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INFLATION DRIVERS IN NEW EU MEMBERS

MARTINA ALEXOVÁ

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www.nbs.sk
Imricha Karvaša 1
813 25 Bratislava

research@nbs.sk

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Working paper NBS

Martina Alexová[2]

Abstract

Detecting the drivers of inflation is essential in designing structural reforms aimed at complementing the main objectives of monetary policy. This paper attempts to uncover the factors causing inflation from both demand and supply side in several new members of European Union by utilizing error correction method. We found out that supply side factors have major influence on inflation. All countries are sensitive to wage development both in long and short run. Furthermore, the integration to euro area and participation in ERM II has a decreasing influence on a price level. Policy makers should pay special attention to excessive wage development as it can significantly distort price development.

JEL classification: E 31, C 22
Key words: inflation, error correction models, wage, productivity, import price, unemployment

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[2] Research Department of the NBS, martina.alexova@nbs.sk.

1. INTRODUCTION

Inflation is one of the key factors which influence macroeconomic stability. Nowadays it is also a widely used term in a connection with an interest rate, crisis and an accession of new countries to Eurozone. Inflation influences not only our real wage and purchasing power but it also affects country's competitiveness and financial situation of households and companies. Therefore it is important to determine factors which effect a change in price level when designing structural reforms, various predictions and last not least in the monetary policy decisions.

With regard to inflation modelling we recognize several methods which lead to various conclusions. Jansen (2004) presents four approaches towards inflation modelling. As a first approach he describes wage-price block defined in Area Wide Model[3]. The next one is P* - model defined by Hallman et al. (1991). In this approach inflation is a pure monetary phenomenon[4], defined by amount of money in circulation, potential output and velocity of money (alternatively by inflation expectations, price gap and other explanatory variables defined in modified P* - model). In another approach inflation is modelled by New Keynesian Philips curve through inflation expectations and demand (Clarida et al., 1999, Svensson, 2000, Gali et al., 2001). Last approach looks at inflation through reduced inflation equation derived from Incomplete Competition Model where both wages and prices are modelled together. This model reliably estimated inflation process for small open economies such as Norway and Great Britain. Domestic and foreign inflation is model jointly with labour market development where companies and unions have bargaining power and therefore they are represented in the model. Other authors, who model inflation together with wage development, use structural vector autoregressive (VAR) and vector error correction (VEC) models. For instance, Juselius (2006) uses cointegration VAR model to determine factors influencing inflation in Finland. Boschi and Girardi (2007) estimate inflation determinants for Eurozone and its members before their accession to the European monetary union (EMU) by VEC model. They investigate relationships between wages, productivity, mark-up, production gap and inflation.

In our paper we concentrate on the significance of inflation's demand and supply factors. Apart from previous study we derive the long run relationship between prices, wages and real economy from paper by Broer et al. (2000). Broer's model for labour market development involves three main components such as companies, unions and government which have influence on the development of wages. Joint effect of these three components is omitted in previous models. Therefore in the long run there is a balance between

[3] This model is described in the paper by Fagan et al. (2001). It is defined by the system of structural economic relationships between variables.
[4] Other authors which model inflation by P* - model are Trecroci and Vega (2002), Gerlach and Svensson (2003), (more in paper by Jansen, 2004).

companies, unions and government. Unemployment also enters the relationship because it influences not only the negotiation process between all three sectors but it also represents the conditions on the labour market and in the whole economy. There is also a significant influence of main model's variables such as prices, labour productivity and unemployment in the short run.

In comparison with other papers we concentrate on new member states of European Union (EU) which are not studied in more detail for various reasons, for instance, due to a lack of relevant data or transformation process in these countries which forbid meaningful modelling. There are several papers which model inflation process in these countries. For instance Kim (2001) models determinants of inflation in Poland by VEC model in 1991-1999. He finds out inflation is influenced by changes on labour market and by prices on foreign markets. Golinelli and Orsi (2002) analyse inflation in the Czech Republic, Hungary and Poland in 1991-2000 by VEC model. They concluded productivity and exchange rate have a significant influence on inflation rate. Kuijs (2002) analyses inflation in Slovakia by VAR model in 1993-2000. He finds out price level is influenced by foreign prices, exchange rate, wage costs and partially by demand factors. Kišidaj and Mihalenko (2006) derive mark-up model of core inflation for Slovakia in which inflation is determined by wage development and inflation expectations. Furthermore they conclude that it is important to react on risk of excessive wage development. Hammermann (2007) focuses on non-monetary factors of inflation in Romania. He finds out labour market development and structural discrepancies generate considerable differences between inflation in Romania and in group of other new member states of EU.

As we have already mentioned we concentrate on countries from Central and Eastern Europe. Originally we wanted to have all ten new members of EU; however, due to lack of relevant data we analyse Slovakia, the Czech Republic, Poland, Hungary, Slovenia and Estonia[5]. All of these countries went through the transition process from central planning economies towards market economies in the same time, they are neighbours, members of EU, and therefore, factors influencing inflation could be similar. On the other hand they have different monetary policies, three of these countries are members of the monetary union, and the other three countries have their own monetary policy focused on inflation targeting.

In our paper we address several questions which we would like to verify and which have not been tested jointly. At first we would like to determine and test which factors (supply or demand) have statistically significant influence on inflation in the long and short run in selected new members of EU. Furthermore, we would like to test whether in the long run selected factors have their parameters in accordance with economic theory. In other words we would like to find out whether in post - communistic countries the elasticity between prices and nominal wages is unit and between prices and productivity is 1 to -1 as stated in the economic theory. At last, three of our countries joined the monetary union therefore we

[5] We omit Latvia, Lithuania, Bulgaria and Romania from further analysis.

would like to test whether the membership of these countries in EMU and in European exchange rate mechanism (ERM II) is statistically significant and whether it has a positive influence on development of prices (whether the membership of these countries in EMU have helped to reduce a growth of prices).

This paper is divided into 6 chapters. In following chapter we introduce model which is the basis for our analysis. In the third chapter we present our data. It is followed by chapter where we estimate our model and test our hypothesis from the long run perspective. In the fifth chapter we present factors influencing inflation dynamics. Last sixth chapter concludes the paper.

2. MODEL

As a starting point we utilize classic error correction model which enable us to model long run relationship between variables and simultaneously determine short run deviations from the long run equilibrium. A meaningful long run relationship is often problematic therefore it is convenient to comply with economic theory.

Originally we base our analysis on the long run relationship from Boschi and Girardi (2007). However their ad-hoc determination of long run relationship does not necessarily holds for all countries. We tested the approximation from Boschi and Girardi (2007) and we concluded they are not suitable for our set of countries. For instance, approximation of output gap by production function and technological progress (expressed by trend) is not suitable in transformative post – communistic countries in comparison with relatively stable and developed Western Europe countries.

In our paper we focus on the model by Broer et al. (2000). Their model is based on a long run relationship for a wage formation. In the long run the balance is achieved between companies, unions and government. Companies are trying to maximize their profits, unions want to gain the highest possible wage and government enters the relationship through various administrative adjustments.

Broer et al. (2000) model all three components through the relationship:

$$\arg\max(w):\left(\frac{p_y y - lw}{p_c}\right)\left(\frac{w(1+\tau)}{p_c} - F\right)^{\alpha} \qquad (1)$$

where first part of equation presents the relationships for companies who set prices. In this case prices represent some form of cost adjustments. τ represents various government adjustments in the form of unemployment benefits and administrative payments and α is a

negotiation power of unions. This relationship can be consecutively adjusted to log – linear equation for a wage formation[6]:

$$\ln w = \ln p_y + \ln h + \chi_1 \Lambda + \chi_2 rp - \chi_3 u + \chi_0 \quad (2)$$

where h is labour productivity (h=y/l), Λ – wedge, which is a ratio of gross wage and net wage, rp – replacement rate, which represents a ratio of benefits between unemployed and employed person and u – unemployment rate.

The standard neoclassical model assumes in the long run wages grow at the same rate as labour productivity. Let's suppose that w is a certain wage level. Then in standard conditions for profit maximization and perfect competition, the marginal costs for producing another item are equal to the value of this item. Therefore for production of another item it is necessary to increase labour productivity and pay higher wages otherwise employees would immediately leave for other company. Similarly as Broer et al. (2000) we assume unit coefficients for productivity which means that employees benefits from a productivity increase. We also assume direct relationship between wages and prices (unit coefficient for prices). Therefore a price increase would raise nominal wage by the same value in the long run. Data for wedge and replacement rate is hard to obtain for our set of countries therefore we assume they are constant. Unemployment enters the relationship because it influences the probability of finding another job and also it covers the part of productive work force who receives unemployment benefits. Furthermore unemployment can be an important explanatory variable for inflation in transitive economies in Central and Easter Europe which cope with high unemployment rate for a long period.

On the basis on this relationship we would like to determine significant demand and supply factors of inflation in the long run. Our modify linear equation is following:

$$\ln p_y = \ln w + \ln h - \chi_1 u + \chi_0 \quad (3)$$

We assume the same linear relationship between prices and wages (as in equation (2)). In case of inflation (prices) and productivity we expect to see negative relationship (Kumar et al., 2012, Clark, 1982). Inflation reduces the purchasing power of workers and therefore their motivation to work, distorts the real value of products (which can lead to ineffective investment plans), increases the rent of capital which indirectly influence the productivity (Christopolous and Tsionas, 2005)[7].

[6] The exact derivation of the relationship is in the paper by Broer et al. (2000) on pages 4-7.
[7] Kumar et al. (2012) presents four important empirical studies which confirm negative relationship between inflation and productivity using different estimation methods (Bitros and Panas, 2001, Tsionas, 2003a, Christopolous and Tsionas, 2005, Mahadevan and Asafu-Adjaye, 2005).

Our selected countries are small open economies for which export and import of goods and services reach separately 75-96% of GDP[8] (for year 2012) therefore omitting import prices can significantly distort the estimation of inflation. We broaden our model to an open economy model (equation (4)). Situation on domestic market is modelled by equation (3). Replacing p_y by equation (3) in equation (4) we get the final relationship for price level as in equation (5).

$$\ln p_c = \alpha \ln p_y + (1-\alpha) \ln p_m + \gamma_0 \quad (4)$$

$$\ln p_c = \alpha(\ln w + \ln h - u) + (1-\alpha) \ln p_m + \gamma_0 \quad (5)$$

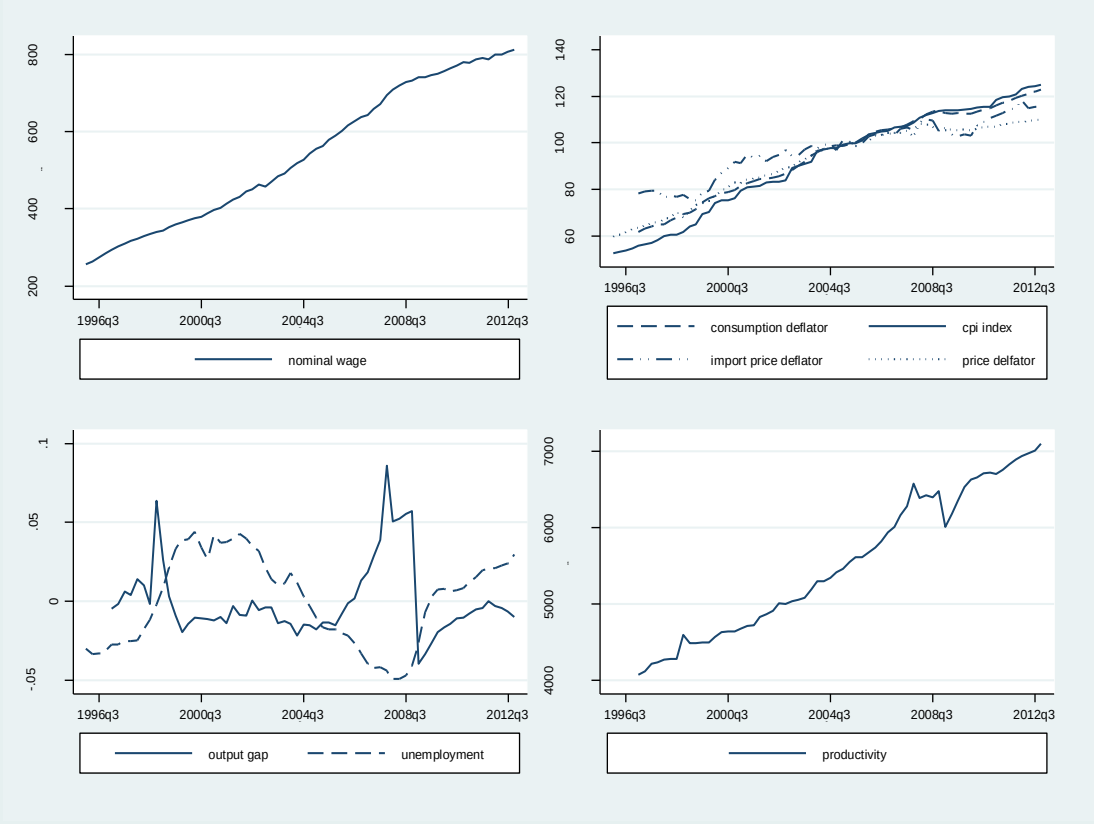
p_y represents prices of domestic producers and p_m are import prices.

3. DATA

We choose years 1998-2012 as your estimation period mainly due to data availability for all countries. Chart 1 depicts main variables for Slovakia (plots for other countries are shown in appendix A). Top right chart shows development of price index, import price deflator[9], price deflator and domestic consumption deflator. The influence of exchange rate is already incorporated in import price deflator, therefore we omit exchange rate as independent variable from analysis. As we can see price index and both deflators (price and consumption) have approximately the same development. For our purposes we use domestic consumption deflator[10]. Bottom left chart presents de-trended unemployment and output gap. Output gap serves as a proxy for unemployment in our analysis because unemployment may not accurately describe the situation on labour market due to transformation process in selected countries[11]. The rest two charts show nominal wage and labour productivity which could enable us to uncover the sources of high price level. Both nominal wage and productivity have growing trajectory while it seems wages are growing faster than productivity. Around 2009 we see a decline in productivity which could point to global economic crisis. In case of other countries productivity development is approximately the same as in Slovakia. With the exception of Poland there is a significant decline in productivity around 2009 (as well as in output gap). Similarly price indicators for the rest of the countries show resembling development as in Slovakia.

[8] With the exception of Poland where export and import reach separately around 50% of GDP.
[9] We could not find data for import prices, therefore we use import price deflator as a proxy. Deflator itself contains oil price, exchange rate and foreign prices which can better capture the development of foreign prices and describe the development of transitive economies. We are aware of problems associated with the use of deflator which is subject to revisions in comparison with relatively fixed CPI index. However, better indicator for import prices is not available.
[10] Originally we wanted to use CPI index. However, in this index are incorporated price deregulations, tax changes, etc. therefore its modeling is problematic.
[11] Output gap is modeled by HP filter.

Chart 1 – Model variables for Slovakia



Source: Eurostat, OECD.

For Hungary we decided to incorporate a dummy variable for two last years (2011-2012) when Hungarian government officially requested external help from International Monetary Fund (IMF) and EU. After these years' data are hard to estimate, therefore we use this dummy. For Poland we shorten the estimation period. We start in 1999 due to various structural reforms in Poland before 1999 which distorted the estimates.

Empirical papers define productivity and nominal wage in inflation relationship differently. While most of the authors define labour productivity as a ratio of output (or GDP in constant prices of a certain year) and employment, various data sources may influence differences in results. For instance, Horst (2003) uses Ameco as a data source, Broer et al. (2000) use Dutch statistical office (CBS), Boschi and Girardi (2007) uses OECD and IMF database, etc. Other authors such as Jansen (2004) use ratio of real GDP to total employment, Golinelli and Orsi (2002) use industrial output, Kumar (2012) utilises output per hour in manufacturing sector and Rosenberg (2010) uses aggregate productivity for various sectors.

Variable, which enters the equation as wage, or labour costs, is also defined variously in papers. Slevin (2003), Banerjee et al. (2002), Jansen (2004) use total cost per employee in whole economy. Golinelli and Orsi (2002) utilise nominal wages as well as Broer et al. (2000) and Horst (2003).

Similarly to Broer et al. (2000) and Horst (2003) we utilise nominal wages defined as an average wage in particular country and productivity defined as a ratio of GDP in constant prices of 2005 and total employment in a country[12].

Table 1 - Variables and data sources which are used in model estimation

		SK	SI	EE	CZ	HU	PL
price indicators							
CPI index	CPI	94.36	97.60	104.78	98.61	95.85	95.86
OECD, 2005		*20.98*	*16.99*	*19.20*	*14.30*	*28.28*	*17.99*
price deflator	py	93.30	97.72	103.54	96.24	93.37	96.21
Eurostat		*14.66*	*15.45*	*22.51*	*10.42*	*25.65*	*16.66*
domestic consumption deflator	pc	95.67	98.15	104.15	96.86	93.49	96.21
Eurostat		*18.23*	*16.76*	*20.83*	*13.24*	*27.15*	*17.91*
import price deflator	pm	97.66	96.55	106.13	100.31	99.39	96.98
Eurostat		*11.99*	*13.92*	*12.20*	*4.08*	*12.96*	*19.29*
other variables							
nominal wage	w	557.48	1150.64	578.61	17393.76	137710.70	2300.21
OECD - labour earnings		*172.37*	*288.07*	*220.78*	*5378.77*	*57295.67*	*780.05*
productivity	h	5532.20	5779.56	4343.66	150433.00	1211809.00	16516.74
Ratio of GDP in constant prices and employment		*929.06*	*595.68*	*766.84*	*22351.68*	*149955.00*	*2812.61*
unemployment rate	u	0.14	0.07	0.10	0.08	0.08	0.14
OECD		*0.03*	*0.01*	*0.03*	*0.02*	*0.02*	*0.03*
employment	l	2.12E+06	9.40E+05	5.97E+05	4.99E+06	4.14E+06	1.49E+07
OECD		*7.21E+04*	*3.04E+04*	*2.65E+04*	*1.23E+05*	*8.07E+04*	*8.06E+05*
GDP in constant prices	GDP_const	1.25E+10	5.45E+09	2.60E+09	7.51E+11	5.02E+12	2.47E+11
OECD, 2005		*2.60E+09*	*7.06E+08*	*5.06E+08*	*1.21E+11*	*6.31E+11*	*4.92E+10*

Source of data (or definition of variable) is a row below a variable name. Below countries are specific descriptive statistics of variables: first row – mean, second row – standard deviation.

4. ESTIMATION

We estimate our model in the two steps:

- At first we determinate parameter 1-α
- Secondly we estimate inflation relationship based on equation (5)

[12] Data sources are stated in table 1.

At first we calibrate the coefficient for import prices 1-α in the relationship $\ln p_c = \alpha(\ln w + \ln h - u) + (1-\alpha)\ln p_m + \gamma_0$. This coefficient can better capture the specific influence of exchange rate on inflation, more precisely, its variability in estimated period. We decided to use calibration of this parameter mainly because of the dynamic development of our countries. During the estimation period countries introduced number of structural reforms, joined EU, EMU and the end of period is marked by global economic crisis. Therefore not fixing this coefficient could lead to misinterpretation of import price development[13]. On the other hand, the coefficient for import prices we obtain directly from data of selected countries. For calibration of this coefficient we use relationship

$$1-\alpha = \frac{M}{C+I+G+E} \qquad (6)$$

where M is a value of import for a country, C is a total consumption of households, G is government consumption, I is a total investment for a country and E is a value of export[14].

Table 2 – Calibrated values for coefficient 1-α

	SK	SI	EE	CZ	HU	PL
1-α	0.45	0.38	0.45	0.40	0.41	0.35

Source: Eurostat and own calculations.

Table 2 shows calibrated coefficient for all countries. The higher the value of coefficient the more dependent the country is on the foreign trade. As we expected in all countries we observe significant influence of import prices of goods and services on overall price level. All countries are dependent on foreign trade therefore high values are not surprising. As expected the least dependent country on the foreign trade is Poland, where the coefficient is lowest, "export" countries such as Slovakia and Estonia have the highest value of the coefficient.

In the second step we estimate the long run relationship for all countries based on equation $\ln p_c = \alpha(\ln w + \ln h - u) + (1-\alpha)\ln p_m + \gamma_0$. For 1-α we take a number from table 2. The equation (4) is further adjusted by two dummy variables for period when Slovakia, Slovenia and Estonia were members of ERM II (DERM) and when they have become members of EMU (DEMU). Before estimation we check the stationarity of all variables by their respective plots (chapter 3 Data) and by Dickey-Fuller (DF) test[15]. All variables are non-stationary (stationary on their first differences (I(1))) except for unemployment for the Czech Republic and Estonia and nominal wage for the Czech Republic and Poland and output gap which is stationary already on the level (what we have expected). Unsatisfactory results of DF test for unemployment and wage could be a subject to a small sample bias. Moreover a variable

[13] Fixing the coefficients for productivity and wages appear to be a big restriction which could lead to misinterpretation of the development in these countries.
[14] Data are on an annual basis for all countries from Eurostat. 1-α is an average for 1998-2012.
[15] Results of Dickey-Fuller test are shown in appendix B.

plots, especially for wage, do point to a non-stationarity of variables. Therefore we decide to continue with the estimation and regard all variables as stationary on their first differences.

As we expected in all estimates the sign of coefficient for wage is significant and correct. Therefore the raise of nominal wage by 1% (if productivity stays constant) would raise price level. All the coefficients for wage are very close to one which supports the theory of unit elasticity between nominal wage and price. High and significant coefficients for wage point out to risk of excessive wage development which has high influence on price development.

Table 3 – Long run estimates

	SK		SI		EE		CZ		HU		PL
1-α	0.450		0.380		0.450		0.400		0.410		0.350
w	1.035	*	0.880	*	0.783	*	0.936	*	0.989	*	0.530
	(0.091)		(0.034)		(0.034)		(0.059)		(0.039)		(0.056)
h	-0.332	*	-0.265	*	-0.208	*	-0.361	*	-0.006		-0.012
	(0.181)		(0.102)		(0.079)		(0.113)		(0.124)		(0.103)
u			-0.851	*			-0.740	*			
			(0.023)				(0.208)				
Y_0	0.499		0.479		0.787	*	-0.200		-4.189	*	0.380
	(0.011)		(0.441)		(0.230)		(0.413)		(0.767)		(0.381)
DEMU	-0.041	*	-0.016	*	-0.003						
	(0.011)		(0.008)		(0.007)						
DERM	-0.024	*	-0.009		-0.016	*					
	(0.009)		(0.007)		(0.005)						
DFC									-0.030	*	
									(0.008)		
R2	0.992		0.996		0.996		0.998		0.996		0.984
DW	0.637		0.914		0.779		0.648		0.724		0.608
DF	-3.941		-4.362		-3.720		-3.286		-3.548		-4.453
	0.003		0.001		0.006		0.020		0.010		0.001

DW: Durbin-Watson statistic

DF: Dickey-Fuller test for the stationarity of the residuals

The second row for each estimation contains standard errors and the p-values for the DF tests

Coefficients with * are significant on α=0.1

Source: Own calculations.

Similarly the sign for productivity is correct and significant with the exception for Hungary and Poland. In case of Hungary we have been observing considerable slowdown in productivity since 2008 even though price level is constant. This could be attributed to the

global economic crisis. For all countries a decrease of productivity by 1% would increase prices due to lack of motivation and effort of employees to continue working for unchanged amount of money or due to change of investment plans and production techniques (which could be influenced by higher inflation). However, relatively small coefficient for productivity does not point to unit elasticity between price and productivity.

The sign for unemployment is incorrect and significant as well as for output gap with the exception for the Czech Republic and Slovenia. Even though we consider the influence of unemployment as significant, in the long run it could not have an effect on prices due to deregulation adjustments and price shocks which could result in higher unemployment rate. Therefore unemployment rate and deflator could be correlated together.

Durbin-Watson (DW) statistic is low in all equations which point to a correlation in data; however, the dynamic estimation can improve this statistic. In comparison with paper by Horst (2003) for six OECD countries DW is lower in our estimations but comparable with estimates for Spain and Great Britain. Dickey-Fuller (DF) statistic tests stationarity of residuals. In all our estimates the residuals are stationary which is also confirmed in error correction estimates where the difference between actual and long run equilibrium price level is negative.

As was already mentioned in the introduction, for Slovakia, Slovenia and Estonia we test the statistical significance of the membership of these countries in ERM II and in the monetary union whether it has some impact on prices. Slovakia joined ERM II on 25th November 2005 and EMU as of 1st January 2009. Slovenia participated in ERM II from 28th June 2004 to 31st December 2006 when it joined the monetary union. Estonia joined ERM II at the same time as Slovenia, 28th June 2004, and joined EMU on 1st January 2011. For all three countries coefficient for the membership in ERM II and in EMU has a negative value. Therefore the membership in EMU or ERM II has helped to decrease prices from the long run perspective. For Slovakia both dummies are statistically significant. For Slovenia only the membership in monetary union is statistically significant. However, Slovenian membership in ERM II was short therefore it could not appear as statistically significant. Similarly for Estonia which joined the monetary union only in 2011 (one year of observations), this membership appears to be statistically insignificant.

Our long run estimates are good representation of data. Widening model to an open economy model and involvement of import prices proves to have a significant influence on prices in the long run. We observe significant wage influence on price level, as well as, influence of productivity on prices; however, it is less profound than wage influence. Unemployment as an explanatory variable is significant only for the Czech Republic and Slovenia. In addition the membership in EMR II and EMU has an important influence on prices in the long run.

For the long run equations we test whether the elasticity between prices and nominal wages is 1 to 1 and whether the elasticity between prices and productivity is 1 to -1 as it is defined

in literature and whether the both coefficients for wage and productivity can be 1 and -1 jointly. We assume that decrease of productivity would increase labour costs and therefore increase prices. Eventually a decrease of productivity and a price increase would change wages. Worker would have to accept slower wage growth for their lower productivity. From the long run perspective we assume a joint effect of wage and productivity increase would not have an effect on price level. Coefficients for nominal wages are close to 1 therefore we expect confirmation of our elasticity hypothesis. On the other hand coefficients for productivity are very low. We do not expect to see confirmation of price-productivity unit elasticity. For instance, Hviding and Thornton (1999) estimate the relationship between inflation and productivity for G7 countries. They confirm negative relationship; however, the magnitude of this relationship is not unit.

Table 4 – Coefficient tests

	w=1	c(1)=1		h=-1	c(2)=-1		w+h=0	c(1)+c(2)=0
	Coefficient	*t-stat*	*prob*	*Coefficient*	*t-stat*	*prob*	*t-stat*	*prob*
SK	1.036	0.390	0.698	-0.332	3.685	0.001	7.091	0.000
SI	0.880	-3.522	0.001	-0.265	7.148	0.000	7.911	0.000
EE	0.783	-6.367	0.000	-0.208	9.999	0.000	12.061	0.000
CZ	0.936	-1.094	0.279	-0.361	5.676	0.000	10.346	0.000
HU	0.989	-0.252	0.802	-0.006	7.987	0.000	11.329	0.000
PL	0.531	-8.256	0.000	-0.012	9.580	0.000	10.343	0.000

Source: Own calculations.

From the table above we can confirm positive unit elasticity between prices and nominal wages for Slovakia, the Czech Republic and Hungary. In the long run, an increase of nominal wage by some amount would cause an increase of prices of the same amount in these countries. Even though we could not confirm unit elasticity for Slovenia and Estonia, the coefficients for wages are very close to one therefore the unit restriction assumption is not incorrect. We were unable to confirm that an increase in productivity would lead to a decrease in prices[16] by the same value and also that an increase of nominal wage and productivity would not have an effect on prices[17]. Central and Eastern Europe countries are specific for their turbulent development and structural reforms connected with their transformation and also global financial crisis could induce that it is not possible to confirm this unit elasticity between variables.

[16] In his paper Horst (2003) confirms unit elasticity for three countries (Germany, the Netherlands and Great Britain); however he is unable to validate this hypothesis for France, Spain and the United States.

[17] These results show unit restriction for wage and productivity in equation (5) would not fit the data correctly, therefore the restriction on import prices proved to be the better one.

5. INFLATION'S DYNAMICS

Determination of inflation factors and its dynamics is especially important for monetary policy. We look at monetary strategy of our countries and see what strategy they implement in order to join EMU or get inflation under control. Slovakia, Slovenia and Estonia used a different monetary policy strategy to adopt the euro as a currency. Slovenia used base money and M1 and M3 targeting and later on two pillar strategy before participation in the ERM II. Slovakia relied on informal inflation targeting. On the other hand Estonia established a currency board. Looking at the inflation criterion for euro adoption, Slovenia was on track since 2005. After euro adoption the country experienced a period of high inflation. Only towards the end of 2008 did inflation decrease again and approached average euro area figures. Although Slovakia followed informal inflation targeting, which in general should help keep inflation under control, the country fulfilled the criterion in 2007 for the first time. Estonia managed to fulfil the criterion in 2009.

The Czech Republic, Hungary and Poland share a similar monetary strategy. At first, all countries pegged their currencies in order to achieve price stability. Around 2000 they switched to inflation targeting. During the crisis inflation targets served as a good anchor of inflation expectations. The Czech Republic's inflation rate has been in line with the ECB's medium target (as well as with Maastricht inflation criterion), except for in 2008. Poland's inflation rate remained around the target value only during 2008-2010 and recently.[18] Hungary inflation rate has been more than 1.5% above the ECB target since its accession to the EU.

To capture inflation dynamics we utilise error correction model which is a dynamic system where deviations from long run equilibrium relationship would show on short run dynamics. Therefore the model can capture the speed by which the dependent variable can reach its long run equilibrium. For the estimation of inflation dynamics we use the relationship:

$$\Delta y = \beta_0 + \beta_1 D + \xi^y \Delta y_{-1} + \xi_1^x \Delta x_{-1} + \xi^{ec} y^*_{-1} \qquad (7)$$

$$y^* = y - y^{eq} \qquad (8)$$

where y is logarithm of dependent variable – prices, pc, x are independent variables such as nominal wage (w), productivity (h), import price (pm) and unemployment (u). D stands for dummy variables and β_0 is a constant. y^* represents long rung relationship, respectively, the deviations of actual price level, y, from its equilibrium value, y^{eq}. y^{eq} is defined by equation (5) in chapter 4. Coefficient ξ^{ec} measures the speed by which the actual price

[18] Target value is EBC medium target rate + 1.5%. Poland has not fulfilled Maastricht inflation criterion since October 2008.

value reaches its equilibrium value. For our estimation we choose one lag for all independent variables which are already differenced[19] (expect for unemployment).

Table 5 – Dynamics estimates

	SK		SI		EE		CZ		HU		PL	
ECM(-1)	-0.128	*	-0.236	*	-0.165	*	-0.293	*	-0.070		-0.106	*
	(0.056)		(0.114)		(0.091)		(0.084)		(0.096)		(0.051)	
Δpc(-1)	0.539	*	-0.334	*	0.149		-0.073		-0.157		0.382	*
	(0.118)		(0.131)		(0.150)		(0.132)		(0.142)		(0.089)	
Δw(-1)	0.057		0.567	*	0.054		-0.008		0.598	*	0.111	*
	(0.109)		(0.224)		(0.065)		(0.056)		(0.198)		(0.028)	
Δh(-1)	-0.115	*	0.158		0.124	*	0.265	*	-0.033		0.195	*
	(0.047)		(0.114)		(0.048)		(0.101)		(0.154)		(0.094)	
Δpm(-1)	-0.031		-0.034		-0.046		-0.002		0.019		-0.014	
	(0.041)		(0.070)		(0.075)		(0.052)		(0.052)		(0.022)	
u	0.019[20]		-0.043		-0.039		-0.143	*	-0.036		-0.022	
	(0.049)		(0.123)		(0.053)		(0.073)		(0.103)		(0.022)	
β_0	0.007	*	0.011		0.009		0.017	*	0.006		0.005	
	(0.003)		(0.012)		(0.007)		(0.006)		(0.010)		(0.004)	
DEMU	-0.005	*	-0.006		0.003							
	(0.003)		(0.004)		(0.003)							
DERM	-0.003		-0.007	*	0.005							
	(0.003)		(0.004)		(0.004)							
DFC									0.000			
									(0.005)			
R2	0.534		0.530		0.422		0.282		0.313		0.625	
DW	1.636		2.225		2.076		1.846		2.380		2.592	

DW: Durbin-Watson statistic

The second row for each estimation contains standard errors

Coefficients with * are significant on α=0.1

Source: Own calculations.

The estimation of inflation dynamics is shown in table 5. We can consider long run estimates as equilibrium estimates since inflation (or price level change) depends negatively on the difference between actual and equilibrium price level. The adjustment speed towards

[19] Originally we started with two lags, however, the value of coefficients as well as their significance was very low, and therefore we omitted more lags from further analysis. Estimation with two lags gives approximately the same results.

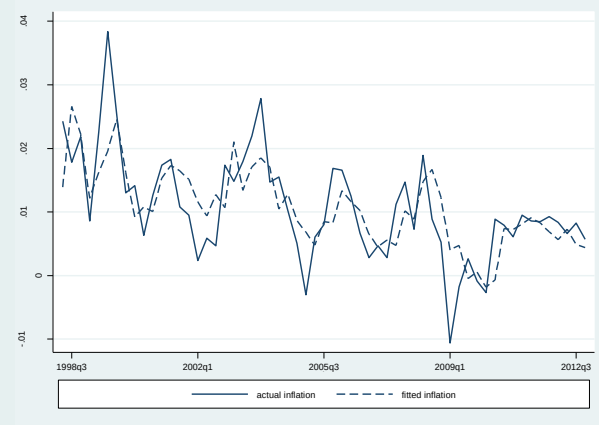
[20] In case of Slovakia we choose output gap instead of unemployment since unemployment was a subject to many revisions in Slovakia.

equilibrium is not very high for all countries. The adjustment speed is the fastest for the Czech Republic and Slovenia, less fast for Slovakia and Estonia and the slowest for Poland. In case of Hungary the adjustment coefficient in error correction estimation is negative, however, very low and insignificant. This confirms the difficulties regarding the estimation of long run relationship where not only the beginning period is problematic, but also the end of the estimation period is marked by government adjustment, global financial crisis, etc. which could distort the price modelling.

Overall, for Slovakia, Slovenia and Poland we observe significant influence of past price level changes. Change in nominal wages positively and significantly influence change in price level in almost all countries. Similarly the influence of productivity change is also significant. Unemployment as a factor with some influence on inflation is statistically significant only for the Czech Republic.

Chart 5 shows actual and modelled inflation for Slovakia. Estimated inflation is a good fit for actual inflation (R2 is 53%). Inflation is mostly determined by its persistence. Moreover, an increase of nominal wage positively influences a change of price level. On the other hand, a decrease in productivity would cause an increase in prices. An increase of output gap (positive output gap) would cause a price increase; however, the influence of output gap on prices is very low. Overall, short run deviations from long run equilibrium are due to inflation persistence. On the other hand, nominal wage and import prices influence inflation development only slightly in the short run. Even in the short run we can observe the significant influence of membership in Eurozone on inflation.

Chart 2 – Actual and estimated inflation for Slovakia



Source: Eurostat, own calculations.

For Slovenia and Estonia we have a good fit of our error correction estimate. Similarly to Slovakia, inflation in Slovenia is influenced by its persistence. In Slovenia we observe statistically significant influence of nominal wage change on inflation. In Estonia, change in productivity significantly influences the change of price level.

In case of inflation targeting countries the best fit of error correction estimate is for Poland. In the short run inflation is influence by its persistence. There is also a significant influence of a change in nominal wage and productivity on inflation. For the Czech Republic we observe significant influence of a change in productivity and unemployment on inflation. In Hungary a change in nominal wage can significantly distort inflation. However, for the Czech Republic and Hungary the estimated inflation does not fit actual inflation very well. In case of Hungary we have problems with determination of long run relationship as well. On the other hand, for the Czech Republic there was not such a problem. Nevertheless, our dynamic estimate could not properly capture the variability of Czech inflation rate.

6. CONCLUSION

We have used an error correction approach to estimate inflation rate for several new member of European Union. In this approach the estimation of meaningful long run relationship is crucial. We have followed methodology proposed by Broer et al. (2000) and adjust the relationship in which companies, unions and government have influence on development of prices through wage, productivity and unemployment adjustments.

Our long run estimates are good representation of data. Involvement of import prices proves to be a significant factor of long run influence on prices in small open economies. From the supply side we observe significant wage influence on price level in the long run. On the other hand from demand side the influence of productivity on prices is less profound than wage influence. Unemployment as an explanatory variable is significant only for the Czech Republic and Slovenia. In addition the membership in EMR II and EMU has an important influence on prices in the long run.

We are able to confirm positive unit elasticity between price and nominal wage for Slovakia, the Czech Republic and Hungary. Even though we could not confirm unit elasticity for Slovenia and Estonia, the coefficients for wages are very close to one therefore the unit restriction assumption is not incorrect. We were unable to confirm negative unit elasticity between prices and productivity. Central and Eastern Europe countries are specific for their turbulent development and structural reforms connected with their transformation and also global financial crisis could induce that it is not possible to confirm unit elasticity between variables.

The estimated inflation rate calculated by error correction estimation follow the actual inflation rate in Slovakia, Slovenia, Estonia and Poland. The relation between modelled equilibrium rate and its determinants varies across countries. In Slovakia, Slovenia and Poland we observe significant influence of past price level changes. Nominal wages positively and significantly influence price level in almost all countries, similarly, as a productivity change. Unemployment as a factor with some influence on inflation is statistically significant only for the Czech Republic.

The unification of monetary policy has led to more uniform inflation rates in euro area in the long run. The inflation rate in countries that joined EMU is less volatile. The integration to euro area and participation in ERM II has a decreasing influence on a price level in Slovakia, Slovenia and Estonia. However, in the short run inflation varies not only between inflation targeting countries and euro countries but also within EMU countries as well. Furthermore, supply side factors have major influence on inflation. All countries are sensitive to wage development in both long and short run. Policy makers should pay special attention to excessive wage development as it can significantly distort price development.

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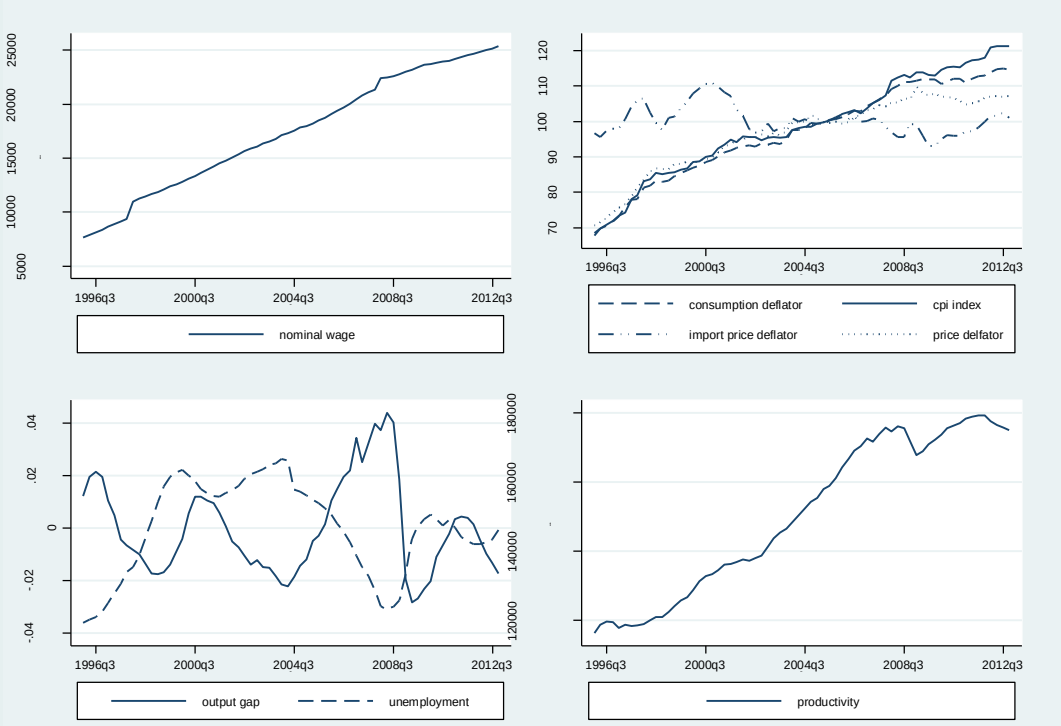
8. ATTACHMENTS

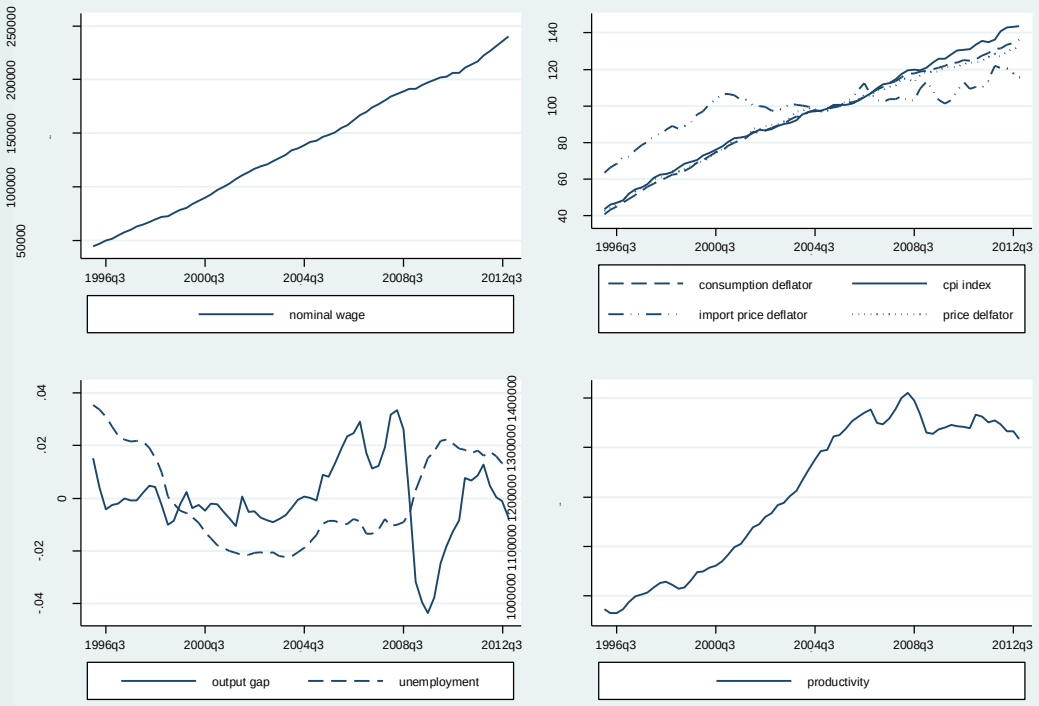
A – VARIABLES FOR OTHER COUNTRIES

Chart A.1 – Model variables for the Czech Republic



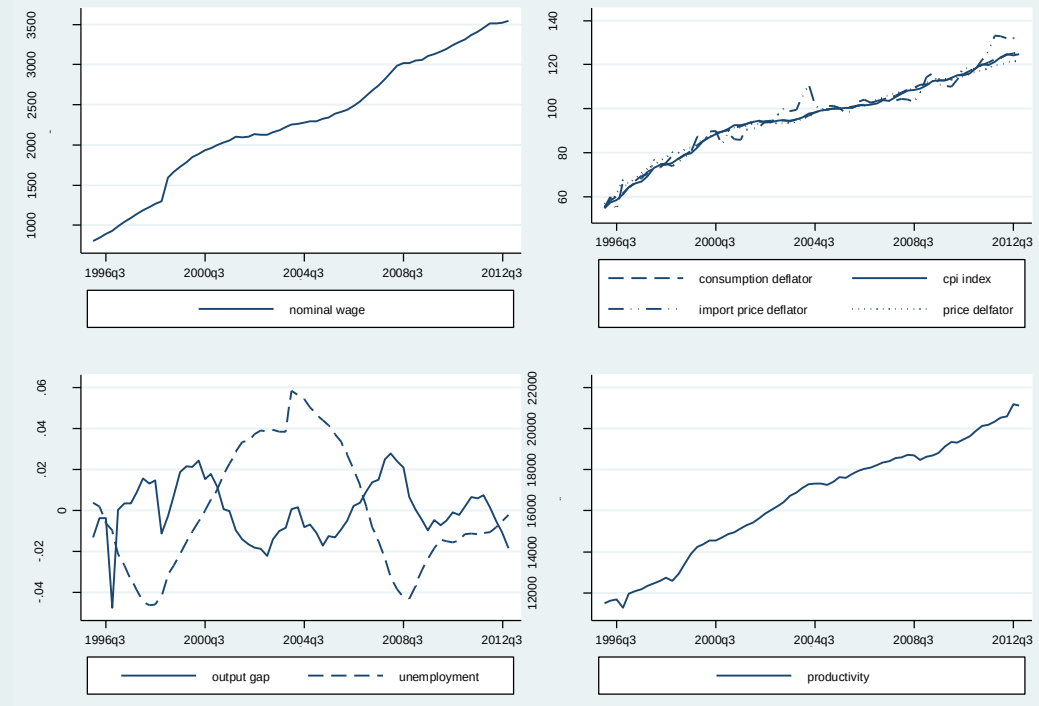
Source: Eurostat, OECD.

Chart A.2 – Model variables for Hungary



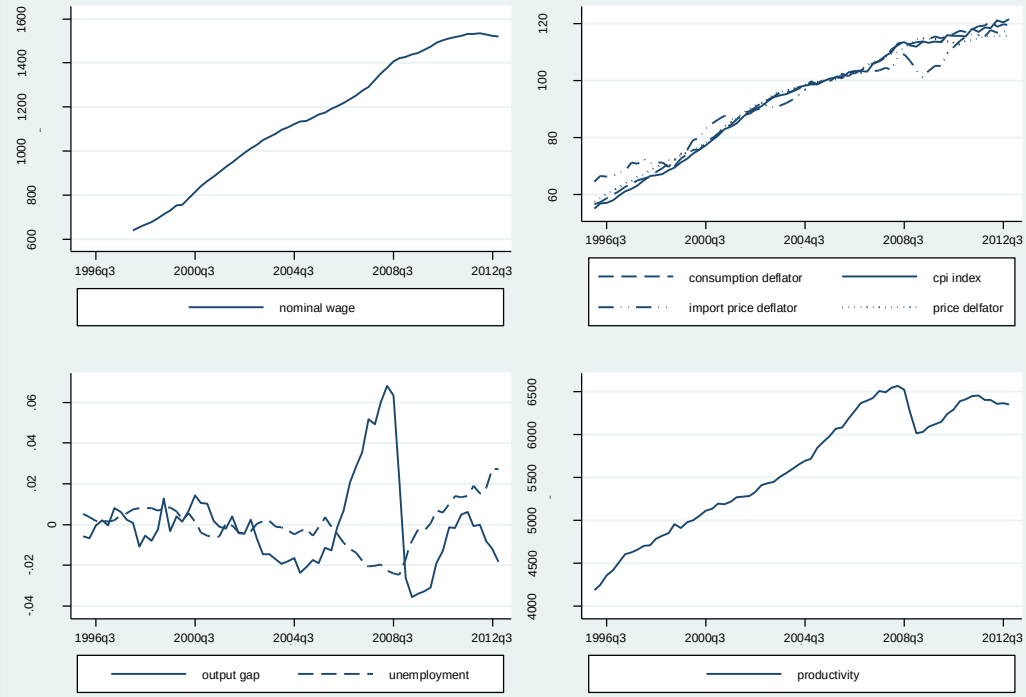
Source: Eurostat, OECD.

Chart A.3 – Model variables for Poland



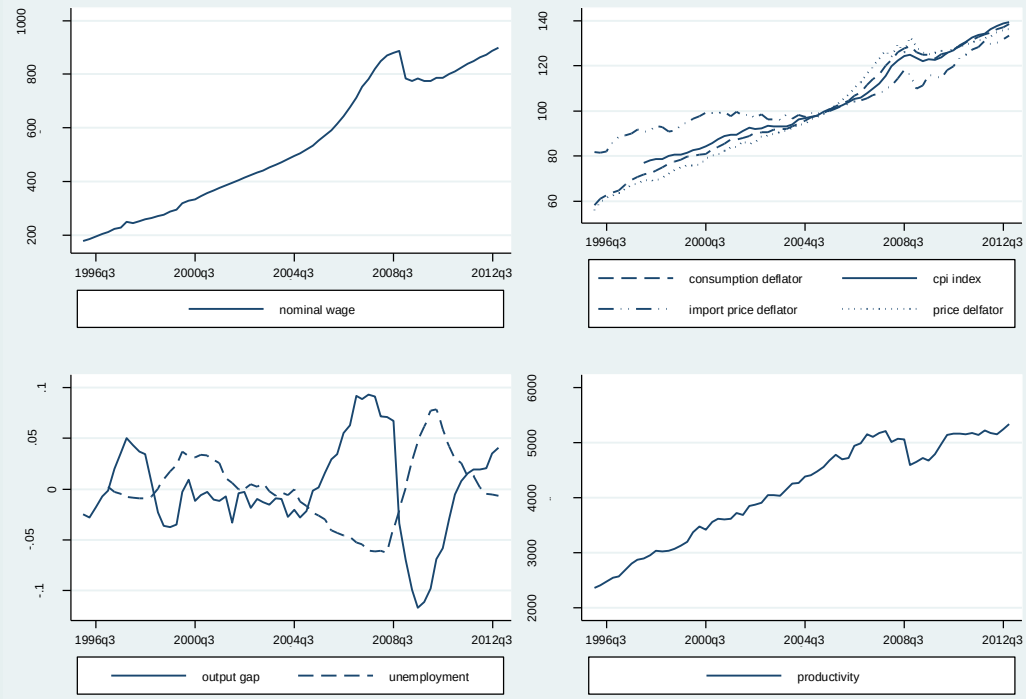
Source: Eurostat, OECD.

Chart A.4 – Model variables for Slovenia



Source: Eurostat, OECD.

Chart A.5 – Model variables for Estonia



Source: Eurostat, OECD.

B – UNIT ROOT TEST

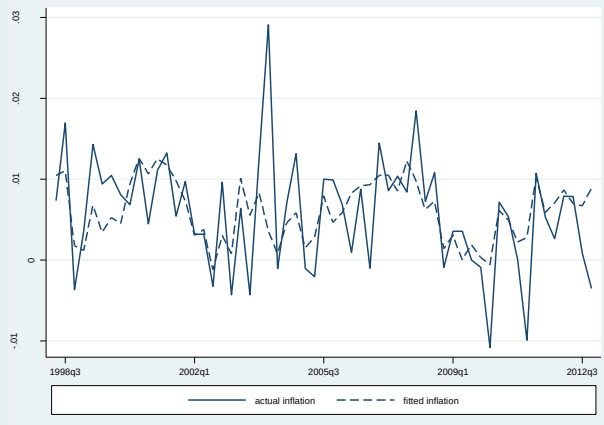
Table B.1 – Unit root tests

	ln pc	*ln w*	*ln h*	*ln pm*	*u*	*OG*
Level						
Slovakia	-1.58	1.59	-3.21	-1.91	-1.48	*-3.13*
Slovenia	-0.45	0.35	-1.24	-1.61	-0.68	*-2.97*
Estonia	-2.58	-0.58	-1.35	-1.41	*-3.31*	*-4.23*
Czech Republic	-2.53	*-4.91*	-0.26	-2.78	*-2.98*	*-2.96*
Hungary	-2.63	-1.58	-0.01	-2.59	-0.63	*-3.54*
Poland	-3.38	*-3.63*	-2.11	-3.26	-2.37	-2.88
First difference						
Slovakia	-4.87	-7.66	-9.31	-8.29	-3.80	-9.16
Slovenia	-10.09	-4.51	-5.03	-7.11	-5.74	-4.92
Estonia	*-3.32*	-6.19	-7.95	-8.28	-3.43	-5.23
Czech Republic	-8.55	-7.82	-4.85	-5.71	-3.13	-4.25
Hungary	-9.05	-2.94	-4.92	-5.40	-3.64	-4.42
Poland	-7.25	-6.41	-6.13	-6.88	-3.45	-6.27

We report the Augmented Dickey-Fuller test. The 5% critical value is -2.91 for a constant and 3.48 for a constant and trend.

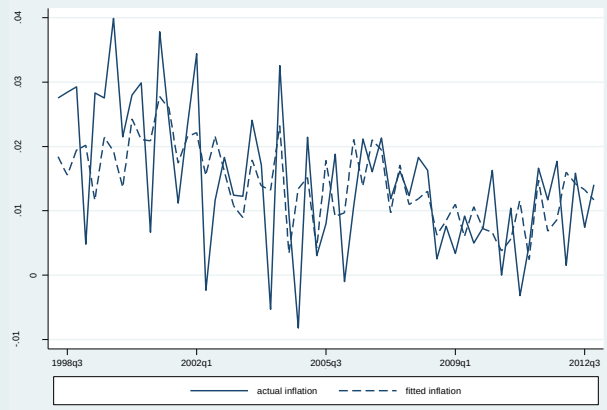
C – ACTUAL AND FITTED INFLATION

Chart C.1 – Actual and fitted inflation for the Czech Republic



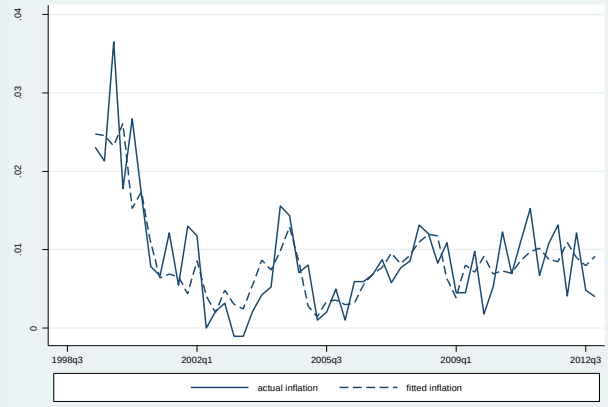
Source: Eurostat, own calculations.

Chart C.2 – Actual and fitted inflation for Hungary



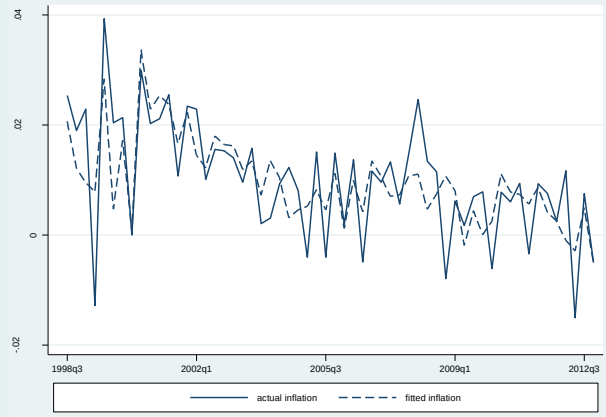
Source: Eurostat, own calculations.

Chart C.3 – Actual and fitted inflation for Poland



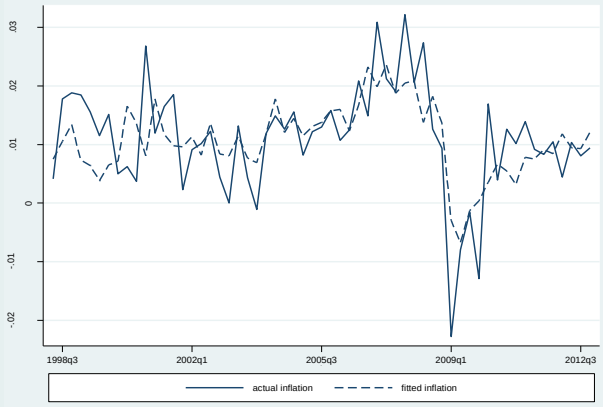
Source: Eurostat, own calculations.

Chart C.4 – Actual and fitted inflation for Slovenia



Source: Eurostat, own calculations.

Chart C.5 – Actual and fitted inflation for Estonia



Source: Eurostat, own calculations.