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

Karsten Staehr

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

Karsten Staehr[1]

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 Code: E31, E42, E63, P24

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

Author's e-mail addresses: karsten.staehr@tseba.ttu.ee, karsten.staehr@eestipank.ee

The views expressed are those of the authors and do not necessarily represent the official views of Eesti Pank.

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[1] Karsten Staehr is a professor at Tallinn University of Technology and a research supervisor at Eesti Pank. The paper has previously been published as Staehr (2009) and is based on 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. Aurelijus Dabušinskas, 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.

Non-technical summary

This paper seeks to analyse and explain the inflation developments for the period 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 pressures from price liberalisations and under-valued exchange rates had abated, and other factors gained importance. Inflation rates vary across the 10 CEE countries and across time, but inflation has generally exceeded the levels observed in the "old" EU countries in the West.

The paper discusses a number of inflation theories or explanations that have 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 considered relevant for all types of economies.

The ability 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 used as dependent variable, while a number of variables "capturing" or reflecting the different theories discussed are used as explanatory variables. A number of complex econometric issues, including multicollinearity and possible endogeneity of the explanatory variables, are addressed in different ways.

The inflation process in the CEE countries exhibits an autoregressive component estimated to be 0.3–0.5, possibly reflecting backward-looking expectations in price and wage setting. Imported inflation has played an important role for domestic inflation, but the pass-through has been far from complete; the short-term pass-through is estimated to be approximately 0.3 and the long-term pass-through to be around 0.5. The exchange rate regime, *per se*, appears to have been unimportant. 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 those with a more prudent fiscal stance.

The effects of a number of structural explanations are also analysed. The Balassa-Samuelson effect is robust across different specifications and subsamples; higher productivity growth in the traded sector than in the non-traded sector has exerted upward pressure on inflation. The Bhagwati effect associated with capital deepening may also have been present, but its impact is difficult to disentangle from the impact of the business cycle.

Variables reflecting the cyclical position have been important, although the effect of the unemployment variable could not be estimated precisely in

some 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 current account balance in a given year is a powerful predictor of inflationary pressures in 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 in indirect taxation cannot be detected, possibly because of data quality issues. Entry into the EU does not appear to have affected inflation.

In general, the empirical analysis in this paper suggests that the relatively high inflation in many new EU countries from Central and Eastern Europe is partly a result of 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, 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. The generally higher inflation in the CEE countries therefore appears to be the result of the explanatory factors being more “extreme” in the CEE countries than in the rest of the EU.

Contents

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.[2] 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 euro area 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 euro area, 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 euro area (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.

Second, in the years 2005–2007 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 2005–2007.

[2] Welsch and 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.

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

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

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 the catch-up process where income levels and economic structures gradually convergence to West European averages. Finally, inflation has 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 and 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 and Fischer, 1993). Subsection 2.1 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 2.2 surveys a number of empirical studies examining the importance of different factors on inflationary trends in the CEE group of countries.[3]

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

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

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 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 and Flanagan, 2007).

These insights lie behind the literature on inflation determination in monetary and fiscal policy games as pioneered by Kydland and Prescott (1977).[4] 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.[5] This link from fiscal policy to inflation is frequently called the "weak form" fiscal theory of inflation (Carlstrom and 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

[4] 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).

[5] 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.

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.[6] 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.[7]

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 par-

[6] This suggests that the inclusion of policy variables in an econometric model may lead to endogeneity and multicollinearity issues.

[7] 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 and 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.

ticular, 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 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.[8] 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.[9]

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 and 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).

[8] Cihak and 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.

[9] Market opening may also affect competitive pressure in the affected sectors and hence change the mark-ups.

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 (including 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.

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 and 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 and 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 and 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 and 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 and Podpiera, 2008).[10] 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 and Podpiera, 2006; Egert et al., 2006; Egert and 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.

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 and Staehr, 2005; Egert, 2007). Darvas and 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

[10] 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.

across different studies (Egert, 2007, 2008; Hammermann and 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.[11] 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.[12] 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.

[11] A list of detailed references for each of the variables is available from the author upon request.

[12] 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 1995–1998 are also missing for other variables.

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.

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 coun-

try 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 and 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 in 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 Appendix 1. 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 in a variable or as a share of GDP.[13] This reduces the risk of a spurious correlation between trending variables.

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.

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

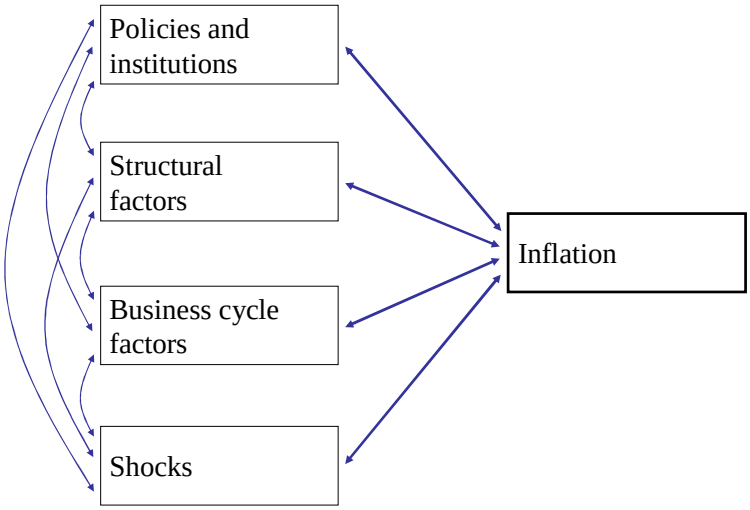

Figure 1: Inflation determinants – interaction and causality

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 and 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.[14]

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 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.[15] System GMM

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

[15] Judson and 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.

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 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 in the nominal effective exchange rate along with the control variables. The coefficient to the lagged percentage change in 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 and 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 and 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 Appendix 1) 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 es-

sentially 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).[16] 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).[17]

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 and 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.

[16] 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.

[17] 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 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.*

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).

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 coun-

tries 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 data-points 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 2003–2007 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.

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 2003–2007. The results are very similar to those for the entire sample.

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.*

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.[18] 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.

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

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Appendix 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

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