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

Karsten Staehr[*]

School of Economics and Business Administration, Tallinn University of Technology
Research Department, Bank of Estonia

Tallinn University of Technology
Kopli 101-323
11712 Tallinn
Estonia

E-mail: karsten.staehr@tv.ttu.ee
Tel.: +372 59 16 14 15
Fax: +372 620 4051

Abstract: This paper seeks to identify factors driving inflation in the new EU member countries from Central and Eastern Europe. A large number of theories are discussed, including some of particular importance to economies experiencing rapid structural change and high economic growth. The explanatory power of the different theories is assessed 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 choice of exchange rate regime is unimportant *per se*. Government debt and large revenues are associated with higher inflation. The cyclical position as measured by unemployment, employment changes or the current account balance is also important. Food price shocks have substantial but short-lived effects on inflation, while energy price shocks have longer-lasting effects. Multicollinearity across the explanatory variables makes it difficult to establish the effect of each individual factor.

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1. Introduction

The 10 countries from Central and Eastern Europe (CEE) that joined the European Union in 2004 and 2007 have undergone dramatic changes since they discarded communism and central planning in 1990-92. Less than two decades later, these countries are democracies with dynamic market-based economies. The admission into the European Union in 2004 and 2007 meant further integration of the CEE countries into European political and economic structures.

Similarly remarkable changes have taken place with respect to the performance of inflation in these countries. Most of the CEE countries had centrally planned and largely fixed prices until the late 1980s; in many cases resulting in distorted prices but also low official inflation rates. Other countries, in particular Hungary, Slovenia and Poland, had a partially decentralised setting of prices, but also suffered from relatively high inflation. When the fixed prices were abolished, each of the CEE countries experienced spikes in prices, although of different magnitudes (Cottarelli & Doyle, 1999). Inflation became a problem to be reckoned with in the CEE countries – and this has been the case since.

This paper seeks to examine and explain the developments in inflation in the CEE countries from the mid- or late-1990s. At that time the first round of inflationary pressure from the price liberalisations had abated and other factors gained dominance. Overall, the CEE countries have had higher inflation than the neighbouring "old" EU countries. At the same time the CEE countries have also experienced faster growth, implying a process of real convergence. The simultaneous processes of fast growth and high inflation (at least in terms of foreign currency) are frequently linked; while income levels in the CEE countries have been converging to the EU average, their price levels have likewise been converging (Dreger *et al.,* 2007; Lein-Repprecht *et al.,* 2007; see also Section 2). The simultaneous processes of real and nominal convergence do not necessarily imply any causal relation and moreover do not explicate the economic mechanisms linking the two processes.[1]

A better understanding of the factors driving inflation in the new EU countries is important for many reasons. First, individuals are usually averse to inflation, and over a certain threshold even anticipated inflation affects welfare negatively.[2] The relatively high inflation rates in Eastern Europe may thus directly reduce social welfare. Second, high inflation is likely to affect the international competitiveness of a country negatively with possible knock-on effects on output and employment, particularly in countries with fixed exchange-rate systems. 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 mid-2008, Slovenia and Slovakia have been admitted to the EMU, but for the remaining eight CEE countries, the main obstacle is their relatively high inflation rates (Staehr, 2008). Fourth, inflation often exhibits substantial persistence so that short-term changes in inflation may affect the inflation rate in the longer term.

This paper sets out and seeks to test the importance of a number of theories which can explain inflationary developments in the CEE countries. The theories or factors explaining inflation

[1] The discussion of the underlying causes of inflation in rapidly-growing economies has a long tradition. It was particularly intense in the context of the high inflation experiences in Latin America (Cochrane, 1972).
[2] 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.

have all been proposed in the academic and policy-oriented literature. Some of the explanations are specific to fast-growing economies with rapid structural changes, 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.[3] 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 short sample and missing data necessitate the use of eclectic modelling approaches. First, each theory is assessed in panel estimations by the introduction of 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 account for potential mutual interdependence across the explanatory variables.

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 Section 3). Only a few studies have sought to assess the importance of several different factors using panel data methods – with Egert (2007) and Hammermann & Flanagan (2007) as prime exceptions. De Grauwe & Schnabl (2008), Zsolt & Szapary (2008) and Goretti (2008) also undertake panel data estimations with the aim of explaining inflation or the price level in the CEE countries, but these studies employ relatively small sets of explanatory variables.

The panel data estimations in this paper should be seen as exploratory and suggestive. First, the sample period is short and data for many of the factors which in theory may drive inflation are unavailable. Second, many of the explanatory variables are correlated with each other and this complicates the identification of the specific factors driving inflation. Third, 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.

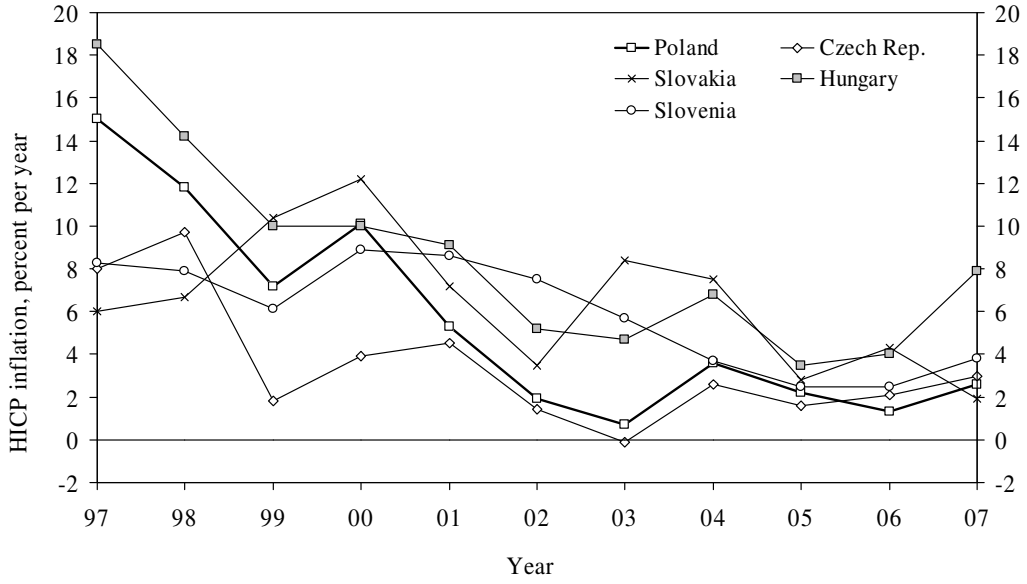
The rest of the paper is organised as follows: Section 2 gives an introduction to the inflationary developments in the CEE countries since the mid-1990s. Section 3 presents a comprehensive set of explanations of inflation in economies subject to real convergence. Section 4 contains the econometric analysis. The data set is presented, the links between specific variables and the inflation hypotheses are explicated and estimations are undertaken. Section 5 sums up and discusses some policy implications.

2. Inflation in the Central and Eastern European countries

Inflation in the 10 new EU countries from Central and Eastern Europe has changed markedly since the mid-1990s. Figure 1 shows the annual change in the Harmonised Index of Consumer Prices (HICP) for the four Visegrad countries and Slovenia, while Figure 2 shows the annual HICP inflation for the three Baltic countries, Romania and Bulgaria. The country groupings are mainly based on geography; the countries in Figure 1 comprise the core of the CEE countries, while the countries in Figure 2 are situated in the European periphery.

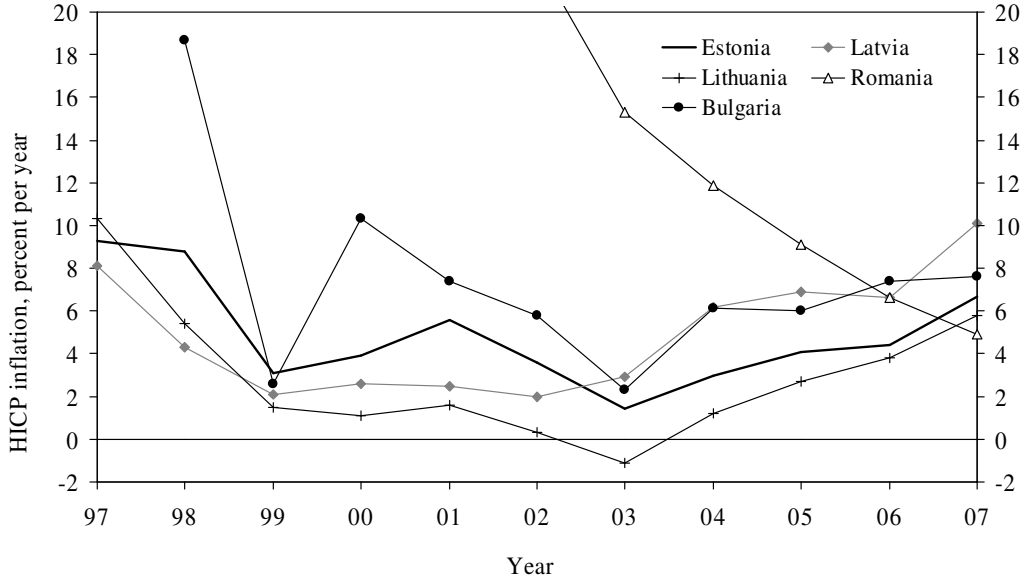
[3] An increasing number of contributions use panel data estimations to analyse inflation processes in both transition, developing and high-income countries; cf. Masso & Staehr (2005), Aisen & Veiga (2005), Willard (2006) and Bjornstad & Nymoen (2008).

Figure 1. Annual HICP inflation, percent per year. Poland, the Czech Republic, Slovakia, Hungary and Slovenia



Source: Eurostat (2008a)

Figure 2. Annual HICP inflation, percent per year. Estonia, Latvia, Lithuania, Romania and Bulgaria



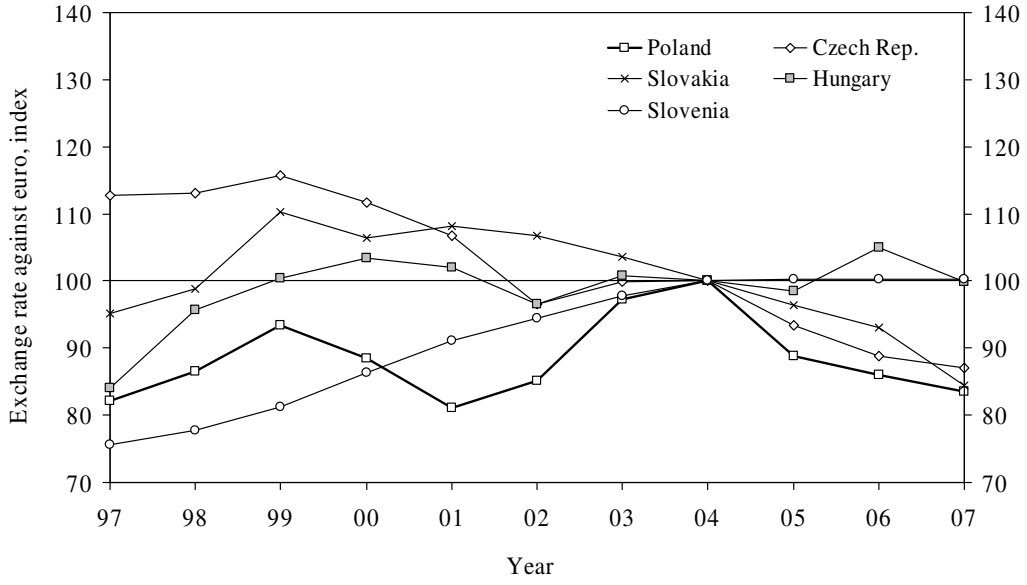
Source: Eurostat (2008a)

A number of regularities emerge. First, in all CEE countries the HICP inflation has been substantially over the level observed in the Eurozone and other West European EU countries, with only a few and short-lived exceptions. Second, inflation has exhibited considerable fluctuations in many CEE countries. Third, Bulgaria and Romania stabilised their inflation relatively late; Bulgaria introduced a currency board in July 1997, which had an immediate effect on the inflation rate. Romania pursued monetary targeting as a disinflationary policy from around 2000, but only succeeded in bringing annual inflation below 20 percent in 2003.

Finally, Figures 1 and 2 also show that inflation has been increasing since 2006 in all the CEE countries. Moreover, there is a clear pattern. The Baltic countries and Bulgaria, which all have currency boards or a very tight peg (Latvia), have experienced very rapid increases in their inflation rates. The Visegrad countries (with Hungary as a partial exception) have also seen increasing inflation, but inflation has been below the levels observed in the first group of countries. The "traditional" disinflationary policy instrument, a fixed exchange rate, has proven unable to contain inflation in the case of the CEE countries since 2006.

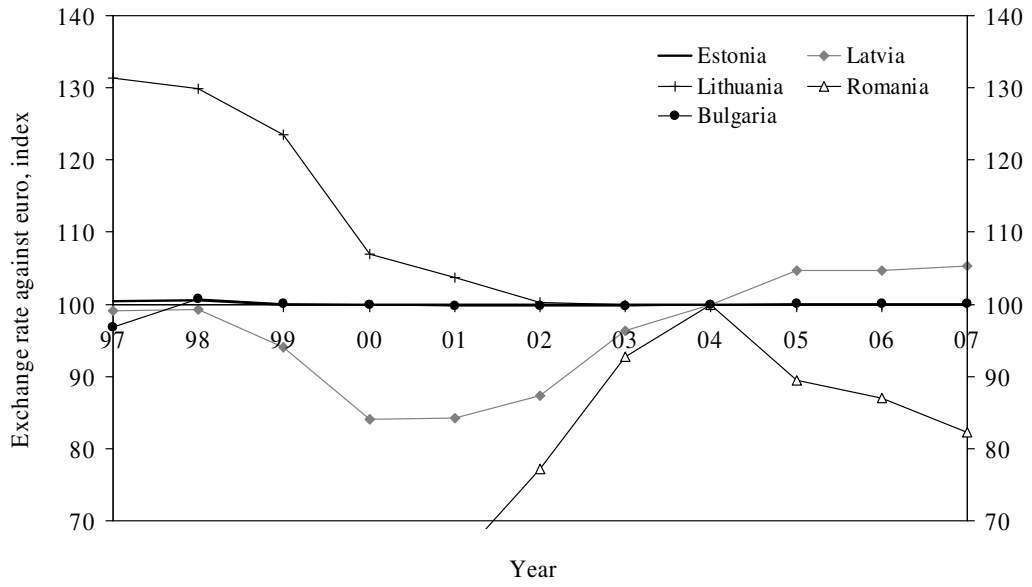
The inflationary developments in the CEE countries have to a large extent been influenced by their choices of exchange rate policy. Figures 3 and 4 show indices for the exchange rate against the euro for each of the 10 CEE countries with the index set equal to 100 for 2004.

Figure 3. Exchange rate against the euro, index, 2004 = 100. Poland, the Czech Republic, Slovakia, Hungary and Slovenia



Source: Eurostat (2008b, 2008c), author's calculations

Figure 4. Exchange rate against the euro, index, 2004 = 100. Estonia, Latvia, Lithuania, Romania and Bulgaria



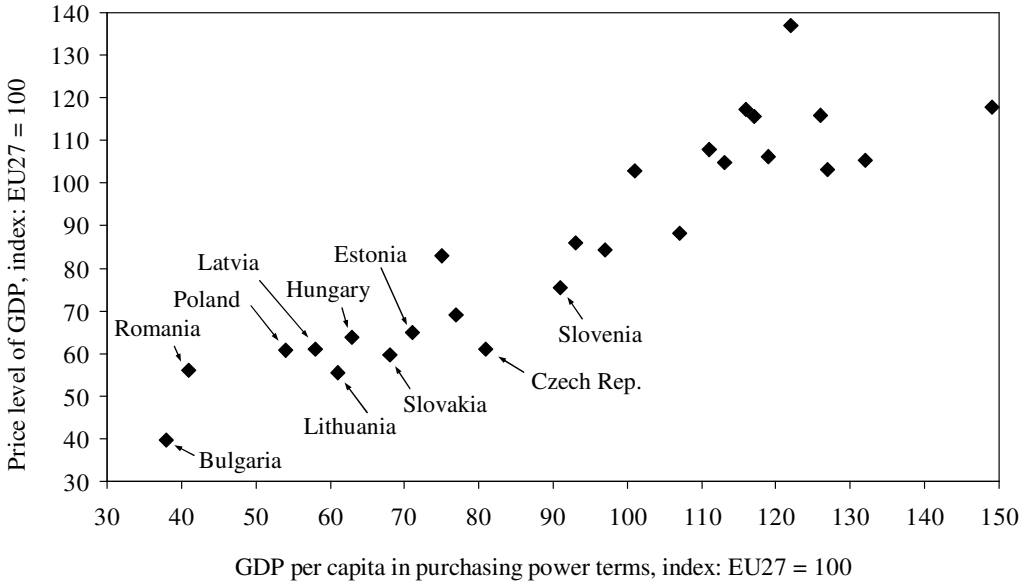
Source: Eurostat (2008b), author's calculations

Figures 3 and 4 confirm that the lower inflation in the Visegrad countries since 2006 has coincided with substantial appreciations of most of the countries' currencies against the euro. Meanwhile, the countries with fixed exchange rates have been enduring relatively high inflation rates. The bottom line is that all CEE countries have experienced substantial real (effective) exchange rate appreciations since 1997 and, in particular, since 2006.

The 10 CEE countries have all experienced rapid economic growth since the mid-1990s and have thus reduced the income gap with the EU average. The process of real convergence has been coinciding with a similar process of nominal convergence in the form of price levels converging. Figure 5 is a cross plot of the GDP levels (in purchasing power terms) and price levels (of total production, GDP) across the EU countries.[4] A tight relationship between the per capita income level and price level is apparent. The CEE countries, which all have comparatively low levels of income, closely follow this relationship.

[4] A qualitatively similar picture emerges if purchasing power-adjusted GDP levels are used.

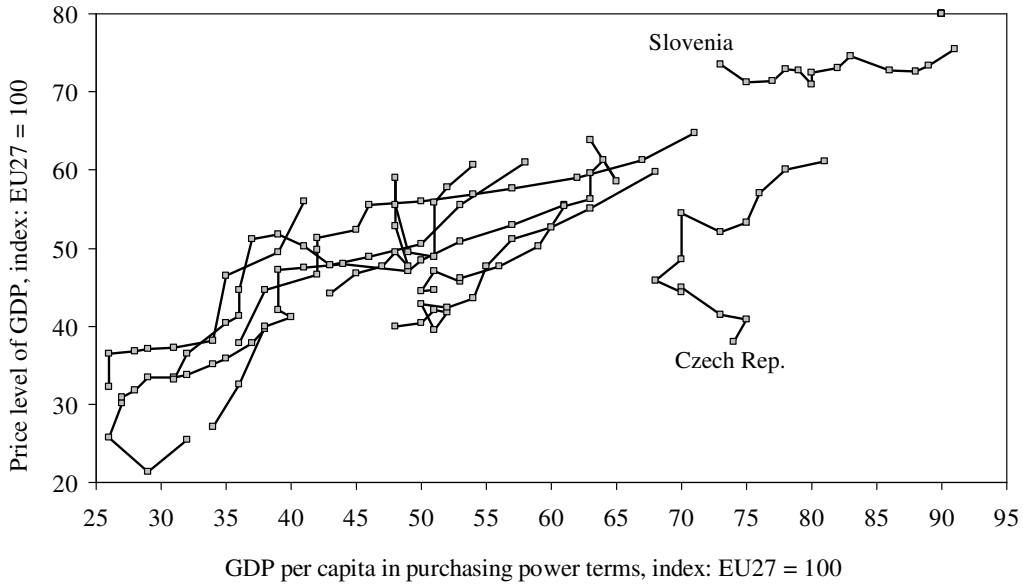
Figure 5. GDP per capita and relative price level of GDP for the EU countries, 2007



Note: Luxembourg is not included.
Source: Eurostat (2008d, 2008e), author's calculations

Figure 5 represents a snapshot of 2007, but the close correlation between GDP and price levels also holds for individual countries across time. Figure 6 shows indices of relative per capital GDP levels (in purchasing power terms) and the price level of GDP for the 10 CEE countries from 1995 to 2007. The "spaghetti pattern" clearly confirms that income and price levels are also closely correlated when considered over time. Moreover, all 10 CEE countries appear to broadly follow the same path. The exception to this may be the Czech Republic, which appears to have a slightly lower price level than the other CEE countries with comparable income levels.

Figure 6. Relative GDP per capita and relative price level of GDP in the CEE countries, 1995-2007



Source: Eurostat (2008d, 2008e), author's calculations

The tight correlation of income and price levels, both at a given period of time and across time, suggests that to the extent the CEE countries continue to experience higher trend growth than the old EU countries, the price level in the CEE countries will also grow faster than in the old EU (Dreger *et al.,* 2007; Lein-Repprecht *et al.,* 2007). The simultaneous real and nominal convergence processes do not necessarily imply any causal relation and moreover do not explicate the economic mechanisms linking the two processes.

3. Theories of inflation and some empirical results for the CEE countries

It is challenging to pinpoint the drivers of inflation, particularly in empirical work dealing with low or moderate levels of inflation (Dornbusch & Fischer, 1993). Inflation results from numerous factors which are mutually interconnected and moreover influenced by economic policy. Subsection 3.1 discusses a number 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.[5]

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.

3.1 Explaining inflation

In all countries the authorities have a number of policy instruments through which they can influence the inflation rate. This can be monetary policy instruments, but also other policies such as budget policies, direct and indirect taxation, income policies and price regulation. The set of monetary policy instruments includes, *inter alia*, the choice of exchange rate regime, exchange rate targets, the interest rate and/or the stock of money. Monetary as well as other policy instruments may affect inflation directly or through inflationary expectations. The numerous instruments available allow the authorities to pursue disinflationary policies provided they are willing to accept the costs of such policies. In other words, inflation is ultimately the result of economic policy, at least as regards structural inflation (Hammermann & Flanagan, 2007).

These insights lie behind the literature on inflation determination in monetary and fiscal policy games as pioneered by Kydland & Prescott (1977).[6] 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.

[5] 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).

[6] 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).

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 (non-indexed) debt. This incentive is carried into inflationary expectations by the public, which may drive inflation upwards depending on the monetary policy setup.[7] 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 are equal to its marginal costs *given* the authorities' preferences, the policymaking setup, the structure of the economy, different shocks to the economy as well as the public's expectations. This insight comprises a useful framework when seeking to pinpoint factors that can explain inflation in the rapidly growing CEE countries.

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.[8] The policy game theory underscores the importance of the formation of expectations, which may also help determine self-reinforcing forces in the inflationary process and the degree of inflationary inertia. The structure and overall functioning of the economy and the financial system will influence the effectiveness and costs of economic policies. Thus, variables proxying the economic and financial structure may 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 (Motonishi, 2002; Egert *et al.,* 2003). The main effect refers to a situation where productivity growth is higher in the traded than in the non-traded sector. Productivity growth in the traded sector drives up wage growth in that sector, which again spills over into higher wage growth in the non-traded sector. If productivity growth is higher in the traded than in the non-traded sector, the result is higher inflation in the non-traded sector than in the traded sector.

The Balassa-Samuelson effect is based on the assumption of exogenous productivity growth in the two sectors. Bhagwati (1984) has proposed a theory which links economic growth and non-traded inflation based on exogenous changes in the economy-wide capital stock. The economy has a traded sector and a non-traded sector, and in both sectors the production takes place using capital and labour. The price of the traded good is determined from abroad, the (real) wage is equal to the marginal product of labour, and the wage is equalised across the two sectors. 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 on 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 some plausible as-

[7] 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.
[8] This suggests that the inclusion of policy variables in an econometric model may lead to endogeneity and multicollinearity issues.

sumptions the result is price increases in the non-traded sector and real appreciation (Bhagwati, 1984; Wood, 1988, pp. 36-37; Samuelson, 1994). One possible set of assumptions is that the non-traded sector is more labour intensive than the traded sector (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 may lower the prices of products with prices initially below international levels, and increase the prices of products with prices initially above international levels.[9] 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.[10]

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.

Rapidly growing economies undergoing many structural changes are particularly exposed to different inflationary shocks. Changes in import, energy and food prices will affect inflation directly and subsequently this may also happen when changes in input prices are carried over into changes in output prices. 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

[9] Cihak & Holub (2001) notice 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.

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

prices (incl. the prices of government-produced goods and services) may also affect overall inflation.

The many theories and explanations of inflation may be collected under four different headings (see also Table 1 in Section 4). 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 Economic Structure) 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.

3.2 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 Egert, 2008). Instead, the focus is on 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 is on explaining why inflation is higher on average 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 many countries, even in the longer term. The results seem to vary across countries, exchange-rate systems and possibly also empirical methodology (Zorzi *et al.,* 2007; Coricelli *et al.,* 2006).

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.

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).[11] 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 Eurozone (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. Therefore, it is likely that a substantial part of both traded and non-traded inflation results from an insufficient adjustment 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 tended to reduce 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 & Staehr, 2005; Egert, 2007). Wage growth may be another proxy for the cyclical position of the economy; Goretti (2008) shows that wage increases are passed through to inflation in the CEE countries. 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.

[11] 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 related to higher productivity growth in the traded than in the non-traded sector.

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).

4. Econometric analysis

This section presents the results of panel data estimations seeking to assess the importance of different factors for inflationary developments in the CEE countries. The inflation rate is taken as the dependent variable, while variables "capturing" or proxying many of the inflation theories discussed in Section 3 are used as explanatory variables. The aim is to cover a large number of the theories, which necessitates the use of annual data. More variables are available at an annual frequency than at higher frequencies; in particular, variables capturing productivity developments, structural change and public finances.

The early 1990s saw outbursts of very high inflation in all the CEE countries, in part as a result of repressed inflation coming out into the open after the setting of price on most goods was liberalised. Moreover, for many variables, comparable and reliable data for the CEE countries are only available from the mid-1990s. The data panel for the 10 CEE countries generally starts in 1997 and ends in 2007. This implies that the number of observations in the panel dataset is relatively low, which puts constraints on the choice of empirical methodology.

4.1 Inflation theories and variables

The primary data source is the web-based statistical indicators produced by Eurostat (Eurostat 2008f). The main advantage of using data from Eurostat is that the data is collected according to uniform guidelines and therefore should be 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 data series. Indices of structural reforms from the European Bank for Reconstruction and Development (EBRD 2008a, 2008b) are also used. A list of detailed references for each of the variables is available from the author upon request.

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 is used as a dependent variable and the focus is therefore on explaining headline HICP inflation.

A number of monetary policy instruments have the potential to affect inflation. We include the annual percentage change in the *nominal effective exchange rate* index. Eurostat con-

[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 1995-98 are also missing for other variables.

structs the variable so that an increasing nominal effective exchange rate is synonymous with an appreciation of the domestic currency. We also include a dummy variable for the *exchange rate regime* based on Frommel (2007). The exchange rate dummy takes the value 1 if the government targets the exchange rate; otherwise it is 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.

The Bhagwati effect links the capital stock per worker with the price level – or relative changes 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 wage and price inflation effect of capital deepening can be assessed.

We account for the 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 picked 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 would 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 within each field 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 position in the business cycle. 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*. We have also included the percentage change in *gross labour earnings* as another proxy of inflationary pressure in the economy. Many observations are missing for the latter variable. 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 1 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 1. Linking variables and theories

Theory / explanation	Variable(s)
Institutions and policies	
Expectations formation	Lagged endogenous
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 in 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.

4.2 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 data set 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.

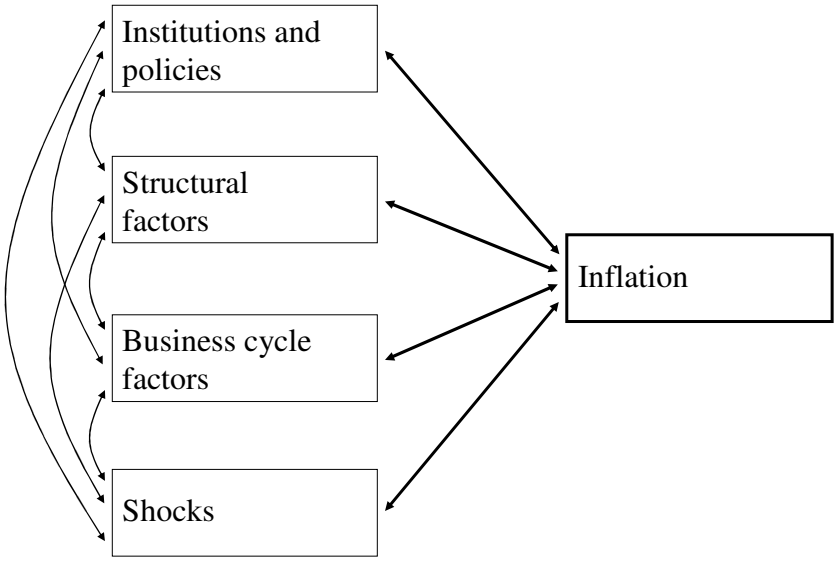
Testing of the time series properties of variables in panels often produce inconclusive results with different tests producing contradictory results. We have generally pursued a strategy where all explanatory variables entered in the empirical model are stationary. This is gener-

ally attained by calculating the absolute or the percentage change of 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 problems are illustrated in Figure 7, 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 7. 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, for instance, in growth regressions

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

where a range of methods have been taken into use to address the problems (Sala-i-Martin, 1997; Barro & Sala-i-Martin, 2003, ch. 12).

The identification problems (multicollinearity, reverse causality) in combination with the dataset containing less than 100 observations call for a careful 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 should reduce the probability of Type II errors; i.e., the rejection of the null hypothesis that a variable has no effect on inflation when the null is correct. However, the choice may increase the probably of Type I errors; i.e., the failure to reject the null hypothesis when the variable matters. In other words, using country effects and controlling for the lagged dependent variables amounts to a relative "conservative" approach, where it is more likely that too few rather than too many factors are found to be of importance.

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 coefficient to the lagged endogenous will be downward biased if the model is estimated using ordinary least squares with country-fixed effects. This Nickell bias will be particularly large for highly autoregressive processes; i.e., where the coefficient to the lagged endogenous is close to 1. A possibly more important issue is the potential endogeneity of many of the explanatory variables; in particular, those which are entered in contemporaneous form.

The Nickell and endogeneity biases can be addressed estimating the dynamic panel using estimation methods based on GMM (Bond, 2002; Roodman, 2006). Both the Difference GMM method developed by Arellano and Bond and the System GMM method developed by Arellano, Bover, Blundell and Bond are applicable. Bond (2002) shows that the coefficients estimated using the System GMM method are generally more precise than those using the

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

Difference GMM method.[15] System GMM combines estimates from a differenced version of the model using level instruments and a level version using differenced instruments. The method uses expanding GMM instruments in order to improve the efficiency of the estimates.

We employ the System GMM method 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 GMM 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 produced estimation results which were more robust to sample changes.

4.3 Separate testing of theories

This subsection 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 4.1. 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 level differences across countries.

Table 2 shows the results of these "parsimonious" models for the variables reflecting *institutions and policies*. As a starting point, Column (2.1) shows the results when only lagged inflation and contemporaneous and one-year lagged inflation are included. As required, there is a first order, but not a second order, of 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 2-4), implying a pass-through from import price inflation to domestic inflation of 0.5 in the long term. As discussed earlier, other studies have also found that the pass-through is far from perfect for the CEE countries.

[15] 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 methodology is not available for unbalanced samples (Judson & Owen, 1999).

Table 2. The impact of selected institutions and policies on annual HICP inflation; One-Step System GMM

	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)
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. GMM instruments lagged 2, 3 and 4 years. Robust standard errors are shown in round brackets; probabilities 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 (2.2) 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 (2.1). 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. (2.3). However, the dummy variable has relatively little variability in the sample and the results might thus not be surprising. 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. (2.4). 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 (2.5) and (2.6) 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); however, their sample 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 3 shows the results concerning the importance of *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 (3.1). 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 3. The impact of selected structural factors on annual HICP inflation; One-Step System GMM

	(3.1)	**(3.2)**	**(3.3)**	**(3.4)**	**(3.5)**	**(3.6)**	**(3.7)**
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. GMM instruments lagged 2, 3 and 4 years. Robust standard errors are shown in round brackets; probabilities 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 (3.2) seems to be of a reasonable magnitude if compared with results in Miyajama (2005). If investment in fixed capital as a share of GDP increases by 1 percentage point, 'inflation increases by 0.1-0.2

percent the following 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. (3.3). When included along with the proxies for the Balassa-Samuelson and Bhagwati effects in (3.4), 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 effect.

The estimated coefficient to the lagged openness variable (the sum of the import and export shares of GDP) is statistically insignificant; cf. Column (3.5). 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 (3.6)-(3.7) provide support for the notion that the financing of government activities has affected inflation in the CEE countries.

Table 4 provides the results for the *business cycle* indicators. A negative effect from lagged unemployment to inflation is discernable; cf. Column (4.1).[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]

[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 4. The impact of selected business cycle indicators on annual HICP inflation; One-Step System GMM

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)
HICP (-1), % change	0.442*** (0.067)	0.457*** (0.051)	0.349*** (0.124)	0.295*** (0.074)	0.381*** (0.090)	0.368*** (0.094)
Import price, % change	0.150*** (0.047)	0.168*** (0.061)	0.175*** (0.049)	0.164*** (0.050)	0.176*** (0.048)	0.168*** (0.047)
Import price (-1), % change	0.120 (0.092)	0.126* (0.071)	0.175** (0.087)	0.248*** (0.048)	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)	..	..	..
Labour gross earnings (-1), %-change	..	..	..	-0.002 (0.043)	..	..
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]	-2.00 [0.045]	-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]	0.70 [0.486]	-0.79 [0.429]	-0.76 [0.448]
Sargan over-identification test	101.28 [0.474]	91.45 [0.526]	113.09 [0.278]	72.94 [0.821]	113.76 [0.263]	113.64 [0.266]
Observations	89	82	94	66	94	94

Notes: Estimations without period fixed effects. GMM instruments lagged 2, 3 and 4 years. Robust standard errors are shown in round brackets; probabilities 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 lagged percentage change in nominal employee compensation is not significant. However, when included without a lag, the variable is highly significant but the estimated coefficient is only around 0.07, whereas the simple correlation coefficient between HICP inflation and the percentage growth in labour gross earnings is 0.47; cf. Table A.1 in the Appendix. Without additional analyses it is difficult to ascertain the importance of wage pressure on inflation in the CEE countries.

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 Section 3, Darvas & Szapary (2008) find a corresponding result in their price level regressions. Remarkably, the trade balance does not attain statistical significance although the sign as expectedly is negative 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 5. Column (5.1) 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 (5.2) 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 5. The impact of selected economic shocks on annual HICP inflation; One-Step System GMM

	(5.1)	**(5.2)**	**(5.3)**	**(5.4)**	**(5.5)**
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. GMM instruments lagged 2, 3 and 4 years. The EU entry dummy is used as standard instrument in (5.4). Robust standard errors are shown in round brackets; probabilities 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 absolute changes of the value-added tax (as a percent of GDP) is positive but very small and statistically insignificant in model (5.3). 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 particular example of changes to the price liberalisation index is shown in (5.5).

The results in Tables 2-5 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.

4.4 More explanatory variables

Only few estimated coefficients are statistically significant if all the variables in Tables 2-5 are included in the inflation regression simultaneously. This is hardly surprising given the small number of observations, multicollinearity across different explanatory variables and the inclusion of both the lagged dependent and country fixed effects. This section seeks to identify factors of importance for CEE inflation by initially 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 estimations with all explanatory variables included simultaneously 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 other variables may change markedly when a variable is removed. Issues like the specific choice of correction of the standard errors and the choice of GMM instruments are also of importance. These factors have led us to experiment with many different possible specifications, essentially applying some trial-and-error in order to gain insights into the forces driving inflation in the CEE countries since the late 1990s.

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. The percentage change in labour gross earnings was also excluded due to many missing observations; the importance of this variable will be considered subsequently.

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 Subsection 4.3 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 real effective exchange rate change enters one period lagged. This pattern is consistent across all specifica-

tions 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 (6.1)-(6.3) in Table 6 shows the last successive steps of the general-to-specific estimation procedure. Model (6.1) includes only variables significant at least at the 15 percent level, model (6.2) only variables significant at the 10 percent level or better, and (6.3) only variables significant at the 5 percent level or better.

Table 6. The impact of selected explanatory variables on annual HICP inflation; One-Step System GMM

	(6.1)	(6.2)	(6.3)	(6.4)	(6.5)	(6.6)	(6.7)
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)	0.517*** (0.032)
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)	0.160*** (0.038)
Real 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)	0.176*** (0.055)
Government budget balance (-1), % of GDP	-0.110* (0.057)	-0.087* (0.045)	..	..	..	..	..
Government debt (-1), % of GDP	..	..	..	..	..	0.022*** (0.008)	0.014 (0.020)
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)	0.029* (0.017)
Gross fixed capital formation (-1), % of GDP	..	..	..	0.031 (0.056)	0.130** (0.058)	0.172*** (0.053)	0.083 (0.056)
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)	..	..	..	..	..
Real gross labour earnings (-1), % change	..	..	..	..	..	..	0.095*** (0.015)
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]	-1.97 [0.049]
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]	-1.09 [0.275]
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]	56.94 [1.000]
Observations	86	89	89	89	89	85	57

Notes: Estimations without period fixed effects. GMM instruments lagged 2 years. Robust standard errors are shown in round brackets; probabilities 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 (6.2), but the difference between the *t*-values of the two variables in (6.2) is marginal.

Overall, model (6.3) 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 Subsection 4.3. 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 (6.4) repeats (6.3) 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 (6.5) 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 investment. The variable is the residual from the abovementioned fixed effect estimation where the current account balance is explained by the investment rate (and the country dummies). It follows from (6.5) 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 (6.6). The investment rate is highly significant in this specification and the coefficient is comparable to the finding in (6.5) as well as (3.2) and (3.4) in Subsection 4.3. In (6.4) the lagged government debt enters, whereas the tax intake attained significance in columns (6.1)-(6.3). The two variables are closely correlated; governments with large debts have on average large tax revenues.[18]

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). Model (6.7) is (6.6) with the percentage real wage growth included as an additional variable. Although the inclusion implies a substantial reduction in available data points, the results are interesting. The coefficient to the real wage growth variable is highly significant and of a reasonable magnitude. At the same time, the estimated coefficients to the lagged productivity growth difference and the investment rate drop markedly and become much less precisely estimated. These results provide additional support for both the Balassa-Samuelson and the Bhagwati effects linking real convergence with structural inflation in the CEE countries.

[18] If the stipulated general-to-specific procedure is not followed slavishly, it is possible to arrive at a specific form in which the lagged total tax revenue appears instead of lagged government debt (in which case also the lagged unemployment rate becomes statistically significant at the 5 percent level).

4.5 Different samples

The results have hitherto been based on the entire sample (with the exception that annual inflation rates above 20 percent have been excluded). In this Subsection, results are reported for different (sub)samples. 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 (7.1) in Table 7 shows the results when (6.3) 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.*, 2006). Column (7.2) shows the results when only data for 2003-07 is included. Even in this small sample the results are little changed – with the possible exception that the coefficient to contemporaneous import price inflation has fallen somewhat.

Table 7. The impact of selected explanatory variables on annual HICP inflation using different subsamples; One-Step System GMM

	(7.1)	**(7.2)**	**(7.3)**	**(7.4)**	**(7.5)**	**(7.6)**
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. GMM instruments lagged 2 years. Robust standard errors are shown in round brackets; probabilities 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 (7.3) 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 (6.3). Column (7.4) shows the results for the Baltic countries, Romania and Bulgaria. The main differences are that the size of the gov-

ernment plays no role in this subsample and the estimated coefficient to the productivity difference is only marginally significant.

Finally, we redo (6.6) for observations with annual HICP inflation smaller than or equal to 5 percent. The result in column (7.5) 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 (7.6) also estimates (6.6) but includes observations only for 2003-07. The results are very similar to those for the entire sample.

5. Final comments

This paper has sought to pinpoint factors driving inflation in the new EU member countries from Central and Eastern Europe. A prime objective has been to link inflation theories with specific variables and then to test the importance of different theories as drivers of inflation. To this end a large number of inflation theories were discussed, including some with particular reference to economies experiencing rapid structural change and high economic growth. The importance of the different theories was assessed in panel data estimations using annual data from 1998 until 2007.

The annual dataset in combination with many missing observations for Bulgaria and Romania meant that the relative few observations were available, which again necessitated a pragmatic modelling approach. We used separate inclusion of explanatory variables as well as general-to-specific modelling and found that the results across the two methods were broadly consistent.

The inflation process appears to exhibit a substantial autoregressive component (of the size 0.3-0.5) possibly reflecting backward-looking expectations and inertia in price and wage setting. Imported inflation plays a crucial role, but the pass-through is far from complete; the short-term pass-through of approximately 0.25 and long-term pass-through around 0.5. The effect of the interest rate on inflation is difficult to estimate with any precision and, similarly, the exchange rate regime *per se* does not appear to be of importance. Fiscal policies also play a role; countries where the government has a large debt and/or high fiscal revenues experience higher inflation than countries with a more prudent fiscal policy stance.

The effects of a number of structural explanatory factors were also considered. The Balassa-Samuelson effect is very robust across different specifications and subsamples; higher productivity growth in traded than in the non-traded sector exerts upward pressure on inflation. The Bhagwati capital-deepening effect is also present albeit it is difficult to disentangle from effects relating to the current account balance. The degree of openness did not appear to play a role for inflation in the CEE countries – except to the extent that openness affects trade and current account balances.

Variables reflecting the cyclical position affect inflation, although it is difficult to attain precise coefficient estimates to the unemployment variable in many specifications. The current account balance (and to a lesser extent the trade balance) is closely related to inflation developments in the new EU countries. The precise underlying mechanism proved difficult to establish. One possibility is that the current account balance is a measure of the tightness of goods and labour markets and hence reflects a Phillips curve relationship. Another possibility emerges from the fact the variable is closely correlated with investment in the economy and

thus picks capital deepening. One possible conclusion would be that the current account balance in one year is a very powerful *predictor* of inflation the following year.

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

The discussion above brought up a large number of factors that have affected inflation in the CEE countries during the period 1998-2007. The analysis suggested that the higher inflation in the new member countries is partly resulting from the catch-up process as capital deepening and high productivity growth in the traded sector drive up inflation. The analysis also showed that economic policies affecting import price inflation, the business cycle and energy price inflation are effective in controlling inflation. Moreover, fiscal policy as reflected by for instance the debt stock or tax revenues also seem to have a strong impact on inflation. In other words, the drivers of inflation in the CEE countries are essentially the same as those found in high-income countries.[19] Consequently, overall higher inflation in the CEE countries is 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, the convergence-related factors have pushed up inflation, while economic policies have not fully counteracted this effect.

The analyses in this paper were inhibited by the difficulty experienced in identifying precisely the effect of different factors on inflation in the CEE countries. It was difficult to attain precise coefficient estimates for many variables. This was in part the result of the few observation points in the annual dataset; future work may therefore gain from using a higher frequency dataset. Multicollinearity problems may also be addressed by using composite indices of different factors using for instance factor analysis. 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.

[19] 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	Correlation with HICP, % change
HICP, % change	1997-2007	5.760	3.887	1.000
HICP (-1), % change	1998-2007	5.973	4.431	0.687
Import price, % change	1995-2007	3.350	5.075	0.506
Nominal effective exchange rate, % change	1996-2007	2.414	6.223	-0.307
Non-floating exchange rate dummy	1995-2007	0.606	0.485	0.053
3-month interest rate, %	1997-2007	7.809	5.232	0.635
Labour productivity in manufacturing, % change	1995-2007	7.045	4.965	-0.019
Labour productivity in private service sectors, % change	1996-2007	3.585	3.695	-0.149
Difference in labour productivities, % change	1997-2007	3.423	6.431	-0.002
Overall labour productivity, % change	1995-2007	5.015	2.679	-0.173
Gross fixed capital formation, % of GDP	1995-2007	24.663	4.274	-0.035
Import, % of GDP	1997-2007	62.263	15.057	-0.116
Export, % of GDP	1997-2007	56.378	15.502	-0.126
Openness (import + export), % of GDP	1997-2007	118.641	30.085	-0.122
Openness, %-point change	1997-2007	3.163	8.512	0.056
Government debt, % of GDP	1995-2007	30.523	19.272	0.289
Government budget balance, % of GDP	1995-2007	-2.848	3.085	-0.140
Government revenue, % of GDP	1995-2007	38.691	3.747	0.281
Total tax revenue, % of GDP	1995-2007	33.478	3.499	0.273
Value added tax revenue, % of GDP	1995-2007	7.776	1.155	0.136
Index of price liberalisation	1995-2007	4.224	0.137	-0.182
Index of price liberalisation, change	1995-2007	0.017	0.071	0.047
Index of forex and trade liberalisation	1995-2007	4.268	0.093	-0.108
Index of forex and trade liberalisation, change	1995-2007	0.012	0.0718	-0.128
Index of competition policy	1995-2007	2.810	0.376	-0.239
Index of competition policy, change	1995-2007	0.068	0.145	-0.094
Unemployment, %	1996-2007	10.479	4.431	-0.151
Employment, % change	1998-2007	0.035	2.513	-0.121
GDP, % change	1995-2007	5.441	2.728	-0.078
Trade balance, % of GDP	1995-2007	-5.885	5.382	-0.038
Current account balance, % of GDP	1995-2007	-6.896	4.638	0.015
Gross labour earnings, %-change	1996-2007	10.662	8.406	0.466
Energy price inflation, % change	1997-2007	3.554	6.849	0.413
Food price inflation, % change	1997-2007	-1.129	3.192	0.704
EU entry dummy	1995-2007	0.304	0.443	-0.272

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

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