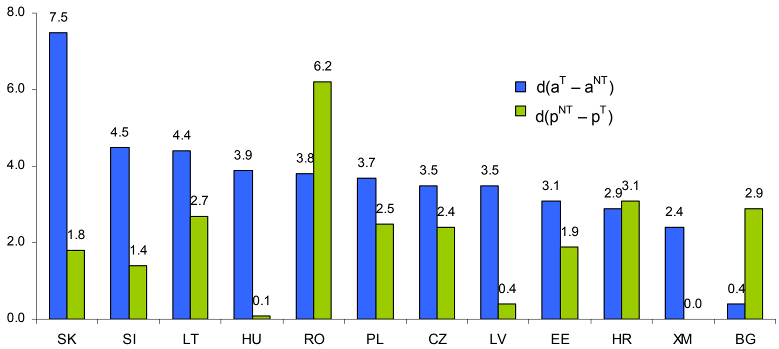
(55) See, however, Égert et al (2006), pp. 12–13, for a version of equation (1) that allows the use of ALP in its own right rather than as a proxy for total factor productivity. That version, however, can be used only in regressions with the real exchange rate as the dependent variable.
(56) Using the Cobb-Douglas production function, $(dY/Y) / (dL/L) = (dA/A) + (1-\alpha) (dK/K) / (dL/L)$.
(57) In the euro area, inflation of non-tradables was only marginally higher than that of tradables.

Table 1: Productivity growth and inflation in CEE[1]

Country (t_0)		Productivity growth			Inflation			
		a^T	a^{NT}	$a^T - a^{NT}$ [2]	P [3]	p^T	p^{NT}	$p^{NT} - p^T$ [4]
Bulgaria	(1998:Q2)	3.3	2.9	0.4	6.8	4.7	7.6	2.9
Croatia	(1997:Q1)	5.2	2.3	2.9	3.4	2.8	5.9	3.1
Czech Rep.	(1996:Q1)	6.3	2.8	3.5	3.6	1.6	4.0	2.4
Estonia	(1997:Q1)	9.0	5.9	3.1	5.1	4.2	6.1	1.9
Hungary	(1996:Q1)	6.0	2.1	3.9	8.4	8.0	8.1	0.1
Latvia	(1998:Q2)	8.8	5.3	3.5	5.0	5.1	5.5	0.4
Lithuania	(1996:Q1)	9.6	5.2	4.4	3.3	2.1	4.8	2.7
Poland	(1997:Q1)	6.2	2.5	3.7	5.6	4.0	6.6	2.5
Romania	(1997:Q1)	9.3	5.5	3.8	23.3	17.4	23.6	6.2
Slovakia	(1996:Q1)	9.5	2.0	7.5	6.4	3.9	5.7	1.8
Slovenia	(1996:Q3)	6.7	2.2	4.5	6.0	4.0	6.3	1.4
Average		***7.3***	***3.5***	***3.7***	***7.0***	***5.3***	***7.7***	***2.3***
Euro area	(1997:Q1)	2.8	0.4	2.4	2.0	1.9	1.9	0.0

1 Four-quarter percentage changes, period averages (initial observation t_0 shown in parentheses after the country name). T = tradables; NT = non-tradables. For the composition of tradable and non-tradable industries and price indices see the Appendix. 2 Difference between productivity growth in tradable and non-tradable sectors, in percentage points. 3 Overall CPI inflation. 4 Difference between inflation of non-tradable and tradable components of the CPI, in percentage points.

Graph 1: Domestic productivity growth and relative price differentials
In percentage points, period average



Source: Authors' calculations, based on the data described in the Appendix.

Table 2 summarises developments in productivity and inflation differentials of CEE countries vis-à-vis the euro area. All CEE countries recorded higher average annual inflation than the euro area over this period, with the differential ranging from around 1.3 percentage points in Croatia and Lithuania to more than 20 percentage points in Romania. All CEE countries (with the exception of Bulgaria) also achieved faster productivity growth in tradables vs. non-tradables than did the euro area. The sectoral productivity differential was on average equal to 1.6 percentage points, or 0.8 point when corrected for the share of non-tradables. This suggests that productivity differentials could explain only around 16% of the CEE countries' average 5 percentage points inflation differential vis-à-vis the euro area. On this preliminary evidence, the international Balassa-Samuelson effect appears to be weaker than the domestic effect, which is in line with previous findings in the literature.

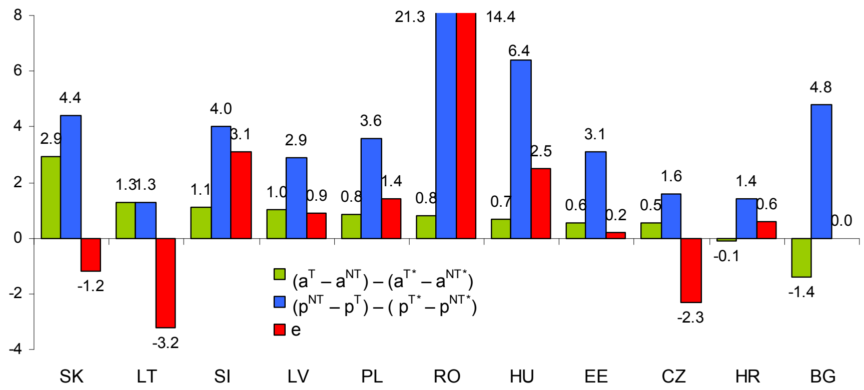
Table 2: Productivity and inflation differentials in CEE vis-à-vis the euro area[1]

Country (t_0)		Inflation differential	Change in nominal exchange rate[2]	Sectoral productivity differential	Share of non-tradables (%)	Balassa-Samuelson effect[3]
		$p - p^*$	e	$(a^T - a^{NT}) - (a^{T*} - a^{NT*})$	$(1 - \alpha)$	$(1-\alpha)(a^T - a^{NT}) - (1-\alpha^*)(a^{T*} - a^{NT*})$
Bulgaria	(1998:Q2)	4.8	0.0	–2.0	62.7	–1.4
Croatia	(1997:Q1)	1.4	0.6	0.5	56.5	–0.1
Czech R.	(1996:Q1)	1.6	–2.3	1.1	62.2	0.5
Estonia	(1997:Q1)	3.1	0.2	0.7	71.0	0.6
Hungary	(1996:Q1)	6.4	2.5	1.5	59.6	0.7
Latvia	(1998:Q2)	2.9	0.9	1.1	76.9	1.0
Lithuania	(1996:Q1)	1.3	–3.2	4.4	66.4	1.3
Poland	(1997:Q1)	3.6	1.4	1.3	67.5	0.8
Romania	(1998:Q2)	21.3	14.4	1.4	53.6	0.2
Slovakia	(1996:Q1)	4.4	–1.2	5.1	60.9	2.9
Slovenia	(1996:Q3)	4.0	3.1	2.1	61.7	1.1
Average		***5.0***	***1.5***	***1.6***	***63.5***	***0.8***
Euro area	(1997:Q1)	…	…	2.4	68.7	…

[1] Four-quarter percentage changes, period averages (initial observation t_0 shown in parentheses after the country name). [2] Negative sign denotes appreciation (fewer units of domestic currency per euro), positive depreciation. [3] Contribution of sectoral productivity differentials to the inflation differential vis-à-vis the euro area.

Changes in nominal exchange rates against the euro (a 1½ percentage point annual depreciation on average) explain around 30% of the CEE countries' inflation differential vis-à-vis the euro area. It is quite surprising how stable, on average, nominal exchange rates have been over the past 10–12 years, including in the Czech Republic, Hungary and Poland, which had adopted inflation targeting and flexible exchange rate regimes. Because of this stability, even with a full pass-through of import prices to domestic inflation, the impact of exchange rate changes on domestic inflation – and hence on inflation differential vis-à-vis the euro area – seems to have been modest.

Graph 2: Productivity and inflation differentials vis-à-vis the euro area
In percentage points, period average



Source: Authors' calculations, based on the data described in the Appendix.

As with the domestic Balassa-Samuelson effect, no clear cross-country pattern emerges between the average size of productivity differentials vis-à-vis the euro area on the one hand and inflation differentials on the other (Graph

2). The former is in general much smaller than the latter, especially in Bulgaria, Hungary and Romania; the two differentials are of about the same size only in Lithuania and come relatively close in Slovakia. This preliminary evidence suggests that the international Balassa-Samuelson effects might be small.

With the Balassa-Samuelson effect and exchange rate changes explaining only about 46% of inflation differentials vis-à-vis the euro area in this simple accounting framework, it is clear that other factors probably play a more important role in inflationary dynamics in CEE countries. What these factors are will not be pursued in this paper; for an exhaustive review see Égert (2007). We turn instead to the task of trying to estimate the Balassa-Samuelson effects more precisely in an econometric framework.

4 ECONOMETRIC ESTIMATES OF THE BALASSA-SAMUELSON EFFECTS

To estimate the two versions of the Balassa-Samuelson effect using time series data, equations (1) and (2) are re-specified as follows:

$$log(CPI/CPI^{*})_t = c_1 + \beta_0 log(CPI/CPI^{*})_{t-1} + \beta_1 log(E_t/E_{t-1}) + \beta_2[(1-\alpha)\, log(LP^{T}/LP^{NT})_t - (1-\alpha^{*})\, log(LP^{T*}/LP^{NT*})_t] + \varepsilon_t \quad (3)$$

$$log(CPI^{NT}/CPI^{T})_t = c_2 + \gamma_0 log(CPI^{NT}/CPI^{T})_{t-1} + \gamma_2\, log(LP^{T}/LP^{NT})_t + \upsilon_t \quad (4)$$

where c_1 *and* c_2 are constants; "*" denotes variables in the euro area; *CPI* is the index of changes in consumer prices; CPI^{NT} and CPI^{T} are indices of changes in non-tradable and tradable goods prices; *E* is index of nominal exchange rate changes; LP^{T} and LP^{NT} are indices of average labour productivity growth in tradable and non-tradable industries; and ε_t and υ_t are error terms.

These two equations are estimated separately for each CEE country because we are interested in whether these effects might be a determining factor in the ability of each of these countries to meet the Maastricht inflation criterion. Admittedly, from an econometric perspective, pooling of the data for all countries or for groups of countries based on exchange rate regimes (eg, fixed vs floating regimes) or other criteria (eg, geographical region, size of the economy) and estimating panel regressions seems highly attractive. However, in the assessment of the Maastricht criteria, convergence reports are prepared for individual countries, not groups of countries. Moreover, as the results below will show, there is considerable heterogeneity among the countries in our sample, so pooling of the data might bias the estimates and make the interpretation of the results tenuous.

By construction, all regression variables are differenced – all productivity and price indices in equations (3) and (4) show seasonally adjusted, four-quarter percentage changes, and the exchange rate enters the regressions in the form (E_t/E_{t-1}). The stationarity of all time series was tested using the augmented Dickey-Fuller test. The results are not shown because of the large volume of test output.[58] The vast majority of time series proved to be stationary in difference form with constant and/or with constant and trend, making it possible to use ordinary least squares to estimate the regression equations. This has significantly simplified the estimation procedure.

A lagged dependent variable is included on the right-hand side in both regressions. One reason is that the Breusch-Godfrey tests pointed to serial correlation of residuals in many regressions. Another is that we wanted to capture persistence in inflation differentials and, at the same time, allow the possibility of partial adjustment of inflation differentials to the changes in explanatory variables. The short-run Balassa-Samuelson elasticity is thus given by the coefficient β_2, and long-run elasticity by $\beta_2/(1-\beta_0)$.

Standard regression statistics are not reported. The fit of regressions is generally very good (adjusted R^2 of 0.95 or higher), and standard test statistics are for the most part satisfactory. Many regressions of equation (4), and some of equation (3), initially had serially correlated residuals, but after applying standard transformations of lagged dependent variables, serial correlation was eliminated from most (though not all) regressions. As with the small number of non-stationary time series, it is highly unlikely that the presence of serial correlation in such a small number of cases could contaminate the estimates.

(58) There would be well over 400 test results to report: 12 different time series for 12 countries, each for 3 cases (with constant, trend, constant and trend).

Table 3: Estimates of the international Balassa-Samuelson effect
Dependent variable: inflation differential vis-à-vis the euro area

Country (Period yy:q)		Explanatory variables				International Balassa-Samuelson effect[1]	
		$\log(CPI/CPI^*)_{t-1}$	$\log(E_t/E_{t-1})$	$(1-\alpha)_t\log(LP^T/LP^{NT})_t - (1-\alpha^*)_t\log(LP^T*/LP^{NT}*)_t$		Short-run	Long-run
		β_0	β_1	$\beta_2^{short\ run}$	$\beta_2^{long\ run}$		
Bulgaria	(98:2–07:3)	0.796	…	–0.003	–0.016	0.006	0.031
Croatia	(98:4–08:1)	0.923	0.127*	–0.102	–1.317	0.013	0.165
Czech R.	(97:2–08:1)	0.775	0.115	0.081	0.360	0.038	0.169
Estonia	(97:1–08:1)	0.963	…	0.058	1.583	0.035	0.947
Hungary	(97:1–08:1)	0.921	0.135*	0.188	2.394	0.122	1.549
Latvia	(98:4–07:3)	0.815	0.104*	0.120	0.649	0.115	0.619
Lithuania	(96:2–08:1)	0.963	–0.097	0.086	2.352	0.170	4.628
Poland	(97:3–07:3)	0.900	0.041x	0.109	1.085	0.091	0.903
Romania	(98:3–07:4)	0.959	0.177*	0.103	2.509	0.018	0.441
Slovakia	(99:1–08:1)	0.833	0.263	0.116	0.695	0.327	1.961
Slovenia	(99:1–07:4)	0.869	0.327	0.166	1.271	0.220	1.686
Average		***0.883***	***0.132***	***0.084***	***1.051***	***0.105***	***1.191***

All estimated coefficients are statistically significant at the 5% (or higher) test level, except for those marked with "*", which are significant at the 10% test level, and those marked with "x", which are not significant.
[1] Contribution of sectoral productivity differential to inflation differential vis-à-vis euro area, in percentage points. Calculated as β_2^i times the average productivity differential $[(1-\alpha)(LP^T-LP^{NT}) - (1-\alpha^*)(LP^{T*}-LP^{NT*})]$ over the period for which the regression is estimated; *i* denotes short-run and long-run elasticities.

The estimates of the ***international Balassa-Samuelson effects*** are shown in Table 3. With few exceptions, all estimated parameters have the expected positive sign and are statistically significant at the 5% (or higher) test level. The estimates of the short-run Balassa-Samuelson coefficient β_2 range from –0.10 (Croatia) to +0.19 (Hungary), and of the long-run coefficient from –1.3 (Croatia) to around 2.5 (Hungary, Lithuania and Romania). On average, the short-run Balassa-Samuelson coefficient is about 0.08 and the long-run coefficient is about 1.1.

When these coefficient estimates are multiplied by the actual productivity growth differentials vis-à-vis the euro area $(LP^T-LP^{NT}) - (LP^{T*}-LP^{NT*})$ observed over the sample periods, one obtains the international Balassa-Samuelson effects. The short-run effects were around 0.10 percentage point on average; the long-run effects around 1.2 points on average. According to this calculation, inflation in CEE countries was on average about 1.2 percentage points higher than in the euro area because productivity growth in tradables vs. non-tradables in these countries was faster than in the euro area. In Hungary, Lithuania, Slovakia and Slovenia, the long-run international Balassa-Samuelson effects were higher than the 1½ percentage point margin allowed by the Maastricht treaty; in Estonia and Poland they were close to 1 percentage point; and in Latvia around 0.6 point. In Bulgaria, Croatia, the Czech Republic and Romania, the estimated Balassa-Samuelson effects ranged from 0.03 to 0.44 percentage point.

For Bulgaria and Croatia, the estimates of the coefficient β_2 for the short-run Balassa-Samuelson effect are negative. This reflects the fact that tradable/non-tradable productivity growth differentials in these countries are lower than in the euro area (see Table 2). Nonetheless, when these negative coefficients are multiplied by, on average, negative productivity growth differentials vis-à-vis the euro area $(LP^T-LP^{NT}) - (LP^{T*}-LP^{NT*})$, one obtains positive international Balassa-Samuelson effects for both countries (Table 3, last two columns).

All CEE countries exhibit a fairly high persistence of inflation differentials vis-à-vis the euro area: estimates of the coefficient β_0 range from around 0.80 in Bulgaria, the Czech Republic and Latvia to around 0.96 in Estonia, Lithuania and Romania, and all of them had the lowest standard errors.

Estimates of the pass-through of exchange rate changes to inflation differentials are less satisfactory. For Poland, no statistically significant estimate of the coefficient β_1 could be obtained; for Lithuania the estimated coefficient was negative and highly significant; and for Hungary, Latvia and Romania it was significant at the 10% level only. Bulgaria and Estonia have kept fixed exchange rates against the euro over the sample period, so exchange rates were not included in their regressions. Latvia and Lithuania switched from their pegs to the SDR and the dollar, respectively, closer to 2004, when they joined the EU, so the results for these countries – in particular the negative exchange rate pass-through for Lithuania – are not entirely surprising. Interestingly, the highest pass-through of exchange rate changes to inflation differentials was observed in Slovenia and Slovakia, the only two countries in the sample that have fulfilled the Maastricht inflation criterion so far.

While these results on the whole suggest that the long-run Balassa-Samuelson effects in CEE might be fairly large, one should not jump to the conclusion that they support claims that the Maastricht inflation criterion needs to be reconsidered. The only countries for which the above regression estimates are very robust to small changes in specifications are the Czech Republic, Lithuania and Slovakia. For all other countries, small changes in initial or final observations, or in the lag structure of explanatory variables, often affected the size and statistical significance of the estimates.

Estimates of the ***domestic Balassa-Samuelson effects*** are shown in Table 4. All estimates of the coefficient γ_2^s except one are statistically highly significant. However, the sign of the short-run Balassa-Samuelson coefficient for Hungary, Latvia and Lithuania is negative, although the size of the coefficient in each case is relatively small. In these three countries, faster productivity growth in tradable vs. non-tradable industries has been associated with a small *decline* in the relative price of non-tradables, contradicting the Balassa-Samuelson hypothesis. In all other countries, the coefficient on relative productivity growth has the expected positive sign; its size ranges from 0.05 (Poland) to 0.24 (Bulgaria).

Estimates of the coefficient γ_0 on lagged relative price changes have the expected positive sign and are statistically highly significant. Their fairly large size indicates strong persistence of past relative price changes and also leads to high estimates of the long-run effects of differential productivity growth γ_2^l.

The contribution of changes in relative productivity differentials $(LP^T\text{–}LP^{NT})$ to changes in relative price differentials (CPI^{NT}/CPI^T) is obtained by multiplying the short-run and long-run coefficients γ_2 with the respective average values of productivity differentials over the sample periods. These contributions amount on average to 0.22 percentage point in the short run and 1.94 points in the long run. Over the long run and on average, the domestic Balassa-Samuelson effects thus account for about 84% of the observed relative price differential of 2.3 percentage points.

Table 4: Estimates of the domestic Balassa-Samuelson effect
Dependent variable: domestic relative price differential P^{NT}/P^{T}

Country (Period yy:q)		Explanatory variables			Contribution of (LP^T/LP^{NT}) to (CPI^{NT}/CPI^T)		Domestic Balassa-Samuelson effect[2]	
		$\log(CPI^{NT}/CPI^T)_{t-1}$	$\text{Log}(LP^T/LP^{NT})_t$					
		γ_0	γ_2^s	γ_2^l	Short-run	Long-run	Short-run	Long-run
Bulgaria	(98:2–07:3)	0.873	0.244	1.924	0.103	0.811	0.065	0.509
Croatia	(98:4–08:1)	0.794	0.121	0.584	0.320	1.552	0.181	0.877
Czech R.	(97:2–08:1)	0.944	0.080	1.433	0.284	5.079	0.176	3.143
Estonia	(97:1–08:1)	0.877	0.077*	0.628	0.315	2.561	0.223	1.814
Hungary	(97:1–08:1)	0.878	–0.038	–0.308	–0.132	–1.079	–0.078	–0.640
Latvia	(98:4–07:3)	0.897	–0.039	–0.377	–0.128	–1.248	–0.099	–0.963
Lithuania	(96:2–08:1)	0.965	–0.036	–1.023	–0.156	–4.481	–0.103	–2.975
Poland	(97:3–07:3)	0.950	0.045	0.890	0.165	3.290	0.111	2.221
Romania	(98:3–07:4)	0.954	0.097	2.139	0.422	9.269	0.217	4.758
Slovakia	(99:1–08:1)	0.740	0.109	0.418	0.880	3.383	0.531	2.044
Slovenia	(99:1–07:4)	0.839	0.074	0.457	0.355	2.201	0.219	1.357
Average		***0.883***	***0.067***	***0.615***	***0.221***	***1.940***	***0.131***	***1.104***

All estimated coefficients are significant at the 1% test level, except the one for Estonia marked with "*", which is significant at the 10% test level.
[1] Contribution of the sectoral productivity differential *(LP^T–LP^{NT})* to non-tradable/tradable goods inflation, in percentage points. Calculated as γ_2^i times the average productivity differential observed over the sample period, where *i* denotes short-run and long-run elasticities. [2] Contribution of sectoral productivity differential *(LP^T–LP^{NT})* to *(CPI^{NT}/CPI^T)* adjusted for the share of non-tradables *(1–α)*; in percentage points. This is a proxy for the contribution of *(LP^T–LP^{NT})* to overall inflation.

The contribution of relative productivity differentials to relative price differentials can be translated into the contribution to *overall* inflation as follows. Starting from the definition of consumer price inflation as a weighted average of tradable and non-tradable goods price inflation (equation 5):

$$\hat{p}_t = \alpha\hat{p}_t^T + (1-\alpha)\hat{p}_t^{NT} \qquad (5)$$

where *α* is the share of traded goods in the CPI basket, and using the expression for the relative price of non-tradables from equation (2) one obtains equation (6):

$$\hat{p}_t = \hat{p}_t^T + (1-\alpha)(\hat{a}_t^T - \hat{a}_t^{NT}) \qquad (6)$$

Ie, the contribution of relative productivity differentials to overall inflation is proportionate to the share of non-tradables *(1–α)* multiplied by the contribution of relative productivity differentials to relative price differentials. This expression gives estimates of the domestic Balassa-Samuelson effect shown in the last two columns of Table 4. On average, the short-run effect amounts to 0.13 percentage point, and the long-run effect to 1.10 points. Faster growth of relative prices of non-tradables, resulting from faster growth of productivity in tradable relative to non-tradable industries, may thus have contributed on average around 1.10 percentage points to inflation in CEE countries over the long run. In other words, the domestic Balassa-Samuelson effect may on average explain only around 16% of overall domestic CPI inflation of 7% in CEE countries.

What is the evidence on the size of the ***Balassa-Samuelson effect over time***?

In the simple accounting framework presented in Tables 1 and 2, the results are mixed. If we take the last quarter of 2001 as the mid-point of the sample, the international and domestic Balassa-Samuelson effects declined in the more recent sub-period (from 2002 to Q1:2008) in Bulgaria, Croatia, Hungary, Latvia and Slovakia; but increased in the Czech Republic, Estonia, Lithuania, Poland and Slovenia (Table 5).

Table 5: Balassa-Samuelson effect over time

Country	Accounting framework[1]				Change in econometric estimates[2]	
	International BSE		Domestic BSE		Inter-national BSE	Domestic BSE
	t_0–2001:Q4	2002:Q1–2008:Q1	t_0–2001:Q4	2002:Q1–2008:Q1		
Bulgaria	0.7	–2.8	0.7	–2.8	no Δ	↓
Croatia	0.8	–0.5	4.7	1.7	↓	↓
Czech Republic	–0.3	1.1	2.6	4.2	no Δ	↑
Estonia	–1.4	1.9	4.2	4.7	no Δ	↓
Hungary	0.7	0.6	4.3	3.6	no Δ	↓
Lithuania	–0.5	2.7	2.1	6.2	↓	↑
Latvia	2.3	0.5	4.2	2.6	no Δ	no Δ
Poland	–0.5	2.0	2.0	5.1	no Δ	↓
Romania	–1.0	1.1	2.3	5.0	↓	↓
Slovakia	3.4	2.3	8.2	7.7	↑	no Δ
Slovenia	1.1	1.6	3.8	5.0	no Δ	no Δ

[1] Based on the historical data summarised in Tables 1 and 2. [2] Based on the estimates of regression equations (3) and (4) for two sub-periods of the main mid-1990s–2008:Q1 period (determined for each country by Chow breakpoint tests). The entries indicate no change (no Δ, increase (↑) or decrease (↓) in the estimated Balassa-Samuelson coefficient between the earlier and later periods.

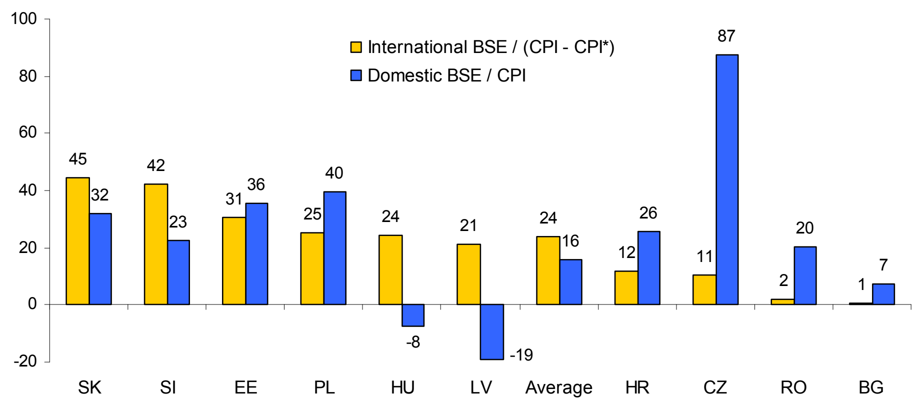
The results of econometric estimates are also mixed. For the international effect, the Chow breakpoint test indicated the presence of a structural breakpoint in the series for differential productivity growth $(LP^T–LP^{NT})–(LP^T*–LP^{NT}*)$ for only four countries: Croatia (at 2004:Q1), Lithuania (2000:Q1), Romania (2001:Q2) and Slovakia (2002:Q1). Evidence on changes in the size of the short-run Balassa-Samuelson coefficient β_2^s in the respective sub-periods was mixed. The size of the coefficient declined in the second sub-period (ie, from the breakpoint through 2008:Q1) in Croatia, Lithuania and Romania, but increased substantially in Slovakia. These estimates are unreliable, however, because of the short length of the time series and – in the case of Croatia, Romania and Slovakia – the long time lags (7–10 quarters) with which differential productivity growth affects inflation differentials vis-à-vis the euro area.

For the domestic Balassa-Samuelson effect, the Chow breakpoint test indicated the presence of a structural breakpoint in the (LP^T/LP^{NT}) series for all the countries except Latvia, Slovenia and Slovakia. The breakpoints were at 2002:Q1 for Bulgaria, Croatia and Romania; 2003:Q1 for the Czech Republic, Estonia, Hungary and Poland; and 2001:Q1 for Lithuania. The size of the short-run coefficient γ_2^s declined in the second, more-recent sub-period in Bulgaria, Croatia, Estonia, Hungary, Poland and Romania, reflecting the slowing of productivity growth in tradables vs. non-tradables in recent years compared with the second half of the 1990s. The coefficient γ_2^s increased in the more recent sub-period only in the Czech Republic and Lithuania. Because of the short length of the time series, these sub-period estimates of the domestic Balassa-Samuelson effects are less reliable than the estimates shown in Table 4, though on the whole they are somewhat better than those for the international effect by sub-periods.

5 CONCLUDING REMARKS

This paper has confirmed the presence of the Balassa-Samuelson effects in CEE countries in the period since the mid-1990s through the first quarter of 2008. Higher productivity growth in tradable relative to non-tradable industries has contributed to both higher inflation vis-à-vis the euro area (the international Balassa-Samuelson effect) and faster increases in domestic relative prices of non-tradables (the domestic Balassa-Samuelson effect). As shown in Graph 3, the international effects explain on average around 24% of inflation differentials vis-à-vis the euro area (about 1.2 percentage points on average). And the domestic effects explain on average 84% of the domestic relative price differentials of non-tradables vs. tradables, or about 16% of overall domestic CPI inflation (about 1.1 percentage points on average).

Graph 3: Percentage of inflation differential vis-à-vis the euro area, and of domestic CPI inflation, explained by international and domestic Balassa-Samuelson effects



Source: Authors' calculations, based on the data described in the Appendix.

For several reasons, estimates of the Balassa-Samuelson effects obtained in this paper are likely to be upward biased. In particular, we used the shares of non-tradables in value added rather than in the consumption basket, and we classified some low-productivity tradable services as non-tradables. Additional control variables such as regulated prices, which are important in non-tradable sectors, might also reduce the size of the Balassa-Samuelson effects compared to the estimates in this paper. However, by extending our sample to a larger number of countries and a much longer period; including the important sector of agriculture in tradables; and especially by using country- and time-specific shares of non-tradables, we have obtained more precise and representative estimates of the Balassa-Samuelson effects than have other available studies.

Real convergence since the early 2000s seems to have reduced the domestic Balassa-Samuelson effects in several countries and the international effects in somewhat fewer countries. But for several countries, the size of both effects may have increased.

The experience of Slovenia and Slovakia, both of which have relatively strong Balassa-Samuelson effects vis-à-vis the euro area (estimated at 2.0 and 1.7 percentage points, respectively), shows that it is possible to fulfil the Maastricht inflation criterion even if these effects might be higher than the 1½ percentage point margin allowed by the Maastricht treaty. At the same time, it cannot be ruled out that a strong Balassa-Samuelson effect could complicate the policy tradeoffs for some EMU candidate countries. Arguably, Lithuania's strong Balassa-Samuelson effect, estimated at 4.6 percentage points, may have been one of the factors behind the country's unsuccessful bid to join the euro area in 2007. This suggests that the Balassa-Samuelson effects are likely to remain on the policy and research agenda for a while, given that the pace of catching-up is likely to remain uneven across countries seeking to join EMU.

Against this background, one should perhaps caution against attempts to start using estimates of the Balassa-Samuelson effects in policy assessment. Obtaining precise and reliable estimates of these effects is much more difficult than, for instance, obtaining estimates of potential GDP. In particular, measurement errors and room for discretion in transforming the data and applying even the simplest estimating procedures are not negligible. Issues of equal treatment would inevitably arise if one sought to standardise these estimating procedures in practice. Therefore, one would be hard pressed to recommend, in good confidence, an operationalisation of the concept of the Balassa-Samuelson effect for the assessment of the Maastricht inflation criterion.

APPENDIX

DATA DESCRIPTION

Traded and non-traded sectors
Traded goods and services: agriculture, forestry and hunting; fishing; mining and quarrying; manufacturing.
Non-traded goods and services: electricity, gas and water supply; construction; wholesale and retail trade, repair of motor vehicles, personal and household goods; transport, storage and communication; financial intermediation; real estate, renting and business activities.
Not included are public administration, defence and compulsory social security; education; health and social work; other community, social and personal services; and activities of household.

DESCRIPTION OF VARIABLES

- Quarterly indices of value added growth (in constant prices) from the production-side estimates of GDP. Sectors are aggregated into traded and non-traded using industries' shares in total value added in a given quarter.
- CPI rates of inflation with subcomponents (quarterly averages of monthly rates). The breakdown into traded and non-traded goods and services followed the production-side classification as closely as possible. However, the complete matching of sectors with price indices was not always possible. The subcomponents are aggregated into traded and non-traded goods inflation using their weights in the CPI basket.
- Nominal exchange rates of domestic currency against the euro (quarterly averages of daily rates).
- Employment (total number of workers, quarterly averages of monthly figures) in traded and non-traded goods industries following the above classification. Employment in traded and non-traded sectors obtained from industries' shares in total employment (quarterly averages).

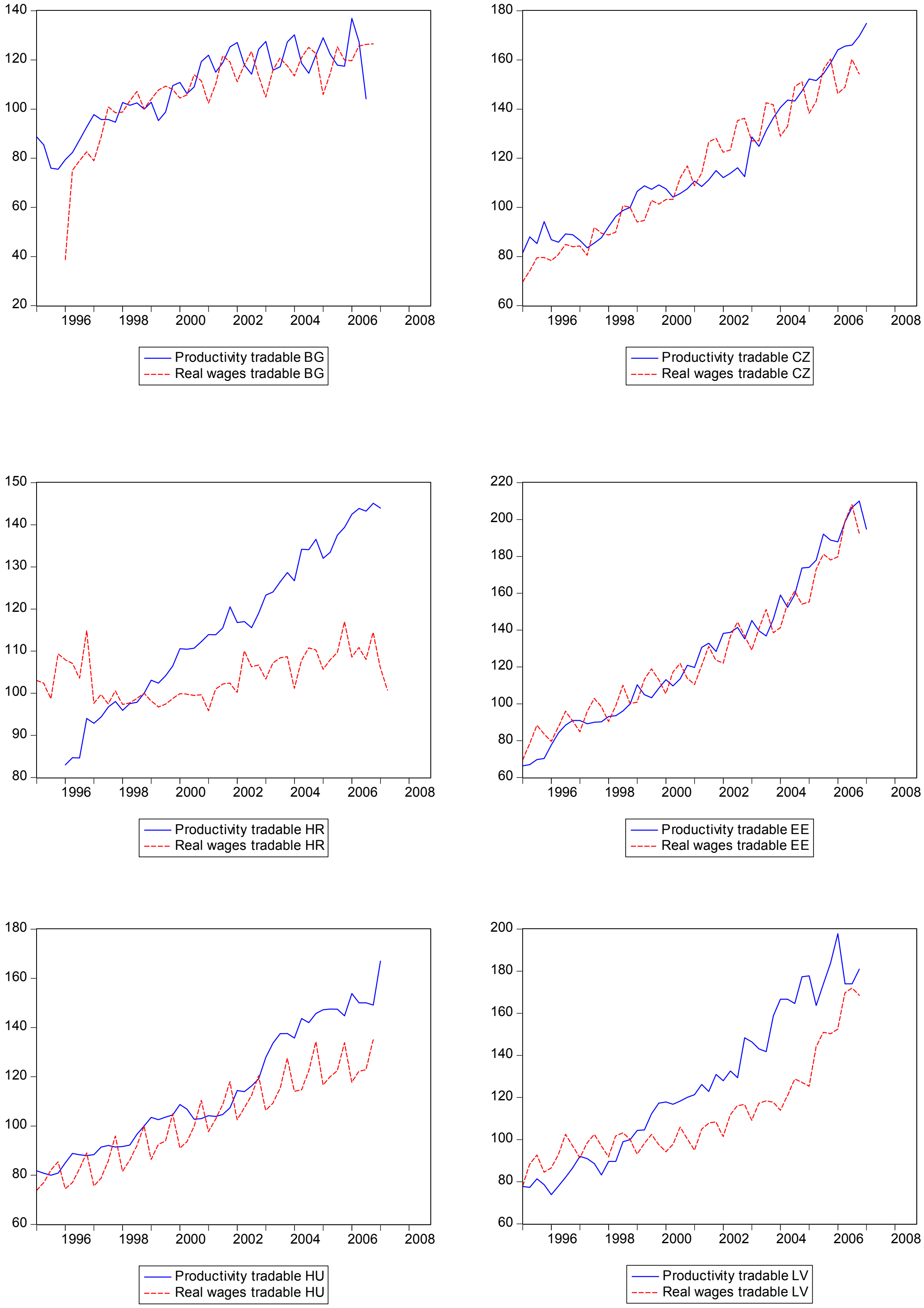
DATA TRANSFORMATIONS

- All variables entering regressions are first expressed in terms of chain indices showing four-quarter percentage changes, with 1999:Q4 = 100.
- For some initial observations in the mid-1990s (sectoral breakdown of value added and employment), quarterly data were linearly interpolated from annual data.
- All indices are then seasonally adjusted using the X-12 procedure.
- Finally, natural logarithms of seasonally adjusted indices are taken.
- These time series are tested for stationarity using the augmented Dickey-Fuller unit root test.

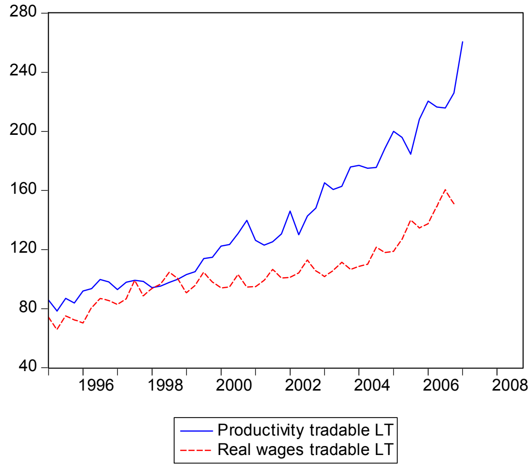
DATA SOURCES

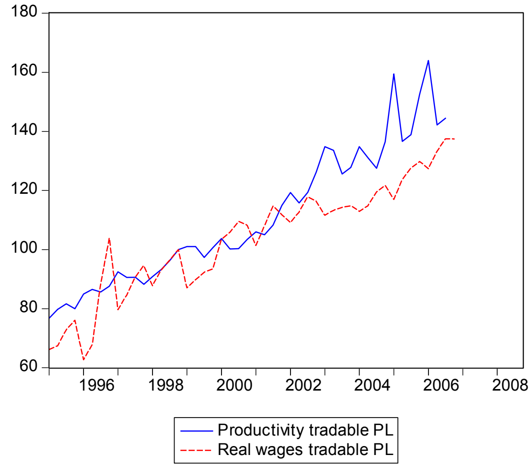
Eurostat; national central banks and statistical offices; European Central Bank; BIS Data Bank; BIS staff estimates.

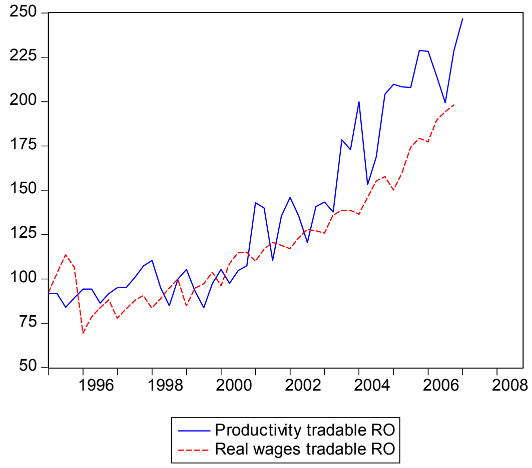
Appendix Graph A1: Productivity and wages in tradable industries
2000:Q4 = 100; not seasonally adjusted

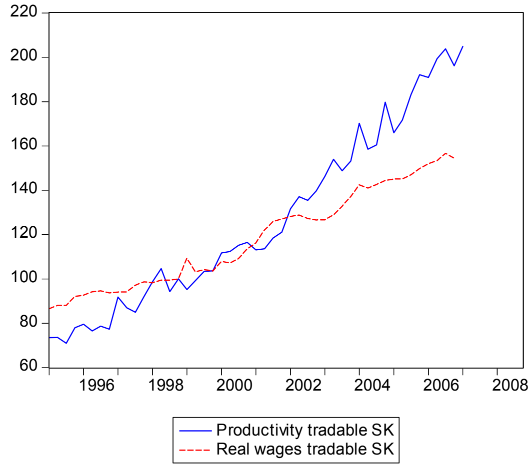


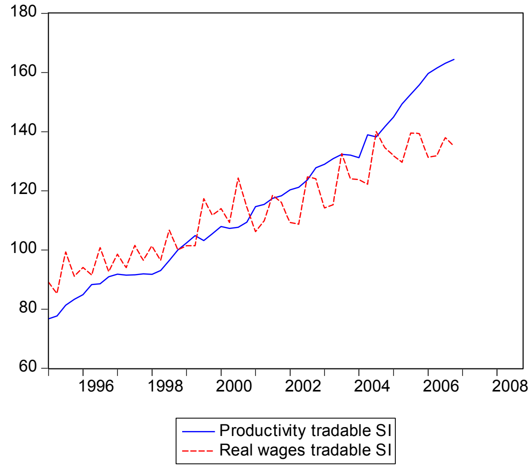
Appendix Graph A1 (cont): Productivity and wages in tradable industries
2000:Q4 = 100; not seasonally adjusted



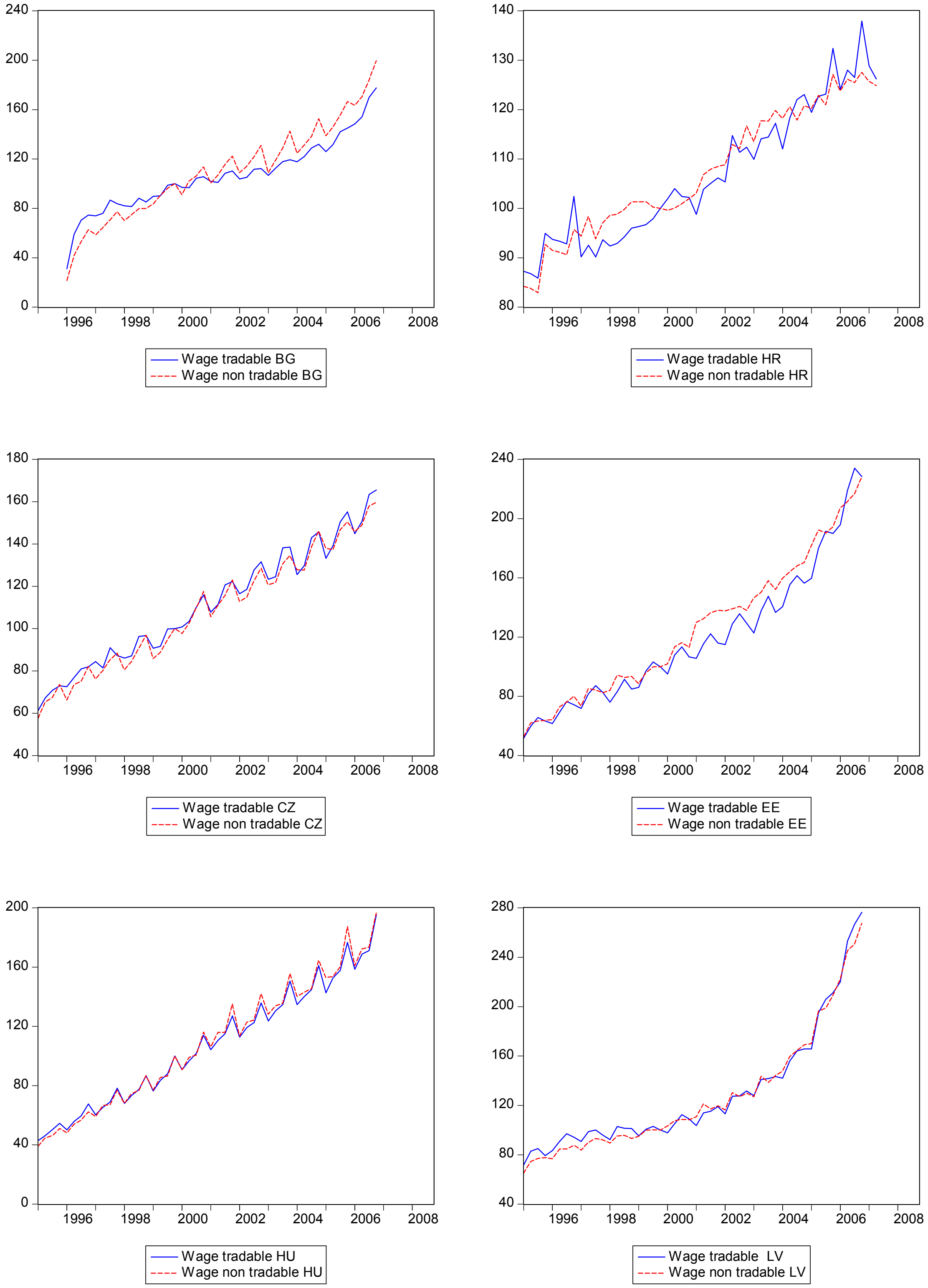




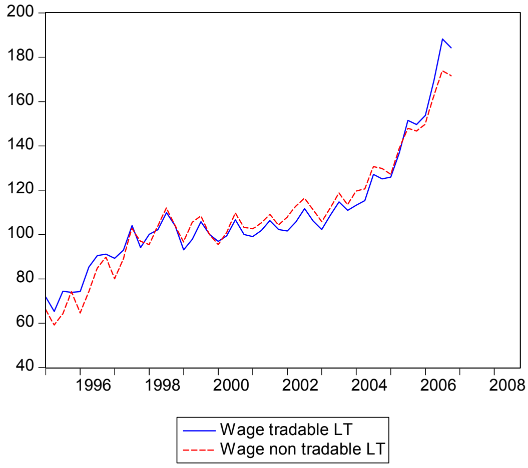


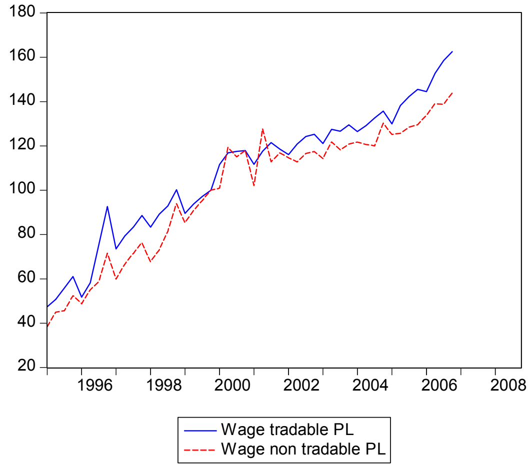


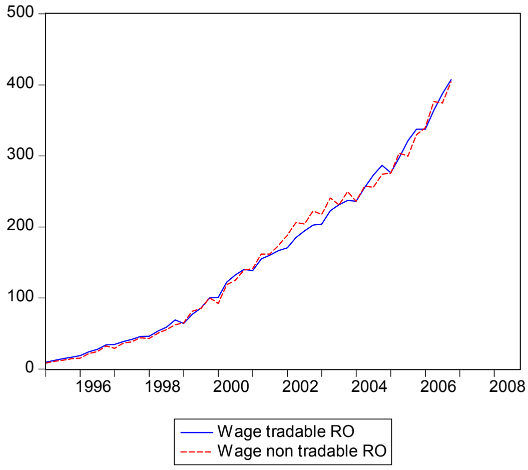
Appendix Graph A2: Wages in tradable and non-tradable industries
2000:Q4 = 100; not seasonally adjusted

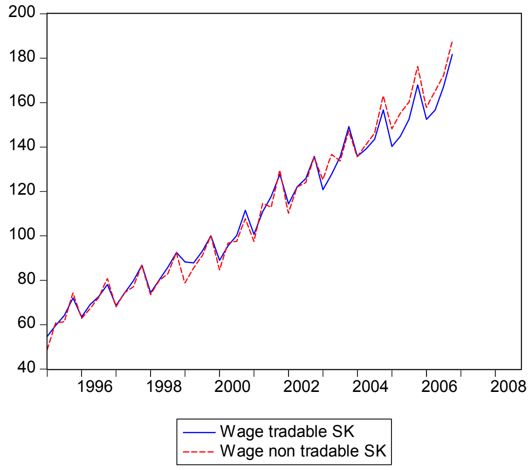


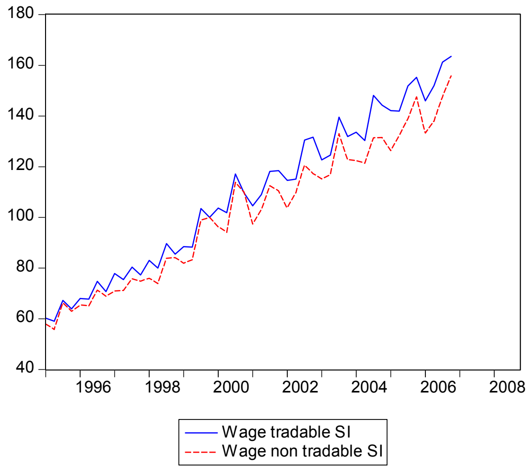
Appendix Graph A2 (cont): Wages in tradable and non-tradable industries
2000:Q4 = 100; not seasonally adjusted











REFERENCES

Alberola-Ila E and T Tyrväinen (1998): "Is there scope for inflation differentials in EMU? An empirical evaluation of the Balassa-Samuelson model in EMU", Banco de España Working Paper no 9823.

Begg, D, B Eichengreen, L Halpern, J von Hagen and C Wyplosz (2003): "Sustainable Regimes of Capital Movements in Accession Countries", CEPR Policy Paper no 10.

Buiter, W and A Siebert (2006): "The inflation criterion for Eurozone membership: what to do when you fail to meet it?" paper prepared for the Annual Meeting of the Turkish Economic Association, Ankara, 11 September.

Buiter W and C Grafe (2002): "Anchor, Float or Abandon Ship: Exchange Rate Regimes for the Accession Countries", *European Investment Bank Papers*, 7(2), 51–71.

Burgess R, S Fabrizio and Y Xiao (2003): "Competitiveness in the Baltics in the run-up to EU accession", IMF Country Report no 03/114. www.imf.org.

Chukalev, G (2002): "The Balassa-Samuelson effect in the Bulgarian economy", Working Paper of the Bulgarian Agency for Economic Analysis and Forecasting.

Cincibuch, M and J Podpiera (2006): "Beyond Balassa-Samuelson: real appreciation in tradables and transition countries", *Economics of Transition*, vol 14, no 3, 547-573.

Cipriani, M (2001): *The Balassa-Samuelson effect in transition economies*, unpublished manuscript, IMF, Washington, September.

Coricelli, F and B Jazbec (2001): "Real exchange rate dynamics in transition economies", *Structural Change and Economic Dynamics*, vol 15, 83–100.

Darvas, Z and G Szapáry (2008): "Euro area enlargement and euro adoption strategies", European Commission, *Economic Papers* No. 304, February.

De Gregorio, J, A Giovannini and H Wolf (1994): "International evidence on tradables and nontradables inflation", *European Economic Review*, 38, 1225–44.

Deroose, S and J Baras (2005): "The Maastricht criteria on price and exchange rate stability and ERM II", in S Schadler (ed), *Euro adoption in central and eastern Europe: opportunities and challenges*, IMF, Washington, 128–41.

Égert, B (2007): "Real convergence, price convergence and inflation differentials in Europe", CESifo Working Paper No 2127, October.

——— (2005a): "Balassa-Samuelson meets south-eastern Europe, the CIS and Turkey: a close encounter of the third kind?" European Journal of Comparative Economics, Vol 2 no 2, 221–234.

——— (2005b): "The Balassa-Samuelson hypothesis in Estonia: oil shale, tradable goods, regulated prices and other culprits", *World Economy*, vol 28, no 2, 259–286.

——— (2003): "Assessing equilibrium exchange rates in CEE acceding countries: can we have DEER with BEER without FEER? A critical survey of the literature", *Focus on Transition*, no 2, 38–106.

——— (2002a): "Estimating the Balassa-Samuelson effect on inflation and the real exchange rate during the transition", *Economic Systems*, 26, 1–16.

——— (2002b): "Investigating the Balassa-Samuelson hypothesis in transition: do we understand what we see? A panel study", *Economics of Transition*, vol 10, 273–309.

Égert, B and J Podpiera (2008): "Structural inflation and real exchange rate appreciation in Visegrad-4 countries: Balassa-Samuelson or something else?" CEPR *Policy Insight* no 20, April. www.cepr.org.

Égert, B, I Drine, K Lommatzsch and C Rault (2003): "The Balassa-Samuelson effect in central and eastern Europe: myth or reality", *Journal of Comparative Economics*, Vol 31, 552–572.

Égert, B, L Halpern and R MacDonald (2006): "Equilibrium exchange rates in transition economies: taking stock of the issues", *Journal of Economic Surveys*, Vol 20, no 2, 257–324.

Flek, V, L Marková and J Podpiera (2002): "Sectoral productivity and real exchange rate appreciation: much ado about nothing?" *Czech National Bank Working Paper*, no 4.

Funda, J, G Lukinić and I Ljubaj (2007): "Assessment of the Balassa-Samuelson effect in Croatia", *Financial Theory and Practice*, vol 31, no 4, 321–351. www.ijf.hr.

Golinelli, R and R Orsi (2002): "Modelling inflation in EU accession countries: the case of the Czech Republic, Hungary and Poland", in W Charmeza and K Strzala (eds) *East European transition and EU enlargement: a quantitative approach*, Berlin: Springer, 267–290.

Halpern, L and C Wyplosz (2001): "Economic transformation and real exchange rates in the 2000s: the Balassa-Samuelson connection", *Economic Survey of Europe*, no 1, Geneva, United Nations Economic Commission for Europe.

Kovács, M (ed) (2002): "On the estimated size of the Balassa-Samuelson effect in five central and eastern European countries", MNB Working Paper, no 5/2002. www.mnb.hu.

Kovács, M and A Simon (1998): "Components of the real exchange rate in Hungary", National Bank of Hungary Working Paper, no 1998/3.

Lojschova, A (2003): "Estimating the impact of the Balassa-Samuelson effect in transition economies", Institute for Advanced Studies (Vienna), Working Paper no 140.

MacDonald, R and C Wojcik (2004): "Catching-up: the role of demand, supply and regulated price effects on the real exchange rates of four accession countries", *Economics of Transition*, vol 12, 153–179.

Mihaljek, D (2008): "The financial stability implications of increased capital inflows for emerging market economies", *BIS Papers*, no 44, December, 11–44.

——— (2006): "Are the Maastricht criteria appropriate for central and eastern Europe?" in S Motamen-Samadian (ed), *Economic Transition in Central and Eastern European Countries*, Cheltenham: Palgrave.

Mihaljek, D and M Klau (2007): "The Balassa-Samuelson effect and the Maastricht criteria: revisiting the debate", in N Batini (ed), *Monetary Policy in Emerging Markets and Other Developing Countries*, New York: Nova Science Publishers.

——— (2004): "The Balassa-Samuelson effect in central Europe: a disaggregated analysis", *Comparative Economic Studies*, vol 46, March, 63–94.

Nenovsky N and K Dimitrova (2002): "Dual inflation under the currency board: the challenges of Bulgarian EU accession", William Davidson Institute Working Paper no 487.

Padoa-Schioppa, T (2003): "Trajectories towards the euro and the role of ERM II", in Gertrude Tumpel-Gugerell and Peter Mooslechner (eds), *Structural Challenges for Europe*, Edward Elgar, 405–412.

Rother, P (2000): "The impact of productivity differentials on inflation and the real exchange rate: an estimation of the Balassa-Samuelson effect in Slovenia", in *Republic of Slovenia: Selected issues*, IMF Staff Country Report no 00/56.

Szapáry, G (2000): "Maastricht and the choice of the exchange rate regime in the transition countries during the run-up to EMU", National Bank of Hungary Working Paper no 2000/7.

Wagner M and J Hlouskova (2004): "What is really the story with the Balassa-Samuelson effect in the CEECs", University of Bern, Economics Department Discussion Paper no 04/16.

The Role of Inflation Persistence in the Inflation Process in the New EU Member States[59]

Michal Franta[60]
(CERGE-EI[61])

Branislav Saxa
(Czech National Bank, CERGE-EI[61])

Kateřina Šmídková
(Czech National Bank, Charles University)

ABSTRACT

The aim of the paper is to compare inflation persistence between the New Member States (NMS) that joined the European Union in years 2004 and 2007 and selected euro area members. If the inflation persistence in the two groups is different, NMS can encounter problems with the fulfillment of the Maastricht criterion on inflation and - after entering the euro area - with the inflation divergence. We argue that due to the transition process experienced by the NMS in the last 15 years, measures of inflation persistence need to be selected carefully. Two measures are estimated. The first one is based on the simple univariate statistical model of inflation with time-varying mean. The second one assumes inflation following fractionally integrated process and measures inflation persistence within an ARFIMA model. Estimation results show that inflation persistence is not an issue for all the NMS. On one hand, Bulgaria, Cyprus, Czech Republic, Malta, Romania, and Slovakia exhibit persistence levels similar to those in the selected euro area countries. On the other hand, Estonia, Hungary, Latvia, Lithuania, Poland, and Slovenia encounter a problem of high persistence stemming from both high intrinsic and expectations-based inflation persistence.

JEL Classification: E31, C22, C11, C32;
Keywords: Inflation persistence, New Member States, time-varying mean, central bank credibility, ARFIMA model, Bayesian estimation, Kalman filter.

[59] The views expressed are those of the authors, and do not necessarily represent those of the affiliated institutions. We thank Roman Horváth, Alf Vanags, Massimo Suardi and all the participants of the workshop organized by the Directorate-General for Economic and Financial Affairs of the European Commission "What Drives Inflation in the New EU Member States?" for useful comments and suggestions. The paper has been written with the support of the European Commission (reference ECFIN/C/2008/010).
[60] The corresponding author is michal.franta@cerge-ei.cz.
[61] A joint workplace of the Center for Economic Research and Graduate Education, Charles University, and the Economics Institute of the Academy of Sciences of the Czech Republic.

1 INTRODUCTION

In the last fifteen years, the average inflation rate in the New Member States (NMS) amounted to 20% in comparison to much lower level of 2.5% in the euro area countries (EAC). This significant difference in inflation rates between the two groups of countries has been most often associated with real convergence and related factors such as the Balassa-Samuelson effect or repercussions of the economic transformation such as price deregulations (ECB, 2006). One would expect that these factors would gradually step aside as the NMS reach advanced stages of real convergence. However, there is another class of factors that may reflect longer-term characteristics of national economies and thus contribute to prevailing inflation differences even in the advanced stages of convergence. Specifically, inflation persistence and inflation expectations can have considerable impact on inflation differences between the NMS and EAC after the effects of economic transformation and real convergence fade away.

In the euro area context, the implications of differences in inflation persistence were studied by various authors in 2002-2004 when inflation divergence among the EAC was first observed (Altissimo, Ehrmann and Smets, 2006). It was shown that the inflation convergence reached prior to adopting the euro has not been sustained among the EAC since 1998 (EC, 2002). The inflation persistence was pointed out as one of the prominent reasons for this divergence of inflation. It was asserted that the euro area economies adjust unevenly to symmetric shocks due to differences in inflation persistence. Although at that time, the NMS were not subject of these studies, later on, considerations of implications for the NMS influenced the debate about euro adoption strategies (CNB, 2007).

Bjorksten (2002) and Ca'Zorzi and De Santis (2003) point out that inflation differences may prevail longer inside the euro area once the NMS introduce the euro because of country differences among the enlarged group of EAC. EC (2002, 2004), ECB (2003), OECD (2002) and IMF (2002) suggest that adequate national structural reforms should be adopted in countries with high inflation persistence in order to avoid divergence. Franta, Saxa and Šmídková (2007) draw attention to the fact that persistence will matter also in the preparatory period for the euro adoption. Significantly higher inflation persistence in the NMS, compared to the EAC, would amplify differences in reactions to symmetric shocks on the national level. As a result, the risk of deviating of national inflation rates from the Maastricht benchmarks (and potentially even the subsequent risks of inflation divergence inside the gradually enlarged euro area) would intensify. Analogously, similarities in inflation persistence would increase the likelihood of symmetric reactions to common shocks. For this reason, policy makers in the NMS should include the analysis of inflation persistence into their background documents when debating euro adoption strategies. Tests indicating high inflation persistence should be viewed as an additional argument to proceed further with institutional and labor market reforms prior to the euro adoption. These reforms would typically improve flexibility of domestic economy and subsequently reduce inflation persistence.

While the link between the different levels of inflation persistence and inflation divergence inside the euro area has been already established (Angeloni and Ehrmann, 2004), connection to the fulfillment of the Maastricht criteria has not been so well covered. According to the most intuitive definition, high inflation persistence corresponds to the slow return of inflation to its long-run value after a shock, including symmetric one (e.g. an oil shock), occurs62. Therefore, should a symmetric shock hit all EU members, whose inflation rates are used to compute the Maastricht benchmark for inflation (Bulíř and Hurník, 2006), all NMS with high estimates of persistence could struggle to meet the Maastricht inflation criterion. They could struggle for two reasons. First, it would take them longer to combat consequences of this symmetric shock and return inflation to its long-run value. This would decrease, ceteris paribus, probability of meeting the Maastricht inflation criterion. Second, the Maastricht benchmark for inflation would be very likely to move in an unfavorable direction. According to the Maastricht criterion on inflation, the NMS must have inflation comparable to the best EU inflation performers. This inherently implies that in the case of symmetric positive shock on inflation, the benchmark will be set by countries with a high speed of inflation adjustment, i.e. lowest inflation persistence. In other words, in the case of large differences in national inflation persistence values across the EU, it would be very difficult to stay close to the Maastricht inflation benchmark for those NMS with relatively high inflation persistence.

[62] There are alternative definitions of inflation persistence. For an excellent summary see Batini (2002).

Many approaches to estimating inflation persistence in the NMS come into question: estimates based on statistical models (from very simple univariate autoregressive models to highly sophisticated unobserved component models) as well as estimates based on structural models of the inflation process (univariate or multivariate systems usually including some version of the New Keynesian Phillips Curve). The statistical measures are instrumental to the debate about the fulfillment of the Maastricht criteria. The structural ones, on the other hand, can also serve as a basis for inferences about the country-specific effects of common monetary policy in the euro area extended to the NMS. As suggested by the Lucas critique, structural parameters are the appropriate measure to underline the discussion on the consequences of unequal inflation persistence after the monetary policy regime switch.

It is important to identify the most adequate approach for the measurement of inflation persistence in the NMS. In Franta, Saxa and Šmídková (2007)63 we found that the naive statistical measures of inflation persistence, derived from the autoregressive model with constant mean, suggest high inflation persistence in the NMS. The estimated inflation persistence for the NMS is close to one, once the confidence intervals are taken into account. This finding is in line with the available micro studies on inflation persistence in the NMS. However, more sophisticated statistical measures, allowing for a time-varying mean, give another picture. According to these measures, the estimates of inflation persistence in the NMS are comparable to those in the EAC. To avoid pitfalls, it is also important to distinguish whether inflation processes in the NMS are better represented as stationary processes with parameter instability or fractionally integrated processes. These processes both imply mean reversion, and hence can look very similar. Despite looking similar, they can imply different inflation persistence levels. Although empirical results based on autoregressive fractionally integrated moving average model suggest that persistence in some NMS may be higher than indicated by models with time varying mean, additional statistical tests imply that assuming a stationary process with breaks is a preferable assumption to fractionally integrated models for almost all considered countries.

The following important conclusions can be drawn from Franta, Saxa and Šmídková (2007). First, standard statistical approaches to measuring inflation persistence, based on constant inflation means can yield misleading conclusions about the role that persistence plays in the inflation formation in the NMS. They have been primarily designed to assess the persistence in developed economies (Marques, 2004). As a result, they do not take fully into account the specific situation of the NMS (e.g. monetary policy regime switches, price deregulations, real convergence towards the euro area, short time series etc.), and they tend to overestimate inflation persistence in the NMS by assuming a constant mean. Second, the univariate models with time-varying mean and autoregressive fractionally integrated moving average models (ARFIMA) are preferable measures of persistence since they account for the specific traits of the inflation processes in the NMS. Third, the structural measures are difficult to estimate due to the above-listed specific features of the NMS and consequent econometric problems.

This paper extends the existing literature in two ways. First, our sample covers all the NMS that acceded EU by May 1st, 2004 and January 1st, 2007. The extended sample allows us to test whether the conclusion about a lack of significant differences in inflation persistence in the NMS compared to the EAC is robust for the whole group. Second, results are updated by using the most recent observations for inflation time series in the NMS. We are able to add two full years of observations to the previously used data samples which is – given the relatively short time span of data series available – a non-negligible improvement of inflation persistence comparison across countries. This paper works solely with statistical inflation persistence measures.

The structure of the paper is as follows. Section 2 reviews the available literature on the topic with special emphasis on the relevance of inflation persistence in the NMS. Section 3 describes stylized facts and the two adopted statistical approaches to measuring and estimating inflation persistence. Section 4 reports on and discusses the results of these alternative estimates. Section 5 concludes. Appendix 1 includes plots of inflation rates for all sample countries; Appendix 2 provides the complete results of the Bayesian estimation of the time-varying mean model. Appendix 3 presents the estimates of perceived inflation targets.

[63] In the pilot study, the NMS were represented by four countries (Czech Republic, Hungary, Poland and Slovakia).

2 RELATED LITERATURE

In this section, we review key theoretical concepts that can be employed to model inflation process in order to estimate inflation persistence. We focus on those concepts that are relevant for the specific situation of the NMS, later we discuss major empirical results related to the NMS.

The first distinction stems from the type of data set employed. Micro data allow detailed examination of individual/sectoral price indexes and thus to avoid the problem of aggregation bias. On the other hand, macro (aggregate) data sets draw on price indexes relevant for the monetary policy. For example, estimates of inflation persistence in Slovakia, the most recent member of the euro area, on micro level, are available in Coricelli and Horváth (2006) as well as on macro level in Franta, Saxa and Šmídková (2007).

The second distinction, already addressed in the introduction, is drawn between statistical and structural approaches. Statistical measures of inflation persistence are usually based on a univariate representation of the inflation process. Marques (2004) provides a summary of such measures, e.g. measures based on the sum of autoregressive coefficients, the largest autoregressive root, half-life and spectral density at frequency zero. Inflation persistence measures based on structural models of inflation usually deal with some specification of the Phillips curve. Calvo (1983) introduces a model of nominal price rigidities where only a fraction of firms can adjust their prices in a given period. The Calvo model leads to purely forward looking reduced form specification and the persistence in inflation originate from the persistence in inflation driving variables (e.g. output gap, real marginal costs). This type of inflation persistence is denoted as extrinsic inflation persistence.

Since the models based on Calvo structural approach have been in terms of data fit inferior to models that incorporate lagged value of inflation, some attempts to extend Calvo model for backward looking behaviour of firms were made. Within the Calvo framework, Galí and Gertler (1999) and Christiano et al. (2005) assume a fraction of backward looking firms that set their prices according to prices in previous period adjusted for inflation. The resulting hybrid version of the New Keynesian Phillips curve (NKPC) introduce a new type of inflation persistence that origin in the price setting process itself and thus that is qualitatively different from the extrinsic inflation persistence. Inflation persistence that stems from the way wages and prices are set is called intrinsic inflation persistence.64

More recently, the question has arisen whether the intrinsic inflation persistence captured by the lagged values of inflation is spurious (see e.g. Sbordone, 2007). Within this debate, attention of researchers turns to the role of inflation trend for modeling inflation process and measuring inflation persistence. Regardless recent models take the form of NKPC or are purely statistical the focus is on the process assumed for inflation trend, interpretation of the inflation trend changes and implications for the persistence of inflation.

Marques (2004) considers several treatments for the inflation trend that is represented by the time-varying mean of inflation. For US and euro area inflation, he applies an HP filter and a moving average. Dossche and Everaert (2005) model the time-varying mean as an AR(2) process. Stock and Watson (2007), and Cogley, Primiceri, and Sargent (2008) assume trend following driftless random walk. In addition to Dossche and Everaert, they also impose stochastic volatility of the inflation trend. Finally, Cogley and Sbordone (2006) derive NKPC by the log-linearization of the Calvo model specification around time-varying trend. This procedure leads to NKPC with time-varying coefficients.

The models with time-varying inflation trend introduce another type of inflation persistence that stems from the changes in trend inflation. In general, papers mentioned in the previous paragraph find the trend inflation to be an important contributor to the overall inflation persistence. Moreover, some of the papers identify significant influence of monetary policy on changes in the inflation trend.

Bilke (2005) and Dossche and Everaert (2005) discuss the role of monetary policy changes for the inflation mean – unobserved component model of Dossche and Everaert includes central bank's inflation target. Inflation mean follows a process dependent on the target. The significant influence of monetary policy on the decrease of overall inflation persistence in developed countries over the last two decades is also discussed in Mishkin (2007), Cecchetti et al. (2007), Sbordone (2007), Stock and Watson (1997), and Benati (2008). Finally, note that not

[64] The structural character of hybrid version of New Keynesian Phillips curve has been questioned on the grounds of micro-evidence. It turns out, for example, that individual prices remain unchanged for several periods contradicting Christiano et al. (2005) assumption on indexation of prices.

only monetary policy regime changes are examined as a source of changes in the inflation trend. Gadzinski and Orlandi (2004) and Levin and Piger (2004), for example, focus on the influence of administrative price changes on the mean of inflation.

Another stream of literature investigating inflation persistence employs fractionally integrated process65 to model inflation. Motivation stems from the fact that literature provides substantial evidence against inflation following both I(0) and I(1) process. Common explanation is that this is the result of structural breaks in the time series. However, the other alternative is that inflation series follow fractionally integrated or ARFIMA process. As Gadea and Mayoral (2006) suggest, stationary processes with structural breaks and fractionally integrated processes can be easily confused. In their paper, they show analytically why inflation in the model with sticky prices could exhibit fractionally integrated behavior and they estimate the order of fractionally integrated process for a set of OECD countries. Assuming fractionally integrated nature of the inflation time series, three measures of inflation persistence are suggested and estimated in their paper. Finally, in order to evaluate the stability of inflation persistence over time, the Lagrange multiplier test of the stability of the order of fractionally integrated process is applied, suggesting that with the exception of three countries, inflation persistence remains stable in all inflation series.

The stability of inflation persistence is investigated also in another study that assumes inflation to follow fractionally integrated process. Unlike Gadea and Mayoral (2006), Kumar and Okimoto (2007) use moving window methodology to asses the stability of inflation persistence. What makes the views of Gadea and Mayoral (2006) on one side and Kumar and Okimoto (2007) on the other side fundamentally different is their treatment of structural breaks. While the authors of the former study view fractional integration as the alternative to stationary process with breaks, authors of the latter paper allow for two structural breaks in their time series keeping the assumption of fractionally integrated process.

In one of the first papers that analyze inflation using fractionally integrated process, Baillie et al. (1996) investigate also the persistence of conditional variances of inflation. Employing ARFIMA-GARCH framework to model the inflation of ten countries, they find that except of inflation of Japan, which appears to be stationary, inflation of nine other considered countries cannot be considered stationary, neither having unit root. Persistence of conditional variances modeled by GARCH process appears to be substantial too.

Two main contributions of the recent research on inflation persistence in developed countries are highly relevant for the NMS. First, to describe the inflation process and capture the inflation persistence fully, one has to allow for the variance in inflation trend (mean). Second, the changes in inflation trend relates to monetary policy regime switches and administrative price regulation. For the NMS some additional factors need to be taken into account e.g. convergence and transition of economy from centrally planned to market economy.

As was already mentioned in the introduction, the most of so far available research on inflation persistence in the NMS is based on micro data and on a limited sample of countries (Czech Republic, Hungary, Poland and Slovakia). Micro analysis is available for the Czech Republic in Babetskii, Coricelli and Horváth (2006), for Hungary in Ratfai (2006), for Poland in Konieczny and Skrzypacz (2005), and for Slovakia in Coricelli and Horváth (2006). They all work with one-country data sets and this makes any international comparisons rather difficult. As far as individual countries are concerned, authors of the respective studies find that in the Czech Republic inflation persistence is lower after the introduction of inflation targeting and that it is lower for non-durables and services. In the case of Hungary, the aggregation of micro data from one sector is shown to provide additional information about inflation dynamics. However, due to a very limited data sample, specific conclusions about the level of inflation persistence are difficult to come to. The Polish study makes use of a large disaggregated data set. It finds out that data are consistent with the menu cost model, and also that economic agents are rather forward-looking.

The macro studies are even fewer than the micro ones. Two studies focus on a selected group of the NMS. They both work with statistical models of persistence. Darvas and Varga (2007) suggest using the time-varying-coefficient models and Flexible Least Squares estimator in order to estimate inflation persistence in the Czech Republic, Hungary, Poland and Slovakia. They argue similarly to the second study - Franta, Saxa and Šmídková (2007) – that models with time-varying coefficients are vital for the inflation persistence analysis in the NMS.

[65] Baillie (1996) surveys applications of fractionally integrated processes in economics and finance. Applications for inflation time series, although predominantly for forecasting purposes, can be found in Baillie et al. (1996), Doornik and Ooms (2004) and Gabriel and Martins (2004).

The results of both studies are in accord. Inflation persistence in the NMS, at least the selected ones, is not very different from the one in the EAC. Both studies also agree that this is a crucial observation for the euro adoption strategies. In addition, Franta, Saxa and Šmídková (2007) propose to look at the most likely causes of inflation persistence by using models that are capable of distinguishing between intrinsic and extrinsic persistence on one hand, and persistence related to monetary policy and expectations on the other hand. This distinction might be useful to policy makers when they try to lower inflation persistence.

3 STYLIZED FACTS AND MODELS FOR ESTIMATING INFLATION PERSISTENCE

In this section, we provide data description and basic stylized facts on inflation in the NMS. We then discuss the two models we employ for the measurement of inflation persistence - the time-varying mean model and ARFIMA model.

3.1 DESCRIPTION OF DATA USED IN THIS STUDY

We work with two groups of countries. The first group of the NMS, that are the focus of this study, consists of 12 countries that joined the EU in 2004 and 2007: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. The second group of selected EAC – the control group – consists of 4 countries: Belgium, Germany, Portugal and Spain. For the sake of simplicity, we do not report results for all EAC, but only for a selected four countries that represent interesting case studies from the point of view of the NMS. Specifically, Belgium is a developed small open economy of a comparable size to most of the NMS. Germany is by many viewed as a country that anchored inflation in Europe. Portugal and Spain are small open converging economies that may face similar problems that are going to be encountered by the NMS in the forthcoming years. We do not compare the NMS with the euro area as a whole because euro area inflation aggregates can suffer from aggregation bias.66 Abbreviations of the countries used in the text, numbers of observations available for the analysis and corresponding time spans are reported in Table 1.

Table 1: Country abbreviations and time spans.

Country	Abbreviation	Observations	Period
Bulgaria	BUL	68	1991Q2-2008Q1
Cyprus	CYP	72	1990Q2-2008Q1
Czech Republic	CZE	60	1993Q2-2008Q1
Estonia	EST	64	1992Q2-2008Q1
Hungary	HUN	72	1990Q2-2008Q1
Latvia	LAT	68	1991Q2-2008Q1
Lithuania	LIT	63	1992Q3-2008Q1
Malta	MAL	72	1990Q2-2008Q1
Poland	POL	72	1990Q2-2008Q1
Romania	ROM	69	1991Q1-2008Q1
Slovakia	SVK	60	1993Q2-2008Q1
Slovenia	SLO	64	1992Q2-2008Q1
Belgium	BEL	72	1990Q2-2008Q1
Germany	GER	68	1991Q2-2008Q1
Spain	ESP	72	1990Q2-2008Q1
Portugal	POR	72	1990Q2-2008Q1

We employ CPI inflation as a preferred measure of inflation as CPI inflation rate is relevant for both domestic monetary policy in the NMS as well as for Maastricht criteria. Data for CPI inflation are taken from International

[66] For discussion on the effect of aggregation on inflation persistence differentials in the euro area see Fiess and Byrne (2007).

Financial Statistics by International Monetary Fund (IFS). We use seasonally adjusted annualized q-o-q rate of change of CPI computed as $400 * \ln\left(CPI_t / CPI_{t-1}\right)$.

3.2 SOME STYLIZED FACTS: INFLATION IN THE NMS

In the last 15 years, inflation rates in the NMS have been notably higher than in the EAC. Table 2 provides average inflation rates for the period 1993Q2-2008Q1 and the sub-period 2001Q1-2008Q1. These are samples available for all analyzed countries, as documented by Table 1. Two observations are worth noting. First, the difference in inflation means between the NMS and the EAC has been decreasing over time. While the inflation rates do not change for the EAC if we restrict the sample to the sub-period 2001Q1-2008Q1, they decrease considerably for almost all NMS.

Second, the NMS are not a homogenous group. They started the process of the EU accession with very different inflation rates. In the last 15 years, two NMS (Bulgaria, Romania) had on average inflation above 20%, five NMS (Estonia, Hungary, Latvia, Lithuania, Poland) faced moderate inflation between 10-20%, three NMS (Czech Republic, Slovakia, Slovenia) achieved inflation relatively close to the EU average (5-10%) and two NMS (Cyprus, Malta) converged with their inflation rates fully to the euro area inflation. Figures that depict inflation rates for all countries can be found in Appendix 1.

Table 2: Inflation means (%).

Period	BUL	CZE	EST	HUN
1993Q2-2008Q1	36	5	10	11
2001Q1-2008Q1	6	3	5	6
	LAT	LIT	POL	ROM
1993Q2-2008Q1	10	13	10	34
2001Q1-2008Q1	6	3	3	12
	SVK	SLO	MAL	CYP
1993Q2-2008Q1	7	8	3	3
2001Q1-2008Q1	5	5	2	3
	BEL	GER	ESP	POR
1993Q2-2008Q1	2	2	3	3
2001Q1-2008Q1	2	2	3	3

Source: Own calculations based on IMF IFS database.

Inflation rates in the NMS were affected by various factors connected to the economic transition, real convergence, EU accession, and various external shocks. Most typically, the transitional factors and EU accession affected inflation in the NMS in the first two thirds of our data sample. For example, price deregulations and tax reforms, including harmonisation of the taxes and excise duties, were among common shocks contributing to higher inflation in that period. More detailed analysis can be found in EBRD (1999). These were all specific shocks that did not hit the EAC.

Despite the one-off character of these specific inflation factors that affected inflation in the NMS in the analyzed period, they have implications for current estimates of the inflation persistence. Their impact on inflation means, that are crucial to our working definition of inflation persistence, was tremendous. According to this definition, inflation persistence is high if inflation converges slowly to its long-term mean after a shock. In order to measure persistence properly, we need a good approximation of the long-term mean. We argue that a constant mean assumption would not fulfil this requirement because of the above-mentioned specific factors. A time-varying mean is a better approximation since it corresponds more to the idea of medium-term mean converging to the long-term one[67], the former being much easier to estimate from data than the latter.

[67] We find it useful to distinguish these two time horizons when discussing inflation persistence in the NMS, since long-term and medium-term equilibria may differ in a period of convergence. For discussion on the importance of time horizons when dealing with the concept of equilibrium, see Driver and Westaway (2005).

3.3 TIME-VARYING MEAN MODEL

To examine the persistence of inflation we set up simple statistical model that reflects recent studies dealing with modelling of the inflation process. The model is univariate and incorporates permanent and transitory components. Moreover, it enables to distinguish intrinsic and expectations-based inflation persistence. Intrinsic inflation persistence relates to nominal rigidities and to the way wages and prices are set. Expectations-based inflation persistence is driven by differences between public perceptions about the inflation target and the central bank's true (explicit or implicit) inflation target.[68] Since the model is univariate it cannot capture extrinsic inflation persistence. The measures of real activity in the NMS are, at least for the beginning of the considered period, of questionable quality and thus we do not attempt incorporate the measures into the model to extend it for the measurement of extrinsic inflation persistence.[69]

The model specification is close to univariate version of the model introduced in Dossche and Everaert (2005). Basically, the model specification consists of three equations.

$$\pi_{t+1}^{T} = \pi_t^{T} + \eta_t \qquad (1)$$

$$\pi_{t+1}^{P} = (1-\delta)\pi_t^{P} + \delta\pi_{t+1}^{T}, \qquad 0 < \delta < 1 \qquad (2)$$

$$\pi_t = \left(1 - \sum_{i=1}^{4}\varphi_i\right)\pi_t^{P} + \sum_{i=1}^{4}\varphi_i\pi_{t-i} + \varepsilon_t, \qquad \sum_{i=1}^{4}\varphi_i < 1 \qquad (3)$$

where π_t^T is the central bank's implicit inflation target, π_t^P is the inflation target as perceived by the public, and disturbances η_t and ε_t are mutually independent zero-mean white noise processes.

In the first equation, the central bank's inflation target is modelled as a random walk and thus represents a permanent component of the modelled inflation process. It is a common practice nowadays to assume that inflation target changes have a permanent effect (see e.g. Leigh, 2005). The model assumes random walk for inflation target even if the central bank does not target inflation explicitly. On the other hand, if a country adopted inflation targeting (e.g. the Czech Republic in 1997/98) we do not impose known targets into the model.

The second equation describes the relationship between the central bank's inflation target and the target as perceived by the public. Public forms its inflation expectations based on current inflation target announced by a central bank and previous period public expectations. Parameter δ represents the weight on the two sources. Similar specification of inflation expectations is assumed e.g. in Bomfim and Rudebusch (2000).

Parameter δ captures the expectations-based inflation persistence – persistence that relates to the time how long central bank inflation target and public inflation expectations can differ after a shock to central bank's inflation target occurs. In the framework of heterogenous agents parameter δ denotes the fraction of forward-looking public. Parameter δ could also be interpreted as parameter capturing credibility of a central bank. Values close to 1 indicate that changes in the inflation target are immediately passed into public inflation expectations.

The third equation imposes autoregressive structure on the level of inflation. The time-varying mean is represented by the perceived inflation target. The sum of autoregressive coefficients captures intrinsic inflation persistence.

The model (1)-(3) was originally set up to measure inflation persistence net of monetary policy actions. However, in the case of the NMS, a component modeled as a random walk captures many other influences. Apart the changes in monetary policy (e.g. monetary policy regime switch), other events like administrative price changes, deregulations and price convergence can be viewed as shocks with permanent effects. Interpretation of our estimates, therefore, is broader than in the original model and we remind it in the section describing estimation results.

[68] For details of the definitions see Angeloni et al. (2006).
[69] We realize that omitting extrinsic inflation persistence term in the model can affect our results. The influence of real activity terms on inflation is captured by the unobserved component of the model.

Putting one period lagged equation (2) into the equation (1) and resulting equation back into the equation (2) together with (3) yields the following system:

$$\pi_t = \left(1 - \sum_{i=1}^{q} \varphi_i\right)\pi_t^P + \sum_{i=1}^{q} \varphi_i \pi_{t-i} + \varepsilon_t \qquad \varepsilon_t \approx N(0, \sigma_\varepsilon^2) \qquad (4)$$

$$\pi_{t+1}^P = (2-\delta)\pi_t^P + (\delta - 1)\pi_{t-1}^P + \delta\eta_t \qquad \eta_t \approx N(0, \sigma_\eta^2) \qquad (5)$$

Since the system (4)-(5) includes an unobservable component (π_t^P) we transform the system into the state space form and use state space analysis methods. The state space form follows:

$$\begin{bmatrix} \pi_{t+1}^P \\ \pi_t^P \end{bmatrix} = \begin{bmatrix} 2-\delta, \delta - 1 \\ 1, 0 \end{bmatrix} \begin{bmatrix} \pi_t^P \\ \pi_{t-1}^P \end{bmatrix} + \begin{bmatrix} \delta \\ 0 \end{bmatrix} \eta_t \qquad (6)$$

$$\pi_t = \left[\left(1 - \sum_{i=1}^{4} \varphi_i\right), 0\right] \begin{bmatrix} \pi_t^P \\ \pi_{t-1}^P \end{bmatrix} + \sum_{i=1}^{4} \varphi_i \pi_{t-i} + \varepsilon_t . \qquad (7)$$

To estimate the unobservable series of perceived inflation π_t^P we use the exact initial Kalman filter (the case of unknown initial conditions) as described for example in Koopman and Durbin (2003). The Kalman filtering assumes known coefficients; therefore we have to estimate them before we employ filtering procedures on the system (6)-(7).

Estimation of the parameter vector is carried out using Bayesian estimation techniques. The advantage of the Bayesian estimation consists in exploiting the maximum of available information. We do not build our estimates solely on information in data as maximum likelihood approach does. On the other hand, we do not rely on information from other sources only as is the case of model calibration. So, we combine information involved in data on inflation and also information provided by other studies that deal with similar issues. We avoid the problem of unrealistic estimates sometimes obtained by the maximum likelihood estimation procedure. Moreover, we do not suffer from low amount of related work for the NMS that would provide sufficiently reliable values for the parameters. The likelihood function is estimated using the Kalman filter and the posterior kernel is simulated using the Metropolis Hastings sampling algorithm. For detailed explanation of Bayesian estimation see, for example, An and Schorfheide (2006).

Following Dossche and Everaert (2005), we take over the priors from several studies that use various estimation techniques and underlying models to estimate particular parameters. The prior for the sum of autoregressive coefficients (intrinsic inflation persistence) is taken from Gadzinski and Orlandi (2004) and Levin and Piger (2004) i.e. from studies that take into account breaks in the inflation mean. These studies are, however, focused on developed countries. For the NMS, we, therefore, use prior distributions with higher standard deviations to reflect higher uncertainty about the priors regarding the NMS. Similarly, we assume higher variances of shocks than Dossche and Everaert (2005) since NMS have been facing structural changes and in general more volatile economic environment. Original variances of shocks on inflation target and inflation are taken from Kozicki and Tinsley (2003) and Smets and Wouters (2005).

Finally, the prior for the parameter δ is taken from the studies dealing with signal extraction (Erceg and Levin, 2003, and Kozicki and Tinsley, 2003), and sticky information (Mankiw and Reis, 2002).

The distribution of priors, prior means and standard deviations are reported in Table 3.

Table 3: Priors.

Parameter	Distribution	Mean	Std. dev.
φ_1	Beta	0.2	0.3

φ_2	Beta	0.1	0.3
φ_3	Beta	0.05	0.3
φ_4	Beta	0.05	0.3
δ	Beta	0.15	0.2
σ_ε^2	Inverse Gamma	2	Inf
σ_η^2	Inverse Gamma	0.5	Inf

The estimation is carried out using a Matlab toolbox Dynare.70 We simulate posterior distribution using 5 blocks of Metropolis Hastings algorithm with 20 000 replications. Acceptance ratio is between 0.2 and 0.4.71 The results of the Metropolis Hastings algorithm are assessed based on Brooks and Gelman (1998). Details are provided in the section dealing with estimation results. Finally note that time series for inflation and inflation target are used as data for the estimation. Inflation target is HP filtered time series of inflation. HP filtering parameter is equal to 1600 as it is usual for quarterly data.

3.4 ARFIMA MODEL

As outlined earlier in this paper, not accounting for structural breaks in inflation time series can lead to upward bias in the inflation persistence estimates. However, as Gadea and Mayoral (2006) suggest stationary processes with breaks and fractionally integrated processes can resemble each other and it can be difficult to distinguish them. Therefore, we follow the approach of Gadea and Mayoral (2006) and model inflation series of the NMS and EAC as a fractionally integrated process.

The time series π_t follows ARFIMA(p,d,q) process if

$$\phi(L)(1-L)^d \pi_t = \theta(L)\varepsilon_t, \qquad (10)$$

where d is a fractional differencing parameter, $\phi(L) = 1 - \phi_1 L - \phi_2 L^2 - \ldots - \phi_p L^p$ is an autoregressive polynomial, $\theta(L) = 1 - \theta_1 L - \theta_2 L^2 - \ldots - \theta_q L^q$ represents moving average polynomial, the roots of $\phi(L)$ and $\theta(L)$ lie outside the unit circle and ε_t is white noise.

Baillie et al. (1996), Baum et al. (1999) as well as Gadea and Mayoral (2006) argue, that ARFIMA model can be an appropriate representation of the stochastic behavior of inflation time series for many countries. Family of ARFIMA models allows a high degree of persistence without assuming a presence of unit root. On the other hand, modeling the inflation process within ARFIMA framework do not allow for distinguishing types of inflation persistence identified by the time-varying mean models.

In the first step, we follow Gadea and Mayoral (2006) and estimate fractional differencing parameter d using Geweke and Porter-Hudak's technique72. Parameter d indicates how long a shock affects the process. The value of d equal to zero describes short memory process and $|d| \in (0,0.5)$ implies long memory process. If $d \in [0.5,1)$, shocks are transitory and variance of the process is unbounded. The process, however, still exhibits a mean reversion. Finally, if $d \geq 1$, the effect of a shock is permanent.

[70] For details on Dynare see http://www.cepremap.cnrs.fr/dynare/.
[71] Note that acceptance ration between 0.2-0.4 is recommended in order to simulations cover parameter space reasonably.
[72] Geweke and Porter-Hudak's is a semiparametric approach based on spectral regression. It is implemented in STATA by Baum and Wiggins (1999).

Based on the estimated value of the parameter d, we estimate the impulse response function of ARFIMA (0,d,0)73. To compare the persistence of shocks in the time series, we report the values of the impulse response function for the time horizons of 4 and 12 quarters after the realization of a shock.

In the next step, we test the hypothesis of a time series following a fractionally integrated process of order d versus a stationary process with breaks, proposed in Mayoral (2004). In order to reflect the convergence process observed in the inflation time series of the NMS, we allow for a break both in level and trend. The test statistics has the following form:

$$R(d) = T^{1-2d} \frac{\inf_{\omega\in\Omega}\left(\sum(\pi_t - \hat{\alpha}_1 - \hat{\delta}_1 DC_t - \hat{\beta}_1 t - \hat{\delta}_2 DT_t)^2\right)}{\sum(\Delta^d(\pi_t - \hat{\alpha}_0 - \hat{\beta}_0 t))^2}, \qquad (11)$$

where T is the number of periods, Ω = [0.15, 0.85] are trimming thresholds, DCt = 1 if t>ωT and 0 otherwise, and DTt = (t-TB) if t>ωT and 0 otherwise. α0, α1, β0, β1, δ1 and δ2 are coefficients from the appropriate regressions. Δd is the operator of differencing of order d. Critical values are computed according to Mayoral (2004). The null hypothesis assumes a fractionally integrated process while the alternative hypothesis assumes a stationary process with breaks.

4 RESULTS

In this section, we provide estimation results of inflation persistence measures introduced in the previous sections. First, we report estimates of intrinsic and expectations-based inflation persistence based on the time-varying mean model. Second, we discuss estimates obtained from the ARFIMA model.

4.1 TIME-VARYING MEAN MODEL

In this sub-section, we present estimation results of the statistical model introduced in Section 3.3. Figure 1 suggests several general differences between and within groups of the countries.

The selected EAC exhibit a very low or even negative level of intrinsic inflation persistence, captured by the sum of autoregressive coefficients at the lagged values of inflation, $\sum \varphi_i$. In the majority of cases, this type of persistence is not significantly different from zero.74 For example, for Belgium all four coefficients at lagged values of inflation rate are not significantly different from zero and thus the sum is not statistically significant as well. For Portugal, intrinsic inflation persistence is found negative but only two coefficients φ_i are significantly different from zero, while other two are positive or close to zero.

For the group of the NMS, the results are more diverse. The NMS can be divided into three sub-groups with respect to the extent of intrinsic inflation persistence. The first sub-group of countries (Bulgaria, Czech Republic, Romania, and Slovakia) attains similar or slightly higher levels of intrinsic inflation persistence than the selected EAC. Inflation process in the second sub-group of countries (Estonia, Hungary, Latvia, Lithuania, Poland, and Slovenia) follows almost unit root process even though we impose non-stationarity in the process for the inflation mean. Finally, for Malta and Cyprus, we observe the level of intrinsic inflation persistence comparable to the group of EAC. All coefficients φ_i are not, for example, statistically different from zero for Cyprus.

[73] The impulse response function measures the effects of the realization of shock in y_t, on subsequent values of time series. We used STATA implementation for ARFIMA written by Baum (2000).

[74] Note that DYNARE provides confidence intervals for single coefficients φ_i only, not for the whole sum. Since the intrinsic inflation persistence is captured by the sum of the coefficients it is difficult to conclude anything about the statistical significance of the intrinsic inflation persistence estimated measure. On the other hand, the confidence intervals for single φ_i 's provide some evidence. For the coefficient δ we obtain confidence interval directly.

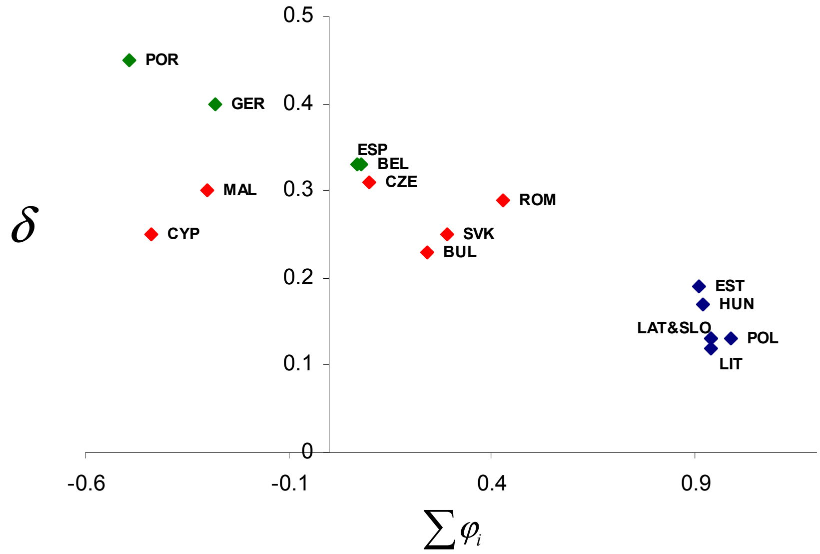
Within the framework of our model the negative estimates of intrinsic inflation persistence suggest that inflation after a shock converges to its long-run value oscillating around the value. In the case of positive value, inflation decays without exhibiting this oscillating pattern.[75]

Regarding the expectations-based inflation persistence, the NMS and EAC also differ. The estimated values of the coefficient δ are lower for the NMS than for the selected EAC. The cross-country differences are often statistically significant (e.g. Latvia, Lithuania, and Slovenia vs. Germany and Portugal) – see 90% confidence intervals in Appendix 2. It is worth noting that coefficient δ can be viewed as the measure of public tendency to be forward looking. Therefore the countries with low δ can be viewed as having high fraction of backward looking public. So, changes in the random walk component of the model are passed into public inflation expectations very slowly – a country exhibit high level of expectations-based inflation persistence.

There are also differences among the NMS themselves. Again, some of the differences are statistically significant (e.g. Czech Republic vs. Latvia). Czech Republic, Romania, Slovakia, Malta and Cyprus exhibit estimates of the parameter δ close to values estimated for the selected EAC. On the other hand, some countries have δ close to zero, and hence they face problems with anchoring inflation expectations (Latvia, Lithuania, Poland, and Slovenia).

[75] Note that since we use statistical model of inflation the negative values are not in conflict with any optimization problem on the micro level which would be the problem in case of negative sum of coefficient in structural measures based on some specification of the New Keynesian Phillips curve.

Figure 1: Intrinsic and expectations-based inflation persistence



Note: The figure depicts three groups of countries: green bullets denote the selected EAC (Belgium, Germany, Portugal, and Spain), red represent the NMS with similar features of inflation persistence to the EAC (Bulgaria, Cyprus, Czech Republic, Malta, Romania, and Slovakia), and blue bullets denote the NMS with higher levels of inflation persistence and problems with anchoring inflation expectations (Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia).

The complete results can be found in Appendix 2 – prior distributions and posterior means with 90% confidence intervals of all coefficients and countries are reported. Furthermore, in the appendix we also discuss the performance of the Metropolis-Hastings algorithm and tools we employ to strengthen the reliability of the estimation results.

In order to assess the effect of the model specification on the estimated values we estimate two extension of the benchmark model. First, we estimate the model from Dossche and Everaert (2005) i.e. the model where inflation target is unobservable. We encounter a problem of identification of the coefficient δ. Intuitively speaking, coefficients at lagged values of inflation are identified since they appeared at the observable variables (lagged values of inflation). The time-varying mean, however, consists of two unobserved components (central bank's inflation target and perceived inflation target). Therefore, the parameter representing the relationship between the two unobserved components need not be identified. The posterior distribution of the parameter δ closely follows the prior distribution which may indicate the lack of identification. Therefore, we view the results of the benchmark model as more reliable. We also impose an autocorrelation structure on the disturbance η_t; the results of main interest do not change significantly.76

Model with estimated parameters can be re-formulated into a state space form (see system (6)-(7) in Section 3.3) and the method of the exact initial Kalman filter can be used to estimate the unobservable components of the system. One has to bear in mind that we do not know the exact parameter values, and must work with estimates. So, the informational value of the filtering exercise is lowered because of the state space model parameter uncertainty. The purpose of the filtering, however, is to point out various profiles of the unobserved component - perceived inflation target - for various countries. For that purpose our knowledge of parameter estimates is sufficient.

Figures 2-4 show the inflation rate and filtered perceived inflation target for several countries from our sample. We present countries that represent each sub-group discussed above. Germany represents the EAC with almost negligible intrinsic inflation persistence and low level of expectations-based inflation persistence. Slovakia is a member of a sub-group of the NMS that exhibit moderate level of intrinsic inflation persistence and Hungary represents high intrinsic inflation persistence countries with high fraction of backward-looking public. Note that

[76] We do not report the results here. They are, however, available upon request.

perceived inflation target serves as time-varying mean of the inflation process and follows non-stationary AR(2) process.

Figure 2: Inflation and perceived inflation target: Germany

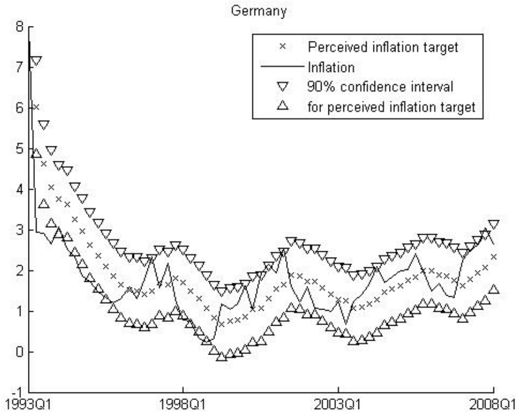


Figure 3: Inflation and perceived inflation target: Slovakia

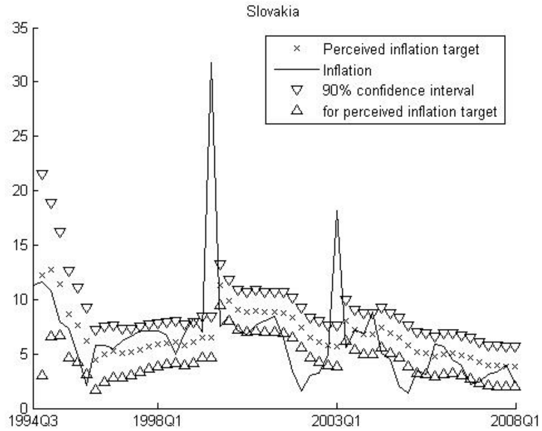


Figure 4: Inflation and perceived inflation target: Hungary

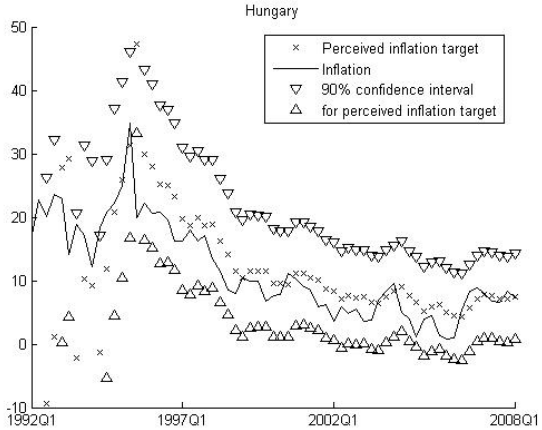
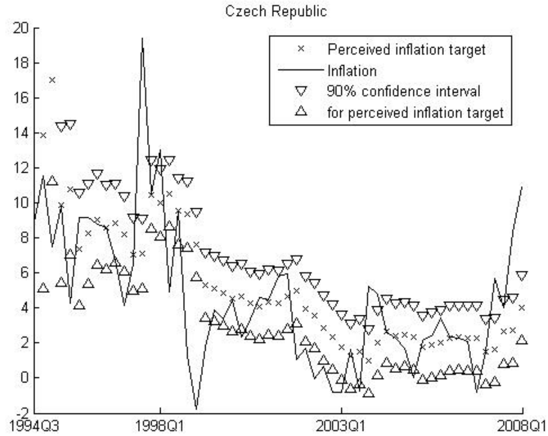


Figure 5: Inflation and perceived inflation target: Czech Republic



Note: The figures for the rest of the NMS and EAC are presented in Appendix 3.

First note that we do not report results of the filtering exercise for the whole period of available data. The method of exact initial Kalman filter assumes infinite variances for initial values of unobserved components of the system. Confidence intervals for the perceived inflation target are, therefore, very large for the few first observations and we focus on a sub-period with reasonable width of confidence intervals for the unobserved variable.

The figures demonstrate what the recent literature put forward as a problem in the inflation persistence measurement and what we thoroughly discussed for the NMS above. Structural breaks in the economy lead to breaks in the inflation mean and consequently to the bias in persistence measures built on models with constant mean. While perceived inflation targets do not exhibit clear breaks for Germany, a few statistically significant breaks are observable for Slovakia and the difference in the perceived inflation target over time attains almost 30 percentage points in Hungary.[77] So, standard measures are not appropriate for the NMS and more flexible models of inflation process should be employed to avoid such biased results.

In addition, the results of the Kalman filtering can capture the effect of introduction of inflation targeting on public inflation expectations. Figure 5 shows the evolution of public inflation expectations (perceived inflation target) for the Czech Republic. The Czech Republic has been targeting inflation since 1998. According to our estimates, expectations had reached the level of announced target (3%) in 5 years and have been close to it since

[77] On the other hand, confidence interval for Hungarian perceived inflation target is very wide.

then. Recently, an upsurge can be observed as a consequence of higher energy and food prices and changes in indirect taxes.

4.2 THE ARFIMA MODEL

In this section, we present estimation results based on the assumption that inflation series follow fractionally integrated process. The estimate of the parameter of fractional differencing d along with its standard error is reported in the second and the third column of the Table 4. Last two columns of the Table 4 show the values of the impulse response function for the time horizons of 4 and 12 quarters after the realization of a positive shock of the size equal to one. Estimates of fractional differencing parameter d are graphically depicted also in the Figure 6.

The results demonstrate that based on the estimate of fractional differencing parameter d, no general distinction can be made between the inflation persistence in the EAC and the NMS. Among EAC, Belgium and Portugal exhibit relatively low persistence, while Germany and Spain end up with fairly high persistence estimates. Among the NMS, Malta and Cyprus exhibit very low inflation persistence and Bulgaria, Czech Republic, Romania and Slovakia can be considered as countries with moderate inflation persistence. On the other side, Estonia, Hungary, Latvia, Lithuania, Poland and Slovenia show high inflation persistence, if evaluated on the basis of fractional differencing parameter.

Table 4: Estimation of fractional differencing parameter *d* and the value of impulse response function in selected time horizons.

Country	*d*	SE(*d*)	IPF(4)	IPF(12)
BUL	0.19	0.11	0.07	0.03
CZE	0.50	0.37	0.28	0.16
EST	0.99	0.19	0.98	0.97
HUN	1.71	0.63	2.94	6.41
LAT	1.34	0.12	1.80	2.61
LIT	0.62	0.08	0.41	0.27
POL	1.20	0.10	1.44	1.79
ROM	0.40	0.31	0.20	0.10
SVK	0.42	0.67	0.21	0.11
SLO	0.90	0.22	0.81	0.72
MAL	-0.03	0.41	0.01	0.00
CYP	0.07	0.35	0.02	0.01
BEL	0.43	0.37	0.22	0.12
GER	0.84	0.51	0.72	0.60
ESP	1.01	0.43	1.02	1.03
POR	0.11	0.59	0.03	0.01

Table 5 summarizes the results of testing the null hypothesis of fractionally integrated process against the alternative of stationary process with breaks. For each country, the cell in bold determines the column closest to the estimated value of parameter d reported in the Table 4. At the 10% level of significance, we can reject the null hypothesis of fractionally integrated process for all countries except of Lithuania, Romania and Germany. Modeling the inflation time series as a stationary process with breaks is thus preferable for most of the considered countries. In light of this result, we consider the analysis employing the time-varying mean presented in the previous part of the paper as our preferred.

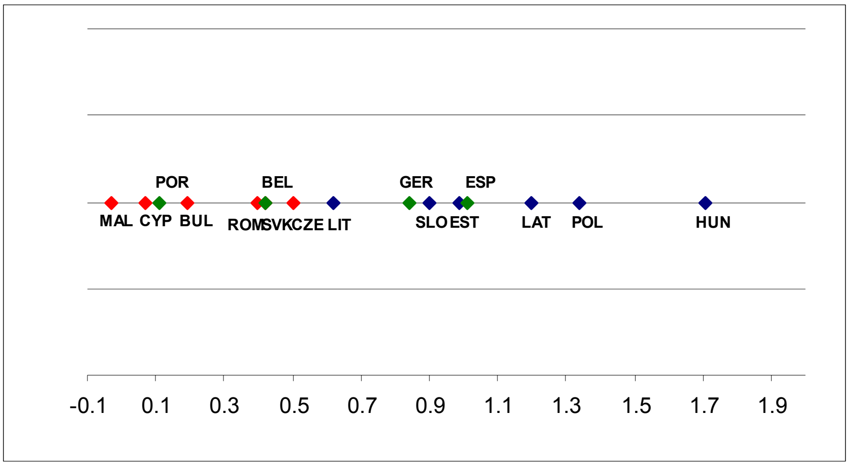
Finally note that the alternative hypothesis to the test presented in Table 5 is that inflation time series follows stationary process with just one break. So, if the test suggests rejecting the null of fractionally integrated process, it follows that model with time-varying mean (i.e. the model allowing for more breaks) is preferable. On the other hand, if the test doesn't find enough evidence against the null, it still doesn't imply that model with more than one break is not preferable.

Table 5: Test of fractional integration of the order *d* versus stationary process with breaks.

Country	*d* 0.6		0.8		1		1.2	
BUL	**0.293**	***	0.051	*	0.009	***	0.001	***
CZE	**0.346**	**	0.062		0.011	***	0.002	***
EST	0.399		0.089		**0.018**	*	0.003	***
HUN	0.549		0.104		0.018		**0.003**	***
LAT	0.231	***	0.085		0.026		**0.006**	***
LIT	**0.946**		0.104		0.012	***	0.002	***
POL	0.431		0.088		0.016	**	**0.003**	***
ROM	**0.492**		0.109		0.022		0.004	***
SVK	**0.337**	**	0.056		0.009	***	0.001	***
SLO	0.285	***	0.049	**	**0.008**	***	0.001	***
MAL	**0.287**	***	0.047	**	0.007	***	0.001	***
CYP	**0.296**	***	0.049	**	0.008	***	0.001	***
BEL	**0.280**	***	0.046	**	0.007	***	0.001	***
GER	0.525		**0.106**		0.019		0.003	***
ESP	0.313	***	0.053	*	**0.009**	***	0.001	***
POR	**0.342**	**	0.060		0.010	***	0.002	***
1% critical values	0.335		0.043		0.015		0.008	
5% critical values	0.364		0.050		0.017		0.009	
10% critical values	0.381		0.054		0.018		0.009	

Notes: Critical values are based on Mayoral (2004). ***, **, and * denote the significance at 1%, 5% and 10% levels. For each country, the cell in bold determines the column closest to the value of *d* estimated using Geweke and Porter-Hudak's technique and reported in the Table 6.

Figure 6: Estimated differencing parameter in ARFIMA model



5 CONCLUSIONS

In this paper we examine inflation persistence in the countries that joined the European Union in years 2004 and 2007. As some recent studies point out that inflation persistence differences cause inflation divergence within a monetary union, we argue that reliable estimates of the inflation persistence are necessary for understanding obstacles that the NMS can face when they decide to enter the euro area.

We estimate measures based on two statistical univariate models. The first model is a model with time-varying mean that is estimated using Bayesian techniques. The model enables identification of two types of inflation persistence – intrinsic and expectations-based inflation persistence. The second employed model, ARFIMA, assumes that inflation follows a fractionally integrated process. ARFIMA models are not capable of distinguishing different types of inflation persistence unlike the model with time-varying mean.

Estimation results of the time-varying mean model suggest that the NMS can be in general divided into two groups. One group consists of Bulgaria, Cyprus, Czech Republic, Malta, Romania, and Slovakia. The main traits of the inflation persistence in this group are very similar to the selected euro area countries (Belgium, Germany, Portugal, and Spain). The other group of the NMS (Estonia, Hungary, Latvia, Lithuania, Poland, and Slovenia) exhibits very high level of intrinsic inflation persistence. Moreover, in the model, public is found to be highly backward looking for this group which indicates problems with anchoring inflation expectations.

The examination of inflation persistence in the NMS faces challenges that can be addressed by future research. Since the choice of models that underlie measures of inflation persistence is partly driven by data quality and availability, the natural direction of future research is to employ multivariate statistical or structural models. With longer time spans and data of higher quality, the original disadvantage of low quality data will be overbalanced by possibility to exploit more information from other relevant time series (output gap, interest rates, exchange rates, etc.).

REFERENCES

An, S., and Schorfheide, F. (2006): "Bayesian Analysis of DSGE models", Federal Reserve Bank of Philadelphia Research Department Working Paper No. 06-5.

Angeloni, I., Aucremanne, L., Ehrmann, M., Galí, J., Levin, A.Y. and Smets, F. (2006): "New Evidence on Inflation Persistence and Price Stickiness in the Euro Area: Implications for Macro Models and Policy", Journal of the European Economic Association, Vol. 4(2–3), 562–574.

Angeloni, I. and Ehrmann, M. (2004): "Euro Area Inflation Differentials", ECB Working Paper No. 388.

Altissimo, F., Ehrmann, M. and Smets, F. (2006): "Inflation Persistence and Price-setting Behaviour in the Euro Area – A Summary of the IPN Evidence", ECB Occasional Paper No. 46.

Babetskii, I., Coricelli, F. and Horváth, R. (2007): "Measuring and Explaining Inflation Persistence: Disaggregate Evidence on the Czech Republic", CNB Working Paper No. 1.

Baillie, R.T., Chung, C.-F., Tieslau, M.A., 1996. "Analysing Inflation by the Fractionally Integrated ARFIMA-GARCH Model," Journal of Applied Econometrics, vol. 11(1), pages 23-40.

Baum, C.F. (2000): "FRACIRF: Stata Module to Compute Impulse Response Function for Fractionally-integrated Time Series", Statistical Software Components S414004, Boston College Department of Economics.

Baum, C.F. and Wiggins, V. (1999): "GPHUDAK: Stata Module to Estimate Long Memory in a Time series", Statistical Software Components 388101, Boston College Department of Economics, revised 25 June 2006.

Baum, C.F., Barkoulas, J. and Caglayan, M. (1999): "Persistence in International Inflation Rates", Southern Economic Journal, 65(4), 900-914.

Batini, N. (2002): "Euro Area Inflation Persistence", ECB Working Paper No. 201.

Benati, L. (2008): "Investigating Inflation Persistence across Monetary Regimes", ECB Working Paper Series, 851.

Bilke, L. (2005): "Break in the Mean and Persistence of Inflation: A Sectoral Analysis of French CPI", Banque de France Working Paper No. 122.

Bjorksten, N. (2002): "Real Convergence in the Enlarged Euro Area: A Coming Challenge for Monetary Policy", Bank of Finland Economics Department Working Paper No. 1.

Bomfim A.N., and Rudebusch G.D. (2000): "Opportunistic and Deliberate Disinflation under Imperfect Credibility", Journal of Money, Credit, and Banking, 32(4).

Brooks, S.P. and Gelman, A. (1998): "Alternative methods for monitoring convergence of iterative simulations", Journal of Computational and Graphical Statistics, 7, 434-455.

Bulíř, A. and Hurník J. (2006): The Maastricht inflation criterion: How unpleasant is purgatory?, Economic Systems Volume 30, Issue 4, December 2006, Pages 385-404.

Calvo, G. (1983): "Staggered Prices in a Utility-Maximizing Framework", Journal of Monetary Economics, 115(1), 383-398.

Ca'Zorzi, M. and De Santis, R.A. (2003): "The Admission of Accession Countries to an Enlarged Monetary Union: A Tentative Assessment", ECB Working Paper No. 216.

Cecchetti, S.G. and Debelle, G. (2006): "Has the Inflation Process Changed?", Economic Policy, Vol. 21, No. 46, 311-352.

Cecchetti, S.G., Hooper, P., Kasman, B.C., Schoenholtz, K.L., and Watson, M.W. (2007): “Understanding the Evolving Inflation Process”, presentation at the U.S. Monetary Policy Forum, Washington, D.C.

CNB (2007): Analyses of the Czech Republic’s Current Economic Alignment With The Euro Area, Czech National Bank, Prague.

Christiano, L., Eichenbaum, M. and Evans, M. (2005): “Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy”, Journal of Political Economy, 113, 1-45.

Cogley, T., Primiceri, G.E. and Sargent T.J. (2008): “Inflation-gap Persistence in the U.S.”, NBER Working Paper 13749.

Cogley, T., and Sbordone A.M. (2006): “Trend Inflation and Inflation Persistence in the New Keynesian Phillips Curve”, Federal Reserve Bank of New York Staff Reports, 270.

Coricelli, F. and Horváth, R. (2006): “Price Setting Behaviour: Micro Evidence on Slovakia”, CEPR Discussion Paper No. 5445.

Doornik, J.A. and Ooms, M. (2004): "Inference and Forecasting for ARFIMA Models With an Application to US and UK Inflation", Studies in Nonlinear Dynamics & Econometrics: Vol. 8: No. 2, Article 14.

Darvas, Z. and Varga, B. (2007): “Inflation Persistence in the Euro-area, US, and New Members of the EU: Evidence from Time-varying Coefficient Models”, Money Macro and Finance Research Group Conference 2006.

Dossche, M. and Everaert, G. (2005): “Measuring Inflation Persistence – A Structural Time Series Approach”, ECB Working Paper No. 495.

Driver, R. and Westaway, P. (2005): “Concepts of Equilibrium Exchange Rates”, Bank of England Working Paper No. 248.

Erceg C.J., and Levin A.T. (2003): “Imperfect Credibility and Inflation Persistence”, Journal of Monetary Economics, Volume 50, Number 4, May 2003, pp. 915-944.

European Bank for Reconstruction and Development (1999): Transition report 1999: Ten years of transition

European Central Bank (2003): “Inflation Differentials in the Euro Area: Potential Causes and Policy Implications”.

European Central Bank (2006): Convergence Report 2006.

European Central Bank (2008): Convergence Report 2008.

European Commission (2002): “Quarterly Report on the Euro Area, No. IV/2002”.

European Commission (2004): “Third Report on Economic and Social Cohesion”.

Fiess, N. and Byrne, J. (2007): “Euro Area Inflation: Aggregation Bias and Convergence”, Department of Economics, University of Glasgow / Working Papers.

Franta, M., Saxa, B. and K. Šmídková (2007): “Inflation Persistence in New EU Member States: Is It Different from Euro Area Members?”, ECB Working Paper No. 810.

Gabriel, V.J.C.R.De A. and Martins, L.F. (2004): "On the Forecasting Ability of ARFIMA Models when Infrequent Breaks Occur", Econometrics Journal, Vol. 7, No. 2, pp. 455-475.

Gadea, M.D. and Mayoral, L. (2006): “The Persistence of Inflation in OECD Countries: A Fractionally Integrated Approach”, International Journal of Central Banking, Vol. 1, No. 4.

Gadzinski, G. and Orlandi, F. (2004): “Inflation Persistence in the European Union, the Euro Area, and the United States”, ECB Working Paper No. 414.

Galí, J. and Gertler, M. (1999): “Inflation Dynamics: A Structural Econometric Analysis”, Journal of Monetary Economics, 44, 195-222.

International Monetary Fund (2002): “Monetary and Exchange Rate Policies in the Euro Area - Selected Issues”, IMF Country Report 02/236.

Konieczny, J. and Skrzypacz, A. (2005): “Inflation and Price Setting in a Natural Experiment”, Journal of Monetary Economics, Vol. 52, No. 3, 621-632.

Koopman, S.J. and Durbin, J. (2003): “Filtering and Smoothing of State Vector for Diffuse State-space Models”, Journal of Time Series Analysis, Vol. 24, No. 1, 85-98.

Kozicki, S. and Tinsley, P.A. (2003): “Permanent and Transitory Policy Shocks in an Empirical Macro Model with Asymmetric Information”, Federal Reserve Bank of Kansas City Working Paper 03-09.

Kumar, M.S. and Okimoto, T. (2007). “Dynamics of Persistence in International Inflation Rates,” Journal of Money, Credit and Banking, Blackwell Publishing, vol. 39(6), pages 1457-1479, 09.

Leigh, D. (2005): “Estimating the Implicit Inflation Target: An Application to U.S. Monetary Policy”, IMF Working Paper No. 05/77.

Mankiw, N.G., Reis, R. (2002) “Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve”, Quarterly Journal of Economics 2002 117:4, 1295-1328

Marques, C.R. (2004): “Inflation Persistence: Facts or Artefacts?”, ECB Working Paper No. 371.

Mayoral, L. (2004): “Testing for Fractional Integration versus Short Memory with Trends and Structural Breaks”, last version from June 2006 available at http://www.econ.upf.edu/~mayoral/laura_mayoral_research.htm

Mishkin, F.S. (2007): “Inflation Dynamics”, BIS Review 29/2007.

Organization for Economic Co-operation and Development (2002): “Inflation Persistence in the Euro Area”, Economic Outlook 72, Chapter VII.

Perron, P. (1989): “The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis,” Econometrica, Vol. 57(6), 1361-1401, November.

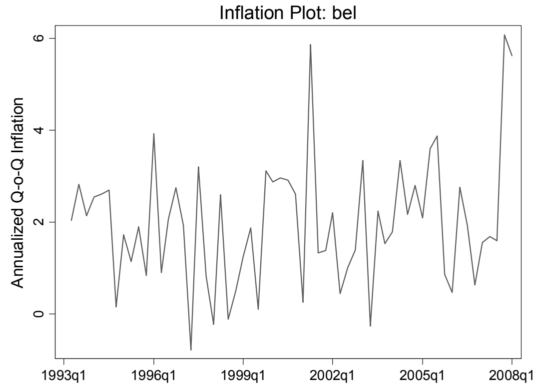
Ratfai, A. (2006): “Linking Individual and Aggregate Price Changes”, Journal of Money, Credit and Banking, Vol. 38, No. 8, 2199-2224.

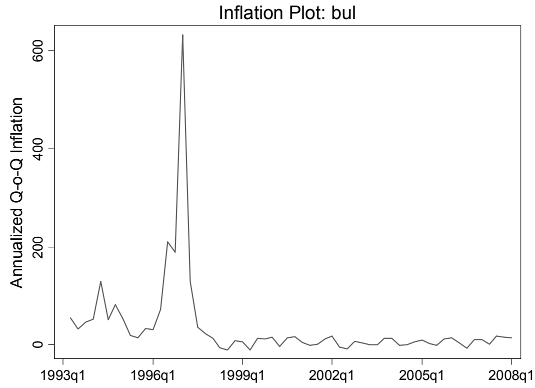
Smets, F. and Wouters R. (2005): “Comparing Shocks and Frictions in US and Euro Area Business Cycles”, Journal of Applied Econometrics.

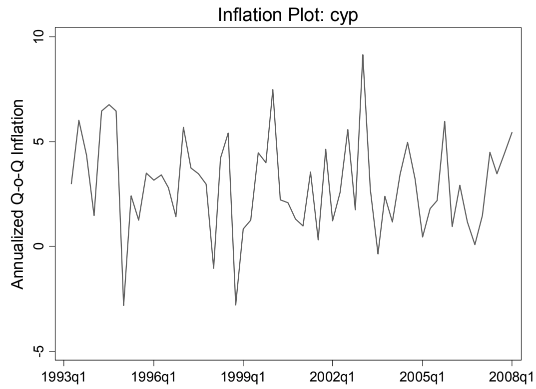
Sbordone, A.M. (2007): “Inflation Persistence: Alternative Interpretations and Policy Implications”, Journal of Monetary Economics, 54, 1311-1339.

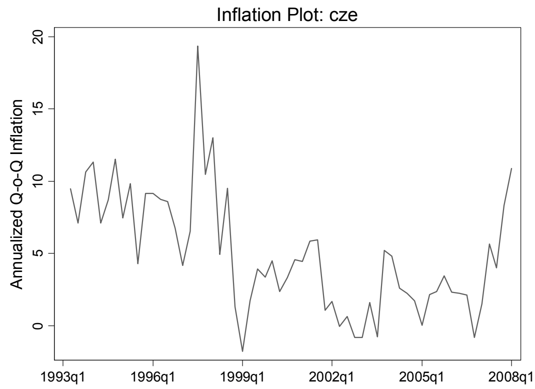
Stock, J.H. and Watson, M.W. (2007): “Why Has U.S. Inflation Become Harder to Forecast?”, Journal of Money, Credit and Banking, 39(1), 3-34.

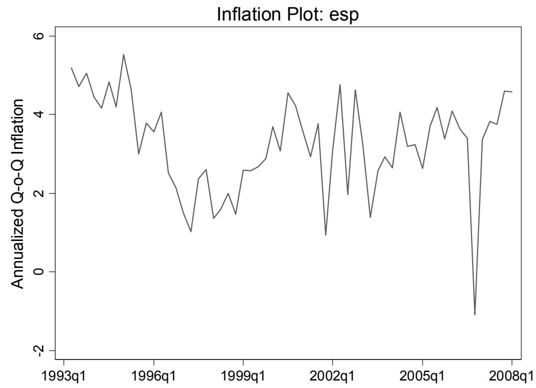
APPENDIX 1: INFLATION PLOTS.

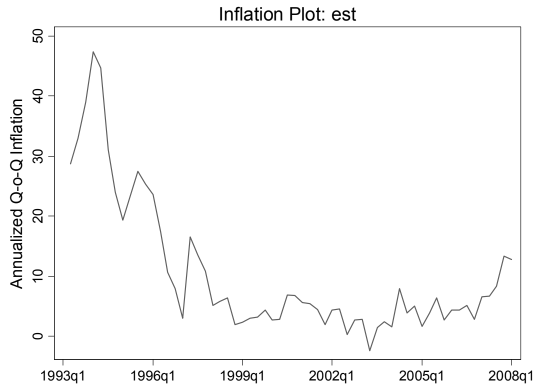


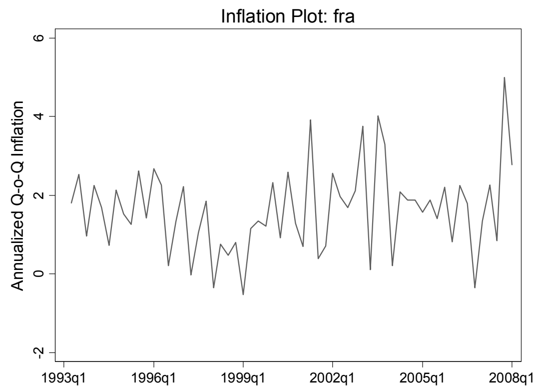


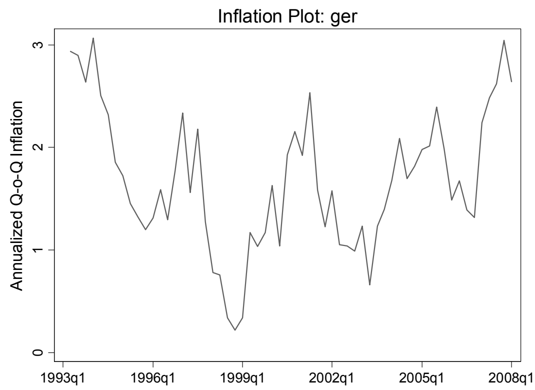


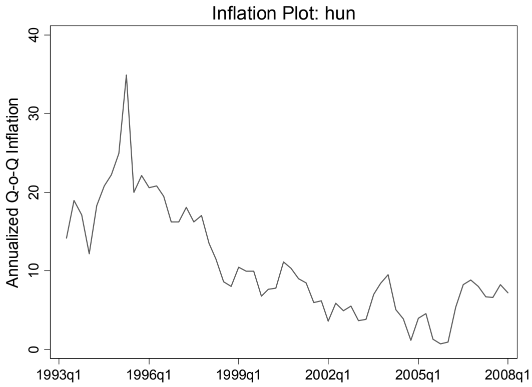


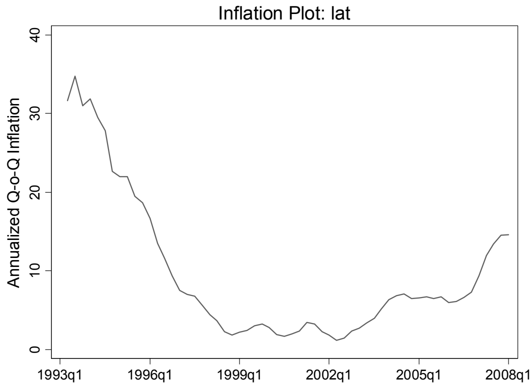


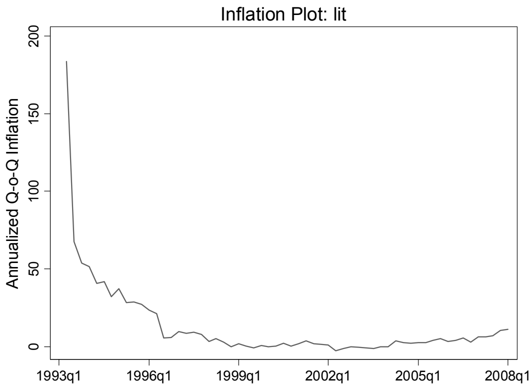


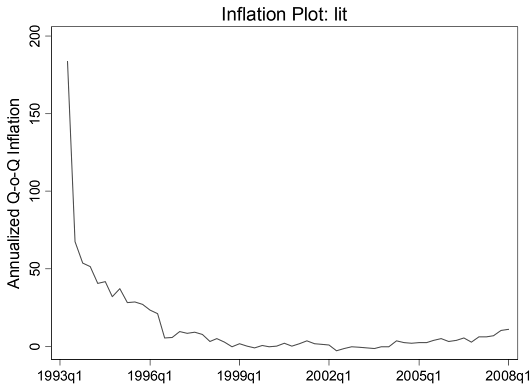


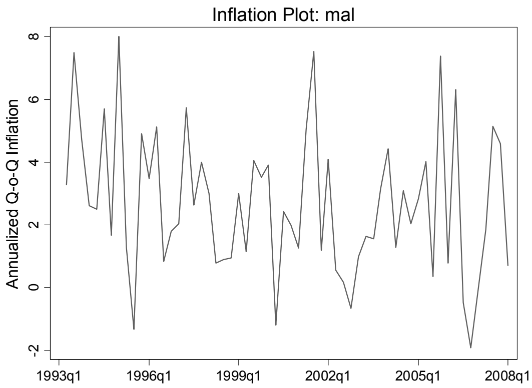


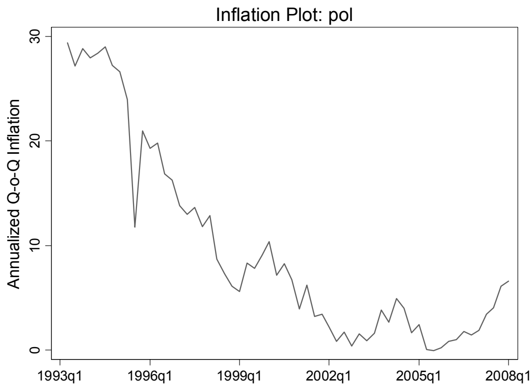

Inflation Plot: hun
Annualized Q-o-Q Inflation
0
10
20
30
40
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1

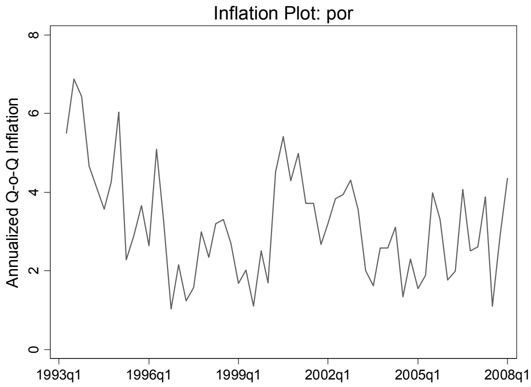

Inflation Plot: lat
Annualized Q-o-Q Inflation
0
10
20
30
40
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1

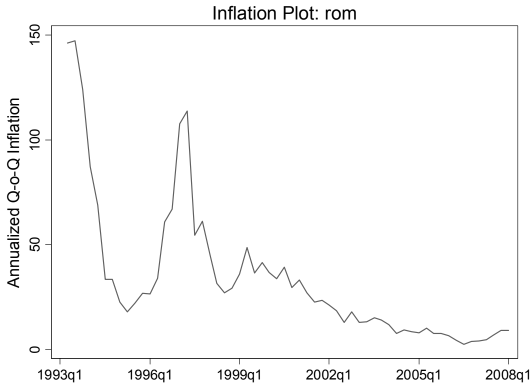

Inflation Plot: lit
Annualized Q-o-Q Inflation
0
50
100
150
200
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1

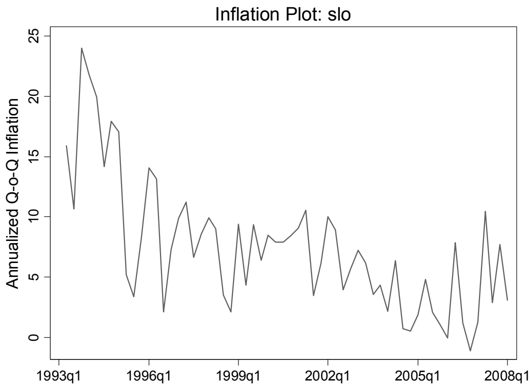

Inflation Plot: lit
Annualized Q-o-Q Inflation
0
50
100
150
200
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1

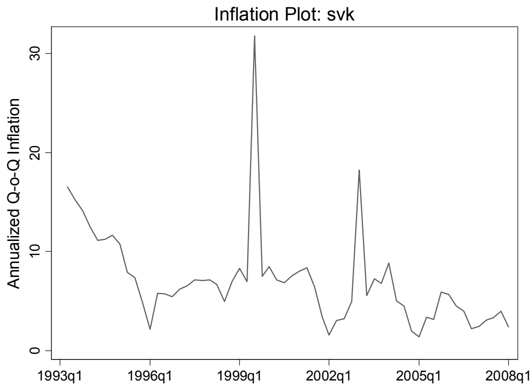

Inflation Plot: mal
Annualized Q-o-Q Inflation
-2
0
2
4
6
8
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1


Inflation Plot: pol
Annualized Q-o-Q Inflation
0
10
20
30
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1


Inflation Plot: por
Annualized Q-o-Q Inflation
0
2
4
6
8
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1


Inflation Plot: rom
Annualized Q-o-Q Inflation
0
50
100
150
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1


Inflation Plot: slo
Annualized Q-o-Q Inflation
0
5
10
15
20
25
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1


Inflation Plot: svk
Annualized Q-o-Q Inflation
0
10
20
30
1993q1
1996q1
1999q1
2002q1
2005q1
2008q1

APPENDIX 2: COMPLETE ESTIMATION RESULTS OF TIME-VARYING MEAN MODEL

In Section 4.1 we discuss measures of intrinsic and expectations-based inflation persistence estimated within the framework of statistical model introduced in Section 3.3. Here, complete estimation results are reported. Following tables report type, mean and standard deviation of prior distribution and posterior mean with 90% confidence interval. Results for four selected EAC and all NMS are reported.

Prior distributions are introduced in Table 4, and discussed in Section 3.3. The performance of the sampling procedure is based on Monte Carlo Markov Chain (MCMC) diagnostics that examines whether the Metropolis-Hastings simulations lead to similar numbers within and between respective simulations. If this is not the case, more iterations of the sampling algorithm should be tested or prior beliefs about distributions of coefficients should be re-considered.

For several countries involved in our analysis, we encountered problems indicated by the univariate MCMC diagnostics and we switched to "more flexible" priors - uniform distribution over wider interval. The uniform priors for some coefficients were taken for Latvia, Romania, Malta and Portugal. Priors that are different from those introduced in Table 4 are denoted by shaded areas in the following tables. For some countries we also increased the number of iterations up to 100 000 e.g. Hungary and Bulgaria. Finally, bad convergence diagnostics for Latvia and Lithuania is resolved by dropping first few observations for which inflation rate attains levels over 100%.

Estimated measures of intrinsic inflation persistence (sum of coefficients φ_i) and expectations-based inflation persistence are discussed in Section 4.1. Regarding the other estimated parameters two issues should be pointed out. First, estimated variances of inflation shock (σ_ε^2) for the NMS are significantly higher than for the EAC. This result is a consequence of many shocks specific to the NMS related to transition of their economies as discussed in Section 3. Second, estimated variances of shocks to inflation target (σ_η^2) are different both within and between the NMS and EAC. The changes in inflation target are almost negligible for the EAC. In general, the NMS exhibit higher estimates of variance of inflation target shock. Moreover, inflation target shocks in Bulgaria, Estonia, Latvia, Lithuania, Poland and Romania are remarkably higher than for the rest of the group of the NMS.

Table A2.1: Estimation results of the time-varying mean model.

	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
BUL						
φ_1	0.2	0.32	0.12	0.51	beta	0.3
φ_2	0.1	0.15	-0.05	0.36	beta	0.3
φ_3	0.05	-0.10	-0.31	0.10	beta	0.3
φ_4	0.05	-0.13	-0.33	0.06	beta	0.3
$\sum \varphi_i$		0.24				
δ	0.15	0.23	0.07	0.40	beta	0.1
σ_ε	2	73.60	63.56	84.75	invg	Inf
σ_τ	0.5	2.47	2.14	2.83	invg	Inf
CZE						
φ_1	0.2	0.26	0.07	0.49	beta	0.3
φ_2	0.1	0.15	-0.05	0.36	beta	0.3
φ_3	0.05	-0.15	-0.37	0.04	beta	0.3
φ_4	0.05	-0.16	-0.39	0.02	beta	0.3
$\sum \varphi_i$		0.10				
δ	0.15	0.31	0.16	0.45	beta	0.1
σ_ε	2	2.86	2.40	3.27	invg	Inf
σ_τ	0.5	0.23	0.19	0.26	invg	Inf
HUN						
φ_1	0.2	0.66	0.50	0.82	beta	0.3
φ_2	0.1	0.18	-0.02	0.39	beta	0.3
φ_3	0.05	0.08	-0.14	0.31	beta	0.3
φ_4	0.05	0.00	-0.18	0.21	beta	0.3
$\sum \varphi_i$		0.92				
δ	0.15	0.17	0.00	0.29	beta	0.1
σ_ε	2	3.81	3.26	4.33	invg	Inf
σ_τ	0.5	0.41	0.35	0.47	invg	Inf

Table A2.2: Estimation results of the time-varying mean model.

	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
EST						
φ_1	0.2	0.81	0.69	0.93	beta	0.3
φ_2	0.1	0.11	-0.13	0.33	beta	0.3
φ_3	0.05	-0.14	-0.39	0.13	beta	0.3
φ_4	0.05	0.13	-0.08	0.35	beta	0.3
$\sum \varphi_i$		0.91				
δ	0.15	0.19	0.00	0.40	beta	0.1
σ_ε	2	4.33	3.66	5.00	invg	Inf
σ_τ	0.5	2.59	2.21	2.97	invg	Inf
LAT						
φ_1	0	0.91	0.88	1.00	unif	0.5774
φ_2	0	0.57	0.37	0.64	unif	0.5774
φ_3	0	-0.23	-0.31	-0.11	unif	0.5774
φ_4	0	-0.32	-0.40	-0.26	unif	0.5774
$\sum \varphi_i$		0.94				
δ	0.5	0.13	0.00	0.12	unif	0.2887
σ_ε	2	1.39	1.15	1.59	invg	Inf
σ_τ	0.5	2.33	2.01	2.69	invg	Inf
LIT						
φ_1	0.2	0.74	0.58	0.90	beta	0.3
φ_2	0.1	0.37	0.12	0.55	beta	0.3
φ_3	0.05	0.08	-0.21	0.27	beta	0.3
φ_4	0.05	-0.24	-0.36	0.20	beta	0.3
$\sum \varphi_i$		0.94				
δ	0.15	0.12	0.00	0.24	beta	0.1
σ_ε	2	3.31	2.77	3.88	invg	Inf
σ_τ	0.5	3.23	2.71	3.72	invg	Inf

Table A2.3: Estimation results of the time-varying mean model.

	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
POL						
φ_1	0.2	0.68	0.52	0.82	beta	0.3
φ_2	0.1	0.24	0.04	0.43	beta	0.3
φ_3	0.05	0.22	0.12	0.40	beta	0.3
φ_4	0.05	-0.15	-0.33	0.09	beta	0.3
$\sum \varphi_i$		0.99				
δ	0.15	0.13	0.00	0.26	beta	0.1
σ_ε	2	4.79	4.13	5.48	invg	Inf
σ_τ	0.5	1.18	1.02	1.34	invg	Inf
ROM						
φ_1	0.2	0.81	0.70	0.94	beta	0.3
φ_2	0.1	0.03	-0.21	0.27	beta	0.3
φ_3	0	0.13	-0.18	0.44	unif	0.5774
φ_4	0	-0.54	-0.75	-0.33	unif	0.5774
$\sum \varphi_i$		0.43				
δ	0.15	0.29	0.25	0.32	unif	0.1
σ_ε	2	14.45	12.23	16.60	invg	Inf
σ_τ	0.5	2.43	2.09	2.77	invg	Inf
SVK						
φ_1	0.2	0.24	0.04	0.46	beta	0.3
φ_2	0.1	0.17	-0.05	0.39	beta	0.3
φ_3	0.05	-0.02	-0.25	0.22	beta	0.3
φ_4	0.05	-0.10	-0.32	0.12	beta	0.3
$\sum \varphi_i$		0.29				
δ	0.15	0.25	0.06	0.46	beta	0.1
σ_ε	2	4.39	3.76	5.10	invg	Inf
σ_τ	0.5	0.25	0.21	0.28	invg	Inf

Table A2.4: Estimation results of the time-varying mean model.

	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
SLO						
φ_1	0.2	0.51	0.23	0.76	beta	0.3
φ_2	0.1	0.22	-0.10	0.52	beta	0.3
φ_3	0.05	0.27	-0.05	0.55	beta	0.3
φ_4	0.05	-0.06	-0.40	0.21	beta	0.3
$\sum \varphi_i$		0.94				
δ	0.15	0.13	0.00	0.28	beta	0.1
σ_ε	2	9.25	7.92	10.51	invg	Inf
σ_τ	0.5	1.00	0.86	1.13	invg	Inf
MAL						
φ_1	0	-0.05	-0.24	0.15	unif	0.5774
φ_2	0	0.10	-0.09	0.31	unif	0.5774
φ_3	0	-0.15	-0.37	0.03	unif	0.5774
φ_4	0	-0.24	-0.46	0.00	unif	0.5774
$\sum \varphi_i$		-0.34				
δ	0.15	0.30	0.11	0.43	beta	0.1
σ_ε	2	2.15	1.87	2.47	invg	Inf
σ_τ	0.5	0.06	0.06	0.07	invg	Inf
CYP						
φ_1	0.2	-0.08	-0.27	0.11	beta	0.3
φ_2	0.1	-0.16	-0.34	0.03	beta	0.3
φ_3	0.05	-0.06	-0.25	0.13	beta	0.3
φ_4	0.05	-0.14	-0.32	0.04	beta	0.3
$\sum \varphi_i$		-0.44				
δ	0.15	0.25	0.10	0.38	beta	0.1
σ_ε	2	2.45	2.11	2.79	invg	Inf
σ_τ	0.5	0.09	0.08	0.10	invg	Inf

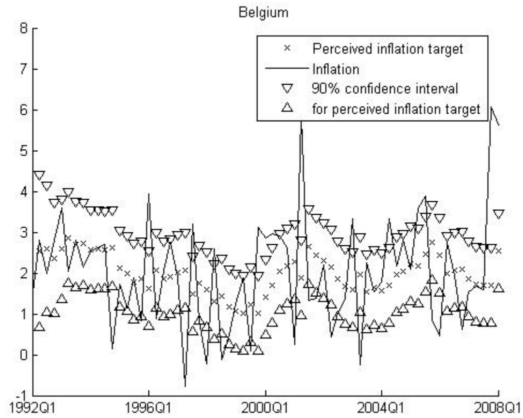
Table A2.5: Estimation results of the time-varying mean model.

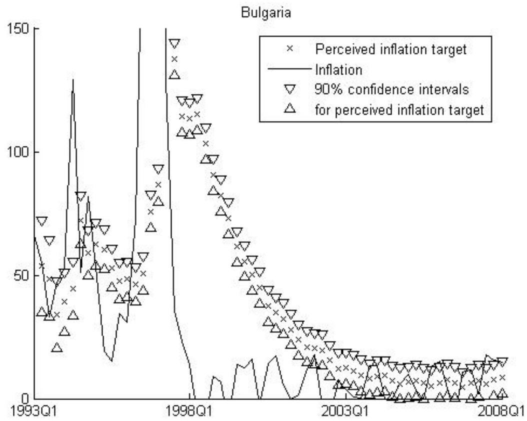
	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
BEL						
φ_1	0.2	-0.03	-0.22	0.17	beta	0.3
φ_2	0.1	0.00	-0.21	0.20	beta	0.3
φ_3	0.05	0.16	-0.05	0.35	beta	0.3
φ_4	0.05	-0.06	-0.24	0.15	beta	0.3
$\sum \varphi_i$		0.08				
δ	0.15	0.33	0.17	0.49	beta	0.1
σ_ε	2	1.32	1.13	1.48	invg	Inf
σ_τ	0.5	0.08	0.07	0.09	invg	Inf
GER						
φ_1	0.2	0.03	-0.17	0.24	beta	0.3
φ_2	0.1	-0.08	-0.30	0.14	beta	0.3
φ_3	0.05	-0.13	-0.35	0.08	beta	0.3
φ_4	0.05	-0.10	-0.30	0.10	beta	0.3
$\sum \varphi_i$		-0.28				
δ	0.15	0.40	0.26	0.55	beta	0.1
σ_ε	2	1.00	0.84	1.12	invg	Inf
σ_τ	0.5	0.12	0.11	0.14	invg	Inf
ESP						
φ_1	0.2	0.19	-0.01	0.38	beta	0.3
φ_2	0.1	0.04	-0.15	0.23	beta	0.3
φ_3	0.05	0.07	-0.14	0.25	beta	0.3
φ_4	0.05	-0.23	-0.41	-0.06	beta	0.3
$\sum \varphi_i$		0.07				
δ	0.15	0.33	0.16	0.48	beta	0.1
σ_ε	2	1.01	0.87	1.14	invg	Inf
σ_τ	0.5	0.10	0.08	0.11	invg	Inf

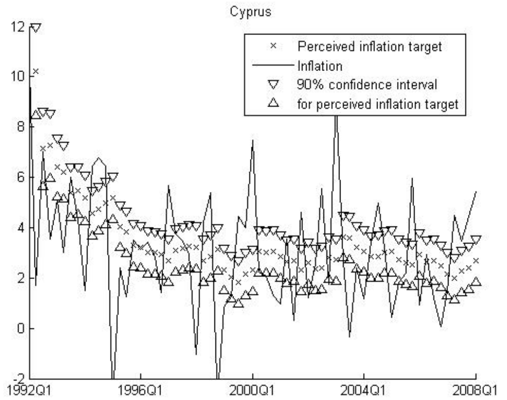
Table A2.6: Estimation results of the time-varying mean model.

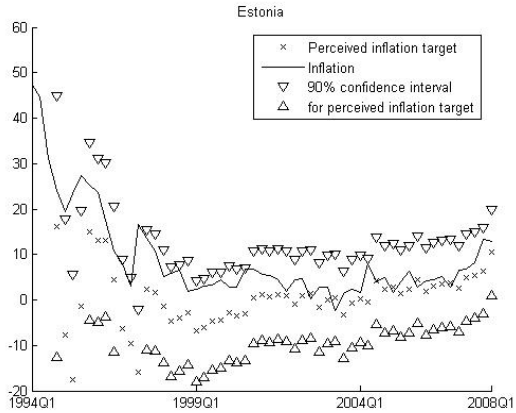
POR	Prior mean	Posterior mean	90% confidence interval		Prior distribution: type	std dev
φ_1	0	0.36	0.11	0.59	unif	0.5774
φ_2	0	-0.37	-0.62	-0.14	unif	0.5774
φ_3	0	-0.05	-0.28	0.19	unif	0.5774
φ_4	0	-0.48	-0.68	-0.27	unif	0.5774
$\sum \varphi_i$		-0.54				
δ	0.15	0.44	0.32	0.55	beta	0.1
σ_ε	2	1.39	1.20	1.60	invg	Inf
σ_τ	0.5	0.23	0.19	0.26	invg	Inf

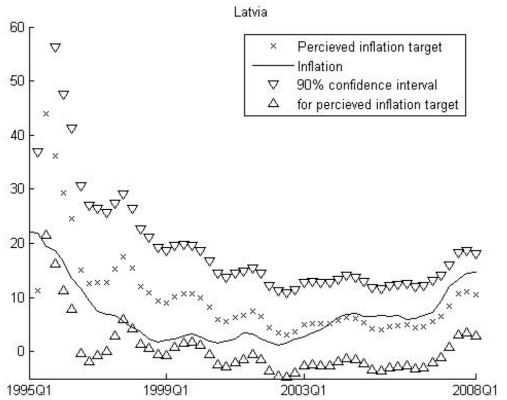
APPENDIX 3: PERCEIVED INFLATION TARGETS

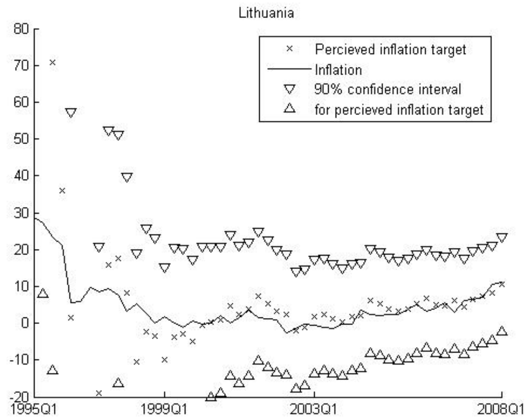


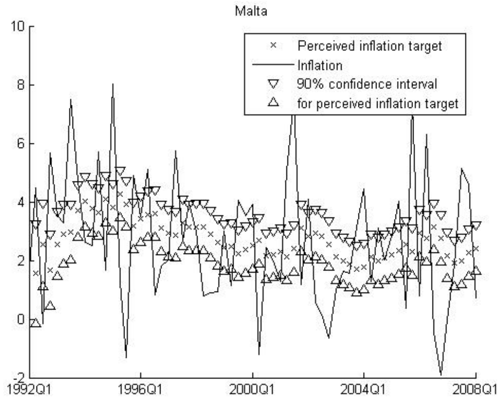


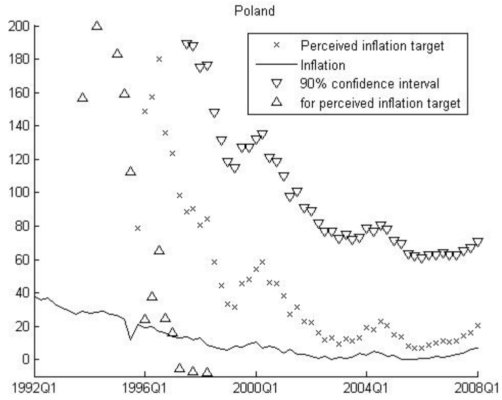


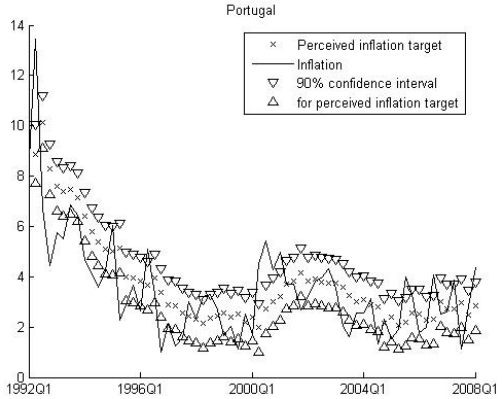


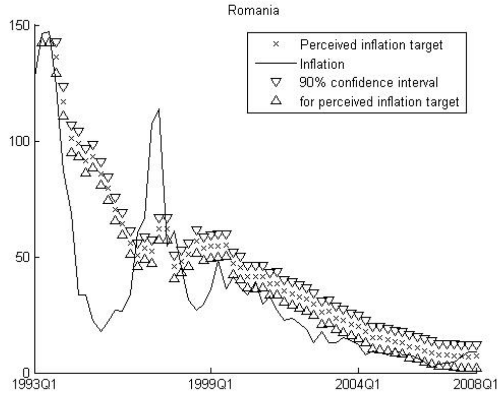


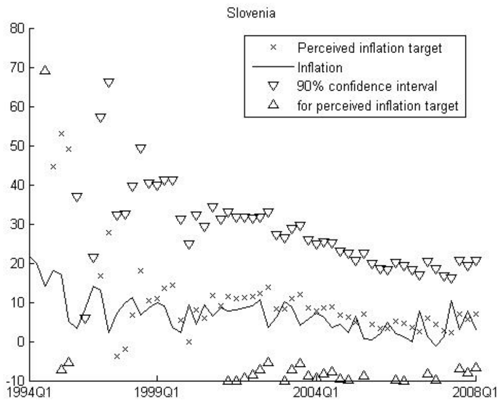


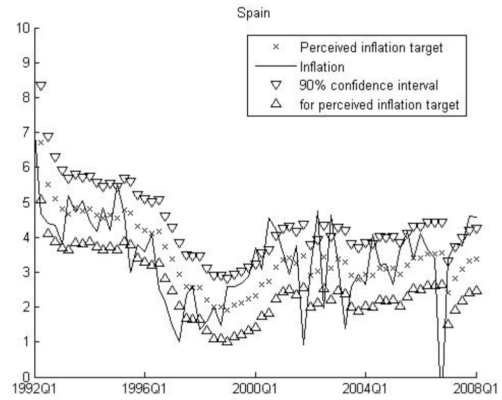

Malta
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1992Q1
1996Q1
2000Q1
2004Q1
2008Q1


Poland
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1992Q1
1996Q1
2000Q1
2004Q1
2008Q1


Portugal
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1992Q1
1996Q1
2000Q1
2004Q1
2008Q1


Romania
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1993Q1
1999Q1
2004Q1
2008Q1


Slovenia
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1994Q1
1999Q1
2004Q1
2008Q1


Spain
Perceived inflation target
Inflation
90% confidence interval
for perceived inflation target
1992Q1
1996Q1
2000Q1
2004Q1
2008Q1

Inflation forecasting in the New EU Member States*

Olga Arratibel[a], Christophe Kamps[b] and Nadine Leiner-Killinger[c]

ABSTRACT

To the best of our knowledge, our paper is the first systematic study of the predictive power of monetary aggregates for future inflation for the cross section of New EU Member States. This paper provides stylized facts on monetary versus non-monetary (economic and fiscal) determinants of inflation in these countries as well as formal econometric evidence on the forecast performance of a large set of monetary and non-monetary indicators. The forecast evaluation results suggest that, as has been found for other countries before, it is difficult to find models that significantly outperform a simple benchmark, especially at short forecast horizons. Nevertheless, monetary indicators are found to contain useful information for predicting inflation at longer (3-year) horizons.

Keywords: Inflation forecasting, leading indicators, monetary policy, information content of money, fiscal policy, New EU Member States

JEL: C53, E31, E37, E51, E52, E62, P24

* We would like to thank, without implying, Hans-Joachim Klöckers, Ricardo Mestre, Philippe Moutot, Ad van Riet, Philipp Rother, Jean-Pierre Vidal and participants at the European Commission Workshop "What drives inflation in the new EU Member States?" for their valuable comments and suggestions. We also thank an anonymous referee for helpful comments. The views expressed are our own and do not necessarily reflect those of the European Central Bank.
[a] Corresponding author. ECB EU Countries Division, email: olga.arratibel@ecb.europa.eu.
[b] ECB Monetary Policy Strategy Division, email: christophe.kamps@ecb.europa.eu.
[c] ECB Fiscal Policies Division, email: nadine.leiner-killinger@ecb.europa.eu.

NON-TECHNICAL SUMMARY

In recent years inflation has accelerated, sometimes very sharply, in most of the non-euro area EU Member States that have joined the EU since 2004 (hereafter, the new EU Member States: NMS). The recent rise in inflation has been largely attributed to a series of adverse supply shocks, such as energy and food price increases, as well as to ongoing changes in the economic structures of these catching-up economies. At least in some countries, capacity pressures also seem to have played a role. Accordingly, the rise in inflation would appear by and large inevitable and, as regards the occurrence of adverse shocks, unpredictable. Indeed, over the past few years, inflation forecasts by international organisations and other professional forecasters appear to have sharply underestimated the recent rise in inflation in the NMS. The question arises whether the recent rise in inflation could have been predicted better by accounting for the signals of monetary indicators like trend money growth, which have not received much attention in discussions of recent inflation developments in the NMS.

Against this background, this paper (1) analyses potential economic and fiscal variables as explanatory variables for inflation developments and (2) takes a close look at the leading indicator properties of monetary and credit aggregates for future inflation. It focuses on inflation developments in eight Central and East European EU Member States, namely Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland and Romania.

To the best of our knowledge, this paper is the first systematic study to analyse the performance of a large set of monetary, economic and fiscal indicators in explaining inflation dynamics in the NMS, including bivariate models and trivariate (two-pillar Phillips curve) models. Three findings can be highlighted. First, we find that the performance of alternative forecasting models differs substantially across countries in that different variables seem to be influencing to a different extent inflation developments at different forecast horizons. Second, at the short-term (one-year) horizon, with the exception of a few countries, it is difficult to find models with forecasts significantly outperforming those of a simple benchmark (the random walk model). This finding is in line with empirical results for the U.S. and other OECD countries suggesting that inflation has become increasingly hard to forecast. In the few countries for which we find forecasting models significantly outperforming the benchmark at the one-year horizon, such models are in general based on economic and fiscal indicators. Third, we find that, over the longer term (three-year) forecasting horizon, monetary indicators contain useful information for predicting inflation in most NMS countries. Interestingly, the role played by monetary factors in driving inflation dynamics does not differ substantially between the NMS with a fixed exchange rate regime and those with a floating exchange rate regime. Thus, monetary indicators appear to become important variables to explain inflation trends across the majority of the NMS over the long-term forecasting horizon.

"Inflation is always and everywhere a monetary phenomenon"

(Milton Friedman (1963), Inflation: Causes and Consequences, Asia Publishing House, New York.)

1 INTRODUCTION

In recent years inflation has accelerated, sometimes very sharply, in most of the non-euro area EU Member States that have joined the EU since 2004 (hereafter, the new EU Member States: NMS). The recent rise in inflation has been largely attributed to a series of adverse supply shocks, such as energy and food price increases, as well as to ongoing changes in the economic structures of these catching-up economies. At least in some countries, capacity pressures also seem to have played a role. Accordingly, the rise in inflation would appear by and large inevitable and, as regards the occurrence of adverse shocks, unpredictable. Indeed, over the past few years, inflation forecasts by international organisations and other professional forecasters appear to have sharply underestimated the recent rise in inflation in the NMS. The question arises whether the recent rise in inflation could have been predicted better by accounting for the signals of monetary indicators like trend money growth, which have not yet received much attention in discussions of recent inflation developments in the NMS. The extent of monetary accommodation could be expected to be a key determinant of the transmission of shocks to inflation over medium-term to long-term horizons.

Against this background, this paper attempts to answer the following questions: To what extent do the above mentioned non-monetary factors explain the rise in inflation in these countries? Why has the rise in inflation over recent years been so heterogeneous across the NMS in the presence of common external shocks and similar levels of economic development? What is the role of money in explaining inflationary developments in the NMS? Could the rise in inflation, and also its heterogeneity across NMS, have been predicted? To address these questions this paper (1) analyses potential economic and fiscal variables as explanatory variables for inflation developments and (2) takes a close look at the leading indicator properties of monetary and credit aggregates for future inflation. It focuses on inflation developments in eight Central and East European EU Member States, namely Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland and Romania. Depending on data availability, the time period analysed in this paper is 1993Q1 to 2008Q2. To the best of our knowledge, our paper is the first systematic study of the predictive power of monetary aggregates for future inflation in the eight NMS. Individual-country studies exist for a few NMS, see e.g. Dabusinskas (2005) and Kotlowski (2005). These studies in general conclude that monetary aggregates provide useful information for forecasting inflation. Our forecast evaluation exercise builds on the empirical framework first applied by Stock and Watson (1999) to U.S. data and subsequently applied by Nicoletti-Altimari (2001), Carstensen (2007) and Hofmann (2008) to euro area data.[78] In this exercise, we consider a large set of monetary and non-monetary (economic and fiscal) indicators.

We find that the performance of alternative forecasting models differs substantially across countries in that different variables seem to be influencing to a different extent inflation developments at different forecast horizons. We also find that at the 4-quarter horizon, with the exception of a few countries, it is difficult to find models with forecasts significantly outperforming those of a simple benchmark (the random walk model). This result is in line with the findings of Stock and Watson's (2008) literature review suggesting that inflation has become increasingly hard to forecast in the U.S. and other OECD economies. However, our results also suggest that, over the longer term (3-year) forecasting horizon, monetary indicators contain useful information for predicting inflation in most NMS countries.

The paper is organised as follows. Section 2 first reviews past inflation developments and assesses inflation forecasts for the eight NMS. It then provides stylised facts on monetary and non-monetary (economic and fiscal) factors that have contributed to inflation developments in the NMS. Section 3 discusses the data and methodology used in the forecast evaluation exercise and Section 4 presents the empirical results. Section 5 concludes, highlighting the implications of monetary indicators for future inflation developments in the NMS.

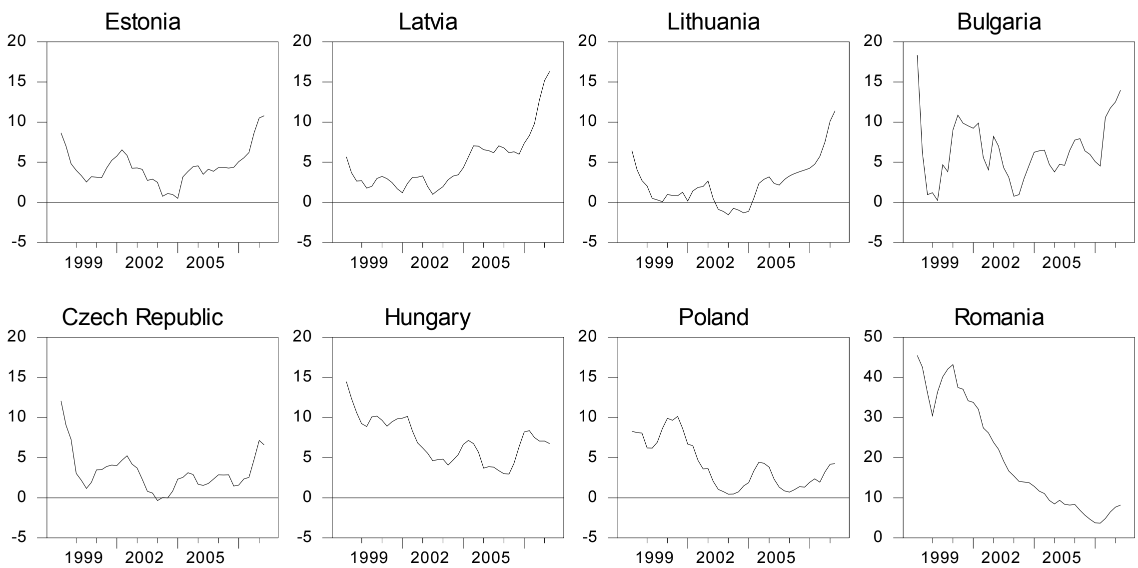
[78] For other methodologies to forecast inflation in the euro area see e.g. De Santis et al. (2008), Hubrich (2005), Calza et al. (2001). These models tend to require relatively large numbers of observations and a stable environment and are thus less suited for forecasting inflation in the NMS.

2 INFLATION DEVELOPMENTS AND INFLATION FORECASTS IN THE NMS: STYLISED FACTS

Since the end of the 1990s until the beginning of this decade inflation rates in most NMS followed a broadly downward path from relatively high levels (see Figure 1). At different points in time between 2003 and 2005, this pattern started to change quite noticeably. First, the disinflation process was interrupted in all countries but Romania. Second, inflation started to increase again, in some countries to remarkably high levels. Third, while the process of disinflation until around 2003 had taken place irrespective of the exchange rate strategy chosen, the rise in inflation over the period 2004-08 has been particularly virulent in the countries that have opted for "hard-pegs" (i.e. the Baltic States and Bulgaria). In the other countries, which follow an inflation-targeting strategy allowing for a higher degree of exchange rate flexibility (hereafter, "the floaters"), the surge in inflation has been generally more contained. Although the economic cycle seems to have peaked in 2008 in many cases, most notably in the Baltic States, strong price pressures remain (see for a survey of economic indicators for the NMS Table A.1 in the Appendix).

In such a changing environment, trying to predict the behaviour of price dynamics has become particularly demanding. This is illustrated in Figure 2 below, which shows for the eight countries considered and for the years 1999-2008, the annual average inflation rate and the respective inflation forecast that was made 18-months ahead, prior to the release of the final outcome. For example, the forecast for the average annual inflation in 2004 is the one made in May-June 2003. The forecasts have been taken from the *Eastern Europe Consensus Forecast*.

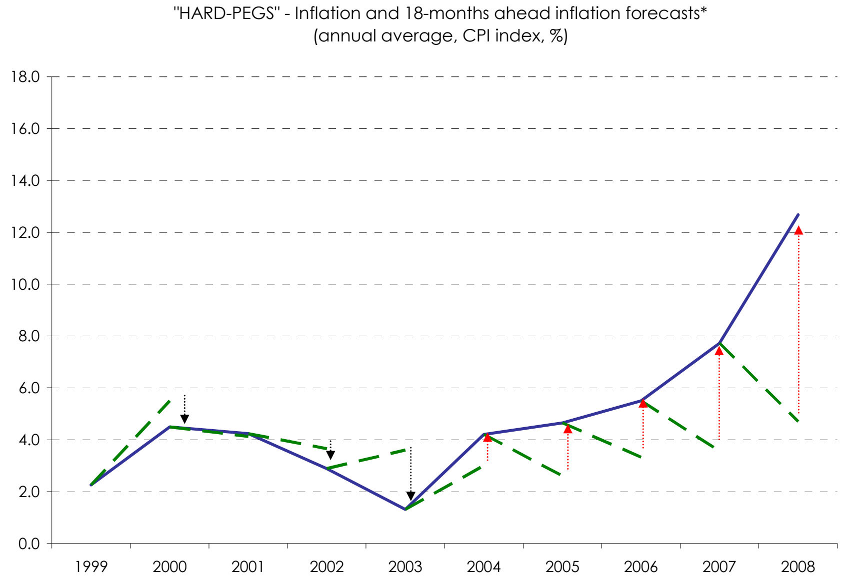
Figure 1: 4-quarter average inflation in NMS (1998Q2 – 2008Q2)



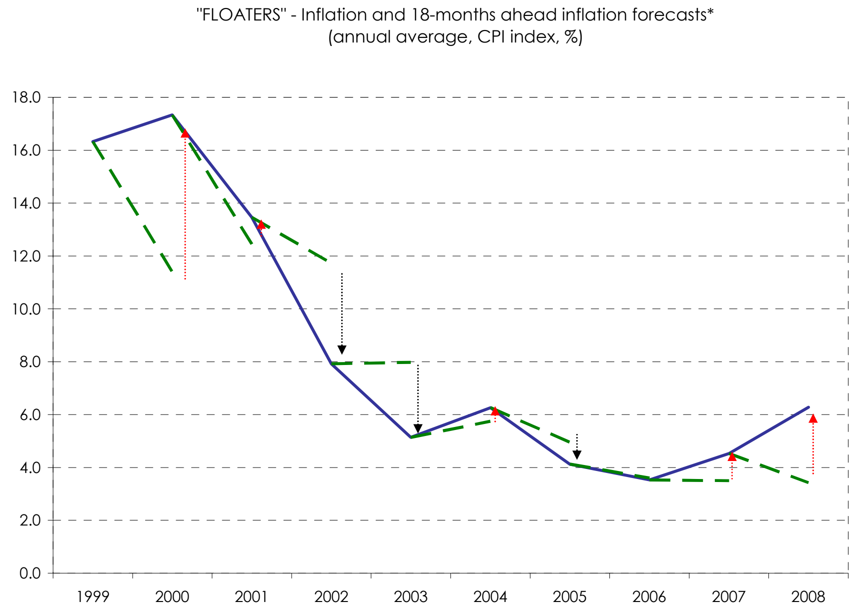
Note: 4-quarter average inflation is defined as 100*ln(CPI_t/CPI_{t-4}).

Interestingly, until 2003 inflation outcomes surprised on average on the downside: with the main exception of the floaters in the year 2000, inflation turned out rather close to and, at times, below the inflation forecast expected by the Consensus Forecast 18 months before. Thereafter, however, inflation has surprised on the upside, particularly in the last two years. Moreover, developments across countries have started to diverge. Specifically, forecasting inflation dynamics in the "hard-peg" countries seems to have become a particularly challenging task, with the forecasts having underpredicted inflation five years in a row. The question arises whether this systematic underprediction of future inflation was unavoidable given a series of unpredictable unfavourable shocks or whether the forecasts missed important information that would have allowed avoiding a downward bias.

Figure 2 Inflation forecasts and actual inflation (1999-2008)



Source: Eastern Europe Consensus Forecasts and IMF (International Financial Statistics).
* Unweighted average of annual inflation rates in Bulgaria, Estonia, Latvia and Lithuania. The arrows heading up (down) denote higher (lower) than expected inflation.The value for 2008 indicates the latest data available (August 2008).



Source: Eastern Europe Consensus Forecast and IMF (International Financial Statistics).

* Unweighted average of annual inflation rates in the Czech Republic, Hungary, Poland and Romania. The arrows heading up (down) denote higher (lower) than expected inflation. The value for 2008 indicates the latest data available (August 2008).

The forecast evaluation exercise presented in Sections 3 and 4 attempts to shed light on this question. In this exercise the "naïve" random walk model will serve as the benchmark to evaluate the performance of alternative forecasting models. As has been shown in the forecasting literature, it has proven difficult to find model-based forecasts or forecasts by professional forecasters that significantly outperform this simple benchmark (see, e.g., Stock and Watson 2007). Visual inspection of Figure 2 confirms that for our set of countries the Consensus forecasts in general did not outperform the simple no-change forecast implied by the random walk model. Going beyond visual impression, we computed a simple metric of forecast performance, the root mean squared forecast error, over the period 2003-08 both for the Consensus forecasts and for the random walk model (in the latter case using the average annual inflation rate over the previous twelve months in June of a given year as the forecast for average annual inflation in the next year). These computations confirm that across our set of countries on average the random walk model performed equally well than the Consensus forecasts, with the latter performing slightly better than the random walk model in the "floating" countries but worse in the "hard-peg" countries.[79] Given these findings and also because only too narrow a set of Consensus forecasts is available, we use the random-walk model as the benchmark in our formal forecast evaluation exercise presented below.

Before turning to this exercise, several non-monetary economic and fiscal as well as monetary factors are analysed with respect to their potential impact on inflation developments in the NMS.

2.1 NON-MONETARY DETERMINANTS OF INFLATION IN THE NEW EU MEMBER STATES

The rise in inflation in the NMS has generally taken place against the background of dynamic economic conditions, with external factors also having played a role. On the domestic side, strong domestic demand, underpinned by robust growth in disposable income, large inflows of foreign direct investment, low real interest rates and buoyant credit growth, have contributed to inflationary pressures in most NMS.[80] Moreover, the rapid tightening of the labour market, exacerbated by labour outflows to other EU countries, has contributed to rapid increases in wages, often significantly above labour productivity growth, hence leading to high growth in unit labour cost, particularly in the fastest growing economies. Under such circumstances, capacity constraints and signs of overheating emerged in many countries, e.g the Baltic States, Bulgaria, the Czech Republic and Romania.[81]

As for the external factors, among the most important drivers of inflation in the NMS are food prices, which had been declining in 2001-03 but have since rebound sharply, and soaring energy prices. These two components have a relatively large weight in the consumption basket of these countries, representing around 43% of the total (61.2% in the case of Romania). In some countries with flexible exchange rates, these price increases have been partly dampened by an appreciating currency (i.e. the Czech Republic and Romania). Moreover, the impact of globalisation and strong competition, noticeably from emerging Asia, seem to have generally contributed to containing growth rates in the price of tradable goods (e.g. textiles, furniture, IT equipment) in many NMS.

Also fiscal policy, through the impact of, inter alia, public finance reform, the fiscal stance, changes in direct and indirect taxation, public wage-setting as well as the liberalisation of administered prices in the wake of EU entry affected inflation performance in the NMS. In several of the eight NMS considered here, direct taxes and social security contributions were lowered in an attempt to reduce tax wedges and thus increase labour supply in the presence of labour shortages and sometimes large shadow economies in these fast growing economies. To the extent that capacity constraints were lowered, these measures contributed to containing inflation. At the same time, to the extent that these measures raised domestic demand, they tended to contribute to a rise in inflation. Furthermore, in several NMS, public wages rose significantly. As Figure 3 indicates, the increase in government spending on compensation of public employees in the general government sector reached double digit values in the Baltic countries, Hungary and Poland between 1995 and 2007. In Bulgaria and the Baltic countries, which faced a strong pick-up in inflation since 2003, compensation of public employees over this period continued to rise

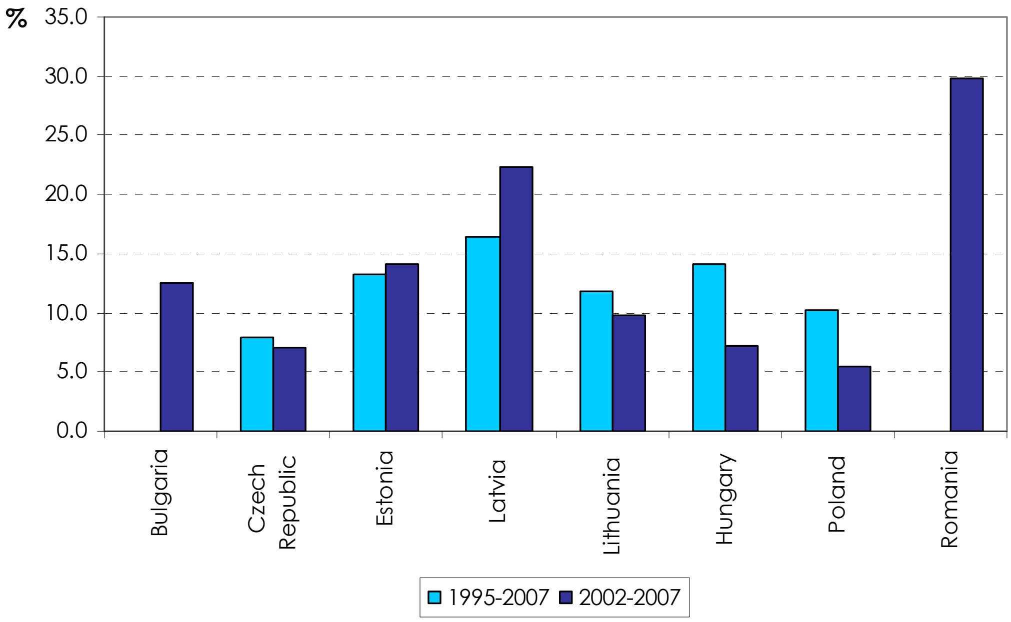
[79] Romania is a clear outlier, for which the random-walk model performs very poorly because it misses the strong downward trend in inflation over the sample period, which at least to some extent was predictable.

[80] The main exception would be Hungary, where output growth has remained relatively subdued.

[81] In most NMS, notably in those that have opted for a "hard-peg" to the euro, the process of catching-up in real income with the euro area is likely to manifest itself in higher inflation. However, the exact size of such effect is difficult to assess. According to most studies, it generally accounts for between 0.4 and 2.4 percentage points of inflation in the NMS (see Darvas and Szapáry (2008)).

at these high rates. At the same, apart from Romania, it fell in those NMS with disinflation, such as in Hungary and Poland, or continued to grow at relatively lower growth rates, such as in the Czech Republic.

Figure 3: Compensation of public employees, general government (annual average percentage changes)



Notes: For Romania 2003-2007, for Hungary 1997-2006.

Source: ESCB, ECB calculations.

Furthermore, the liberalisation of administered prices in sectors such as e.g. energy and transport contributed to price increases that varied across the NMS. As regards indirect taxes, over the last decade, three of the eight NMS considered lowered their VAT rates, partly substantially in view of EU tax harmonisation, namely the Czech Republic, Hungary and Romania.[82] While in Romania these measures took place in a disinflation environment, they were followed by a pick-up in inflation in the others. Moreover, most of the NMS receive partly substantial EU Structural Funds within the EU cohesion policy framework that may affect inflation. In 2007, the allocation of EU Funds to the eight NMS considered here amounted to about 2½% of GDP on average. While these funds are aimed at improving long-term growth and employment prospects in the supported regions they may in the short run raise domestic demand significantly, thus raising inflation particularly at times of capacity constraints.[83] As regards fiscal policy, overall, fiscal efforts to comply with the requirements of the Stability and Growth Pact tended to foster fiscal consolidation in the NMS that should in principle have worked in the direction of inflation containment. Nevertheless, one may conjecture that, at times, a loosening fiscal stance, resulting from e.g. high capital spending in the presence of large infrastructure needs and measures to raise labour supply, may have contributed to an increase in inflation. In addition, at some instances, the fiscal stance has not been tight enough to sufficiently contribute to inflation containment (see Figure A.2 in the Appendix).

[82] In Hungary, the VAT rate was lowered by 5 percentage points to 20% in 2006, and in the Czech Republic by 3 percentage points to 19% in 2003 (see Figure A.1 in the Appendix). In Romania the VAT rate was reduced by 3 percentage points to 19% in 2000.

[83] See for details Kamps et al. (2009). It is, however, difficult to gauge the impact of these funds on inflation as one has to disentangle allocations from actual payments, which do not coincide in general. Due to data limitations, we cannot account for the role of EU funds in our forecasting exercise.

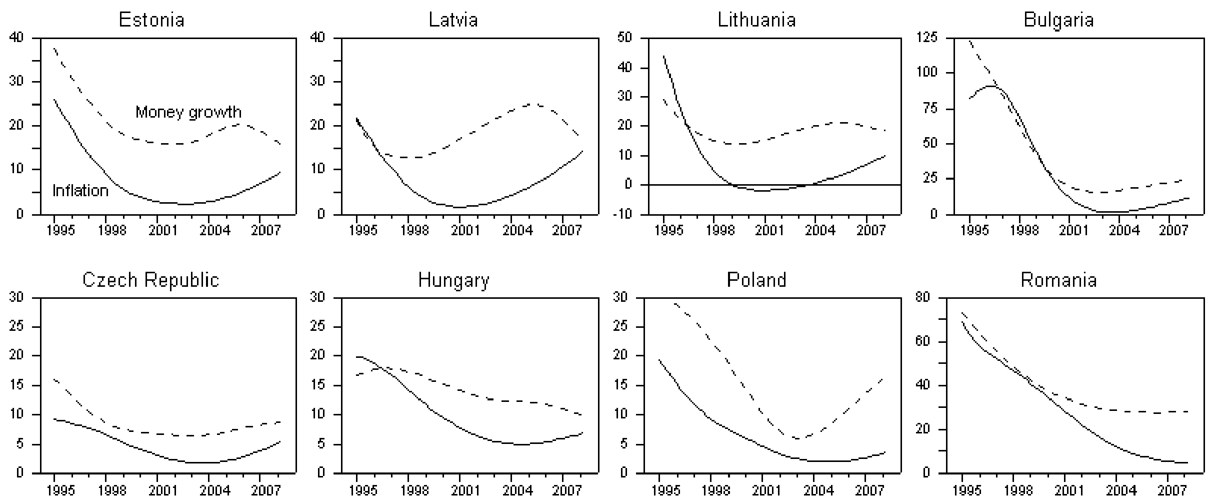
2.2 MONETARY DETERMINANTS OF INFLATION IN THE NEW EU MEMBER STATES

The economic and fiscal determinants of inflation developments in the NMS share the following feature: it is often unanticipated shocks to these variables – and their more or less sluggish propagation – what drives inflation developments over the short to medium run. Shocks to food and energy prices, for example, not only heavily affect relative prices but, in the short to medium run, also strongly affect overall inflation. However, in the long run such shocks need not impact on overall inflation unless monetary policy chooses to at least partly accommodate them. This subsection presents one indicator of monetary-policy induced inflationary pressures, namely the evolution of trend money growth.

The empirical literature has established a strong link between money growth and inflation for OECD countries, looking at data that span more than a century (see, e.g., Lucas 1996 and Benati 2008). This evidence suggests that surges in money growth in general precede high-inflation episodes, making money growth a potentially useful indicator for future inflation. More recently, Assenmacher-Wesche and Gerlach (2007, 2008) showed that the empirical link between money growth and inflation is particularly strong at low frequencies, while the relationship is rather noisy at business cycle frequencies. Figure 4 shows the low-frequency components of annualised quarter-on-quarter money growth and inflation for the eight NMS under review for the period 1995 to 2008, where the low-frequency components of the two series have been estimated with a Hodrick-Prescott filter.

The figure reveals a number of interesting findings. First, there has been pronounced disinflation in all eight countries in the second half of the 1990s, accompanied by a strong deceleration in trend money growth. Second, trend inflation and trend money growth started to accelerate in all countries except for Hungary and Romania around the start of the current century. Third, in all these countries the turning point for trend money growth preceded the turning point for trend inflation. On average, trend money growth reached its low point five quarters before trend inflation (median: four quarters) did, with the lead being longest in the case of Latvia (almost three years) and shortest in the case of the Czech Republic (half a year). Also, the pick-up in trend money growth suggests that the recent surge in inflation in the NMS is not exclusively due to the occurrence of unanticipated shocks but at least partly has monetary roots.[84] Fourth, in some countries (Estonia, Latvia and Lithuania) trend money growth peaked in 2005 and decelerated thereafter, suggesting gradually declining inflationary pressures in these countries. All in all, the stylised evidence presented in this subsection suggests that trend money growth contains useful information for predicting future inflation, a hypothesis that will be tested in the remainder of this paper.

Figure 4: Trend money growth and inflation in NMS (1995Q1 – 2008Q2)



Note: Money growth based on broadest available monetary aggregate (M3 for Bulgaria, Hungary and Lithuania, M2 for remaining countries). Trend estimated with Hodrick-Prescott filter (tuning parameter set equal to 1600).

[84] Note that even the recent surge in commodity prices (one of the "shocks") might have been partly driven by loose monetary policy, albeit at the global level (Frankel 2006).

3 THE EMPIRICAL FRAMEWORK

This section presents the empirical framework used to evaluate the performance of alternative forecasting models. The first subsection discusses the data, while the second subsection presents the alternative forecasting models used for this exercise. The empirical results are presented in Section 4.

3.1 DATA

We use data for eight NMS, namely Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland and Romania. Most series were retrieved from the Haver Analytics DLX databases "Eurostat", "EMERGECW" and "IFS" (see Appendix A.2 for details). Most time series are seasonally adjusted by the source. Whenever this is not the case, we seasonally adjust the respective series using the Census X11 multiplicative procedure. Depending on data availability, we use quarterly data for 1993Q1 to 2008Q2. However, data availability differs substantially across countries and for some countries some series start only in the end-1990s. For the forecasting regressions, we only used data that were available at least from 1995Q1 onwards. For Bulgaria and Romania, data availability is particularly limited and also data quality appears to be an issue, suggesting that the results for these countries should be taken with a grain of salt.

We group the explanatory variables that we consider in the forecasting exercise into three groups, namely monetary, economic and fiscal indicators. The monetary indicators tested include the monetary aggregates M1, M2 and M3 as well as loan growth. For those countries for which M3 is not available we use M0, M1 and M2 instead. The monetary indicator variables also include concepts such as trend broad money growth, the real money gap, the monetary overhang and the change in P-star (see Appendix A.1 for details).

Economic indicators include both domestic and external factors. Domestic factors comprise the output gap, real GDP growth, employment growth, a measure of the employment gap, the change in the unemployment rate, a measure of the unemployment rate gap, growth in compensation per employee, wage growth, industrial production growth and, finally, the level and change in producers' selling price expectations as well as consumers' price expectations based on surveys compiled by the European Commission. External factors include the nominal effective exchange rate, commodity price inflation as well as changes in oil prices. Commodity prices and oil prices expressed in euro are taken from the ECB Monthly Bulletin database and converted into national currency using spot exchange rates.

Fiscal variables comprise growth in general government revenue and expenditure, changes in direct and indirect taxes, changes in VAT revenues, changes in government consumption and growth in compensation of government employees. Unfortunately, a long enough time series of the latter variable is available for the Czech Republic only. However, given that compensation of government employees is by far the largest sub-item in government consumption, one can interpret changes in government consumption as a proxy for government-induced wage pressures.

The trend and gap measures referred to above (e.g. trend money growth and the output gap) are constructed as follows. First, the trend component of the respective variable is estimated with a Hodrick-Prescott filter (with tuning parameter set equal to 1600). We follow Stock and Watson (1999) and Hofmann (2008), using a one-sided filter to estimate the trend components. This filter for each period uses only information up to that period, which is important for the pseudo real-time out-of-sample forecasting exercise we carry out. We estimate the one-sided Hodrick-Prescott filter using the Kalman filter. Once the trend component has been estimated, the gap measure is obtained as the (log) difference between the raw series and the Hodrick-Prescott trend.

3.2 METHODOLOGY

The forecast evaluation exercise builds on the empirical framework first applied by Stock and Watson (1999) to U.S. data and subsequently applied by Nicoletti-Altimari (2001), Carstensen (2007) and Hofmann (2008) to euro area data.[85] To the best of our knowledge, our study is the first attempt to apply this methodology to study the performance of alternative forecasting models for the NMS. The following description of the methodology closely follows Hofmann (2008).

As is common in this literature, we concentrate on single-equation forecasting models with few independent variables for the following reasons. First, single-equation inflation-forecasting models have been found in the forecast evaluation literature to outperform large multiple-equation models such as vector autoregressions or traditional structural macroeconometric models (see, e.g., Stock and Watson 2008). Second, we concentrate on models with few independent variables in order to account for our short data samples. Increasing the number of indicator variables included in the models would quickly exhaust the degrees of freedom. Yet, in order to reflect the large set of information available to professional forecasters in practice, we also present results for combined forecasts that average over the large set of forecasting models (between 40 and 60 per country) we consider in the exercise.

To begin with, the variable to be forecasted has to be chosen. It has become common practice in the literature to focus on annualised average inflation over the coming *h* quarters, which can be formally expressed as $\pi_{t+h}^{h} = (400/h)\ln(CPI_{t+h}/CPI_{t})$ and where π denotes the inflation rate and *CPI* denotes the consumer price index. In the empirical exercise we consider three alternative forecasting horizons, namely 4-quarter ahead forecasts, 8-quarter ahead forecasts and 12-quarter ahead forecasts (h = 4, 8, 12).

Benchmark model for forecast evaluation

In order to evaluate the forecasting performance of alternative models, we compare their forecast errors with those obtained for a simple benchmark model. Two candidate benchmark models have been routinely used in the forecasting model. First, the "naïve" random walk model (hereafter RW), which states that the forecast of *h*-quarter ahead inflation at time *t* is simply the last observable value of h-quarter inflation:

$$(1) \qquad \hat{\pi}_{t+h|t}^{h} = \pi_{t-1}^{h},$$

where $\pi_{t-1}^{h} = (400/h)\ln(CPI_{t-1}/CPI_{t-h-1})$. Here, we assume – as is the case in practice – that the inflation rate at time *t*, π_{t}^{h}, is not part of the time-*t* information set.

Second, a univariate autoregressive model for inflation (hereafter AR), which can be expressed as:

$$(2) \qquad \pi_{t+h}^{h} = \beta_0 + \beta_1(L)\pi_t + u_{t+h}^{h},$$

where $\beta_1(L)$ is a finite polynomial of order *p* in the lag operator *L* ($\beta_1(L) = \beta_{11}L + ... + \beta_{1p}L^p$). Again, we assume that the inflation rate at time *t*, π_t, is not part of the time-*t* information set. We follow Carstensen (2007) and use a stepwise procedure to determine which lagged values of inflation enter the model, considering up to four

[85] See Fischer et al. (2006) for a discussion of the role these forecasting models play in ECB monetary analysis.

lagged values of inflation ($p = 4$).[86] The *h*-quarter ahead forecast, after model estimation, is calculated as $\hat{\pi}^h_{t+h|t} = \hat{\beta}_0 + \hat{\beta}_1(L)\pi_t$.

The results presented in Section 4 suggest that, in the cross-section of countries considered in this paper and across forecasting horizons, the random walk model on average outperforms the autoregressive model, in the sense that it produces lower root mean squared errors (RMSE). Therefore, we pick the random walk model as the benchmark model when testing whether the alternative forecasting models presented below significantly outperform the benchmark. For this purpose, we use the test for equal predictive ability developed by Diebold and Mariano (1995), which is applicable in the case of non-nested models.[87]

Bivariate forecasting models

The first set of forecasting models used in the forecasting exercise extends the univariate autoregressive model discussed above by including one indicator variable, x_t , at a time:

$$\pi^h_{t+h} = \beta_0 + \beta_1(L)\pi_t + \beta_2(L)x_t + u^h_{t+h}, \tag{3}$$

where $\beta_2(L)$ is a polynomial of order *p* in the lag operator *L*. Again, we assume that the respective indicator variable at time *t*, x_t , is not part of the time-*t* information set. A stepwise procedure is used to determine which lagged values of inflation and of the respective indicator variable enter the model, considering up to four lagged values of both inflation and the respective indicator variable ($p = 4$). The *h*-quarter ahead forecast, after model estimation, is calculated as $\hat{\pi}^h_{t+h|t} = \hat{\beta}_0 + \hat{\beta}_1(L)\pi + \hat{\beta}_2(L)x_{t\,t}$.

In the empirical exercise the bivariate models are estimated for each country and each indicator variable in turn. The maximum number of bivariate forecasting models is 32 per country, given that we have up to 8 monetary indicators, up to 17 economic indicators and up to 7 fiscal indicators.[88]

Trivariate (two-pillar Phillips curve) forecasting models

Gerlach (2003, 2004) proposed a simple trivariate (two-pillar Phillips curve) forecasting model intended to capture at the same time the information of both monetary and economic indicators. Such trivariate (two-pillar Phillips curve) forecasting models specify *h*-quarter ahead average inflation as a function of its own lags, lags of trend broad money growth (Δm^T_t), estimated with the one-sided Hodrick-Prescott filter discussed above, as well as lags of a non-monetary indicator variable (x_t):

$$\pi^h_{t+h} = \beta_0 + \beta_1(L)\pi_t + \beta_2(L)x_t + \beta_3(L)\Delta m^T_t + u^h_{t+h}, \tag{4}$$

[86] Lagged values enter the model only if they are significant at a pre-specified significance level (here the overall significance level is set to 0.2). Compared to lag-length selection criteria the stepwise procedure has the advantage of additional flexibility. For example, it might be that lags 1 and 4 turn out to be highly significant but lags 2 and 3 are insignificant. A conventional selection criterion would probably pick a model with one lag only as the best model. However, this would miss the information contained in the fourth lag, which may strongly affect forecast accuracy. The stepwise procedure, instead, would include lags 1 and 4 in the model.

[87] Note that some of the models are nested, implying non-standard asymptotic distributions under the null hypothesis, see Clark and McCracken (2005). Since forecasts are multiple-step, the proper size of the tests would need to be derived by Montecarlo simulation. As doing this for all the models considered in this paper would be computationally prohibitive, we opted for the Diebold-Mariano test, noting its limitations in some cases.

[88] Given that not all series are available for each country, the effective number of bivariate forecasting models ranges between 20 (Romania) and 31 (Czech Republic, Estonia, Latvia).

where $\beta_3(L)$ is a polynomial of order p in the lag operator L. Again, we assume that trend broad money growth at time t, Δm_t^T, as well as the respective indicator variable at time t, x_t, are not part of the time-t information set. A stepwise procedure is used to determine which lagged values of inflation, of trend money growth and of the respective indicator variable enter the model, considering up to four lagged values of both inflation and the respective indicator variable ($p = 4$). The h-quarter ahead forecast, after model estimation, is calculated as $\hat{\pi}_{t+h|t}^h = \hat{\beta}_0 + \hat{\beta}_1(L)\pi + \hat{\beta}_2(L)x_t + \hat{\beta}_3(L)\Delta m_t^T$.

In the empirical exercise the trivariate (two-pillar Phillips curve) models are estimated for each country and each indicator variable in turn. The maximum number of trivariate (two-pillar Phillips curve) forecasting models is 24 per country, given that we have up to 17 economic indicators and up to 7 fiscal indicators.[89]

Forecast combinations

In addition to the individual-indicator bivariate and trivariate (two-pillar Phillips curve) forecasting models we also provide evidence on the performance of simple forecast combinations. We consider five alternative forecast combinations: combining the forecasts of (i) the monetary-indicator bivariate models, (ii) the economic-indicator bivariate models, (iii) the fiscal-indicator bivariate models, (iv) all bivariate models, and (v) all trivariate (two-pillar Phillips curve) models. All these forecast combinations are computed as the simple average of the forecasts produced by the models with the individual indicators, for each point in time, forecasting horizon and country.

The reason for including these forecast combinations is that such combinations have been shown to significantly improve forecast accuracy in previous studies (see, e.g., Stock and Watson 1999 and Hofmann 2008). Also, forecast combinations based on simple averages have been shown to perform equally well or even better than combinations assigning different weights to the forecasts produced by different models according to some optimality criterion. This result suggests that forecast combinations based on simple averages can best deal with uncertain structural breaks that may heavily affect the forecast performance of individual models. In this context, it may be wise not to assign too much weight to a particular model. These considerations are particularly relevant for our set of countries, characterised by an ongoing convergence process and substantial structural change.

Forecast evaluation sample

In the simulated out-of-sample forecasting exercise, the individual forecasting models are estimated using data prior to the forecasting period in such a way as to reflect the information set available to forecasters in real time. Note, however, that since we lack a real-time database we have to rely on revised data from the most recent vintage of official statistics. In this sense, we conduct a pseudo real-time exercise.

The sample period for the recursive forecasting regressions starts in 1998Q2 for all models, in order to allow for the long lags in the dependent and independent variables. Take the bivariate model with h=12 as an example. The observation of h-quarter inflation for 1998Q2 (which is price level in 1998Q2 divided by price level in 1995Q2) is modelled as depending on values of the indicator variable in 1995Q1 (lag 1), 1994Q4 (lag 2), 1994Q3 (lag 3), 1994Q2 (lag 4). This is the earliest observation of h-quarter inflation we can model given the data constraints we face.

The forecast evaluation sample runs from 2003Q3 to 2008Q2 and is, thus, based on quarterly observations for five years. In general, for each forecast horizon h the first out-of-sample forecast is constructed in period 2003Q3-h in order to ensure that for each forecasting horizon we obtain a forecast evaluation sample of equal length. Take the forecast for 2003Q3 and the bivariate model with h=4 as an example. This forecast is made in 2002Q3 and is based on a forecasting regression using data up to 2002Q2. Once the forecast for a given quarter in the forecast evaluation sample has been computed, the procedure moves one quarter forward and uses one additional data point per step to estimate the forecasting regression and to construct the forecast. The procedure stops after the forecast for 2008Q2 has been constructed, the last period in our data sample.

[89] Given that not all series are available for each country, the effective number of trivariate forecasting models ranges between 14 (Romania) and 24 (Czech Republic).

4 EMPIRICAL RESULTS

This section discusses the forecast evaluation results for the above-mentioned bivariate and trivariate (two-pillar Phillips curve) models using alternative monetary and non-monetary (economic and fiscal) variables over the three alternative forecasting horizons. It focuses on the short-term horizon (4-*quarter ahead*) and the long-term horizon (12-*quarter ahead*); the results for the medium-term horizon (8-*quarter ahead*) are displayed in the Appendix (see Table A.2). In presenting the empirical results, countries have been grouped according to their choice for exchange rate flexibility (i.e. Bulgaria, Estonia, Latvia and Lithuania as “hard-pegs” and the Czech Republic, Hungary, Poland and Romania as “floaters”) in an attempt to identify possible differences in the ability to forecast inflation trends among these two groups of countries. As mentioned above, the performance of the bivariate and trivariate (two-pillar Phillips curve) models is assessed by comparing their respective RMSE with the RMSE obtained from a simple random walk (RW).

Three findings become immediately apparent just from a visual inspection of the results. First, the results differ substantially across countries in that different variables seem to be influencing to a different extent inflation developments at different forecast horizons. This is likely to derive from the fact that, notwithstanding some similarities, economic structures and institutions do vary across the NMS. Moreover, monetary and fiscal policies and structural reform in these countries have addressed to a different extent country-specific policy requirements reflecting, for example, different states of real convergence and/or different policy options. Second, at the 4-quarter horizon, with the exception of Bulgaria, Estonia and Hungary, none of the bivariate and trivariate (two-pillar Phillips curve) forecasting models produce a RMSE that is significantly smaller than that of a RW model. This result echoes the findings of Stock and Watson’s (2008) recent literature review suggesting that inflation is hard to forecast in the U.S. and other OECD economies and that it is difficult to improve upon simple benchmark models. Third, at the 12-quarter horizon a number of bivariate models and trivariate (two-pillar Phillips curve) models significantly improve upon the forecasts of the RW model. In particular, monetary indicators do appear to contain useful information for predicting inflation at longer (3-year) horizons in these countries.

4.1 SHORT-TERM FORECAST OF INFLATION DEVELOPMENTS (4 QUARTERS AHEAD)

Following the methodology described in Section 3.2, Table 1 displays the *absolute* RMSE for the RW as well as the values of the RMSEs of the different models *relative* to the RW. Hence, relative RMSEs smaller than unity correspond to models outperforming the RW. When marked bold, relative RMSEs smaller than unity correspond to models that significantly outperform the RW (by reference to a Diebold-Mariano test).

Looking at Table 1, the results show that at the 4-quarter horizon the bivariate and trivariate (two-pillar Phillips curve) models perform worse than the RW benchmark in all countries but Bulgaria, Estonia and Hungary. This confirms that at the short-term horizon it is difficult to improve the forecast performance upon this simple RW benchmark. In the three countries where either bivariate or trivariate (two-pillar Philipps curve) models are able to significantly outperform the RW, it appears that different factors can help explaining inflation developments as indicated by the best-performing models.

- In Bulgaria the bivariate model with commodity price inflation performs best, possibly reflecting the relatively large weight of food and energy prices in the consumer’s basket of this economy. The bivariate model with growth of compensation per employee and the trivariate (two-pillar Phillips curve) model with trend M3 growth and commodity price inflation also significantly outperform the RW and to a lesser extent also improve upon the AR model.

- In Estonia the bivariate model with ULC growth performs best. The bivariate model with producers' price expectations also performs significantly better than either the RW or the AR model (the latter performs worse than the RW for Estonia). In addition, the trivariate (two-pillar Phillips curve) models with the output gap, the unemployment gap and ULC growth perform better than the RW. With the exception of ULC growth, these trivariate (two-pillar Phillips curve) models perform better than the bivariate models with these economic variables, which suggests that combining a monetary indicator (here: trend M2 growth) with economic indicators in some cases improves forecast accuracy.

- In Hungary the bivariate models with consumers' price expectations and M1 growth perform best. Both models display considerably better forecasting performance than the AR model, which itself performs significantly better than the RW. The bivariate models with loan growth, the change in the unemployment rate and government consumption growth also perform significantly better than the RW even though the improvement upon the AR model is not very sizeable. Interestingly, Hungary with its high and rather volatile general government deficit is among the few countries for which we find that fiscal policy has predictive power for inflation in the short run.

As regards the forecast combinations at the 4-quarter horizon, they are not able to significantly outperform the RW forecast in any NMS apart from Bulgaria and Hungary. In Hungary, the combined forecast of monetary indicators performs the best among these combined forecasts.

Overall, we find that when trying to forecast inflation developments at the 4-quarter horizon, in the few countries in which we find models performing significantly better than the RW, the best performing models are bivariate models with economic indicators. In Estonia and Bulgaria some labour market indicators seem to be particularly capable to outperform the RW. This may broadly reflect a labour market tightening over the sample period in these fast growing and at times overheating economies.

Table 1. Relative root mean squared error for alternative forecasting models (forecast horizon = 4 quarters ahead)

	Hard-Pegs				Floaters			
	BG	EE	LV	LT	CZ	HU	PL	RO
Random walk model (RMSE)	3.87	2.82	3.86	3.02	2.26	2.73	2.30	4.00
Autoregressive model	**0.84**	1.03	1.33	1.29	0.95	**0.88**	1.27	3.04
Bivariate models								
(a) Monetary indicators								
M3/M2 (change)	0.90	0.95	1.33	1.30	1.12	0.98	1.22	3.13
Trend M3/M2 (change)	0.88	0.96	1.17	1.32	1.32	0.99	1.55	2.06
P* (change)	0.93	0.95	1.33	1.31	1.16	0.87	1.07	3.04
Real money gap	0.88	1.13	1.33	1.40	1.11	1.29	1.26	1.92
Monetary overhang	0.99	1.05	1.23	1.31	1.48	1.35	1.71	2.41
M1/M0 (change)	**0.86**	0.91	1.33	1.45	1.05	**0.69**	1.38	4.85
M2/M1 (change)	0.91	0.92	1.25	1.31	-	0.94	1.44	-
Loans	0.96	1.08	1.33	1.45	1.43	**0.85**	0.98	-
(b) Economic indicators								
Output gap	**0.84**	1.20	1.33	1.56	1.42	1.19	1.67	2.67
Real GDP (change)	**0.85**	1.12	1.30	1.31	1.01	0.96	1.25	3.02
Employment (change)	**0.85**	1.33	1.40	1.15	0.95	1.05	1.28	2.54
Employment gap	0.90	1.37	1.36	1.01	1.42	1.39	1.42	2.65
Unemployment rate (change)	0.93	1.24	1.34	1.38	1.00	**0.88**	2.08	2.61
Unemployment rate gap	0.99	1.10	1.33	1.34	1.40	1.16	2.40	2.02
Compensation per employee (change)	**0.83**	0.89	1.01	1.32	1.01	1.04	-	2.55
Wages (change)	**0.84**	1.03	1.18	1.41	0.92	1.54	1.18	2.95
ULC (change)	**0.84**	**0.73**	0.98	1.29	1.07	1.46	-	-
Industrial production (change)	-	1.07	1.34	1.30	1.16	1.00	1.31	2.82
Nom. eff. exchange rate (change)	**0.84**	1.02	1.30	1.29	0.89	0.90	1.90	3.02
Commodity prices (change)	**0.77**	0.97	1.17	1.05	0.94	1.00	1.41	2.89
Oil prices (change)	0.97	1.07	1.33	1.34	1.01	1.00	1.55	3.20
Cons. price expectations (level)	-	1.30	1.01	-	1.25	**0.66**	-	-
Cons. price expectations (change)	-	1.09	1.30	-	1.32	1.17	-	-
Prod. price expectations (level)	1.07	**0.86**	1.12	1.14	0.95	-	1.66	1.97
Prod. price expectations (change)	**0.86**	1.01	1.29	1.29	0.99	-	1.33	2.92
(c) Fiscal indicators								
Direct taxes (change)	-	1.03	1.33	1.33	0.95	-	1.21	-
Indirect tax (change)	-	1.03	1.33	1.25	0.95	-	1.28	-
VAT (change)	-	1.03	1.33	1.24	0.95	-	1.39	-
Social contributions (change)	-	1.03	1.32	1.28	1.04	-	0.93	-
Tax burden (change)	-	1.03	1.33	1.24	0.95	-	1.31	-
Government consumption (change)	**0.84**	1.02	1.34	1.29	1.21	**0.82**	1.28	-
Government compensation (change)	-	-	-	-	0.95	-	-	-
Trivariate models								
(a) Economic indicators								
Output gap	0.89	**0.85**	1.21	1.66	1.51	1.10	1.51	1.72
Real GDP (change)	**0.87**	1.01	1.17	1.30	1.28	1.15	1.55	1.90
Employment (change)	0.90	1.33	1.26	1.28	1.46	0.96	1.69	2.00
Employment gap	0.98	1.10	1.19	1.25	1.60	2.01	2.08	2.22
Unemployment rate (change)	1.00	1.03	1.17	1.50	1.46	1.02	3.02	2.10
Unemployment rate gap	1.11	**0.77**	1.17	1.75	1.48	1.08	1.87	1.81
Compensation per employee (change)	**0.85**	1.17	1.02	1.33	1.34	0.97	-	2.31
Wages (change)	**0.87**	0.97	0.92	1.42	1.47	1.30	1.57	2.24
ULC (change)	**0.87**	**0.83**	1.02	1.39	1.49	1.22	-	-
Industrial production (change)	-	0.98	1.18	1.33	1.36	0.95	1.59	2.11
Nom. eff. exchange rate (change)	**0.88**	0.95	1.33	1.33	1.30	1.00	1.40	2.00
Commodity prices (change)	**0.82**	1.01	1.04	1.02	1.14	0.91	1.54	2.02
Oil prices (change)	0.98	1.01	1.20	1.39	1.38	1.33	1.59	2.18
Cons. price expectations (level)	-	1.23	1.17	-	1.72	1.07	-	-
Cons. price expectations (change)	-	0.98	1.30	-	1.43	1.14	-	-
Prod. price expectations (level)	1.07	0.94	0.88	1.14	1.35	-	1.57	1.79
Prod. price expectations (change)	0.88	0.93	1.08	1.32	1.29	-	1.50	2.05
(b) Fiscal indicators								
Direct taxes (change)	-	0.96	1.17	1.40	1.32	-	1.49	-
Indirect tax (change)	-	0.96	1.19	1.29	1.41	-	1.61	-
VAT (change)	-	0.92	1.22	1.25	1.40	-	1.87	-
Social contributions (change)	-	0.91	1.17	1.31	1.49	-	1.45	-
Tax burden (change)	-	0.96	1.17	1.28	1.29	-	1.75	-
Government consumption (change)	**0.84**	1.03	1.17	1.32	1.33	1.01	1.55	-
Government compensation (change)	-	-	-	-	1.33	-	-	-
Forecast combinations								
(a) Bivariate models								
Monetary indicators	0.89	0.95	1.28	1.34	1.05	**0.81**	1.08	1.81
Economic indicators	**0.86**	1.00	1.19	1.25	0.96	**0.89**	1.25	2.53
Fiscal indicators	-	1.02	1.33	1.27	0.98	-	1.16	-
All indicators	**0.87**	0.98	1.24	1.28	0.96	**0.84**	1.15	2.28
(a) Trivariate models								
Economic and fiscal indicators	0.89	0.91	1.08	1.32	1.33	0.99	1.61	1.91

Note: The first line of the table displays the root mean squared error (RMSE) for the random walk model. The remaining lines report the RMSE of the respective alternative forecasting model divided by the RMSE of the random walk model. Figures in bold indicate that the respective forecasting model significantly outperforms the random walk model (based on Diebold-Mariano test, at 10% significance level).

4.2 LONG-TERM FORECAST OF INFLATION DEVELOPMENTS (12 QUARTERS AHEAD)

Looking at Table 2, it emerges that when forecasting 12-quarter ahead inflation dynamics in the NMS, an improved performance vis-à-vis the RW benchmark may be obtained in many of these countries when the information from monetary and non-monetary (economic and fiscal) indicators is taken into account. The main exceptions would be Bulgaria and Romania, but as discussed below the results for these countries should be taken with a grain of salt. Interestingly, the findings suggest that monetary indicators perform particularly well at the 12-quarter horizon across all other NMS. Turning first to the group of countries with a fixed exchange rate regime, the findings reveals the following:

- Specifically, in Estonia the bivariate model with trend M2 growth appears to perform best. Although, all in all, 6 monetary bivariate models, 7 economic bivariate models and 4 fiscal bivariate models significantly outperform the RW benchmark, none of them significantly outperform the bivariate model with trend M2 growth. Five trivariate (two-pillar Phillips curve) models significantly outperform the RW model, but only one (the one with the tax burden change) does marginally better than the bivariate model with trend M2 growth, hence suggesting that adding a third variable to a model with lagged inflation and trend M2 growth does not noticeably improve upon the forecast performance of the latter.

- In Latvia, the trivariate (two-pillar Phillips curve) model with employment gap performs best. At the same time, however, this is the only model significantly outperforming the RW.

- In Lithuania, the bivariate model with loan growth performs best at the 12-quarter horizon. Moreover, both the bivariate model with trend M3 growth and the P* model perform better than the RW and AR models. In addition, 5 bivariate models with economic indicators, 5 bivariate models with fiscal indicators and 10 trivariate (two-pillar Phillips curve) models significantly outperform the RW but do not improve upon the forecasts of the bivariate model with loan growth.

- As already mentioned, for Bulgaria, there is not a single model outperforming the RW at the 12-quarter horizon. However, this result is distorted by the inclusion of the 1990s in the regression sample, a period still characterised by hyperinflation in this country. This is clearly reflected in the AR model, the forecasting performance of which is worse than that of the RW by a factor of 20. If the regression sample start were instead set to 2000Q2 to exclude the volatile 1990s (which comes at the cost of a short evaluation sample), then a number of models with monetary and economic indicators would improve upon the RW. The main message of this exercise is that for true out-of-sample forecasts (say 12-quarter ahead forecasts made in 2008Q3) there should be models that significantly improve upon the forecasts of the simple RW. However, in this paper we have chosen to adopt the same approach across countries in order to ensure equal treatment and comparability of results.

In the remaining countries, i.e. "the floaters", a similar picture emerges.

- In the Czech Republic, the bivariate model with trend M2 growth performs best. Moreover, nine trivariate (two-pillar Phillips curve) models also significantly outperform the RW, but only two (the ones with changes in indirect taxation and the nominal effective exchange rate) do marginally better than the bivariate model with trend M2 growth.

- In Hungary, the bivariate model with growth in government consumption performs the best, yet only marginally better than the model with the P-star monetary indicator. These are the two single models that outperform the forecast of a simple AR model.

- As regards Poland, the bivariate model with the unemployment rate gap performs the best at the 12-quarter horizon, followed by the bivariate model with wage growth. The finding that fiscal indicators work well compared to other countries may be related to the fact that Poland enacted several tax- and benefit reforms with a view to increasing labour supply and implemented a funded pension pillar.

- Finally, in Romania the only model able to significantly outperform the RW benchmark is the trivariate (two-pillar Phillips curve) model with growth in compensation per employee. In general, the forecast performance of all models (including the RW) is very weak, which – as in the case of Bulgaria – reflects the fact that the economic environment was still quite unstable in the second half of the 1990s. As for Bulgaria, choosing the regression sample to start two years later (2000Q2) reveals that many models would significantly outperform the RW, a finding that may be useful for future forecasts of inflation for Romania.

As regards combined inflation forecasts for the 12-quarter horizon, most combined forecasts significantly outperform the RW benchmark in four countries (Estonia, Lithuania, Hungary and Poland) but not the respective best performing bivariate model in each of these countries.

From these results one can conclude that over the long-term (12-quarter ahead) forecast horizon the role played by monetary factors in driving inflation dynamics does not differ substantially between the NMS with a "hard peg" and those with a floating exchange rate regime. In particular, monetary indicators appear to become important variables to explain inflationary trends across the majority of the NMS. Compared to the short-term inflation dynamics, fiscal indicators also seem to play a more prominent role over the longer term. For example, in Hungary the best-performing model over the 12-quarter horizon is the bivariate model with government consumption; in Estonia and the Czech Republic the bivariate models with fiscal indicators also perform rather well. This may be explained by the fact that some fiscal policy measures may take time before they change the structure of the economy and take effect on inflation.

Table 2. Relative root mean squared error for alternative forecasting models (forecast horizon = 12 quarters ahead)

	Hard-Pegs				Floaters			
	BG	EE	LV	LT	CZ	HU	PL	RO
Random walk model (RMSE)	2.95	2.09	3.49	2.94	1.93	2.99	3.76	16.59
Autoregressive model	20.28	**0.85**	1.18	0.96	1.51	**0.41**	**0.80**	2.20
Bivariate models								
(a) Monetary indicators								
M3/M2 (change)	11.73	**0.79**	1.15	0.99	1.41	1.44	1.02	1.86
Trend M3/M2 (change)	18.64	**0.70**	1.09	**0.88**	**0.61**	1.09	1.35	1.40
P* (change)	12.71	0.99	1.21	**0.90**	1.50	**0.35**	**0.91**	2.20
Real money gap	16.23	**0.71**	1.13	1.01	2.87	**0.74**	1.16	2.52
Monetary overhang	8.23	1.63	1.05	1.01	1.65	**0.78**	1.21	2.56
M1/M0 (change)	2.25	**0.85**	1.25	1.12	2.25	**0.77**	**0.84**	2.13
M2/M1 (change)	1.92	**0.85**	1.21	1.00	-	**0.58**	**0.77**	-
Loans	22.11	**0.84**	1.15	**0.74**	2.29	**0.49**	**0.85**	-
(b) Economic indicators								
Output gap	31.15	**0.90**	1.21	1.02	2.89	1.25	**0.95**	2.22
Real GDP (change)	20.60	1.02	1.18	**0.96**	1.36	**0.60**	**0.97**	2.28
Employment (change)	18.48	1.24	1.26	**0.92**	2.10	**0.64**	**0.86**	2.55
Employment gap	47.65	0.89	0.99	2.23	4.41	1.50	1.12	3.84
Unemployment rate (change)	18.87	1.33	1.17	1.39	2.23	**0.51**	**0.57**	2.57
Unemployment rate gap	37.34	1.30	1.40	1.47	3.49	**0.61**	1.26	3.51
Compensation per employee (change)	20.97	**0.74**	1.12	**0.95**	1.15	**0.86**	-	1.11
Wages (change)	22.83	**0.83**	1.17	**0.94**	0.96	0.98	**0.72**	2.26
ULC (change)	21.23	**0.71**	1.16	1.08	0.95	0.90	-	-
Industrial production (change)	-	**0.90**	1.19	**0.95**	1.46	**0.69**	**0.94**	2.28
Nom. eff. exchange rate (change)	20.75	**0.92**	1.20	0.99	1.68	**0.75**	**0.78**	2.18
Commodity prices (change)	19.87	1.05	1.19	1.29	1.95	0.90	**0.87**	2.17
Oil prices (change)	18.70	0.96	1.20	0.97	1.67	**0.63**	**0.85**	2.16
Cons. price expectations (level)	-	1.33	1.71	-	2.04	1.66	-	-
Cons. price expectations (change)	-	**0.84**	1.21	-	1.52	**0.66**	-	-
Prod. price expectations (level)	13.16	1.07	1.19	0.93	1.64	-	**0.74**	1.91
Prod. price expectations (change)	22.63	0.91	1.20	0.95	1.42	-	**0.80**	2.19
(c) Fiscal indicators								
Direct taxes (change)	-	**0.88**	1.17	0.98	1.53	-	**0.82**	-
Indirect tax (change)	-	0.87	1.18	**0.95**	1.51	-	**0.77**	-
VAT (change)	-	0.88	1.18	**0.94**	1.51	-	**0.82**	-
Social contributions (change)	-	**0.83**	1.19	**0.94**	1.22	-	**0.77**	-
Tax burden (change)	-	**0.83**	1.20	**0.94**	1.36	-	**0.82**	-
Government consumption (change)	21.73	**0.73**	1.18	**0.93**	1.27	**0.30**	**0.97**	-
Government compensation (change)	-	-	-	-	1.51	-	-	-
Trivariate models								
(a) Economic indicators								
Output gap	30.53	1.30	1.11	1.06	1.75	1.07	1.47	1.72
Real GDP (change)	20.49	1.72	1.13	**0.93**	**0.63**	**0.72**	1.50	1.51
Employment (change)	15.88	1.55	1.11	0.95	1.19	1.69	1.22	1.22
Employment gap	47.51	1.80	**0.87**	3.04	1.57	2.85	0.97	2.55
Unemployment rate (change)	18.65	1.53	1.12	0.94	2.08	1.29	1.19	1.77
Unemployment rate gap	36.81	1.82	1.19	1.23	3.59	1.65	0.96	2.70
Compensation per employee (change)	20.28	**0.77**	1.13	0.96	1.07	0.91	-	**0.82**
Wages (change)	21.56	**0.86**	1.02	**0.94**	**0.61**	1.14	1.29	1.30
ULC (change)	19.84	**0.78**	1.17	1.01	**0.71**	0.86	-	-
Industrial production (change)	-	0.93	1.19	**0.95**	**0.64**	1.08	1.62	1.52
Nom. eff. exchange rate (change)	19.62	0.92	1.17	0.93	**0.60**	0.88	1.40	1.41
Commodity prices (change)	18.80	0.96	1.14	1.01	0.95	1.02	1.26	1.55
Oil prices (change)	17.47	**0.80**	1.08	0.96	**0.64**	1.22	1.38	1.43
Cons. price expectations (level)	-	0.98	1.11	-	1.39	2.46	-	-
Cons. price expectations (change)	-	**0.70**	1.10	-	0.97	1.02	-	-
Prod. price expectations (level)	8.15	1.64	1.08	0.97	0.94	-	1.34	1.26
Prod. price expectations (change)	21.50	**0.78**	1.08	**0.84**	1.02	-	1.36	1.45
(b) Fiscal indicators								
Direct taxes (change)	-	**0.74**	1.18	**0.91**	0.80	-	1.46	-
Indirect tax (change)	-	0.88	1.18	**0.94**	**0.59**	-	1.36	-
VAT (change)	-	0.88	1.18	**0.92**	**0.68**	-	1.35	-
Social contributions (change)	-	0.92	1.18	**0.95**	0.92	-	1.36	-
Tax burden (change)	-	**0.67**	1.19	**0.95**	0.98	-	1.32	-
Government consumption (change)	19.46	**0.72**	1.08	**0.93**	0.96	1.34	1.56	-
Government compensation (change)	-	-	-	-	**0.64**	-	-	-
Forecast combinations								
(a) Bivariate models								
Monetary indicators	10.68	**0.77**	1.15	**0.92**	1.17	**0.68**	**0.76**	2.07
Economic indicators	21.60	**0.87**	1.20	0.97	1.76	**0.62**	**0.82**	2.25
Fiscal indicators	-	**0.78**	1.18	**0.93**	1.37	-	**0.81**	-
All indicators	17.73	**0.81**	1.18	**0.95**	1.52	**0.59**	**0.79**	2.19
(a) Trivariate models								
Economic and fiscal indicators	19.91	**0.79**	1.08	0.94	0.94	0.93	1.27	1.46

Note: The first line of the table displays the root mean squared error (RMSE) for the random walk model. The remaining lines report the RMSE of the respective alternative forecasting model divided by the RMSE of the random walk model. Figures in bold indicate that the respective forecasting model significantly outperforms the random walk model (based on Diebold-Mariano test, at 10% significance level).

5 CONCLUSIONS

To the best of our knowledge, this paper is the first systematic study to analyse the performance of a large set of monetary, economic and fiscal indicators in explaining inflation dynamics in the NMS, including bivariate models and trivariate (two-pillar Phillips curve) models. Three findings can be highlighted.

First, the performance of the bivariate and trivariate (two-pillar Phillips curve) forecasting models differs substantially across countries in that different variables seem to be influencing to a different extent inflation developments at different horizons. This is likely to derive from the fact that, notwithstanding some similarities, economic structures and institutions do vary across the NMS.

Second, at the 4-quarter horizon, with the exception of Bulgaria, Estonia and Hungary, none of the bivariate and trivariate (two-pillar Phillips curve) forecasting models significantly outperform the RW model. This result echoes the findings of Stock and Watson's (2008) recent literature review suggesting that inflation is hard to forecast in the U.S. and other OECD economies and that it is difficult to improve upon simple benchmark models. Overall, we find that when trying to forecast inflation developments at the 4-quarter horizon, in the few countries for which we find models performing better than the RW, such models are in general based on economic and fiscal indicators. In the hard peg countries Estonia and Bulgaria some labour market indicators seem to be particularly capable to forecast short-run inflation. This may reflect a labour market tightening over the sample period in these fast growing and at times overheating economies.

Third, at the 12-quarter horizon a number of bivariate and trivariate (two-pillar Phillips curve) forecasting models significantly outperform the forecasts of the RW model. In particular, monetary indicators do appear to contain useful information for predicting inflation at longer (3-year) horizons in these countries. Interestingly, the role played by monetary factors in driving inflation dynamics does not differ substantially between the NMS with a "hard peg" and those with a floating exchange rate regime. Thus, monetary indicators appear to become important variables to explain inflationary trends across the majority of the NMS over the long-term forecasting horizon.

REFERENCES

Assenmacher-Wesche, K., and S. Gerlach (2007). Money at Low Frequencies. *Journal of the European Economic Association* 5: 534–542.

Assenmacher-Wesche, K., and S. Gerlach (2008). Interpreting Euro Area Inflation at High and Low Frequencies. *European Economic Review* 52: 964-986.

Benati, L. (2008). Money, Inflation and New Keynesian Models. ECB (mimeo).

Calza, A., D. Gerdesmeier and J. Levy (2001). Euro area money demand: measuring the opportunity costs appropriately. *IMF Working Paper No. 01/179.*

Carstensen, K. (2007). Is Core Money Growth a Good and Stable Inflation Predictor in the Euro Area? Kiel Working Paper 1318.

Clark, T.E. and M.W. McCracken (2005). Evaluating Direct Multistep Forecasts. *Econometric Reviews* 24: 369-404.

Dabusinskas, A. (2005). Money and Prices in Estonia. Bank of Estonia Working Paper 705.

Darvas, Z. and G. Szapáry (2008). Euro Area Enlargement and Euro Adoption Strategies. *European Economy*. Economic Papers 304, February 2008.

De Santis, R., C.A. Favero, B. Roffia (2008). Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability. ECB Working Paper No. 926.

Diebold, F.X., and R.S. Mariano (1995). Comparing Predictive Accuracy. *Journal of Business and Economic Statistics* 13: 253-563.

Fischer, B., M. Lenza, H. Pill, and L. Reichlin (2006). Money and Monetary Policy: The ECB Experience 1999-2006. Paper presented at the 4th ECB Central Banking Conference.

Frankel, Jeffrey (2006). The Effect of Monetary Policy on Real Commodity Prices. In John Campbell (Editor). *Asset Prices and Monetary Policy.* University of Chicago Press.

Gerlach, S. (2003). The ECB's Two Pillars. CEPR Discussion Paper 3689.

Gerlach, S. (2004). The Two Pillars of the European Central Bank. *Economic Policy* 40: 389-439.

Hofmann, B. (2008). Do Monetary Indicators Lead Euro Area Inflation? ECB Working Paper 867.

Hubrich, K. (2005). Forecasting euro area inflation: Does aggregating forecasts by HICP component improve forecast accuracy?. *International Journal of Forecasting* 21: 119-136.

Kamps, C., N. Leiner-Killinger and R. Martin (2009) The Cyclical Impact of EU Cohesion Policy in Fast Growing EU Countries, *Intereconomics*, forthcoming.

Kotlowski, J. (2005), Money and Prices in the Polish Economy: Seasonal Cointegration Approach, Warsaw School of Economics, Dept. of Applied Econ. Working Paper 3-05.

Lucas, Robert E., Jr. (1996). Nobel Lecture: Monetary Neutrality. *Journal of Political Economy* 104: 661-682.

Nicoletti-Altimari, S. (2001). Does Money Lead Inflation in the Euro Area? ECB Working Paper 63.

Orphanides, A. (2008). Taylor Rules. In S.N. Durlauf and L.E. Blume (Editors). *The New Palgrave Dictionary of Economics*. 2nd edition. Palgrave Macmillan: Basingstoke.

Stock, J., and M. Watson (1999). Forecasting Inflation. *Journal of Monetary Economics* 44: 293-335.

Stock, J., and M. Watson (2007). Why Has U.S. Inflation Become Harder to Forecast? *Journal of Money, Credit and Banking* 39: 3-33.

Stock, J., and M. Watson (2008). Phillips Curve Inflation Forecasts. NBER Working Paper 14322. Cambridge, MA.

Taylor, J.B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy* 39 (Dec.): 195-214.

APPENDIX

A.1 DERIVING THE THREE MEASURES OF EXCESS LIQUIDITY

This appendix explains the derivation of the three measures of excess liquidity (real money gap, monetary overhang and change in P-star) included among the monetary indicators alongside M1, M2 and M3 growth, loan growth and trend M3 growth.

In each case, the starting point is the simple money demand function

(A.1) $m_t - p_t = \alpha_0 + \alpha_1 y_t + \alpha_2 R_t + u_t$,

where m_t, p_t and y_t denote (logs of) the stock of broad money (M3 if available, M2 otherwise), the price level (as measured by the GDP deflator) and real GDP, respectively. R_t denotes the nominal short-term interest rate which, in the absence of a better measure for our set of countries, is used as a proxy for the opportunity cost of holding money. The three measures of excess liquidity can be obtained as followed from the estimated money demand equation:

(i) The *monetary overhang* is set equal to the regression residual $\hat{u}_t$. It is defined as the difference between the actual level of real M3 and the "equilibrium" level of real M3 given by the long-run relation from the money demand function.

(ii) The long-run trend price level P-star is given by $p_t^* = m_t - \hat{\alpha}_0 - \hat{\alpha}_1 y_t^T - \hat{\alpha}_2 R_t^T$, where y_t^T and R_t^T denote the long-run trend levels of output and the interest rate, respectively (both estimated with a one-sided Hodrick-Prescott filter; see Section 3.1 for details). The *change in P-star* is then simply given by $\Delta p_t^* = \Delta m_t - \hat{\alpha}_1 y_t^T - \hat{\alpha}_2 R_t^T$.

(iii) The *real money gap* (RMG_t) is given by $RMG_t = m_t - p_t - (\hat{\alpha}_0 + \hat{\alpha}_1 y_t^T + \hat{\alpha}_2 R_t^T)$. Substituting p_t^* into this expression reveals the link between the real money gap and P-star: $RMG_t = p_t^* - p_t$. In other words, the real money gap is positive whenever the actual price level is lower than the equilibrium price level, signalling inflationary pressures down the road necessary to re-establish the equilibrium.

A.2 LIST OF DATA SERIES USED IN THE EMPIRICAL ANALYSIS IN SECTION 4

Harmonised index of consumer prices (CPI)	National Statistical Institute (all countries
Monetary aggregate M0	National Central Banks (EE, PL and LV)
Monetary aggregate M1	National Central Banks (all countries)
Monetary aggregate M2	National Central Banks (all countries)
Monetary aggregate M3	National Central Banks (BG, LT and HU)
Loans	IMF (all countries except RO)
Short-term interest rates	National Central Banks (all countries, except BG, LT, PL). IMF (BG, LT, PL)
Long-term interest rates	Eurostat (all countries but PL). IMF (PL)
Nominal effective exchange rate	National Central Banks (CZ, EE, LV, HU) J.P. Morgan (BG, PL and RO)
Real effective exchange rate	Bank of Lithuania (LT)
Nominal exchange rate against the euro	National Central Banks (all countries)
Nominal exchange rate against the US dollar	National Central Banks (all countries)
Real Gross Domestic Product	National Statistical Institute (LV) Eurostat (BG, EE, LT, HU, PL, RO) IMF (CZ)
Nominal Gross Domestic Product	National Statistical Institute (LV, RO) Eurostat (BG, EE, LT, HU, PL) IMF (CZ)
Employment	National Statistical Institute (all countries)
Unemployment rate	National Statistical Institute (all countries except CZ) Ministry of Labour and Social Affairs (CZ)
Compensation per employee	Eurostat (EE, HU, LT, LV and RO) ECB staff calculations (other countries except PL)
Wages	National Statistical Institute (all countries except LT, HU and PL) IMF (PL) Eurostat (HU and LT)

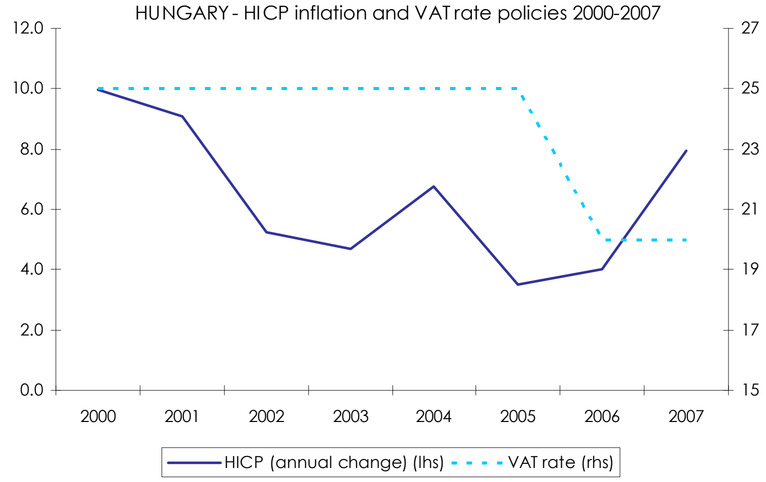
Unit Labour Costs	National Statistical Institute (BG, CZ and LV) ECB staff calculations (other countries except PL and RO)
Industrial production	National Statistical Institute (all countries except CZ, LV and PL) IMF (CZ) Eurostat (LV and PL).
Commodity prices	ECB Monthly Bulletin (HWWI)
Oil prices	ECB Monthly Bulletin (ECB calculations based on Thomson Financial Datastream Data)
Consumer price expectations	European Commission (all countries)
Producer price expectations	European Commission (all countries)
Direct taxes	ESCB (all countries except BG, HU and RO)
Indirect taxes	ESCB (all countries except BG, HU and RO)
VAT	ESCB (all countries except BG, HU and RO)
Social contributions	ESCB (all countries except BG, HU and RO)
Tax burden	ESCB (all countries except BG, HU and RO)
Government consumption	ESCB (all countries except RO)
Government compensation	ESCB (CZ)

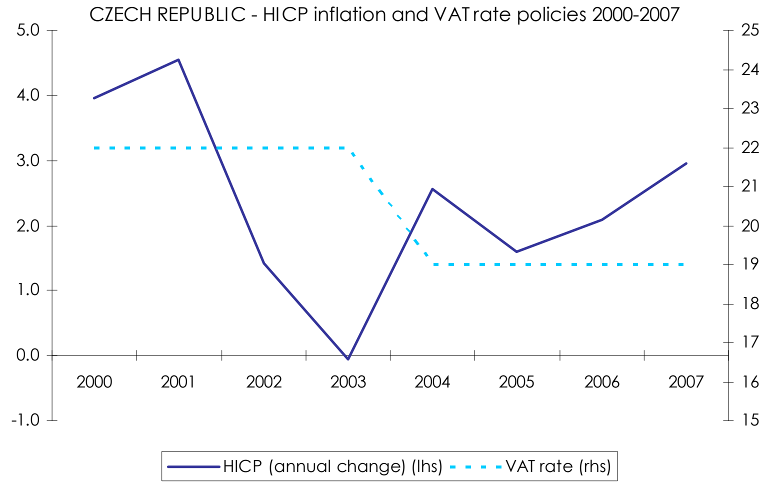
Table A.1. Relative root mean squared error for alternative forecasting models (forecast horizon = 8 quarters ahead)

	Hard-Pegs				Floaters			
	BG	EE	LV	LT	CZ	HU	PL	RO
Random walk model (RMSE)	3.03	2.49	3.07	3.02	1.89	2.22	2.71	10.21
Autoregressive model	6.67	**0.88**	1.37	1.10	1.41	**0.93**	1.19	2.64
Bivariate models								
(a) Monetary indicators								
M3/M2 (change)	4.78	**0.87**	1.38	1.12	1.45	1.00	1.37	2.24
Trend M3/M2 (change)	9.82	1.06	1.48	1.08	1.20	1.05	1.69	1.06
P* (change)	7.65	**0.80**	1.38	1.10	1.51	0.95	1.24	2.67
Real money gap	17.46	**0.61**	1.45	1.13	2.69	1.03	1.47	3.16
Monetary overhang	7.66	0.84	1.30	1.11	4.26	1.32	1.99	3.51
M1/M0 (change)	1.35	1.01	1.38	1.14	1.82	1.09	1.43	2.72
M2/M1 (change)	1.24	**0.80**	1.39	1.11	-	1.00	1.49	-
Loans	6.67	0.97	1.44	1.08	1.96	0.99	1.48	-
(b) Economic indicators								
Output gap	9.96	**0.89**	1.37	1.28	3.53	1.34	1.34	2.62
Real GDP (change)	4.28	0.95	1.38	1.18	1.55	1.05	1.19	2.61
Employment (change)	6.67	1.20	1.40	1.16	2.67	1.08	1.30	3.04
Employment gap	23.12	0.94	1.30	**0.84**	4.92	1.13	1.69	5.18
Unemployment rate (change)	9.40	1.15	1.30	1.16	2.67	1.02	1.32	3.24
Unemployment rate gap	22.42	1.14	1.35	1.12	4.14	1.62	1.57	4.21
Compensation per employee (change)	7.69	**0.87**	1.14	1.14	1.20	1.16	-	1.43
Wages (change)	6.67	**0.88**	1.38	1.14	1.06	1.11	1.16	2.55
ULC (change)	7.74	**0.71**	1.28	1.16	1.17	1.34	-	-
Industrial production (change)	-	0.89	1.45	1.14	1.55	1.56	1.27	2.87
Nom. eff. exchange rate (change)	6.63	**0.87**	1.40	1.11	1.42	**0.78**	1.95	2.65
Commodity prices (change)	6.67	**0.86**	1.31	0.92	1.39	1.09	1.13	2.72
Oil prices (change)	7.13	**0.83**	1.38	1.05	1.43	1.01	1.23	2.64
Cons. price expectations (level)	-	1.58	1.04	-	1.69	1.58	-	-
Cons. price expectations (change)	-	**0.89**	1.30	-	1.57	**0.77**	-	-
Prod. price expectations (level)	1.81	1.08	1.36	1.11	1.54	-	1.34	2.07
Prod. price expectations (change)	8.55	**0.88**	1.37	1.10	1.08	-	1.41	2.65
(c) Fiscal indicators								
Direct taxes (change)	-	**0.88**	1.37	1.07	1.41	-	1.28	-
Indirect tax (change)	-	**0.88**	1.40	1.10	1.62	-	1.41	-
VAT (change)	-	0.95	1.40	1.11	1.97	-	1.23	-
Social contributions (change)	-	**0.88**	1.38	1.10	1.89	-	1.35	-
Tax burden (change)	-	**0.88**	1.40	1.10	1.48	-	1.45	-
Government consumption (change)	6.67	**0.78**	1.36	1.10	1.40	1.06	1.17	-
Government compensation (change)	-	-	-	-	1.47	-	-	-
Trivariate models								
(a) Economic indicators								
Output gap	8.05	1.01	1.49	1.43	2.00	1.10	1.69	**0.80**
Real GDP (change)	7.46	1.00	1.48	1.25	1.21	1.04	1.70	1.04
Employment (change)	9.82	1.21	1.46	1.18	1.38	1.28	1.75	1.17
Employment gap	29.98	1.05	1.22	1.25	1.32	1.28	1.25	2.58
Unemployment rate (change)	18.88	1.42	1.39	1.19	1.35	0.91	2.30	1.69
Unemployment rate gap	14.51	1.31	1.44	1.22	1.37	1.61	1.72	1.74
Compensation per employee (change)	8.29	1.21	1.08	1.13	1.26	0.94	-	1.04
Wages (change)	11.30	1.06	1.48	1.12	1.15	1.01	1.70	1.27
ULC (change)	4.25	1.05	1.36	1.14	1.21	0.99	-	-
Industrial production (change)	-	0.95	1.40	1.16	1.10	1.59	2.01	1.18
Nom. eff. exchange rate (change)	6.93	1.11	1.48	1.24	1.15	1.14	2.01	0.97
Commodity prices (change)	8.20	1.18	1.47	**0.85**	1.12	0.89	1.71	1.21
Oil prices (change)	2.01	1.06	1.50	1.03	1.17	1.17	1.41	1.22
Cons. price expectations (level)	-	1.68	0.98	-	1.19	1.66	-	-
Cons. price expectations (change)	-	1.09	1.44	-	1.20	1.17	-	-
Prod. price expectations (level)	5.34	1.28	1.49	1.04	1.17	-	2.22	1.34
Prod. price expectations (change)	7.05	1.06	1.48	1.07	1.20	-	1.63	1.04
(b) Fiscal indicators								
Direct taxes (change)	-	1.06	1.48	1.10	1.20	-	1.69	-
Indirect tax (change)	-	1.07	1.47	1.08	1.31	-	1.77	-
VAT (change)	-	1.06	1.49	1.09	1.24	-	1.98	-
Social contributions (change)	-	1.03	1.48	1.08	1.20	-	1.67	-
Tax burden (change)	-	1.06	1.49	1.07	1.19	-	1.70	-
Government consumption (change)	11.93	1.01	1.47	1.08	1.09	1.46	1.69	-
Government compensation (change)	-	-	-	-	1.13	-	-	-
Forecast combinations								
(a) Bivariate models								
Monetary indicators	6.87	**0.74**	1.40	1.10	1.71	**0.88**	1.17	2.53
Economic indicators	8.20	0.89	1.31	1.08	1.92	1.03	1.14	2.71
Fiscal indicators	-	**0.86**	1.38	1.10	1.48	-	1.25	-
All indicators	7.60	**0.83**	1.35	1.09	1.75	0.97	1.16	2.65
(a) Trivariate models								
Economic and fiscal indicators	8.80	1.06	1.40	1.09	1.19	0.97	1.64	1.01

Note: The first line of the table displays the root mean squared error (RMSE) for the random walk model. The remaining lines report the RMSE of the respective alternative forecasting model divided by the RMSE of the random walk model. Figures in bold indicate that the respective forecasting model significantly outperforms the random walk model (based on Diebold-Mariano test, at 10% significance level).

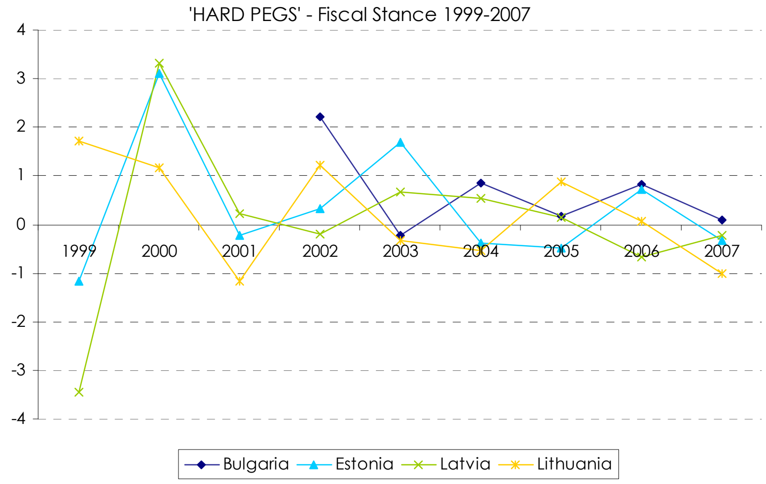
Figure A.1: HICP inflation and VAT rate policies

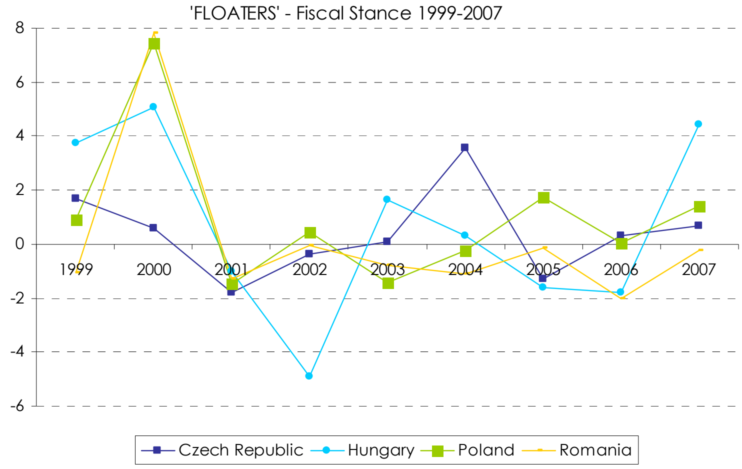




Source: Eurostat, European Commission, ECB staff calculations.

Figure A.2: Fiscal stance in the new EU Member States (1999-2007)





Notes: The fiscal stance is measured as the change in the cyclically adjusted primary balance.

Source: Eurostat, ECB staff calculations.