2008

Inflation Differentials in the European Union

Panel Data Analysis of the Driving Factors for Inflation Differentials in the New Member States

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21 May 2008

Abstrakt

V této diplomové práci se zabýváme analýzou inflačních diferenciálů v Evropské Unii, přičemž si vytyčujeme dva hlavní cíle. Prvním cílem je podat souhrnný přehled dlouhodobých trendů inflačních diferenciálů a jejich možných příčin, a to jak pro členy eurozóny, tak pro nové členské země Evropské Unie. Druhým cílem je vyhodnotit příčiny inflačních diferenciálů v nových členských zemích EU. Pro tento účel jsme použili metodologii ze studie Honohan a Lane (2003), která zkoumá vliv nominálního efektivního kurzu, pozice cyklu, fiskálních politik a cenové konvergence na inflační diferenciály v eurozóně. Naše výsledky naznačují, že tyto faktory jsou významné i pro nové členské země EU.

Abstract

In this diploma thesis, we analyse inflation differentials in the EU. The aim of the study is twofold. First, based mainly on literature review, we describe long-term trends and potential causes of inflation differentials in the euro area as well as in the new EU member states. Second, we investigate the driving factors for inflation differentials in the new EU member states. In particular, we use the methodology of the influential study by Honohan and Lane (2003) exploring the role of nominal effective exchange rate, cyclical conditions, fiscal policies and price convergence in inflation differentials across the euro area countries. Our results suggest that these factors are important determinants of inflation differentials in the new EU member states, too.

List of Abbreviations

Abbreviations of countries

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SK	Slovak Republic
SI	Slovenia
UK	United Kingdom
US	United States

Other abbreviations

B-S	Balassa-Samuelson
CNB	Czech National Bank
CPI	Consumer Price Index
EA12	Euro Area – 12 countries (AT, BE, DE, ES, FI, FR, GR, IE, IT, LU, NL, PT)

ECB	European Central Bank
EMU	Economic and monetary union
ERM II	Exchange rate mechanism II
EU	European Union
EU15	European Union – 15 countries (AT, BE, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, NL, PT, SE, UK)
EUROSTAT	Statistical Office of the European Community
FICS	Fiscal stance
GAP	Output gap
GDP	Gross domestic product
HICP	Harmonised Index of Consumer Prices
HP	Hodrick and Prescott filter
ID	Inflation differential
NEER	Nominal effective exchange rate
ΔNEER	Growth rate of nominal effective exchange rate
NMS	New Member States (BG, CY, CZ, EE, HU, LT, LV, MT, PL, RO, SI, SK)
P	Price level
QPM	Quarterly projection model

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1 Introduction

In a monetary union, inflation differentials (i.e. relative differences in inflation rates) play a pivotal role in determination of real interest and exchange rates and therefore belong to fundamental factors influencing competitiveness across the member countries. When the project for the European Monetary Union (EMU) was designed, the general expectation was that monetary unification would favour price convergence. Alongside the process of price convergence a significant narrowing of inflation dispersion from 1992 to 1999 took place in the current euro area countries. Nevertheless, it does not seem that the introduction of a single currency has further pushed towards price growth convergence. Starting with 1999 just after the euro was introduced the empirical evidence points to widening differences in inflation rates in the euro area. While there is no suggestion that a narrowing of inflation differentials should be a goal of the European Central Bank (ECB), persistently high inflation rates as observed in a number of the EU countries are a matter of concern. In general, primary objective of the ECB is maintaining price stability in the euro area as a whole. In other words, under such inflation targeting regime the ECB's policy does not track individual countries' needs. As a consequence, the common monetary policy may be too loose for some and too restrictive for others. Under limited flexibility of the European labour and product markets, a lack of significant centralised fiscal transfer mechanisms and decentralised responsibility for fiscal and other economic policies, asymmetries and persistences in the inflation differentials across countries could lead to unanticipated distributional effects and jeopardize economic growth.

After the EU enlargement in 2004 and 2007, 12 new countries became members of the EMU with derogation on the euro introduction. In our thesis, we denote this group as the new member states (NMS). In fact, the derogation means that sooner or later the NMS will accept the euro as their own currency. Generally, we anticipate that this process will cause further widening of inflation differentials in the EMU and therefore will represent a major challenge not only for the ECB's common monetary policy. While a vast number of studies were dedicated to analysis of inflation differentials and their sources in the original euro area countries (we denote them as the EA12 in this thesis), less work has been done with respect to inflation differentials and their driving forces in the NMS. Recently, however, much more attention both in academic and policy circles has been attracted to this topic. Indeed, inflation differentials in the NMS became a steering wheel also in this diploma thesis.

The aim of our study is twofold. First, based mainly on literature review, we describe long-term trends and potential causes of inflation differentials in the EA12 as well as in the NMS. Second,

we investigate the driving factors for inflation differentials in the NMS. In particular, we use the methodology of the influential study by Honohan and Lane (2003) investigating the role of nominal effective exchange rate, cyclical conditions, fiscal policies and price convergence in inflation differentials across the euro area countries.

The roadmap of the diploma thesis is the following. Section 2 provides empirical evidence on long-term trends in inflation diversity in the EU. Section 3 discusses potential causes of inflation differentials in the EMU distinguishing between transitory factors, permanent determinants and policy-induced factors. Furthermore, in section 3, we review a few selected econometric studies that investigate sources of inflation differentials in the stylized models. Section 4 presents our panel data analysis – a key part of our study. And finally, section 5 provides concluding remarks.

2 Trends in inflation diversity in the EU

In order to motivate our further investigation, we firstly present evidence on the statistical features of observed dispersion in headline inflation rates in the EU. We start this section by brief assessment of long-term trends in inflation dispersion within the EA12. The purpose of this action is offer to reader a broader picture of empirical evidence and the ability to evaluate the current situation relative to historical standards. Afterwards, we present updated figures addressing the distribution of inflation over the last decade again in the EA12 but this time also in the NMS which will be in the centre of our econometric modelling later in this study.

2.1 Long-term trends in inflation dispersion

In this section, we comment on the long term development of inflation dispersion within the EMU. To get a proper idea about the relative magnitude of the dispersion many authors utilize the direct comparison with the US data or with the data from selected regions of EMU.[1] The analyses of inflation dispersion can be investigated by various instruments. Probably the most common measures for evaluation are standard deviation, coefficient of variation of inflation rates or inflation differentials towards the average inflation rate of the selected area given in percentage points.[2]

For illustration of the main trends, we firstly present figures of unweighted standard deviation and unweighted coefficient of variation as retrieved from study of ECB (2003). Figure 1 shows those measures for 12 prospective euro area countries in comparison to the 14 Metropolitan Statistical Areas (MSAs) of the United States since 1990 until 2002. Figure 2 puts into contrast aforementioned indicators for the EA12, Germany, Spain and Italy over the period 1994-2002.

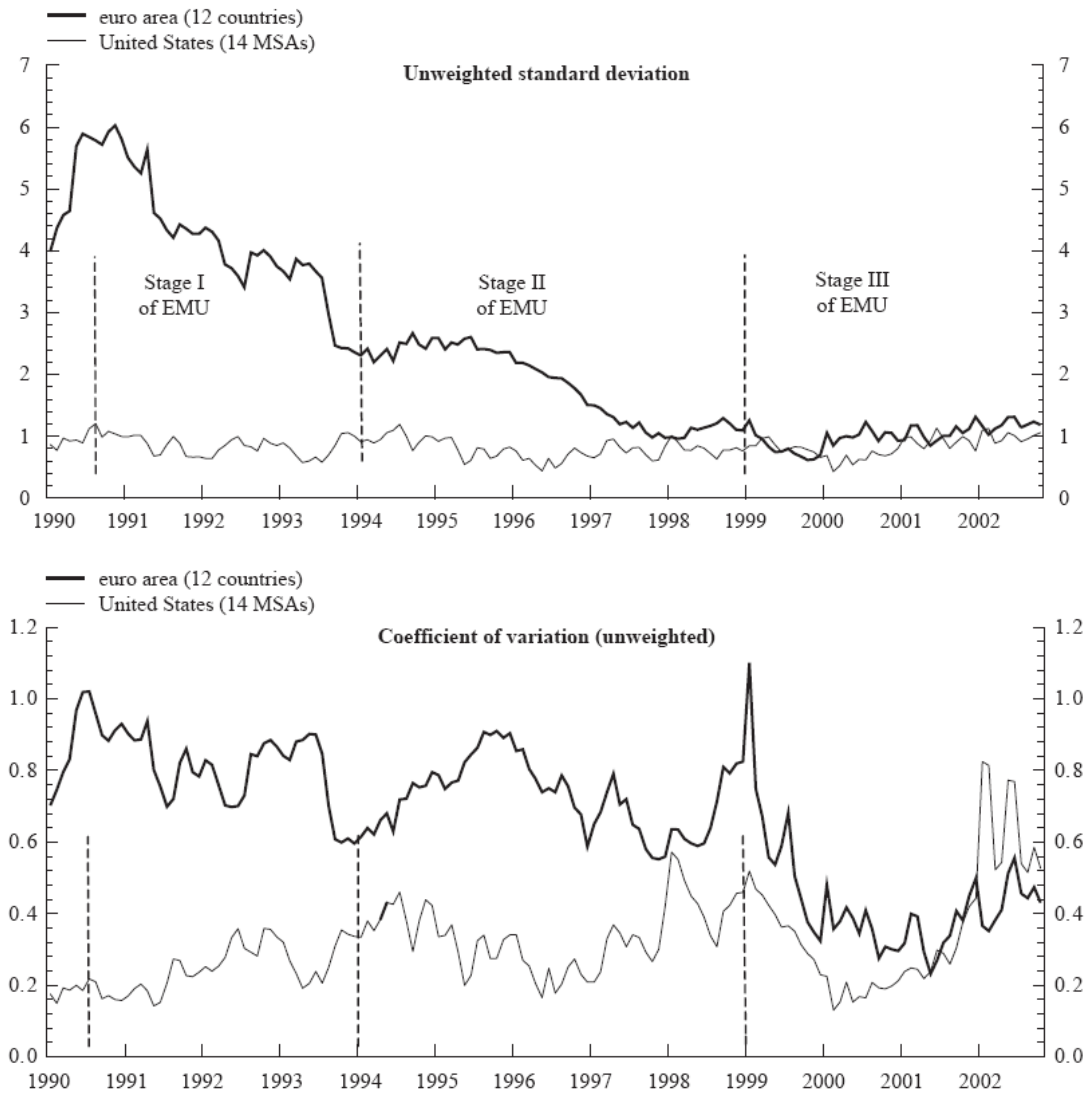
As shown in both following figures, inflation differentials among the prospective euro area countries measured by the unweighted standard deviation have declined steadily in the run-up to the third stage of EMU. The standard deviation dropped from a level of above 5 percentage points in 1990 to a bottom of below 1 percentage point in 1999. Since then, the standard deviation rose by about half percentage point and later fluctuated around this level.

[1] See for example ECB (2003), Angeloni and Ehrmann (2004), Hofmann and Remsperger (2004), Duarte *et al.* (2005).

[2] Readers interested in more details of measurement techniques should refer for example to ECB (2003).

For assessing the magnitude of inflation dispersion a good number of studies[3] draw a comparison either between the dataset of the euro area and the US or between the EA12 and regions of individual member countries. As shown in Figure 1, the US has historically a much lower degree of dispersion until around 1997. Since then, the degree of dispersion in the EA12 seems to be at similar level as observed within the US. The picture is broadly alike when comparing this indicator for the EA12 and regions of Germany, Spain and Italy. The dispersion of inflation in those countries has been much lower for the whole investigated period and has oscillated only around 0.5 percentage point.

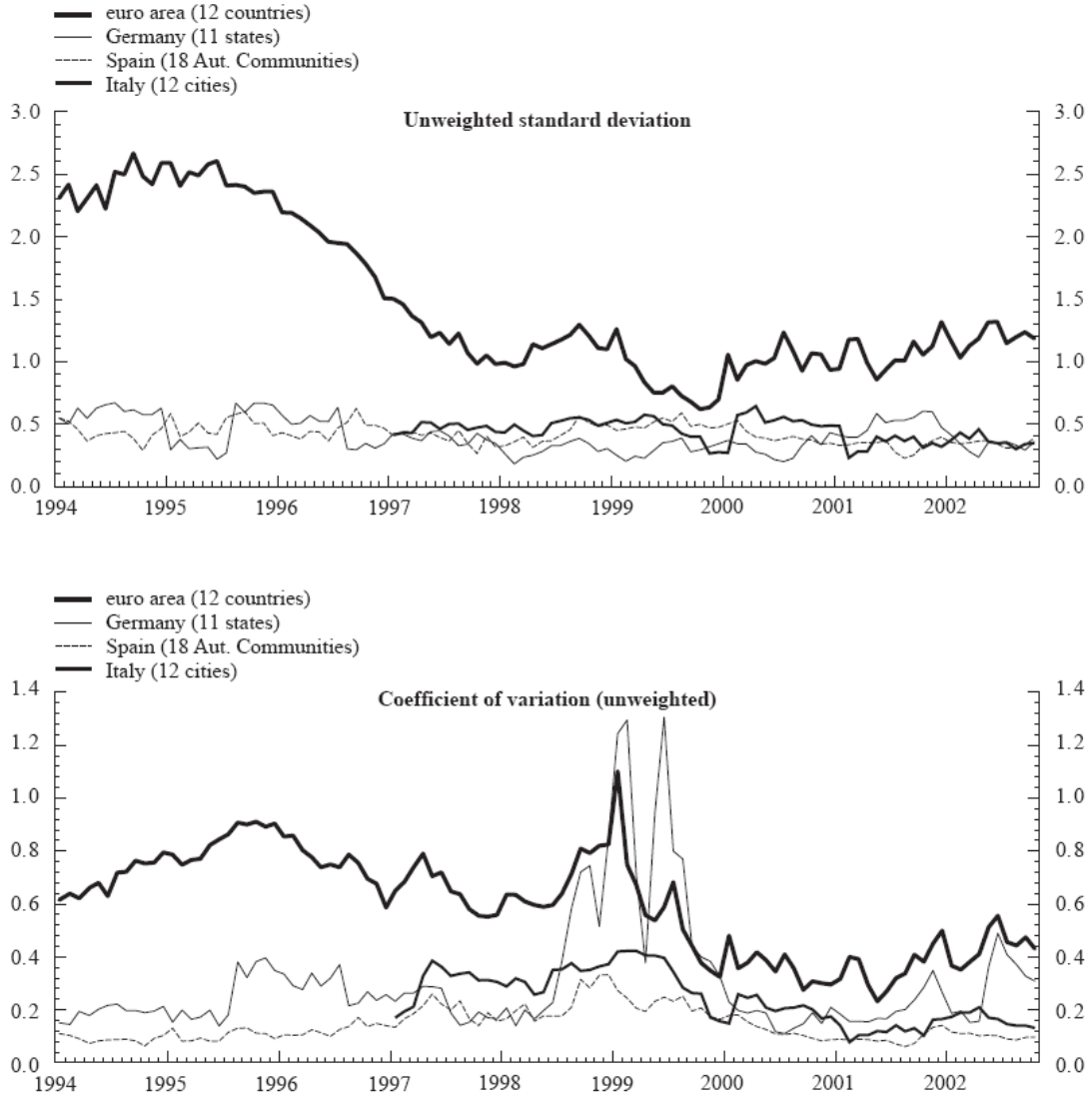
Figure 1: Inflation dispersion in the EA12 and the US, 1990-2002



Source: ECB (2003).

[3] See for example ECB (2003), Angeloni and Ehrmann (2004), Hofmann and Remsperger (2004).

Figure 2: Inflation dispersion in the EA12, Germany, Spain and Italy, 1994-2002



Source: ECB (2003).

The empirical evidence concerning the coefficient of variation (i.e. the standard deviation divided by the mean) shows a different profile as the decline in the standard deviation is adjusted by the fall in average inflation. As judged by this measure, ECB (2003) reports that the dispersion of the EA12 inflation fluctuated around a roughly constant value over the most of the 1990s, however, at higher levels than in the US and Germany, Spain and Italy. Only after the inception of stage three of EMU this indicator has dropped to somewhat smaller value and become comparable to the coefficient of variation in other investigated areas.

From Table 1, Duarte *et al.* (2005) infer three aspects that are worth mentioning when comparing the pre-euro area period (1973-1998) with the period after introduction of third stage of EMU (1999-2004). Firstly, as other authors, they draw our attention to a sharp reduction of the rate of inflation of every participant country. Secondly, they deduce that except for Greece the

correlations with the EA12 averages declined as if the rate of inflation in each country has started to behave more independently within the euro area. Thirdly, while the mean rate of inflation dropped, the coefficients of variation increased with the exception of Ireland, Italy, the Netherlands and Portugal. In this respect, they ask a question of whether the rate of inflation in EA12 countries has been showing signs of significant persistence or not and whether the introduction of euro has promoted the contraction of inflation differentials or not.

Table 1: Inflation in the EA12 – Summary statistics, 1973-2004

Country	1973-2004			1973-1998			1999-2004		
	Mean	CV	R	Mean	CV	R	Mean	CV	R
Austria	3.50 (3.3)	94.28	0.61*	3.85 (3.39)	88.05	0.59*	1.81 (2.19)	121.00	0.41*
Belgium	4.14 (4.16)	100.48	0.73*	4.59 (4.28)	93.25	0.71*	1.99 (2.57)	129.15	0.69*
Finland	5.62 (5.82)	103.56	0.71*	6.45 (5.94)	92.38	0.68*	1.55	172.90	0.50*
France	5.20 (4.68)	90.00	0.81*	5.90 (4.74)	80.61	0.80*	1.76 (2.27)	128.98	0.48*
Germany	2.92 (3.02)	103.42	0.50*	3.22 (3.09)	96.57	0.47*	1.44 (2.13)	147.92	0.41*
Greece	12.72 (10.88)	85.53	0.38*	14.70 (10.81)	74.22	0.27*	3.22 (3.09)	95.96	0.43*
Ireland	6.99 (8.31)	118.88	0.66*	7.66 (8.90)	116.64	0.66*	3.82 (2.85)	74.61	0.45*
Italy	8.08 (6.64)	82.18	0.74*	9.25 (6.72)	72.99	0.71*	2.44 (1.06)	43.44	0.23
Luxemburg	3.99 (4.24)	106.26	0.66*	4.33 (4.30)	102.81	0.69*	2.35 (3.58)	152.34	0.32*
Netherlands	3.53 (3.47)	98.30	0.65*	3.72 (3.65)	98.11	0.69*	2.61 (2.23)	85.44	0.23
Portugal	11.81 (15.99)	135.39	0.36*	13.60 (16.98)	125.31	0.30*	3.09 (2.24)	72.49	0.13
Spain	8.34 (7.45)	89.33	0.62*	9.41 (7.64)	81.28	0.58*	3.13 (2.95)	94.28	0.14
EU12	**5.14 (3.33)**	**64.78**		**5.85 (3.27)**	**55.89**		**1.87 (0.49)**	**26.20**	

Note: The numbers in parenthesis are standard deviations. *CV = (St Dev / Mean) * 100*, is Pearson's coefficient of variation, and *R* is the correlation coefficient between the rate of inflation in country *i* and the EA12 average inflation rate. An asterisk (*) indicates significance at the 5 percentage level. To avoid a potential upward bias, authors computed each correlation coefficient excluding the corresponding country *i* from the EA12 average rate of inflation.
Source: Duarte *et al.* (2005).

In their paper, Duarte *et al.* (2005) conclude that in the long run, for most of the EA12 countries, domestic prices were cointegrated with the union-wide price level, and in the short run inflation rates moved to adjust price level divergences. In addition, they emphasize that the divergences in the evolution of the price level across countries increased after the introduction of the single

currency in the EMU. As a potential reason, Duarte *et al.* (2005) accentuate the loss of monetary independence of individual states that became bound by common monetary policy of the ECB, and in consequence, they could no longer react to country-specific shocks at national central bank level.

Now, let us turn to the third indicator of inflation dispersion, more specifically to the inflation differential measured as the difference of individual country's inflation rate and the average inflation rate of the selected area given in percentage points. Table 2 shows such a dataset for the EA12 in period of 1990-2002 and presents also results for three consecutive periods: 1990-1993, 1994-1998, and 1999-2002. As can be seen in Table 2, Greece, Italy, Portugal and Spain have had relatively large and persistent, although declining, positive inflation differentials since 1990. In contrast, Austria, Belgium, France and Germany have experienced persistently negative inflation differentials of around 0.5 percentage point over the same period. For completeness, Finland, Ireland, Luxemburg and Netherlands have fluctuated around the average, with Ireland and Netherlands having the widest amplitude of its inflation differential. Readers interested in more details should refer to ECB (2003).

Table 2: Inflation differentials across the EA12 countries relative to the EA12 average

	1990-2002	1990-1993	1994-1998	1999-2002
Austria	-0.5	-0.8	-0.4	-0.4
Belgium	-0.5	-1.1	-0.4	-0.1
Finland	-0.1	0.3	-0.9	0.2
France	-0.7	-1.1	-0.5	-0.5
Germany	-0.6	-0.6	-0.6	-0.6
Greece	6.5	12.9	5.4	1.1
Ireland	0.3	-1.6	0.3	2.1
Italy	1.1	1.6	1.5	0.3
Luxemburg	-0.3	-0.6	-0.6	0.3
Netherlands	-0.1	-1.4	-0.3	1.3
Portugal	2.8	6.0	1.2	1.2
Spain	1.5	1.9	1.3	1.2

Note: Annual averages in percentage points.
Source: ECB (2003).

Utilizing again the comparison of the EU with the US data, ECB (2003) assesses the size of the currently observed inflation differentials across euro area countries as not notably different from those seen in the US, however, it appraises the differentials as relatively more persistent.

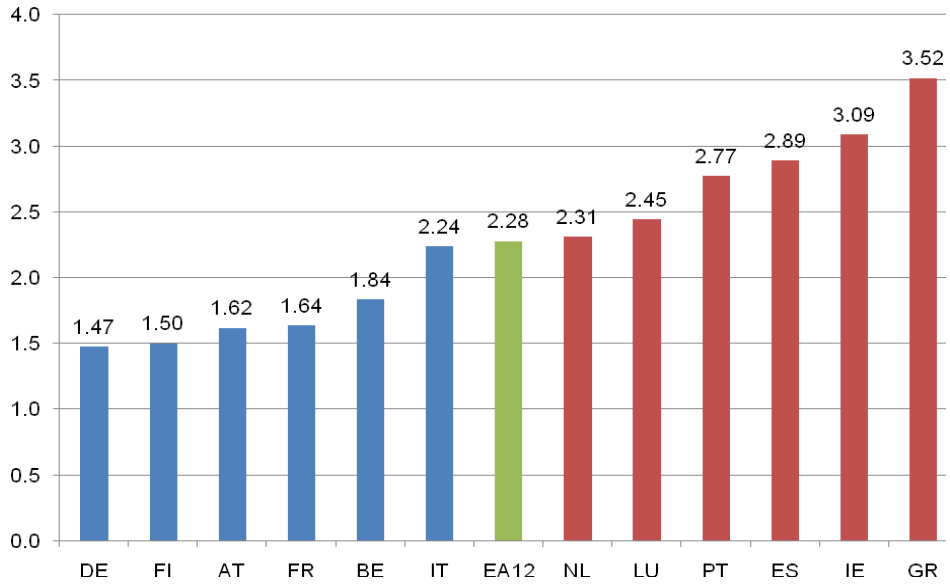
2.2 Distribution of inflation over the last decade

In this section, we bring out results of our own calculations that track the development of the inflation and inflation differentials in the last decade not only in the EA12 but also in the NMS.[4] Our first aim is to compare updated figures for the EA12 with those presented in the previous section. Secondly, we are interested in direct comparison of figures of the EA12 and the NMS that became members of EMU with derogation on euro introduction. Such an analysis might be useful especially in respect to evaluation of current position of the NMS within the EU and their prospects to euro adoption that will be highly sensitive *inter alia* on the magnitude of price level changes.[5]

2.2.1 Inflation characteristics in the EA12

Over the period 1997-2007, inflation rate in the EA12 reached unweighted average of 2.28 percentage points. As Figure 3 shows, there were six countries below and six countries above this level. On average, the lowest inflation rates were observed in Germany and Finland (1.47 and 1.50 percentage points respectively) and the highest in Ireland and Greece (3.09 and 3.52 percentage points respectively).

Figure 3: Average annual inflation rates in the EA12 countries, 1997-2007



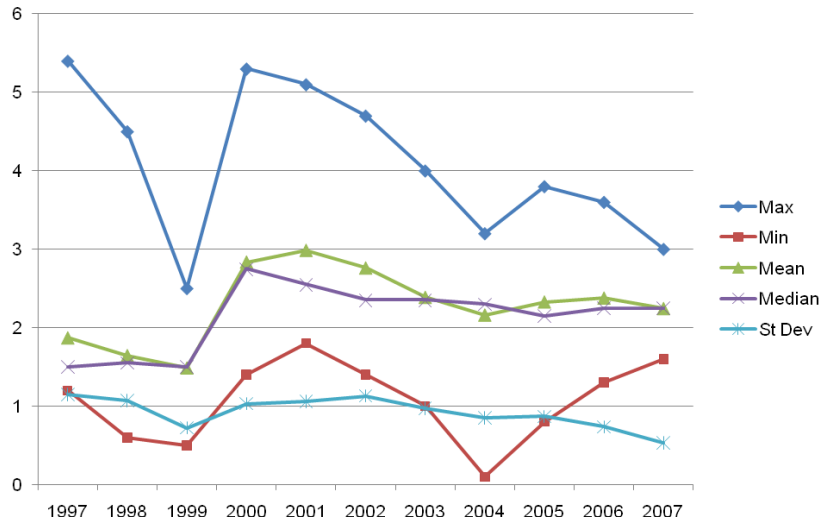
Note: The figure displays national averages of annual HICP inflation rates over the period 1997-2007; in percentage points.
Source: Author's calculations based on *EUROSTAT* data.

[4] Calculations were based on data retrieved from EUROSTAT database.

[5] Price stability is one of four Maastricht criteria that create necessary conditions for euro adoption. The next three criteria are sustainability of government finance, exchange rate stability and durability of convergence (CNB, 2003).

Development of the distribution of the EA12 inflation rates over time is depicted in Figure 4. Here, one interesting phenomenon can be pointed out. Specifically, we talk about the mean of the EU12 inflation that increased suddenly after the launch of third stage of EMU while before it experienced rather declining trend. However, average inflation rate has later declined back to the level close to 2 percentage points.

Figure 4: Distribution of the EA12 inflation rates



Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); in percentage points; period 1997-2007; euro zone (EA12) = AT, BE, DE, ES, FI, FR, GR, IE, IT, LU, NL, PT.
Source: Author's calculations based on *EUROSTAT* data.

Table 3 summarizes average inflation differentials in the EA12 over the period 1997-2007. More or less, we observe that our results display similar patterns as were characteristic in the past.[6]

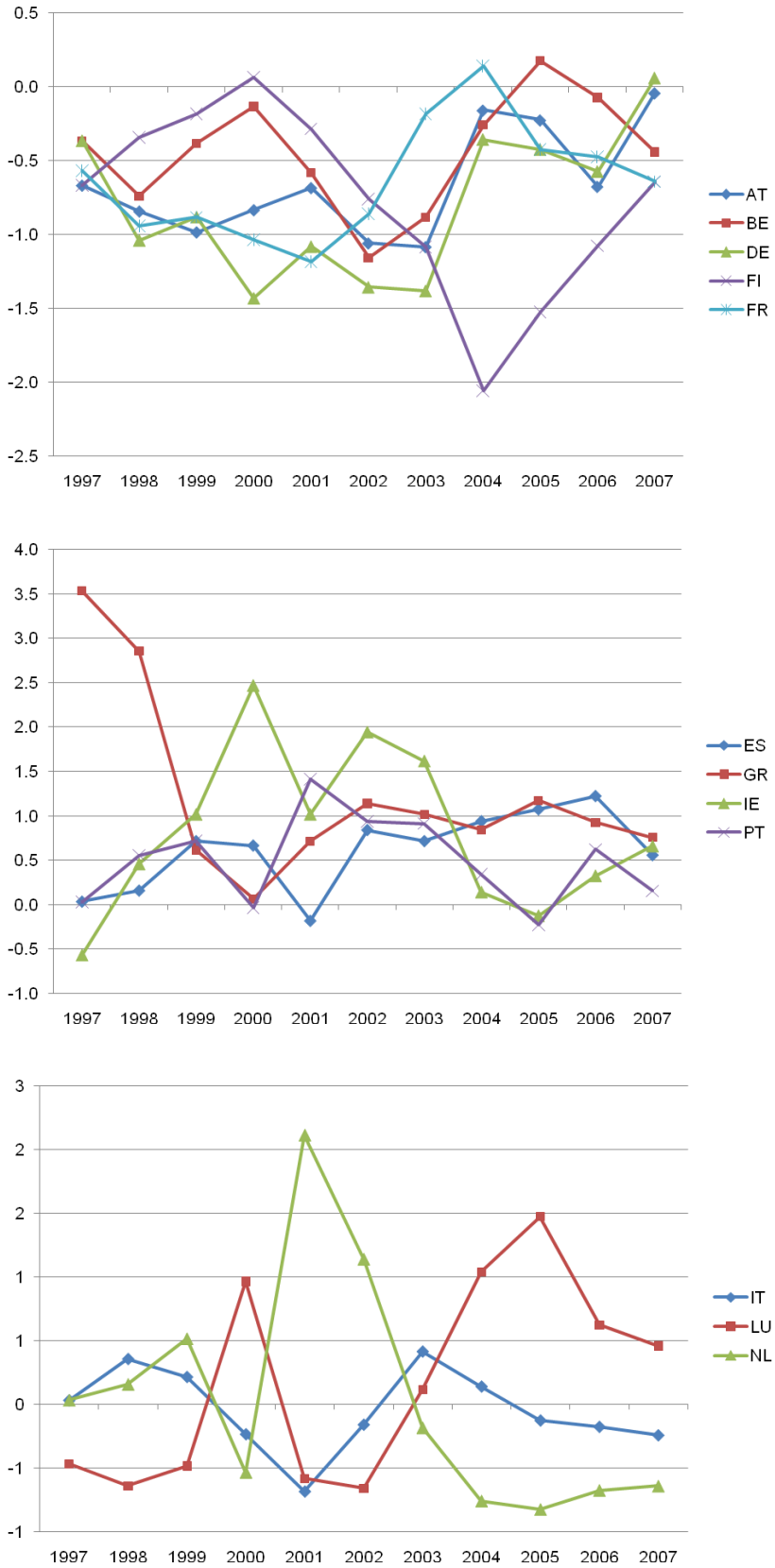
Table 3: Inflation differentials in the EA12 countries relative to the EA12 average, 1997-2007

Country	Code	ID	Country	Code	ID
Austria	AT	-0.66	Ireland	IE	0.81
Belgium	BE	-0.44	Italy	IT	-0.04
Finland	FI	-0.78	Luxembourg	LU	0.17
France	FR	-0.64	Netherlands	NL	0.03
Germany	DE	-0.80	Portugal	PT	0.50
Greece	GR	1.24	Spain	ES	0.61

Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); unweighted average of annual inflation differentials in period 1997 – 2007; in percentage points.
Source: Author's calculations based on *EUROSTAT* data.

[6] See Section 2.1.

Figure 5: Inflation differentials in the EA12, 1997-2007



Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); in percentage points; period 1997 – 2007; euro zone (ea12) = AT, BE, DE, ES, FI, FR, GR, IE, IT, LU, NL, PT.
Source: Author's calculations based on *EUROSTAT* data.

Closer look at evolution of inflation differentials in the course of the last decade is offered in Figure 5. For the purpose of transparency, we decided to separate investigated group of countries into three subgroups. In the first diagram, we present figures of countries that have experienced negative inflation differential for most of the period (i.e. Austria, Belgium, Finland, France and Germany). On the contrary, second diagram shows figures of countries with rather positive inflation differential (i.e. Greece, Ireland, Portugal and Spain). There are only three countries left that have reached negative as well as positive deviations without any obvious persistency in their figures (i.e. Italy, Luxembourg and the Netherlands).

Summing up, it can be argued that there has been a relatively large and persistent inflation gap between countries which mostly have been below the euro area average and countries which mostly have been above the average over the last eleven years. Our findings about the persistence of inflation differentials in the EA12 confirm conclusions of other authors researching in this field. The maintenance of relatively sizeable and lasting inflation differentials seems to be a specific feature of the inflation diversity within the EA12.[7]

2.2.2 Inflation characteristics in the NMS

Over the period 1997-2007, inflation rate in the NMS reached unweighted average of 7.73 percentage points. This result can be, however, considered as biased upwards due to contribution of extremely high inflation rate in Romania. If we omit Romania, we will get an average of 5.02 percentage points. As Figure 6 shows, there were six countries below and six countries above the level of the NMS11. On average, the lowest inflation rates were observed in Malta and Cyprus (2.58 and 2.61 percentage points respectively) and the highest in Hungary and Romania (8.54 and 35.01[8] percentage points respectively). If we compare these results from the NMS to those of the EA12, we will find one obvious fact: in the given period, average annual HICP inflation rate was in each of the NMS above the mean of the EA12 inflation rate.

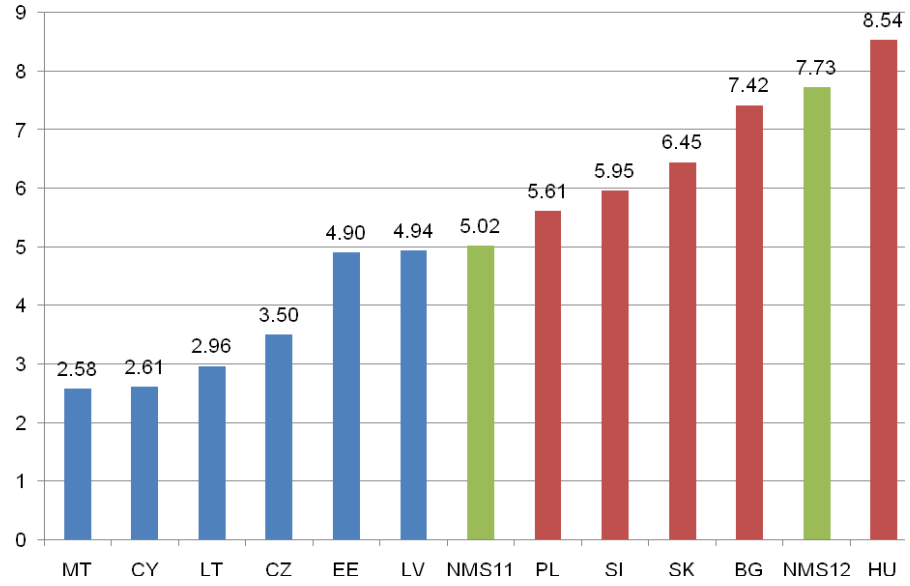
Detailed information about the distribution of inflation rates in the NMS is illustrated in Figure 7 and Figure 8. Figure 7 shows summary statistics for all twelve countries and indicates the steady fall in inflation rates since 1997. The picture, however, suffers from the problem of low differentiation and therefore we are not able to distinguish important details. Therefore, we decided to omit Romania from the sample and in this way present more comprehensible view as

[7] See for expamle ECB (2003), Angeloni and Ehrmann (2004), Hofmann and Remsperger (2004).

[8] Due to the abnormally high level of average inflation rate that was observed in Romania, we decided to exclude such an observation from Figure 6.

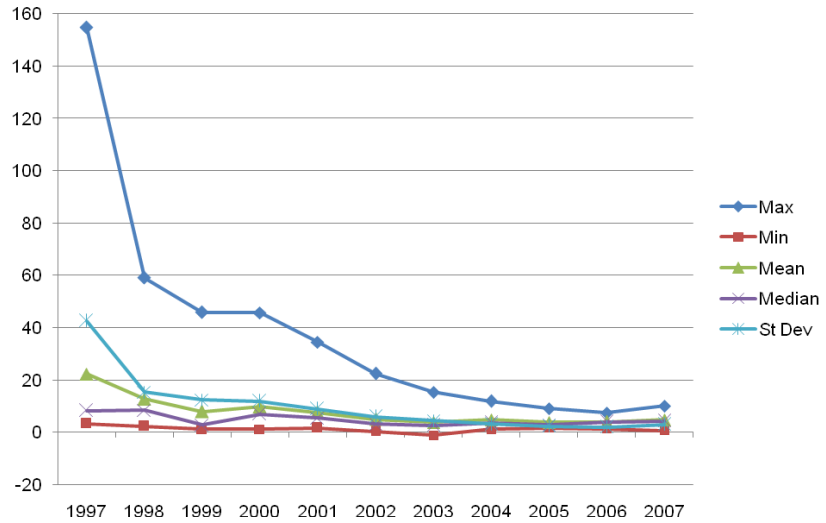
shown in Figure 8. Here, we can see that the inflation rate has declined from average of almost 10 percent in 1997 to below 5 percent in 2007 while the lowest level of 2.8 percent was observed in 2003. In addition, the unweighted standard deviation has dropped from about 5 percent to approximately 2.5 percent in respective period which is, nevertheless, well above the EA12 standards.

Figure 6: Average annual inflation rates in the NMS, 1997-2007



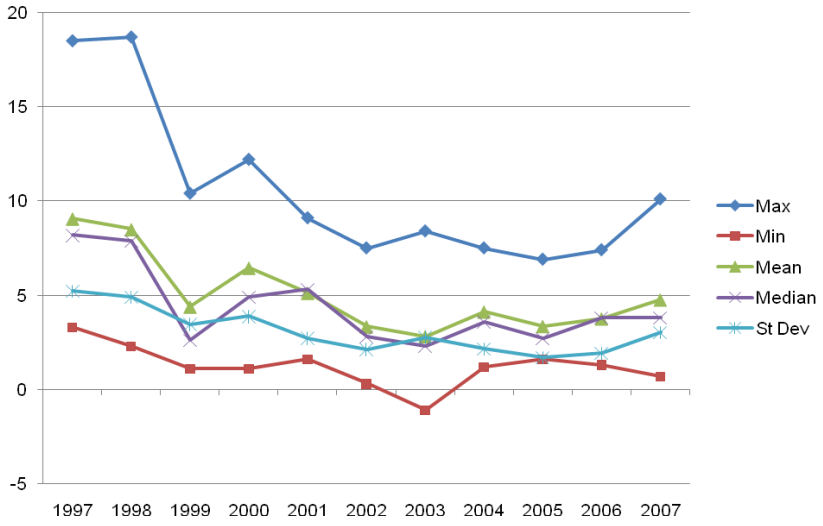
Note: The figure displays national averages of annual HICP inflation rates over the period 1997-2007; in percentage points; green bars stand for the group average – first green bar put together data from all the NMS but Romania, second green bar include data from the whole sample of the NMS.
Source: Author's calculations based on *EUROSTAT* data.

Figure 7: Distribution of the NMS inflation rates (Romania included)



Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); in percentage points; period 1997 – 2007; summary of data from the NMS (BG, CY, CZ, EE, HU, LT, LV, MT, PL, RO, SI, SK).
Source: Author's calculations based on *EUROSTAT* data.

Figure 8: Distribution of the NMS inflation rates (Romania excluded)



Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); in percentage points; period 1997 – 2007; summary of data from NMS but without Romania.
Source: Author's calculations based on *EUROSTAT* data.

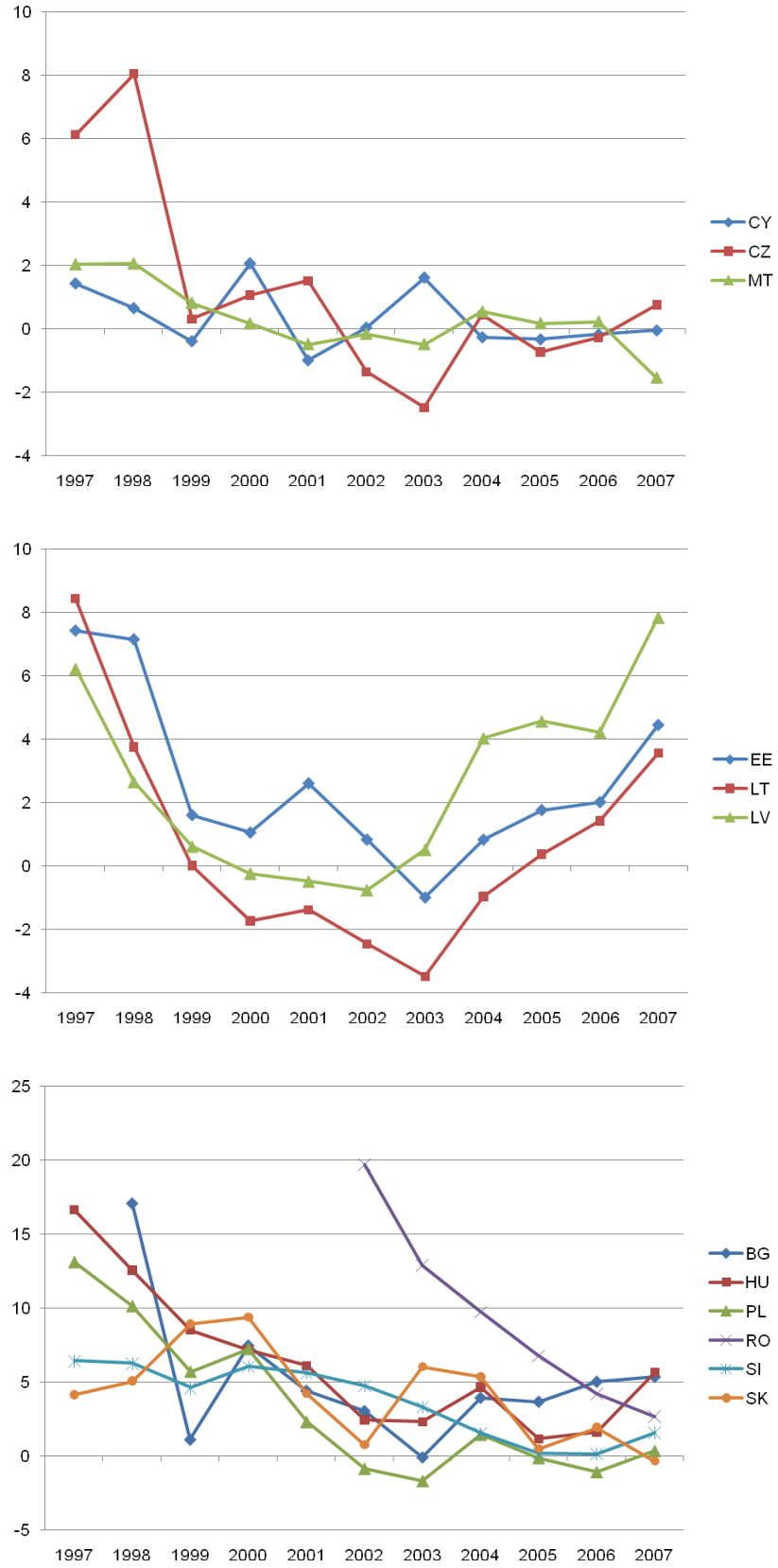
Table 4 summarizes average inflation differentials in each of the NMS relative to the EA12 over the period 1997-2007. Overall, it reached average of 5.45 percentage points. Figure 9 brings information about the evolution of inflation differentials in individual countries in the course of the last decade. In the first diagram, we put together countries that have experienced relatively stable inflation differentials which have fluctuated around the EA12 mean for most of the time (i.e. Cyprus, the Czech Republic and Malta). The U-shaped figures are characteristic for development of inflation differentials in the Baltic countries whose inflation rates have gone through the massive decline until 2003 but later have surged up again. The third group (i.e. Bulgaria, Hungary, Poland, Romania, Slovakia and Slovenia) can be labelled as group of high inflation countries that have, however, underwent relatively successful process of disinflation.

Table 4: Inflation differentials in the NMS relative to the EA12 average, 1997-2007

Country	Code	ID	Country	Code	ID
Bulgaria	BG	5.44	Lithuania	LT	1.01
Cyprus	CY	0.65	Malta	MT	0.63
Czech Rep.	CZ	1.55	Poland	PL	3.65
Estonia	ES	2.95	Romania	RO	35.34
Hungary	HU	6.58	Slovak Rep.	SK	4.49
Latvia	LV	2.98	Slovenia	SI	4.00

Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); unweighted average of annual inflation differentials in period 1997 – 2007; in percentage points.
Source: Author's calculations based on *EUROSTAT* data.

Figure 9: Inflation differentials in NMS relative to EA12



Note: Inflation rate is based on Harmonized Index of Consumer Prices (y-o-y growth rate, annual data); in percentage points; period 1997 – 2007; NMS = BG, CY, CZ, EE, HU, LT, LV, MT, PL, RO, SI, SK.
Source: Author's calculations based on *EUROSTAT* data.

3 Causes of inflation differentials in the EU

In the previous chapter, we indicated that inflation differentials in the EU are relatively profound and rather long-lasting phenomenon. Even though, they have showed a declining trend especially in the run-up to the third stage of EMU and have become comparable to the US levels, the persistency has remained still their apparent characteristic in Europe. While the measurement of inflation differentials is more or less straightforward, accurate identification of their driving factors resembles a fiendish puzzle. On the one hand, a vast number of empirical studies focus its attention to determination of various potential causes of inflation differentials via the simple correlations between the respective variables or via graphical means. On the other hand, many researchers employ more advanced econometric techniques and build the stylized models that investigate the relative contribution of each of explanatory factors. We believe that the first approach may be useful especially for primary identification of explanatory variables that later enters the more advanced econometric modelling. In this section, we firstly present causes of inflation differentials that are frequently stated in the literature. And secondly, for illustration, we briefly summarize findings of a few selected papers that are built on econometric modelling.

3.1 Underlying determinants of inflation differentials

There exist many studies[9] that aim to identify causes of inflation differentials. Indeed, the specification of them is not an easy task. For example, we can find following differentiation: internal versus external factors; structural, cyclical and other reasons; determinants with different time horizon of the effectiveness; overall and sectoral view; etc. In reality, one category often influence the other and many interlinks exist. We have chosen the following segmentation: Firstly, we discuss factors with potentially transitory effects that are mainly related to convergence processes. Secondly, we identify determinants that can be considered rather long-lasting. And finally, we focus on policy-induced factors. This prime structure is basically taken over from the speech by González-Páramo (2005). However, we recognize information from the other related literature as well.

3.1.1 Transitory factors related to convergence process

Here, let us start with the convergence hypothesis. Despite broadly acknowledged view that inflation entails costs that reduce the economy's growth capacity, according to Alberola (2000),

[9] See for example ECB (1999), Alberola (2000), Duarte (2003), ECB (2003), Honohan and Lane (2003), Angeloni and Ehrmann (2004), Égert (2004), Hofmann and Remsperger (2004), MacDonald and Wojcik (2004), Rogers (2002), Von Hagen and Hofmann (2003).

there are theoretical arguments with a degree of empirical evidence that, in a monetary union, greater growth can give rise to positive inflation differentials and these may be considered as inherent to convergence and integration processes. In the EU this catching-up development in income and price levels was confirmed, among others, by Vojinović and Oplotnik (2008) who present the analysis of unconditional β and σ convergence among the European countries in the second half of the 1990s and the 2000s.[10]

3.1.1.1 Real versus nominal convergence

When talking about the catching-up processes, we should be aware of two types of convergence. In particular, we distinguish real and nominal one. There are several definitions of both of them. For our purposes, we specify real convergence as the process of catching-up in terms of GDP per capita and nominal convergence as convergence in relative price levels.[11] It is widely recognised that with convergence in productivities and GDP levels, less developed countries are likely to experience convergence in their price levels as well. According to Čihák and Holub (2005), this is equivalent to a real appreciation of their currencies, which can go either through an inflation differential or nominal exchange rate appreciation. In this respect, we deduce that countries that are already members of the euro area has got irrevocably fixed their exchange rates and therefore can experience the catching-up process exclusively through inflation differential. On the other hand, countries still waiting for the euro adoption may spread the real appreciation into both aforementioned channels. Figure 10 demonstrates that the price level as well as GDP per capita in PPS of transition economies and less developed old EU countries are well below those observed in core euro area countries. From all said above, we indicate this state as a potential stimulus for emergence of inflation differentials in the EU. To make a broad picture of how long time those convergences could possibly take, follow the green dots in Figure 10 representing the predicted trajectory of the Czech GDP per capita in PPS and the Czech price level of consumption over the period 1995-2016.[12]

Summing up, the widely shared belief that the EU NMS will have to undertake a price level convergence process is based on an empirical observation that price level in less advanced

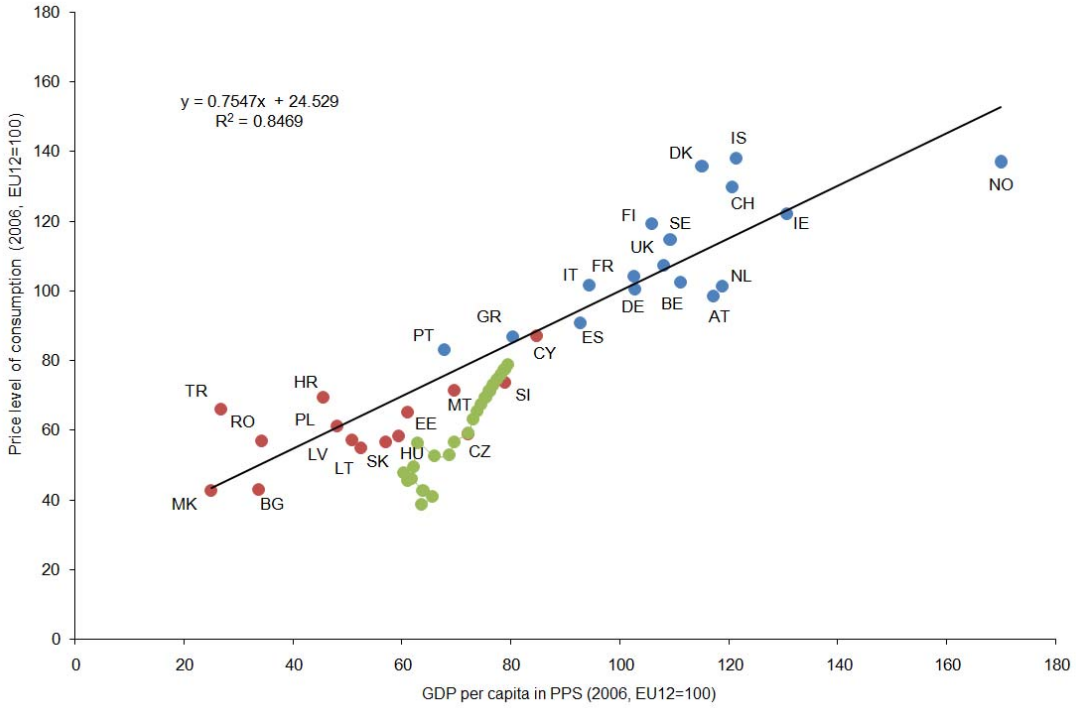
[10] Unconditional β convergence means that the less developed countries (with lower GDP per capita) grow faster than the more developed countries (with higher GDP per capita). σ convergence exists when income differentiation among economies decreases over time (Vojinović and Oplotnik, 2008).

[11] For more definitions see for example Žďárek (2006).

[12] CNB (2007).

countries tend to be lower than in developed ones.[13] As GDP per capita and productivity levels in less developed countries of the EU are expected to converge to the EU average in the future, price levels should follow suit. Over this transitory period, real as well as nominal convergence will determine at least partially the magnitude of the EU inflation dispersion.

Figure 10: GDP per capita in PPS and price level of consumption, 2006



Notes: Regression on data from 32 countries (marked in figure); data from 2006; average of EU12 = 100; blue and red dots represent old EU countries and new EU plus some of other transition countries, respectively; green dots show actual and predicted trajectory of the Czech GDP per capita in PPS and the Czech price level of consumption over the period 1995-2016.
Source: Dataset for Analyses of alignment, CNB (2007).

3.1.1.2 Price level development

As stated already above, existing research has confirmed that the price level convergence plays a role in the EU and belongs among factors that are emphasized fairly often as influential for inflation differentials.[14] Besides other studies, the price level convergence as a phenomenon by itself is examined in Duarte *et al.* (2005). Authors concentrate primarily on the long-run relationship and the dynamic of adjustment between domestic and average inflation rates in the EU12 countries. Their findings are basically twofold. First, they find evidence that the price level of the core countries in the EU12 (i.e. Austria, Belgium, Germany, France, Italy and Luxembourg) have kept in line with the average price level, except for the Netherlands, while the

[13] Balassa (1964) and Samuelson (1964) in Čihák and Holub (2005).

[14] See for example Rogers (2002), Duarte *et al.* (2003), ECB (2003), Honohan and Lane (2003) and Égert *et al.* (2004).

price level in peripheral countries (i.e. Greece, Portugal, Spain and Ireland) have shown signs of convergence to the EU12 average.[15] Second, they alert that the introduction of the euro has not contributed to the improvement of the speed of convergence in price level in the studied area. On the contrary, their results suggest even divergent tendencies in the evolution of the price level across the countries after the introduction of the single monetary policy in the EMU. Looking ahead, González-Páramo (2005) argues that the importance of price level convergence for the EU inflation differentials should diminish over time. According to Čihák and Holub (2005), such a catching-up process may take about 10 to 25 years for the price structure in the NMS to converge to the least developed EU countries.

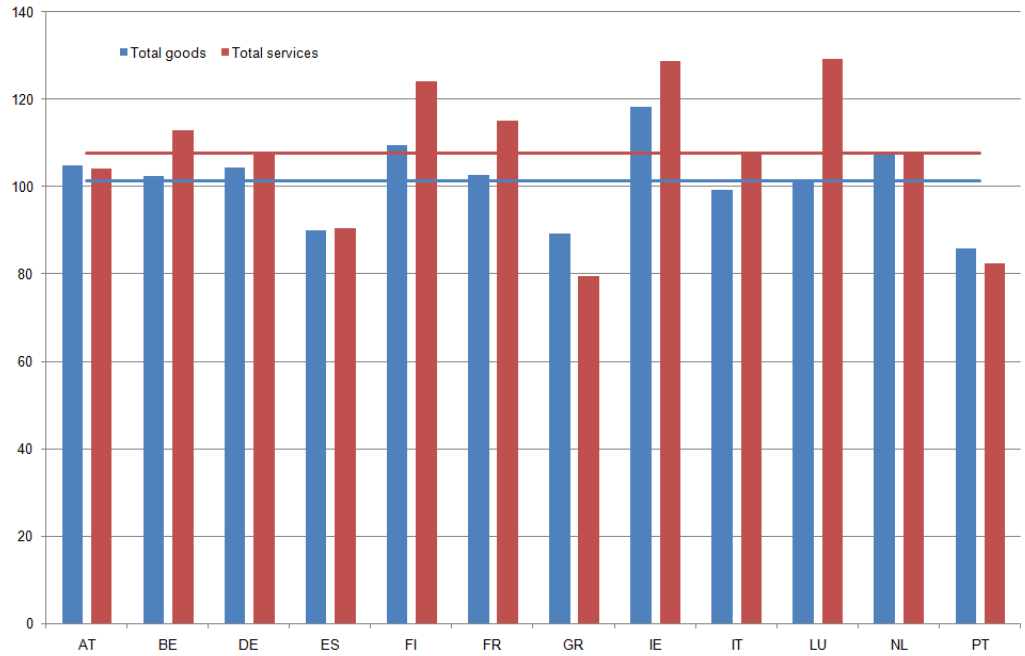
3.1.1.3 Tradable and non-tradable goods price convergence

In general, measure of comparative price level of GDP can be further disaggregated into various groups showing comparative price level of single goods and services. When looking for sources of inflation differentials, literature often distinguishes convergence effects related to so called tradable or non-tradable goods prices.

As regards tradable goods, in literature, it is often assumed that purchasing power parity[16] holds. However, the differences in prices of tradable goods seem to prevail across the EU, even though they are much smaller than price differences for non-tradable goods (see Figure 11 and 12 where we approximate tradable goods by total goods and non-tradable goods by total services). In this respect, we would like to mention that much of the marked decline in dispersion of tradable goods price level has taken place during 1990s in reaction to implementation of the European Single Market. Nevertheless, as indicated by Rogers (2002), the convergence process has slowed down at the beginning of 2000s. The introduction of euro is, however, likely to reinforce further the arbitrage mechanisms and foster the tradable goods prices convergence. According to ECB (2003), price disparities for tradable goods are likely to be affected by the level of national and international competition, which in turn depends inter alia on the efficiency of national competition policies or a countries' exposure to international trade and market integration. To this list of influential factors, European Commission (2002a) adds also indirect taxation, the structure of distribution networks, market power related to pricing-to-market practices and inefficiencies in the services sectors. Prevailing segmentation of the Single Market has played role as well (European Commission, 2002b).

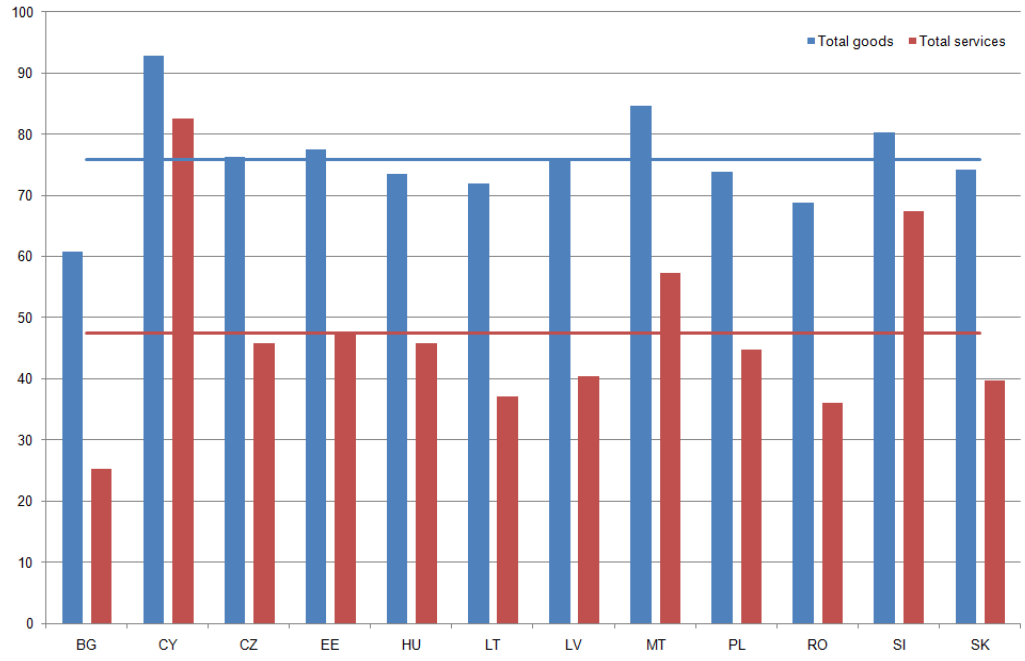
[15] These results follow from authors' descriptive and more formal cointegration analysis (Duarte *et al.*, 2005).

Figure 11: Comparative price level of total goods and total services in the EA12, 2006



Note: Blue and red bars show comparative price level of total goods and total services, respectively; relative measure is average of the EU27 (EU27 = 100); blue and red lines indicate unweighted average of respective indices for the EA12 (i.e. 101 for total goods and 108 for total services).
Source: Author's calculations based on *EUROSTAT* data.

Figure 12: Comparative price level of total goods and total services in the NMS, 2006



Note: Blue and red bars show comparative price level of total goods and total services, respectively; relative measure is average of the EU27 (EU27 = 100); blue and red lines indicate unweighted average of respective indices for the NMS (i.e. 76 for total goods and 48 for total services).
Source: Author's calculations based on *EUROSTAT* data.

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[16] Purchasing power parity means that prices of homogenous products expressed in the same currency do not differ between locations (ECB, 2003).

Overall, we argue that stricter enforcement of Single Market legislation and further improvements in competition on markets would lead to additional reduction of remaining fragmentation in the European Single Market in tradable goods prices.

Concerning non-tradable goods price development, it is often attributed to so-called Balassa-Samuelson (B-S) effect whose main attributes are summarized in Box 1. The model explains inflation differentials as a result of uneven growth of prices in non-tradable sector among countries in consequence of differences in productivities between tradable and non-tradable goods.

Box 1: Balassa-Samuelson model

The Balassa-Samuelson (B-S) model (see Balassa, 1964; Samuelson, 1964) is one of the cornerstones of the traditional theory of the real equilibrium exchange rate. As a starting point, two sectors in the economy should be distinguished. On the one hand, there exists a tradable goods sector which is exposed to foreign competition and whose prices are essentially determined on international markets (e.g. manufactures). Importantly, it is assumed that purchasing parity holds for tradables. And on the other hand, there is a non-tradable goods sector (encompassing most services) sheltered from foreign competition and whose prices are determined domestically. The key empirical observation underlying the model is that productivity tends to grow more in the exposed sector than in the sheltered sector, owing to the fact that the former is generally more capital intensive and, therefore, benefits more from technological progress. These characteristics, along with condition that wages are assumed to be linked between the tradable and the non-tradable sector due to the assumed perfect mobility of labour, wages and prices will also increase in the non-tradable sector. This helps explain the existence of sectoral inflation differentials. The greater productivity in the exposed sector pushes nominal wages across the whole economy upwards in such a way that, if real wages are to reflect appropriately the sectoral productivity gains, the prices of non-tradable goods must outgrow the prices of tradable goods. To sum up, the B-S effect leads to an increase in the overall price level in the economy which in turn results in an appreciation of the real exchange rate.

Source: Alberola *et al.* (2000); Čihák and Holub (2003).

In reality, the quantification of B-S effect is not straightforward. Numerous of studies estimated the size of the B-S effect both for old EU member states and transition countries. As summarized in Égert (2004), a first strand of studies argued, based on data for the 1990s, that the B-S effect had a sizable impact on inflation rates in Central and Eastern Europe. More recent research emphasized, however, that the impact on the inflation rate is now considerably lower and lies between 0 and 2 percentage points a year in those countries. The results are broadly alike

for old member states of the EU. Similar results are found also by Lein-Rupprecht *et al.* (2007) and others.[17]

3.1.2 Permanent determinants

In this section, we shed some light on more long-lasting factors of inflation differentials. In particular, we remind effects of structural and cyclical differences existing across the EU countries.

3.1.2.1 Consumption patterns

According to ECB (2003), origins of inflation differentials may be related to the differences in households' preferences regarding consumption. There are notable differences not only in price levels and developments of individual consumer goods and services across countries, but also differences in shares of given categories of goods and services in national consumption. This so called composition effect leads to application of different weights of the various sub-indices in the HICP across countries.[18] As a consequence of diverse consumption baskets, inflation across member states may vary, although all prices were hypothetically the same. As regards the euro area countries, ECB (2003) concluded that differences in consumption patterns do not have a major impact on inflation dispersion. However, high degree of heterogeneity in consumption patterns is observed when comparing weights of HICP sub-groups of old and new members of the EU.[19] Unfortunately, we did not find any exact figure that would estimate the possible total effect of those divergences numerically. To the future, we believe that the structure of the NMS' consumption will gradually converge towards that of the old members, especially with respect to share of the services in consumption that is anticipated to increase.

3.1.2.2 Dependency on external environment

As argued by González-Páramo (2005), the divergence in inflation rates within the EU may also be influenced by external factors related to member states' exposure to changes in the exchange rate and prices of raw materials. In particular, inflation is to some extend reflection of so-called exchange rate pass-through, whose strength is dependent on many factors, such as the degree of extra-openness of economy[20], the geographical structure of international trade, the commodity

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[17] For comparison of the estimates of the B-S effect found in a number of research papers, see Appendix A.

[18] Hofmann and Remsperger (2004).

[19] For more details, we refer to Égert (2004).

[20] For euro area countries, ECB (2003) defines term "extra-openness" as a measure of the degree of openness among individual countries towards trading partners outside the euro area.

composition of imports from countries outside the euro area or expectations concerning perception of duration of exchange rate changes.

In general, the greater the extra-openness, the higher should be the weight of extra-euro area goods in a country's overall consumption basket, and therefore a stronger pass-through effect from fluctuation of exchange rate on domestic prices. As reported in ECB (2003), the considerable depreciation of the euro in 1999 and 2000 may have contributed to higher inflationary pressures in Ireland and Netherlands, which are relatively more exposed to extra-euro area trade.[21] By contrast, in Belgium, another very open economy, inflation was quite subdued.[22] This example shows that not always the greater exposure to external trade translates into higher inflation automatically. However, the empirical study of Honohan and Lane (2003) showed that increase in inflation diversity shortly after 1999 in the euro area was driven among other factors by distinct impact of the changes in the nominal effective exchange rates, rather than by differences in the productivities.

Another factor having some effect on exchange rate pass-through and therefore inflation differentials across countries is the geographical trade structure that reflects a country's exposure to exchange rate fluctuations given their degree of openness. "If the trade structure of a country is weighted towards countries whose exchange rates tend to fluctuate less vigorously against the euro, the impact of an appreciation/depreciation episode on domestic prices can be expected to be weaker (ECB, 2003)."

Similarly to the geographical structure of trade, inflation differentials depend also on commodity composition of imports. In this respect, the most important factors are a country's dependence on oil and oil intensity of economy. Regarding those measures, there are large disparities across the EU member states. Major differences are observed when comparing old and new countries of the EU. Despite profound economic restructuring and modernisation, Égert *et al.* (2006) shows that the economies of the former Eastern bloc remain very oil intensive, as well as highly oil dependent. Oil price shocks have an impact on the inflation rate and materialize in several "waves". Firstly, the change in oil prices is reflected almost directly in the energy component of the HICP. Later, with some delay, the second round effects take place. Oil price shock is passed on prices of related goods and services, and therefore influences the economic activity and

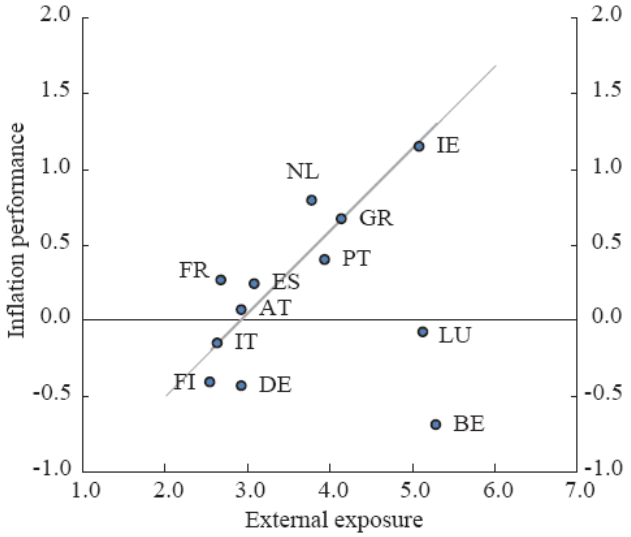
[21] ECB (2003) measures extra-euro area import openness in terms of GDP. Among the most open countries in this respect belong Belgium, Ireland, and the Netherlands.

[22] ECB (2003) relates the downward bias in Belgian inflation to changes of administered prices – for more information about the effect of administered prices, see Section 3.1.3.

international competitiveness of the country in relation to aforementioned oil intensity and dependency ratios.[23] Due to those second round effects, the evaluation of influence of oil price shocks on inflation differentials in the EU is not straightforward. Indeed, simple correlations between oil dependency ratios and inflation rates are rather low.[24]

ECB (2003) assessed the joint impact of aforementioned factors on inflation performance divergence for the euro area countries in the period from the first quareter of 1999 to 2002. In particular, it constructed a syntethic indicator of "external exposure" that incorporated extra-openness, geographical trade structure, the commodity composition of imports and oil dependency into one variable that was then put into comparison with infltion performance. According to Figure 13, there exists a positive relationship between external exposure and inflation performance indicating that inflation differentials may arise as a consequence of different sensitivity of countries about external shocks (e.g. greater dependency on oil) and diverse intensity of projection of those shocks into prices (e.g. higher pass-through from exchange rate changes). Outlying position of Belgium was interpreted as result of then changes in administered prices in 2002.

Figure 13: External exposure and inflation performance, 1999-2002



Source: ECB (2003).

In addition, inflation differentials may be influenced also by expectations regarding the exchange rate movements: changes in the exchange rate viewed as permanent are likely to have

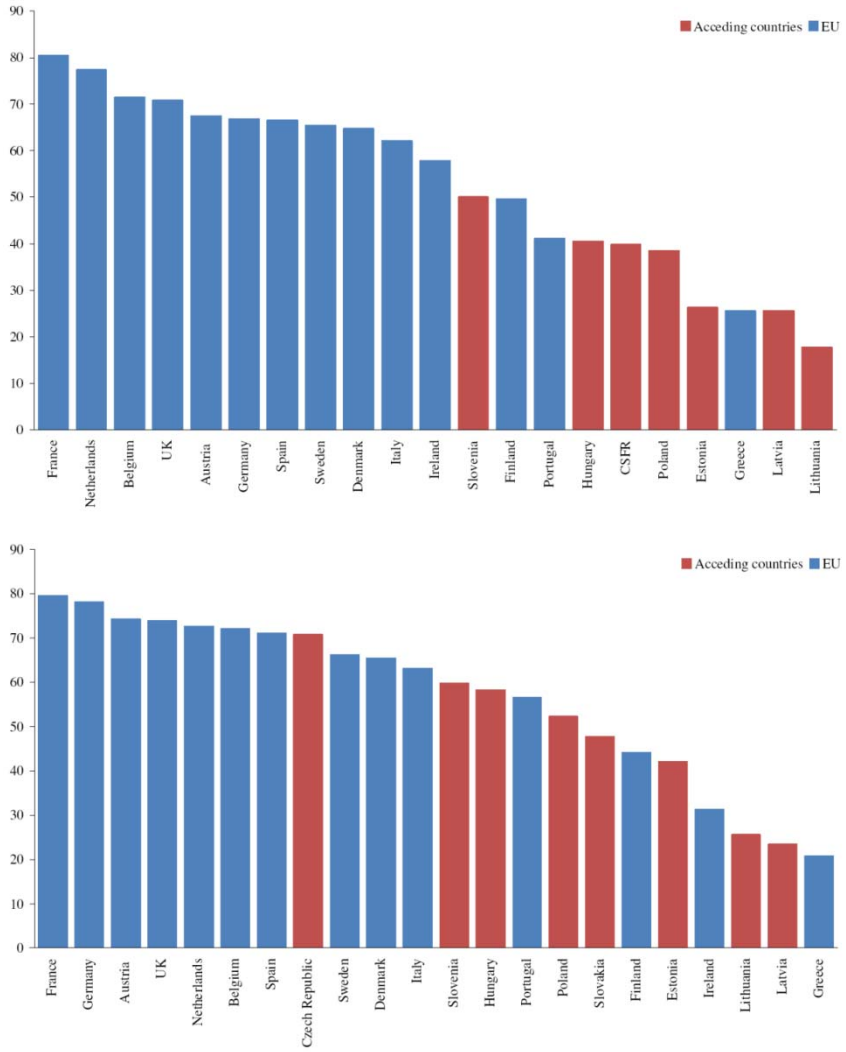
[23] "There is, however, evidence of the asymmetry of the lag length. While the pass-through of positive oil price shocks on energy prices takes place almost instantaneously (lag of one month), the estimated lag length is eight months in the case of decreasing oil prices (Égert *et al.*, 2004)."

[24] For more information, see for example ECB (2003), Égert *et al.* (2004), and Égert *et al.* (2006).

longer-lasting effects on prices in contrast to changes considered to be transitory. Moreover, Égert *et al.* (2004) add that the larger the change and the lower the volatility of the nominal exchange rate, the higher the pass-through will be.

Summing up, the exchange rate pass-through is one of the relevant factors influencing inflation differentials in the EU. However, with more intensified intra-EU trade induced by the European integration process and the euro adoption, the importance of exchange rate shocks on inflation rates and inflation differentials is expected to diminish. As regards the NMS of the EU, the exchange rate-pass through should play an important role there because most of them are very open economies with relatively lower intra-industry trade with the EU15, see Figure 14. With supposed adoption of euro in those countries, Égert *et al.* (2004) argue that inflation differentials caused originally by exchange rate shocks should be dampened. Nevertheless, let us mention that the stage of the euro adoption by all NMS is still relatively distant.

Figure 14: Intra-industry trade with the EU15 in 1989 (upper figure) and in 2001 (bottom figure)

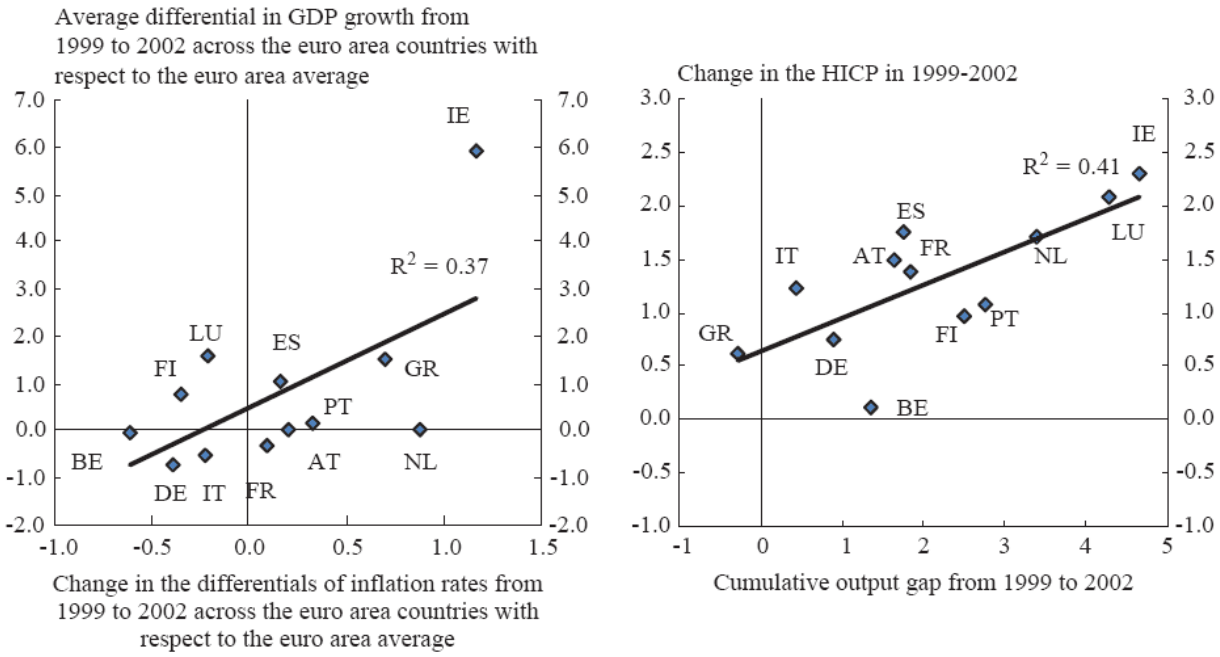


Source: Djablik and Fidrmuc (2004).

3.1.2.3 Cyclical reasons

The cyclical position of economy is usually considered to be a prominent factor having an impact on inflation differentials.[25] The most common measure of the business cycle position is the output gap – the deviation of actual output from potential GDP as a percentage of potential GDP. ECB (2003) illustrates a positive relationship between measures of the relative cyclical positions of euro area countries and their relative inflation rates. Left-hand panel of Figure 15 indicates that counties with above-average inflation rates have experienced higher cumulative output growth than the euro area average, and vice versa. Moreover, right-hand panel of Figure 15 shows that the accumulation of inflationary pressures has been the highest in countries with relatively large positive cumulative output gaps. ECB's findings are in line with those of Blanchard (2001) or Rogers (2002), for example. In contrast, Égert *et al.* (2006) alert that the link between output gaps and inflation rates is not that obvious because some items such as regulated prices and the prices of those goods which are strongly influence by external factors may be not connected to domestic output gaps.

Figure 15: Inflation differentials, differences in output growth and cyclical position, 1999-2002



Source: ECB (2003).

The literature on optimal currency areas has dealt with question of how business cycles can get more synchronised if the exchange rate get fixed and found the reply in trade openness with

[25] For more details, we refer to Honohan and Lane (2003), Angeloni and Ehrmann (2004), Hofmann and Remsperger (2004).

intensified intra-industry trade, similar economic structures, profound factor mobility and labour market flexibility.

Because we talked about the intra-industry trade already in the previous section, we only shortly state here that Frankel and Rose (1998) describe the intra-industry trade as a key determinant of business cycle harmonization and argue that the higher the share of the openness and the more important the share of intra-industry trade in total trade flows, the stronger the business cycle will get synchronised (so-called endogeneity argument) because the slowdown or acceleration in a given sector will equally affect both countries.

As regards the markets' flexibility, situation in Europe is roughly speaking poor. If demand or supply shocks hit the economy, the existing rigidities in price and wage-setting, current labour laws, institutional structure and cultural diversities will limit the speed of necessary adjustment processes across the EU countries and give rise to distortions in relative prices, thereby contribute to lasting inflation differentials. In this respect, let us mention that Eurosystem Inflation Persistence Network[26] computed the average consumer price duration – the time elapsing between two successive price changes – in the euro area to be between four and five quarters, while the estimate for the United States was only around two quarters. This seems to indicate that there is greater rigidity in price-setting in the euro area than in the United States. According to González-Páramo (2005), a substantial part of the persistent divergence of price developments may stem from differences in wage developments and in wage-setting mechanisms.

When comparing the alignment of economic development of the NMS with the euro area, the empirical results indicate a substantial amount of heterogeneity across countries.[27] Eickmeier and Breitung (2006) find that transition economies are less correlated with the euro area than core euro area countries among themselves. The endogeneity argument should, nevertheless, lead to more synchronization in the future.

3.1.3 Policy-induced factors

Inflation differentials may be also reinforced through the inappropriate use of fiscal instruments. In this respect, González-Páramo (2005) asserts that "there is some evidence that the pro-cyclical

[26] Eurosystem Inflation Persistence Network is a research network of the Eurosystem studying the pricing behaviour of firms in the euro area (González-Páramo, 2005).

[27] For summary of results of 35 papers dealing with the business cycle synchronization in the EU, see Fidrmuc and Korhonen (2006).

effects of the fiscal policies of euro area countries may have helped to increase cyclical differences among euro area countries in the recent past."

Moreover, government is responsible for the prices of regulated goods and services. Administered prices matter for overall inflation developments not only because of their high share in the HICP (they account for around 6 percentage of the HICP) but also because they usually exhibit a peculiar evolution over time. The great dispersion in inflation is observed when comparing the EA12 and the NMS, which distinguishes by much lower price level of the administered prices but at the same time as noted by Égert *et al.* (2004) regulated price inflation in Central and Eastern Europe is persistently above average inflation due to two main reasons. First, prices were below cost recovery in most transition economies. Second, the capital stock in some of the sectors is very obsolete and needs to be renewed to improve the quality to catch-up with the EU standards. Alongside administered prices, government pursue time to time changes in indirect taxation, which contributes to divergence in the inflation rates across countries. Both changes in administered prices and indirect taxes can add to inflation dispersion, at least in the short to medium term.[28]

Among policy-induced factors, we present effects that are ascribed to the ECB. Under inflation targeting regime the ECB's common monetary policy does not track individual needs but pursue its one main goal, in particular stabilize the average euro area inflation. This objective may, however, result in unanticipated distributional consequences. On the one hand, high-inflation countries benefit at first sight from lower-than-average real interest rates, which may, nonetheless, amplify their inflationary pressures and deteriorate their international competitiveness in its consequence. On the other hand, low-inflation countries confront higher-than-average real interest rates that can undermine their economic growth, but at the same time, lead to a fall in domestic relative price level which at the end causes overheating. To sum up, the overall outcome is thus an enhancement of boom-bust cycles and maintenance of persistence in inflation differentials (Honohan and Lane, 2003; European Commission, 2006, Marzinotto, 2006).

3.2 Review of selected econometric studies

Recently, variants of the New Keynesian model have been used to analyse inflation differentials in the euro area. One of such models of the euro area economies was built by Hofmann and

[28] For more details, we refer to Égert *et al.* (2004).

Remsperger (2004). Their empirical analysis includes eleven euro area countries[29] and is carried out by panel Generalised Method of Moments over the period 1999Q1 till 2004Q2. At the end, the results suggest that the observed inflation differentials are mainly driven by differences in cyclical positions and fluctuations of the effective exchange rate combined with a rather high level of inflation persistence, while the proxies of price level convergence does not come out significantly. Authors also argue that the degree of inflation persistency in the individual countries may differ depending on the past monetary policy regime and past expectations. Hofmann and Remsperger (2004) indicates that in the group of countries with a history of low and stable inflation rates there has been basically zero persistence while the persistence has been rather high in the rest of the euro area countries. Given this finding, authors conclude that the monetary policy of the Eurosystem geared at delivering and maintaining low and stable inflation rates in the euro area should push down inflation persistence in the future.

Analogously to aforementioned study, Angeloni and Ehrmann (2004) propose a stylised 12-country model of the euro area represented by an aggregate demand and an aggregate supply equation and use it to analyse the inflation and output differentials observed across the EMU over the period 1998Q1 till 2003Q2. Authors focus on performance of economies after realization of nation-specific shocks that cumulate into changes in external competitiveness and give rise to international trade spillovers. In their model, inflation depends on future expected inflation, lagged inflation, the output gap and the change in the effective nominal exchange rate. Angeloni and Ehrmann (2004) point out that the main source of differentials in the early years of the EMU have been aggregate demand or potential output shocks, followed by domestic cost-push disturbances, while euro exchange rate shocks come third. Moreover, authors emphasize that inflation persistence have played a central role in amplifying and perpetuating inflation differentials within the currency area. They claim that for plausible parameter values even small changes in persistence can produce a dramatic surge in the differentials. The paper also concludes that a tight control of average area-wide inflation around a target tends to reduce the differentials.

Long-run determinants of inflation differentials in a monetary union were examined also by Altissimo *et al.* (2005). In first part of their study, authors analyze evidence on the statistical features of observed dispersion in headline inflation rates as well as changes in the components of the consumer price index in the euro area. Their findings confirm that most of dispersion in European inflation occurs in the service category of the EU's HICP. In the second part of the

[29] Luxemburg was not included (Hofmann and Remsperger, 2004).

study, authors build a dynamic factor model to investigate the sources of dispersion in sectorial measures of dispersion in, on the one hand, a common component driven by common factors, and on the other hand, an idiosyncratic component. The model of a monetary union assumes full price flexibility and in several respects departs from the Balassa-Samuelson hypotheses. Altissimo *et al.* (2005) conclude that their outcomes are in contrast with the result that movements in the real exchange rate are mainly driven by regionally asymmetric productivity shocks in the traded sector. Indeed, they point instead to relative variations in productivity in the non-traded sector as the primary cause of price and inflation differentials, with shocks to productivity in the traded sector being largely absorbed by movements in the terms of trade in the regional economies.

Another interesting empirical study was presented by Honohan and Lane (2003). Authors build the panel data model that investigates the driving factors of inflation differentials in the euro area over the period 1999 and 2001. More specifically, they examine the relative influence of the country's external exposure, the cyclical position, the fiscal policy, and finally the price level convergence. At this point, let us mention that reading of this study gave us an inspiration for replicating the Honohan and Lane's methodology, however, for a group of the new member states of the EU. For more details, we refer you to the next section which brings you closer insight into the blueprint model and presents its results for the old member states in comparison with our results for the new member states of the EU.

4 Panel data analysis: Driving factors for inflation differentials in the NMS

In this chapter, we present our empirical research that concentrates on assessing the relative contributions of the key driving factors of inflation differentials in the New Member States.

4.1 Methodology

Our study was inspired by Honohan and Lane (2003) who focus their attention to finding the relationship between inflation and firstly, the role of exchange rate channel, secondly, the output gap, thirdly, the role of fiscal policy, and finally, the countries' relative price level. Honohan and Lane's study (2003) investigated above mentioned relations in panel of euro zone countries using annual data over 1999-2001. The derivation of their model is presented briefly in the subsection 1.1.1. The specification of our modified version comes after.

4.1.1 Honohan and Lane's blueprint

Here, we summarize the model of Honohan and Lane (2003) that was used as a blueprint for our main econometric analysis. Authors start the analysis with a fairly general specification for inflation differentials that can be written as

$$\pi_{it} - \pi_t^E = \beta(z_{it} - z_t^E) + \delta([P_{it-1} - P_{it-1}^*] - [P_{t-1}^E - P_{t-1}^{E*}]) + \varepsilon_{it} \quad (1)$$

where π_{it} and π_t^E are the annual national and euro zone inflation rates respectively; z_{it} and z_t^E are national and euro zone variables that exert short-term influence on the inflation rate; P_{it} and P_t^E are the national and euro zone price levels and P_{it}^* and P_t^{E*} are the national and euro zone long-run equilibrium price levels.

For a convergence club such as the euro zone with tight trade and institutional linkages eliminating income and productivity differentials over time, we can assume a common long-run national and euro zone price level.[30] The assumption of a common long-run price level[31] allows us to simplify the expression (1) to

$$\pi_{it} - \pi_t^E = \beta(z_{it} - z_t^E) + \delta(P_{it-1} - P_{t-1}^E) + \varepsilon_{it} \quad (2)$$

[30] See for example Froot and Rogoff (1995) or the empirical work by Zussman (2003). The latter finds evidence of absolute convergence in price levels among OECD countries.

[31] Honohan and Lane (2003) experimented also with the alternative hypotheses that long-run price levels may diverge due to productivity or income differences, however, they did not find a significant role for these variables. Therefore, they focused their attention back to their main model, so do we.

Now, the important step is to realize that combination of euro variables results in the time dummy. Hence, we can write

$$\pi_{it} = \phi_t + \beta z_{it} + \delta P_{it-1} + \varepsilon_{it} \tag{3}$$

Following the analysis in the Honohan and Lane's paper, we include three variables in the z-vector. These are the rate of change in the nominal effective exchange rate (lagged by one period), the impulse in the cyclically adjusted fiscal surplus and the output gap. This gives the empirical specification

$$\pi_{it} = \phi_t + \beta_1 \Delta NEER_{it-1} + \beta_2 GAP_{it} + \beta_3 FISC_{it} + \delta P_{it-1} + \varepsilon_{it} \tag{4}$$

where π_{it} is the annual inflation rate, $\Delta NEER_{it-1}$ is the lagged growth rate of the nominal effective exchange rate, GAP_{it} is the output gap, $FISC_{it}$ is the impulse in the cyclically adjusted primary surplus and P_{it-1} is the lagged price level. Note that the time dummies (ϕ_t) in the regression captures EMU-wide common movements in inflation and in the regressors, so that the regression is explaining inflation differentials in terms of idiosyncratic national movements in the determinants.

To sum up, authors ran panel regression using annual data (specifically over 1999-2001) to establish the relative contributions of the key factors of inflation differentials within the euro zone. They use proxies of the catch-up effect and the three macroeconomic variables: nominal effective exchange rate changes, the fiscal balance, and the output gap.

4.1.2 The Model

We model the driving factors of the inflation differentials in the similar fashion as in the research paper of Honohan and Lane (2003).[32] Contrary to our blueprint, we decided to use quarterly data. Our panel regression is based on identical specification as defined by equation (4), but the measurement of some variables differs. In our model, π_{it} is the annual inflation rate, $\Delta NEER_{it-1}$ is the lagged growth rate of the nominal effective exchange rate, GAP_{it} is the output gap, $FISC_{it}$ is the fiscal stance (with surplus in positive values) and P_{it-1} is the lagged comparative price level. All the variables in the model are in percentages. The time dummies (ϕ_t) captures EMU-wide

[32] For detailed description see Section 4.1.1.

common movements in inflation and in the regressors. Therefore, inflation differentials are explained in terms of idiosyncratic national-level movements.[33]

$$\pi_{it} = \phi_t + \beta_1 \Delta NEER_{it-4} + \beta_2 GAP_{it} + \beta_3 FISC_{it} + \delta P_{it-4} + \varepsilon_{it} \quad (5)$$

Due to the use of quarterly frequency instead of annual one, we also run the regression with the time lag of four periods.

4.1.3 Specification of hypotheses

In our study, we specify four hypotheses about the expected signs of the coefficients of the panel regression. Firstly, the role of exchange rate channel in driving inflation differentials is examined in *Hypotheses 1*. According to the economic reasoning, a country that experiences a rate of depreciation of its nominal effective exchange rate that is larger than the European average will also have relatively higher inflation. On the other hand, the higher appreciation of the country's nominal effective exchange rate than the European average will lead to relatively lower inflation. In the data, the appreciation (resp. depreciation) of the nominal effective exchange rate has positive (resp. negative) sign. Therefore, we conclude that the expected sign of the coefficient β_1 should be negative. *Hypothesis 2* deals with the effect of the output gap. We believe that a positive output gap accelerates the inflation and therefore can be seen as one of sources of inflation differential. Therefore, the sign of the coefficient β_2 is assumed to be positive. Thirdly, the model analyzes the role of fiscal policy. *Hypothesis 3* supposes that the fiscal surplus is negatively related to inflation and therefore to inflation differential, while the fiscal deficit is related to inflation positively. Thus, the expected sigh of β_3 is negative. Finally, the model search for the importance of price convergence for resulting inflation differentials. According to *Hypothesis 4*, the higher price level than the European average will lead to negative pressure on the inflation, whereas the lower price level to positive one, and therefore the expected sign of coefficient δ is negative.

Table 5: Hypotheses of the model

Hypothesis	Coefficient	Expected Sign
Hypothesis 1	β_1	-
Hypothesis 2	β_2	+
Hypothesis 3	β_3	-
Hypothesis 4	δ	-

[33] In EViews, we selected fixed period effects specification and White (diagonal) coefficient covariance method.

4.2 Data description

To scrutinize the sources of the inflation differentials as defined by the equation (4 and 5) in the sections 1.1.1 and 1.1.2, we constructed a panel data structure that is composed of 12 cross-sections (countries) and ranges over the period from the first quarter of 1997 to the last quarter of 2006. In contrast to Honohan and Lane's (2003) study that ranges only from 1999 to 2001, our sample includes wider time period because we believe that grater time coverage is preferable. The main data source was EUROSTAT.[34] Incompleteness of the databases made us estimate only unbalanced panel regression. The panel is unbalanced in the sense that we have more observations on some countries than on others. Another issue was the unavailability of quarterly frequency for some of the time series. Therefore, transformation of either monthly or annual data set to quarterly one was necessary. Altogether, there are 407 complete observations.[35] In the following text: (1) we present the sample of selected countries entering to our panel; (2) we specify all variables of the model and their descriptive statistics.

4.2.1 Country specification

In total, our panel data structure includes 12 cross-sections. The countries considered in this research study are those that joined the EU in 2004 and 2007, in particular, we mean Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. In the following text, we denote our target sample as the New Member States (NMS) of the EU. Table 6 summarizes the list of codes of our particular countries, as well as information on the time of their accession to the EU, the date of the entry to the Exchange Rate Mechanism II (ERM II) and the date of the euro adoption.

[34] We chose this database because it provides statistical information about all countries of the EU at one place and under one methodology.

[35] The complete EViews file will be provided upon request.

Table 6: Countries in the panel and their relations to the EU, ERM II, and EA

Country	Code	Accession to the EU	Entry to ERM II	Euro Adoption
Bulgaria	BG	01/2007	Outside	
Cyprus	CY	05/2004		01/2008
Czech Republic	CZ	05/2004	Outside	
Estonia	EE	05/2004	06/2004	
Hungary	HU	05/2004	outside	
Latvia	LV	05/2004	05/2005	
Lithuania	LT	05/2004	06/2004	
Malta	MT	05/2004		01/2008
Poland	PL	05/2004	outside	
Romania	RO	01/2007	outside	
Slovakia	SK	05/2004	11/2005	01/2009*
Slovenia	SI	05/2004		01/2007

Note: * denotes planned date of the euro adoption
Source: http://www.europa.eu/

Figure 16: Map of the EU

Source: http://www.economist.com/

4.2.2 Variable specification

As mentioned earlier, the equation (5) in the section 1.2 gives our panel regression specification. The dependent variable is the annual inflation rate (π) and there are four explanatory variables, in particular the lagged growth rate of the nominal effective exchange rate (ΔNEER), the output gap (GAP), the fiscal stance (FISC) and the lagged comparative price level (P).[36]

In the following subchapters, we provide a short description of the model variables and present their descriptive statistics that are depicted in general as well as country specific manner.[37] During the research, we came to the decision to run two panel regressions. In particular, regression of *Panel A* that is constructed of the full sample of 12 studied countries, while *Panel B* represents the full sample of studied countries except Romania. Such a decision stems from our suspicion that Romania is an outlier of our research sample, especially concerning the inflation rate and the growth rate of the nominal effective exchange rate. Even though, we label Romania as our sample outlier, we will conduct the panel regression on both panels and use the comparison of results as one variant of the sensitivity analysis.

[36] All variables in the model are in percentages. Retrieved variables, except HDP, are not seasonally adjusted.

[37] For the graphical illustration of all time series, see Appendix C.

4.2.2.1 π

The annual inflation rate is based on the Harmonized Index of Consumer Prices (HICP).[38] Table 7 shows that the standard deviation slumps dramatically when Romania is taken out of the sample.

Table 7: Descriptive statistics of π

Panel	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Panel A	464	7.85	16.83	4.10	177.70	-1.30
Panel B	424	4.75	3.56	3.80	22.10	-1.30
Country	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Bulgaria	36	6.51	4.31	6.10	22.10	-1.20
Cyprus	40	2.66	1.35	2.50	6.30	0.10
Czech Republic	40	3.51	3.10	2.55	12.50	-0.60
Estonia	40	4.67	2.61	4.30	11.90	0.40
Hungary	40	8.54	4.71	7.15	19.10	2.40
Latvia	40	4.37	2.27	3.65	8.50	0.90
Lithuania	40	2.56	2.97	2.05	10.60	-1.30
Malta	40	2.77	0.89	2.90	4.50	0.80
Poland	28	3.47	3.12	1.85	10.50	0.40
Romania	40	40.61	44.95	27.70	177.70	4.90
Slovakia	40	6.89	3.47	6.60	16.80	2.30
Slovenia	40	6.15	2.51	7.00	9.80	1.70

Notes: π denotes the annual inflation rate; period 1997:1-2006:4; Panel A represents the full sample of studied countries; Panel B represents the full sample of studied countries except Romania.
Source: Author's calculations based on *EUROSTAT* data.

[38] Monthly data (y-o-y growth rate) were transformed to quarterly data by the method of the last observation.

4.2.2.2 ΔNEER

The nominal effective exchange rates were used to create the annual growth rates of the nominal effective exchange rate that are used in the model in the lagged form.[39] Positive (resp. negative) values of ΔNEER correspond to appreciation (resp. depreciation). From descriptive statistics, we conclude that Romania might be again considered as the outlier of the sample, however, this conclusion in not such a clear-cut as in case of inflation. Another interesting finding is that on average appreciation has dominated depreciation in most of the NMS.

Table 8: Descriptive statistics of ΔNEER

Panel	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Panel A	480	0.76	13.29	1.19	42.51	-94.52
Panel B	440	2.25	11.77	1.49	42.51	-94.52
Country	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Bulgaria	40	-4.07	28.31	2.15	25.36	-94.52
Cyprus	40	6.18	9.85	2.48	32.56	-4.03
Czech Republic	40	3.67	6.27	3.78	19.53	-10.46
Estonia	40	3.88	10.12	0.70	35.79	-4.62
Hungary	40	-1.34	5.69	-2.47	8.62	-9.96
Latvia	40	4.12	11.36	0.83	40.48	-6.40
Lithuania	40	9.12	10.24	7.01	42.51	-3.12
Malta	40	1.16	2.27	1.42	5.96	-3.92
Poland	40	1.00	8.25	0.56	22.19	-12.44
Romania	40	-15.60	17.56	-14.14	15.54	-54.21
Slovakia	40	1.98	4.10	2.66	10.91	-8.70
Slovenia	40	-0.96	4.81	-1.35	13.35	-8.58

Notes: ΔNEER denotes the growth rate of nominal effective exchange rate; period 1997:1-2006:4; Panel A represents the full sample of studied countries; Panel B represents the full sample of studied countries except Romania.
Source: Author's calculations based on *EUROSTAT* data.

[39] Monthly time series of the nominal effective exchange rates were transformed to quarterly series by the method of the last observation.

4.2.2.3 GAP

Probably the most controversial task was to elaborate the measure for the output gap. The author worked with gross domestic product at market prices in millions of national currency in chain-linked volumes with reference year 2000 that included euro fixed series for euro area countries. The seasonally adjusted data were retrieved from EUROSTAT database and the natural logarithm was applied on the given series. To obtain the output gap, the author opted for using the Hodrick and Prescott filter available in EViews. This method is, however, not without drawbacks. Perhaps the biggest problem of the Hodrick and Prescott filter is its end point bias. Therefore, we decided to use the data of as long period as available for most of the investigated countries (1996:1 to 2007:1) and then cut the tails. For the sake of accuracy of given filtering technique, we compared our results for the Czech output gap with the output gap of Quarterly Projection Model of the Czech National Bank. We found out that our output describes the trend satisfactorily well. However, the level is shifted upwards.[40]

Table 9: Descriptive statistics of GAP

Panel	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Panel A	456	-0.03	1.48	-0.07	5.37	-14.13
Panel B	428	-0.03	1.51	-0.05	5.37	-14.13
Country	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Bulgaria	40	-0.45	2.40	0.06	1.44	-14.13
Cyprus	40	-0.06	0.92	-0.03	2.00	-2.60
Czech Republic	40	-0.19	0.90	-0.39	1.33	-1.51
Estonia	40	0.11	2.08	0.09	5.30	-4.68
Hungary	40	0.03	0.28	0.05	0.56	-0.60
Latvia	40	-0.02	1.37	-0.18	3.51	-2.29
Lithuania	40	0.15	2.09	0.12	5.10	-3.50
Malta	28	-0.07	1.96	-0.09	5.37	-4.29
Poland	40	0.12	1.23	0.05	2.29	-2.09
Romania	28	0.01	0.98	-0.33	2.61	-1.54
Slovakia	40	0.07	1.32	-0.44	3.21	-3.74
Slovenia	40	-0.03	0.81	-0.17	2.18	-1.19

Notes: GAP denotes the output gap; period 1997:1-2006:4; Panel A represents the full sample of studied countries; Panel B represents the full sample of studied countries except Romania.
Source: Author's calculations based on *EUROSTAT* data.

[40] See Figure 21 in Appendix C.

4.2.2.4 FISC

In Honohan and Lane (2003), FISC stands for the impulse in the cyclically adjusted fiscal stance. Due to the lack of data for NMS, we approximated this variable by fiscal stance (with surplus in positive values) as percentages of GDP.[41] On average, ten out of twelve countries has run the fiscal deficit.

Table 10: Descriptive statistics of FISC

Panel	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Panel A	440	-3.23	3.12	-2.93	4.69	-17.06
Panel B	404	-3.29	3.23	-2.98	4.69	-17.06
Country	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Bulgaria	36	1.12	1.40	1.53	4.20	-1.17
Cyprus	36	-3.54	1.49	-3.64	-1.42	-6.45
Czech Republic	40	-4.46	1.45	-3.87	-2.41	-7.22
Estonia	28	1.47	1.48	1.99	4.69	-0.39
Hungary	40	-6.46	2.07	-6.99	-2.54	-9.75
Latvia	40	-1.40	1.86	-1.44	1.72	-5.66
Lithuania	40	-2.82	3.45	-1.66	-0.25	-17.06
Malta	36	-6.22	2.52	-6.30	-2.53	-10.62
Poland	40	-3.93	1.48	-3.95	-1.22	-6.65
Romania	36	-2.66	1.25	-2.15	-1.34	-4.78
Slovakia	40	-5.52	2.88	-5.09	-1.85	-12.14
Slovenia	28	-2.63	1.00	-2.53	-1.33	-4.28

Notes: FISC denotes the fiscal stance; +/- stands for government surplus/deficit; period 1997:1 – 2006:4; Panel A represents the full sample of studied countries; Panel B represents the full sample of studied countries except Romania.
Source: Author's calculations based on *EUROSTAT* data.

[41] The annual data were transformed to quarterly by EViews frequency conversion low to high, quadratic-match average.

4.2.2.5 P

The price level was measured by the comparative price level indices (EU15=100). The annual data were transformed to quarterly by EViews frequency conversion low to high, quadratic-match average. From descriptive statistics of the Panel we can conclude that the comparative price level of the NMS has been roughly 50% lower comparing to the average of the EU15.

Table 11: Descriptive statistics of P

Panel	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Panel A	468	51.46	14.44	48.59	84.76	21.66
Panel B	432	52.67	14.30	49.18	84.76	21.66
Country	Observations	Mean	Std. Dev.	Median	Maximum	Minimum
Bulgaria	40	31.16	3.36	32.13	36.15	21.66
Cyprus	40	83.09	1.00	83.06	84.76	80.96
Czech Republic	40	47.68	5.39	48.85	57.07	37.01
Estonia	40	52.35	3.91	53.76	59.66	43.41
Hungary	40	49.63	5.62	50.02	57.68	42.61
Latvia	40	45.70	4.23	46.79	53.04	38.10
Lithuania	40	43.59	3.86	44.73	49.33	36.01
Malta	32	65.48	1.65	65.56	68.37	61.46
Poland	40	49.47	3.87	47.99	55.87	43.80
Romania	36	36.91	5.48	35.28	49.09	29.49
Slovakia	40	44.33	4.53	41.86	53.21	38.52
Slovenia	40	69.47	0.96	69.08	71.28	67.53

Notes: P denotes the comparative price level; period 1997:1 – 2006:4; Panel A represents the full sample of studied countries; Panel B represents the full sample of studied countries except Romania.
Source: Author's calculations based on *EUROSTAT* data.

4.2.3 Assessing multicolinearity

Before proceeding further it is important to check whether there is no major multicolinearity in the data. Table 12 shows correlation matrix of explanatory variables. The results indicate that there is no problem with multicolinearity.

Table 12: Correlation matrix of explanatory variables

	ΔNEER	GAP	FISC	P
CNEER	1.000	-0.060	0.002	0.007
GAP	-0.060	1.000	0.093	-0.006
FISC	0.002	0.093	1.000	-0.149
P	0.007	-0.006	-0.149	1.000

Source: Own calculations.

4.3 Estimation results

In this section, we provide our estimation results. Table 13 shows the results of the model with the time lag of one period, while the results of the model with time lag of four periods are depicted in Table 14. Individual columns represent eight different estimations. The results in columns (1) and (5) are based on the regression on data of the whole sample of 12 countries in period since the first quarter of 1997 to the last quarter of 2006. The columns (2) and (6) represent again the regression on data of the full sample of 12 countries, but within the shortened period, in particular since the first quarter of 1997 to the last quarter of 2005. The columns (3), (7), (4) and (8) show the results of the regressions on data of the restricted sample of countries, again in the whole and the shortened time span, respectively.

The restricted cross section excludes Romania, a country that seems to be an outlier of our studied sample.[42] Two different time spans as well as time lags were used mainly to test for the sensitivity of the model. Moreover, by shortening of time span we examine whether the potential end point bias in GAP makes a difference.

Overall, we can say that the estimation proved to be relatively successful. The model did not generate any evidently out of line figures. In general, the adjusted R-squared ended up around 0.4 which is an acceptable value for economic research. The model showed to be more or less stable and robust. Now, let us turn to the specific evaluation of our empirical findings.

[42] See Section 2.2.2.

Table 13: Inflation differentials (panel Least Squares estimates), time lag of one period

		(1)	(2)	(3)	(4)
Lagged change in nominal effective exchange rate (-1)	β_1	-0.3998***	-0.4041***	-0.1976***	-0.1969***
		[-6.43] (0.0622)	[-10.90] (0.0629)	[-11.01] (0.0180)	[-10.90] (0.0181)
Output gap	β_2	0.1183	0.1055	0.1002	0.0980
		[0.61] (0.1948)	[0.52] (0.2042)	[0.83] (0.1206)	[0.78] (0.1260)
Fiscal stance	β_3	-0.1677**	-0.2394***	-0.1037**	-0.1586***
		[-2.55] (0.0657)	[-3.25] (0.0736)	[-2.05] (0.0507)	[-2.83] (0.0560)
Lagged price level (-1)	δ	-0.1224***	-0.1251***	-0.0569***	-0.0549***
		[-7.15] (0.0171)	[-6.71] (0.0186)	[-5.88] (0.0097)	[-5.29] (0.0104)
Cross-sections included		12	12	11	11
Total panel (unbalanced) observations		407	359	379	335
Adjusted R^2		0.453	0.452	0.443	0.448

Notes: The results in columns (1) – (4) are based on following regressions: (1) the full sample of 12 countries, period 1997:1 – 2006:4; (2) the full sample of 12 countries, period 1997:1 – 2005:4; (3) the full sample of studied countries except Romania, period 1997:1 – 2006:4; (4) the full sample of studied countries except Romania, period 1997:1 – 2005:4. In regression, nominal effective exchange rate and price level are lagged by one quarter. Period fixed effects included. The *t*-statistics are based on White diagonal standard errors (d.f. corrected) and are in square brackets. *, **, *** denote significance at the 10, 5, and 1 % levels respectively. Standard errors are in round brackets.
Sources: Author's calculations based on *EUROSTAT* data.

Table 14: Inflation differentials (panel Least Squares estimates), time lag of four periods

		(5)	(6)	(7)	(8)
Lagged change in nominal effective exchange rate (-4)	β_1	-0.2470***	-0.2491***	-0.1066***	-0.1039***
		[-4.36]	[-4.30]	[-4.24]	[- 4.20]
		(0.0567)	(0.0579)	(0.0251)	(0.0247)
Output gap	β_2	0.4711*	0.4993*	0.3123**	0.3309**
		[1.75]	[1.75]	[2.11]	[2.14]
		(0.2699)	(0.2852)	(0.1483)	(0.1549)
Fiscal stance	β_3	-0.2160**	-0.2505**	-0.1206**	-0.1598***
		[-2.59]	[-2.51]	[-2.25]	[-2.61]
		(0.0835)	(0.0998)	(0.0536)	(0.0613)
Lagged price level (-4)	δ	-0.1077***	-0.1066***	-0.0492***	-0.0464***
		[-6.87]	[-6.21]	[-5.52]	[-4.80]
		(0.0157)	(0.0172)	(0.0089)	(0.0097)
Cross-sections included		12	12	11	11
Total panel (unbalanced) observations		392	344	364	320
Adjusted R^2		0.405	0.401	0.356	0.356

Notes: The results in columns (5) – (8) are based on following regressions: (5) the full sample of 12 countries, period 1997:1 – 2006:4; (6) the full sample of 12 countries, period 1997:1 – 2005:4; (7) the full sample of studied countries except Romania, period 1997:1 – 2006:4; (8) the full sample of studied countries except Romania, period 1997:1 – 2005:4. In regression, nominal effective exchange rate and price level are lagged by four quarters. Period fixed effects included. The *t*-statistics are based on White diagonal standard errors (d.f. corrected) and are in square brackets. *, **, *** denote significance at the 10, 5, and 1 % levels respectively. Standard errors are in round brackets.
Sources: Author's calculations based on *EUROSTAT* data.

Firstly, let us comment on the role of exchange rate channel. In Table 13 and 14, the coefficient β_1 representing the impact of the exchange rate on inflation is negatively signed and highly significant across all columns. Such a result confirms our Hypothesis 1 that claims that a country which experiences a rate of depreciation of its nominal effective exchange rate that is larger than the European average will also have relatively higher inflation. In column (3), the point estimate of -0.1976 means that a relative depreciation of 5% is associated with an additional one percentage point of inflation. This is a large effect. For instance, the Czech nominal effective exchange rate appreciated on average by 3.67% during 1997-2006 whereas the Hungarian exchange rate depreciated by 1.34%.

Secondly, the influence of cyclical component showed to be important only in regression with the time lag of four periods. Nevertheless, it proved to be significant on 5% significance level at best. In the model with one lagged period of respective explanatory variables, the output gap was insignificant. Furthermore, the value of coefficient β_2 varies widely when comparing models of one and four time lags although the output gap does not enter in a lagged form. Therefore, we do not consider the value of this coefficient as predicative. At this point, the only conclusion we come up with is that the given sign corresponds to our expectations.

Regarding the fiscal stance, the negative sign of β_3 in all of the estimated regression equations confirms our third hypothesis. The relevance of the fiscal surplus/deficit is rather high. The coefficient β_3 is significant on 1% and 5% significance level at three and five cases out of eight, respectively. The magnitude of β_3 might be considered as relatively stable reaching values from -0.2505 to -0.1037. When talking about the results of the restricted cross-section model β_3 is more or less the same in both versions of either one or four lagged specification. For the full as well as the shortened time span version, the differences between estimated values of the given coefficient are negligible. In column (3), the point estimate of -0.1037 indicates that increase in inflation differential of one percentage point would be related to the fiscal deficit of 9.64% of GDP. If we realize that the Stability and Growth pact requires the budget deficit of 3% of GDP maximally, we will come to the conclusion that the fiscal stance have rather limited but still significant effect on the inflation differentials.

Finally, we can conclude that also the last Hypothesis 4 was approved by our results. Negative sign of coefficient δ indicates that the price convergence effect is present in reality. Moreover, our empirical analysis showed high significance of this effect in all estimated regressions. In column (3), the -0.0569 point estimate implies that a country with a comparative price level approximately one-sixth below the European average would experience an additional one

percentage point of inflation. In 2006, the NMS' comparative price level was 57.2%[43] of the EU15 average. In this respect, the price convergence might be seen as one of the most important drivers for inflation differentials in this area.

4.4 Comparison of results: the EA12 versus the NMS

In this section, we will compare our results with those of our blueprint from research paper of Honohan and Lane (2003). For the comparison, we chose the results of our third and seventh regression estimation. The numerical summary is provided in Table 15.

To begin with, Honohan and Lane found that nominal effective exchange rate movements had had a substantial impact on inflation differentials in the EA12, reflecting the different degrees of exposure of member states to trade outside this area. In this respect, we came up with the same conclusion. According to our results, in the NMS the effect of lagged change in nominal effective exchange rate is an important factor influencing the differences in inflation rates. However, it seems to have relatively lower impact than in the EA12. Furthermore, this effect gets weaker when four lags are taken into account. Generally speaking, both analyses suggest that the strengthening of the currency should lead to a fall in inflation, especially in the externally oriented member states.

When comparing the results for the output gap and the fiscal stance, we recognized significant differences between outcomes of models for the EA12 and the NMS. While much of the remaining pattern of inflation movements in the EA12 was explained to a large extend by national output gaps in the blueprint study, our results suggest that the cyclical component is not so relevant in the NMS. As regards the role of fiscal policy, the situation is opposite. The inclusion of fiscal imbalances adds no significant explanatory power in euro zone. Even the sign on this coefficient in Honohan and Lane is contrary to prior expectations. The authors conclude that there does not seem to be a strong role for the fiscal impulse in determining inflation. On the other hand, our results show that the fiscal stance matters in the NMS. However, we should keep in our mind that direct comparison of the effect of fiscal stance in euro zone versus the NMS is not possible because we used the different explanatory variable specification. Let us repeat that we worked with the fiscal surplus/deficit instead of the primary fiscal impulse that was a measure in Honohan and Lane.

[43] The average comparative price level for NMS in 2006 was calculated as arithmetic average of the comparative price levels of studied countries in given year excluding Romania – source EUROSTAT, own calculations.

Table 15: EA12 versus NMS – comparison of results

	H&L Model	Our Model	
Frequency of data	Annual	Quarterly	Quarterly
Specification of lags	-1	-1	-4
Lagged change in nominal effective exchange rate	-0.28	-0.1976	-0.1066
	[-2.71]**	[-11.01]***	[-4.24]***
		(0.0180)	(0.0251)
Output gap	0.22	0.1002	0.3123
	[2.65]**	[0.83]	[2.11]**
		(0.1206)	(0.1483)
Fiscal stance	0.02	-0.1037	-0.1206
	[0.32]	[-2.05]**	[-2.25]**
		(0.0507)	(0.0536)
Lagged price level	-0.03	-0.0569	-0.0492
	[-2.88]**	[-5.88]***	[-5.52]***
		(0.0104)	(0.0089)
Cross-sections included		11	11
Total panel (unbalanced) observations		379	364
Adjusted R^2	0.61	0.443	0.356

Notes: H&L column shows the results presented in the paper of Honohan and Lane (2003). Our model is based on regression of the full sample of studied countries except Romania, period 1997:1 – 2005:4. In regression, nominal effective exchange rate and price level are lagged by one and four quarters, respectively. Period fixed effects included. The *t*-statistics are based on White diagonal standard errors (d.f. corrected) and are in square brackets. *, **, *** denote significance at the 10, 5, and 1 % levels respectively. Standard errors are in round brackets.
Sources: Honohan and Lane (2003), *EUROSTAT*, own calculations.

Finally, Table 15 shows that the lagged price level is marginally significant in the EA12 and highly significant in the NMS. "For CPI inflation, the -0.03 point estimate implies that a country with a price level one-third below the European average would experience an additional one percentage point of inflation. This is significant in terms of the inflation variation observed in the euro zone but also implies that the convergence process is quite gradual (Honohan and Lane, 2003)." For HICP in the NMS, the -0.0569 and -0.0492 point estimates (from models of one and four lags respectively) indicate that the price convergence effect is stronger in the NMS than in the EA12. We assess those results as a logical consequence of the lower initial price level observed in the

NMS. In general, we can sum up that inflation differentials reflect price level convergence. The price convergence effect might be viewed as a long-run constraining factor on inflation differentials: long-run price levels in the euro zone should move together.

Summing up, these results show that a considerable proportion of the inflation differential in the EA12 over 1999-2001 and in the NMS over 1997-2006 can be systematically related to a small number of macroeconomic variables. However, the full explanatory power of the model is limited, especially when we take into consideration a high number of time dummies that were included in our econometric framework.

Conclusion

The aim of our diploma thesis was twofold. In the first part of the study, based mainly on literature review, we provided a description of the long-term trends and potential causes of inflation differentials in the EA12 as well as in the NMS. Indeed, it is worth noting that a majority of studies was dedicated to an analysis of inflation differentials and their sources in the original euro area. Much less work has been done with respect to such phenomena in the NMS. Therefore, we decided to attract more of our attention to the driving forces for inflation differentials in the NMS in the second part of this study.

Concerning the long-term trends in inflation differentials in the EA12 countries, we showed that inflation dispersion declined considerably in the run up to the third stage of the EMU during the 1990s. Inflation differentials became nearly comparable to those observed in the US. However, ECB (2003) appraised the differentials as relatively more persistent. Furthermore, some authors emphasized that the divergences in the evolution of the price levels across the EA12 increased after the introduction of the single currency in 1999. The loss of monetary independence of individual countries is seen as one of the influential factors in this respect. In addition, we stressed that there had been a relatively large and persistent inflation gap between countries which were mostly below the euro area average (i.e. Austria, Belgium, Finland, France and Germany) and countries which were mostly above the average (i.e. Greece, Ireland, Portugal and Spain) over the last decade. The maintenance of asymmetric and lasting inflation differentials seems to be a specific feature of the inflation diversity within the EA12. As regards the situation in the NMS, we indicated that inflation rates were higher than the EA12 average for all of them. In the last decade, the following similarities in trends among groups of countries were observed: inflation differentials of Cyprus, the Czech Republic and Malta fluctuated around the EA12 mean for most of the time; the U-shaped figure was characteristic for development of inflation differentials in the Baltic countries whose inflation rates went through the massive decline until 2003 but later surged up again; and finally, we labelled Bulgaria, Hungary, Poland, Romania, Slovakia and Slovenia as a group of high inflation countries that, however, underwent relatively successful process of disinflation.

While the measurement of inflation differentials is more or less straightforward, accurate identification of their driving factors resembles a fiendish puzzle. In this thesis, we have chosen the following segmentation of inflation differentials' determinants: Firstly, we discussed factors with potentially transitory effects that mainly relate to price level convergence processes in tradable as well as non-tradable sector. Secondly, we identified rather long-lasting causes, such as

divergences in consumption patterns, country's dependency on external environment (i.e. exchange rate movement, countries extra-openness, commodity structure of trade, etc.) and position in the business cycle. Finally, we focused on policy-induced factors. Disclosure of the relative contribution of various channels showed to be a complicated problem employing many researchers nowadays. For inspiration, we presented review of selected econometric studies from this field.

A key part of the diploma thesis was presented in Section 3 in which we investigated the driving factors for inflation differentials in the NMS by means of panel data analysis. In particular, we used the methodology of the influential study by Honohan and Lane (2003) exploring the role of nominal effective exchange rate, cyclical conditions, fiscal policies and price convergence in inflation differentials across the euro area countries. Our results suggest that these factors are important determinant of inflation differentials in the NMS, too.

More specifically, we demonstrated that nominal effective exchange rate movements have had a substantial impact on inflation in the NMS, reflecting the different degrees of exposure of member states to international trade. However, according to our outcomes it seems that this channel had relatively lower influence in the NMS than in the EA12. Generally speaking, our analyses proposed that the strengthening of the currency should lead to a fall in inflation, especially in the externally oriented member states. When comparing the results for the output gap and the fiscal stance, we recognized significant differences between outcomes of models for the EA12 and the NMS. While much of the remaining pattern of inflation movements in the EA12 was explained to a large extend by national output gaps in the blueprint study, our results indicated that the cyclical component is not so relevant in the NMS. As regards the role of fiscal policy, the situation was opposite. Our results showed that the fiscal stance matters in the NMS. Last but not least, we found that the price convergence effect is stronger in the NMS than in the EA12. We assess this result as a logical consequence of the lower initial price level observed in the NMS. To the future, we believe that nominal convergence will play a pivotal role in influencing the inflation differentials in the NMS.

Summing up, our analysis showed that a considerable proportion of the inflation differentials in the EA12 over 1999-2001 and in the NMS over 1997-2006 can be systematically related to a small number of macroeconomic variables. However, the full explanatory power of the model is limited, especially when we take into consideration a high number of time dummies that were included in our econometric framework.

In our concluding remark, we would like to alert that the existence of certain inflation differentials within the monetary union should not be necessarily seen as a signal of disequilibrium or loss of competitiveness, since it may be compatible with macroeconomic stability. Indeed, we tend to view a certain level of inflation differentials across countries as a normal feature and as an integral part of the adjustment mechanism of relative prices in a single currency area. Price level changes will be especially important for the NMS after they fix their currencies towards the euro, because they will serve as the only adjustment tool for the equilibrium real exchange rate appreciation that has been under the process in most of the transition economies. However, we must be aware of the fact that the re-equilibrating mechanisms sometimes appear slow to operate in the EU, and some of persistent divergences observed may be harmful if not seriously addressed by policy-makers.

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EUROSTAT

Appendix A: Balassa-Samuelson effects in the EU

Table 16: Inflation induced by Balassa-Samuelson effect – summary of results for the EU12

in %	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
Alberola-Tyrväinen (1998)											
1975-1993/1996	1.8	3.1	1.3	3.1	2.4	1.7			2.4	2.3	
1985-1993/1996	1.5	2.7	1.3	3.5	1.5	1.6			2.4	2.1	
Swagel (1999)											
1960-1996		1.7	0.3		1.4	0.2	0.8		1.8	0.5	2.0
1990-1996		0.2	0.0			-0.2	1.7		1.4	0.4	1.2
Aitken (1999)											
1993-1996								2.9			
Sinn-Reutter (2001)											
1987-1993/1995	1.4	0.8		1.5	2.4	1.3		2.4	1.5	1.4	0.8
1991/1995-1997/1999							4.3				
Canzoneri et al. (2002)											
1973-1991	1.2	2.4		1.5	1.0	1.1			2.0		
1973-1997	0.8	1.6		1.4	1.6	1.4			1.8		
Lommatzsch-Tober (2003)											
1995-2002	1.5	1.0	0.1	0.4	1.2	1.5	-0.1	2.6	0.5	0.6	-1.0
Wagner (2005)											
1992-2001	1.9	2.0		2.8	1.9	1.8			2.8	2.3	
Average	**1.4**	**1.7**	**0.6**	**2.0**	**1.7**	**1.2**	**1.7**	**2.6**	**1.8**	**1.4**	**0.8**

Note: Percentage points per annum.
Source: Égert, Ritzberger-Grünwald and Silgoner (2004).

Table 17: Inflation induced by Balassa-Samuelson effect – summary of results for the NMS

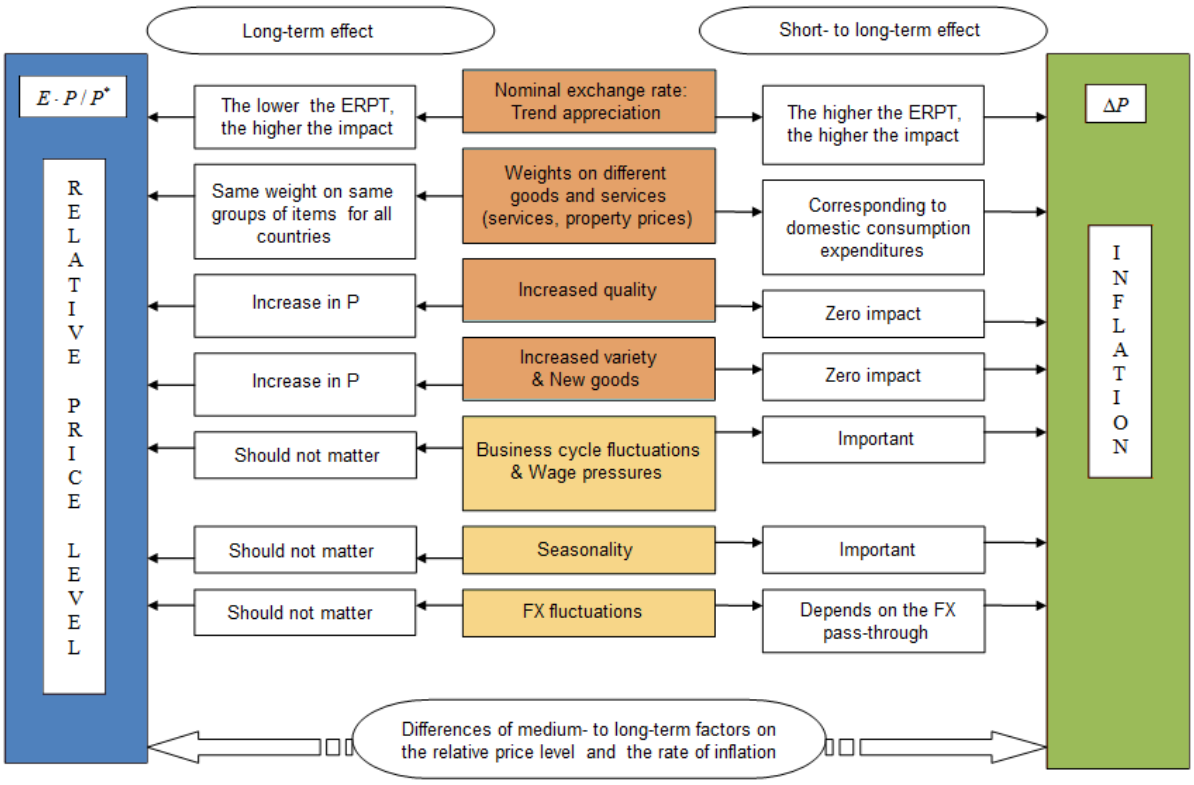
	BG	CZ	EE	HU	LV	LT	PL	RO	SK	SI
in %				**Conventional view (high estimates)**						
Backé *et al.* (2003)		0.8		4.9			9.8			3.9
Golinelli and Orsi (2002)		4.5		2.3			5.3			
Rosati (2002)		1.4	2.4	4.3			4.6			2.4
Rother (2000)							3.0			
Sinn and Reutter (2001)		3.1	3.6	7.1			4.4			3.6
Average		**2.4**	**3.0**	**4.6**			**6.0**			**3.2**
in %					**New view (low estimates)**					
Burgess *et al.* (2003)			0.8		0.8	0.9				
Égert (2002)		0.6		1.8			2.3		-0.4	-0.2
Égert (2005a)			1.1							
Égert (2005b)	-0.5							0.9		
Égert *et al.* (2003)			0.9	1.2			2.1		1.3	1.1
Flek et al. (2002)		0.1								
Kovács (2001)				1.9						
Kovács and Simon (1998)				2.0						
Kovács (2002)		0.5		2.3						
Mihaljek and Klau (2004)				1.6			1.5		0.7	0.7
Wagner and Hlouskova (2004)		0.6	0.3	1.1	0.5	1.0	1.1		0.2	0.9
Žumer (2002)										1.1
Average	**-0.5**	**0.4**	**0.7**	**1.7**	**0.6**	**0.9**	**1.7**	**0.9**	**0.4**	**0.7**

Note: Percentage points per annum.
Source: Égert, Halpern and MacDonald (2006).

Appendix B: Price level convergence versus inflation

In Figure 17, we present a diagram that was used by Égert *et al.* (2006). It illustrates that not necessarily price level convergence equals inflation, as often mixed up by general public.

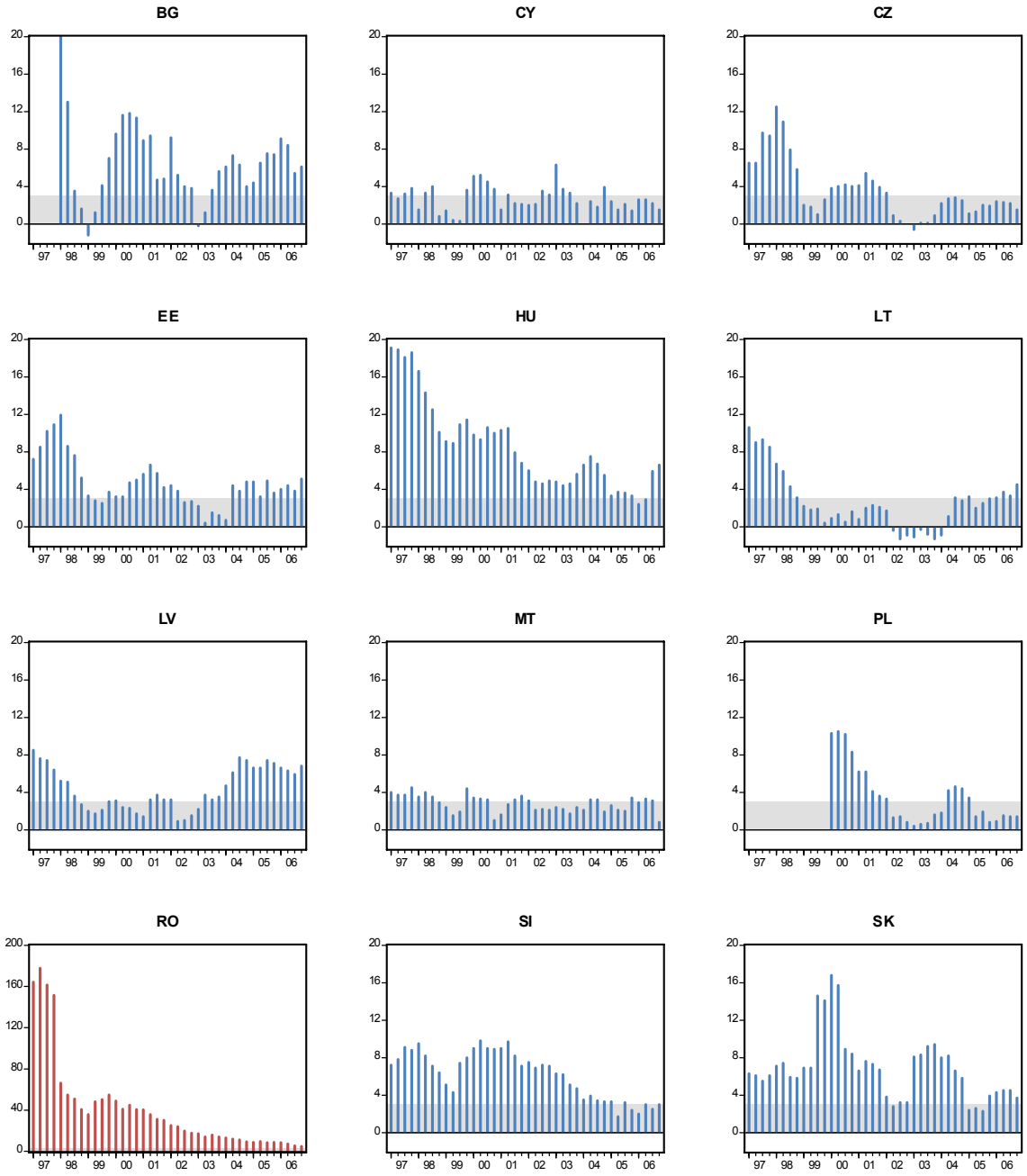
Figure 17: Differences and similarities of factors affecting price level convergence and inflation



Notes: E = nominal exchange rate, P = domestic price level, P* = foreign price level, ERPT = exchange rate pass-through.
Source: Égert *et al.* (2006).

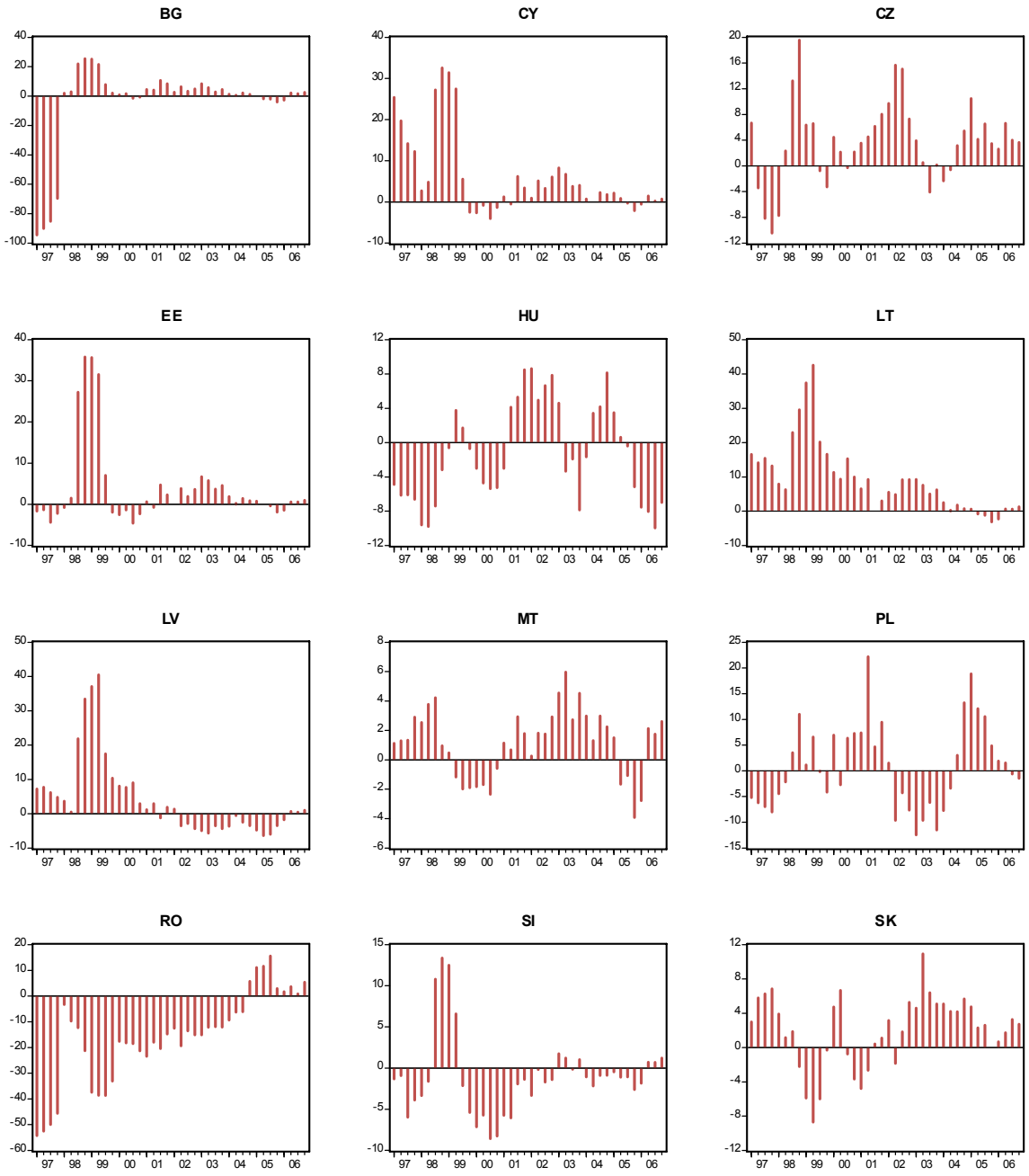
Appendix C: Model variables

Figure 18: Inflation rates in the NMS, 1997-2007



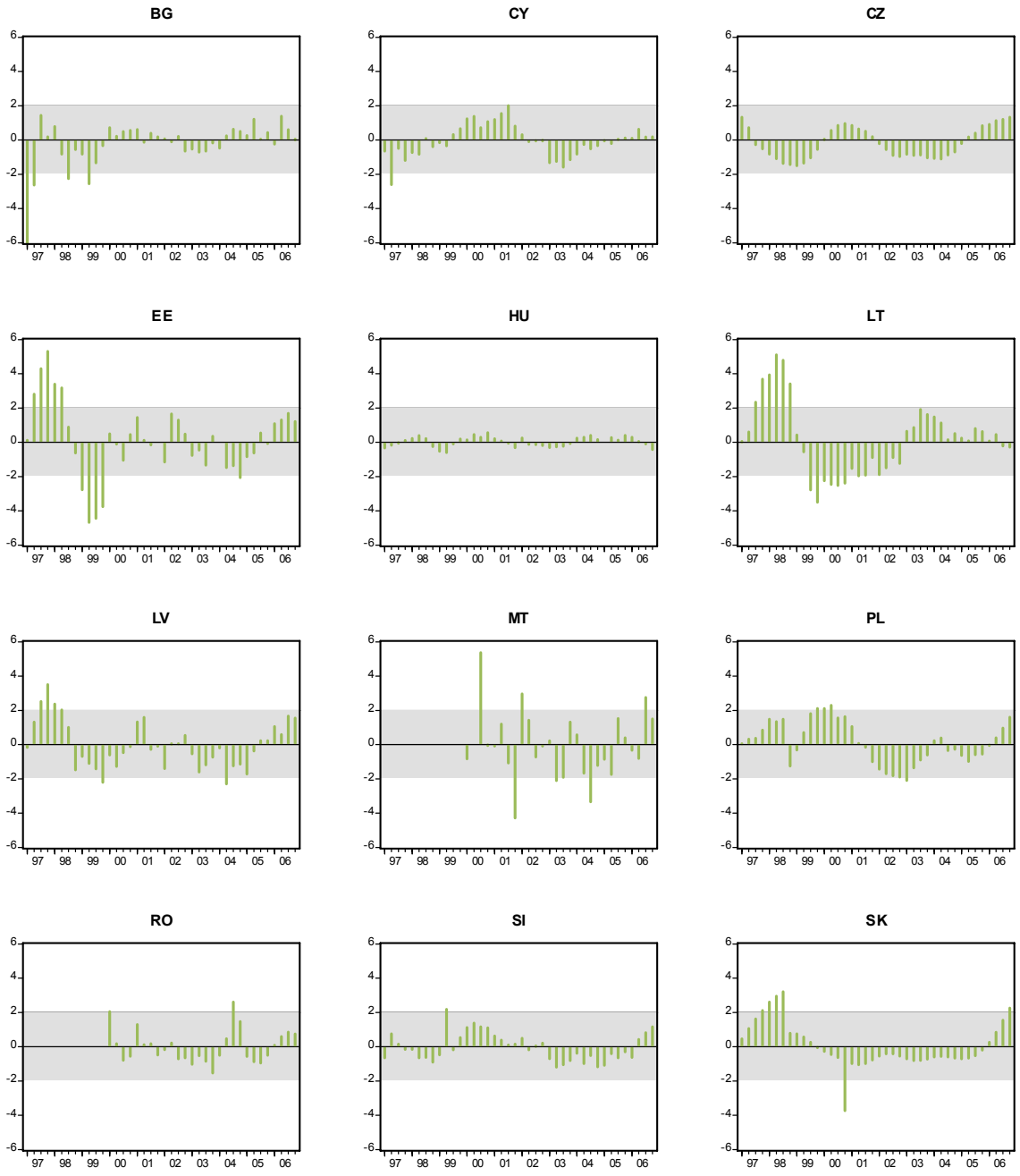
Notes: Inflation rate is based on Harmonized Index of Consumer Prices; y-o-y growth rate; quarterly data.
Source: Author's calculations based on *EUROSTAT* data.

Figure 19: The rates of change in the nominal effective exchange rates in the NMS, 1997-2006



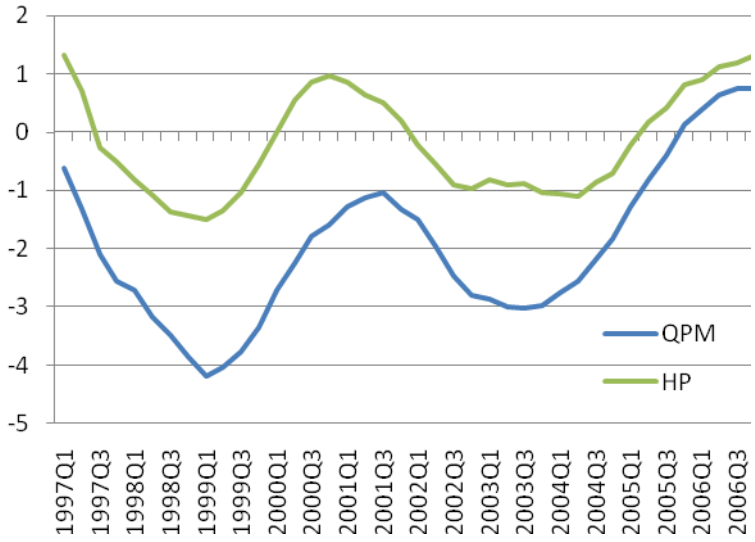
Notes: Positive (resp. negative) values denote appreciation (resp. depreciation) of the nominal effective exchange rate; quarterly data; in per cent per annum.
Source: Author's calculations based on *EUROSTAT* data.

Figure 20: Output gaps in the NMS, 1997-2006



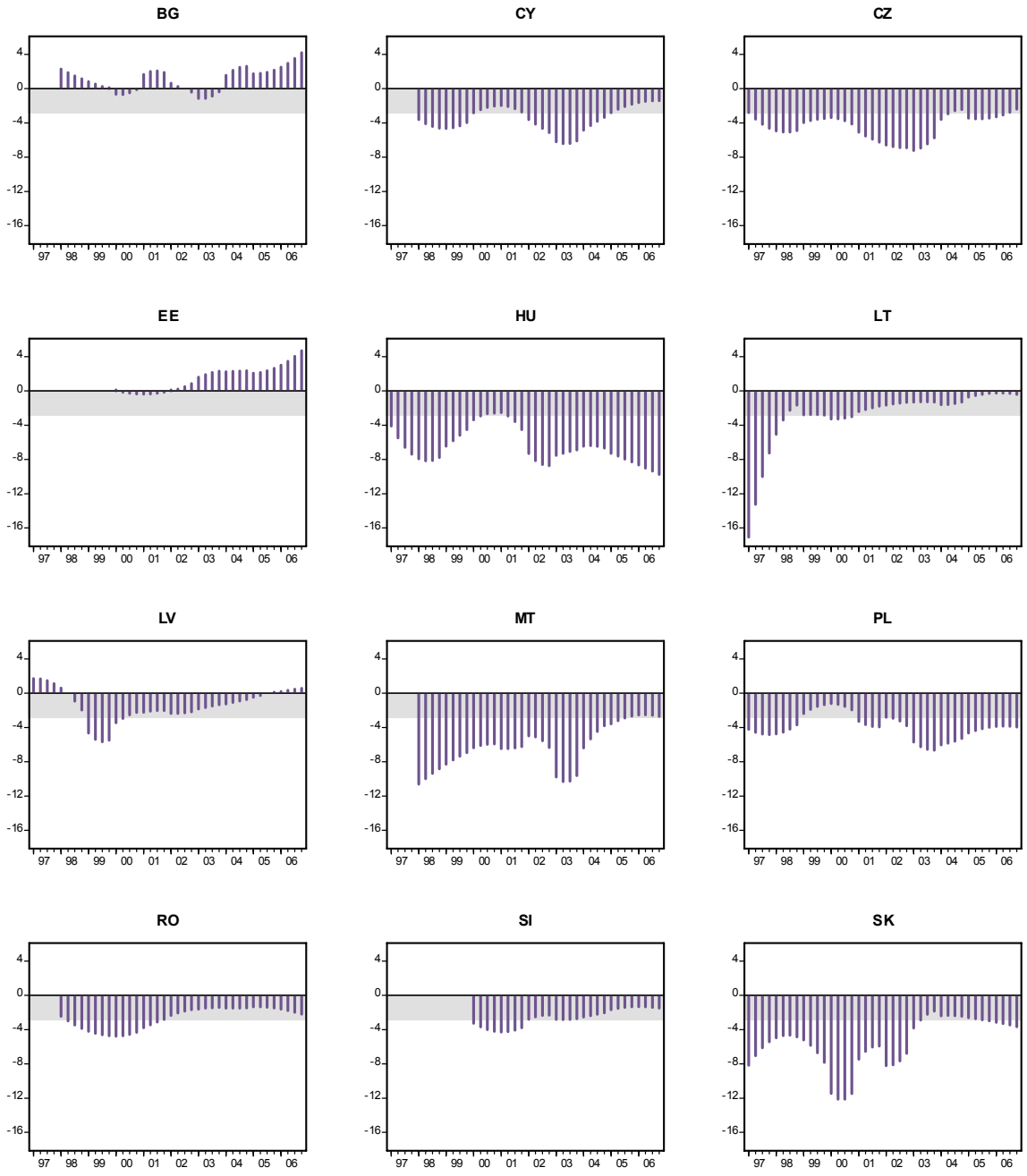
Notes: Output gaps were obtained by the Hodrick and Prescott filter in EViews; quarterly data; in percentage.
Source: Author's calculations based on *EUROSTAT* data.

Figure 21: Czech output gap - HP filter versus QPM's Kalman filter



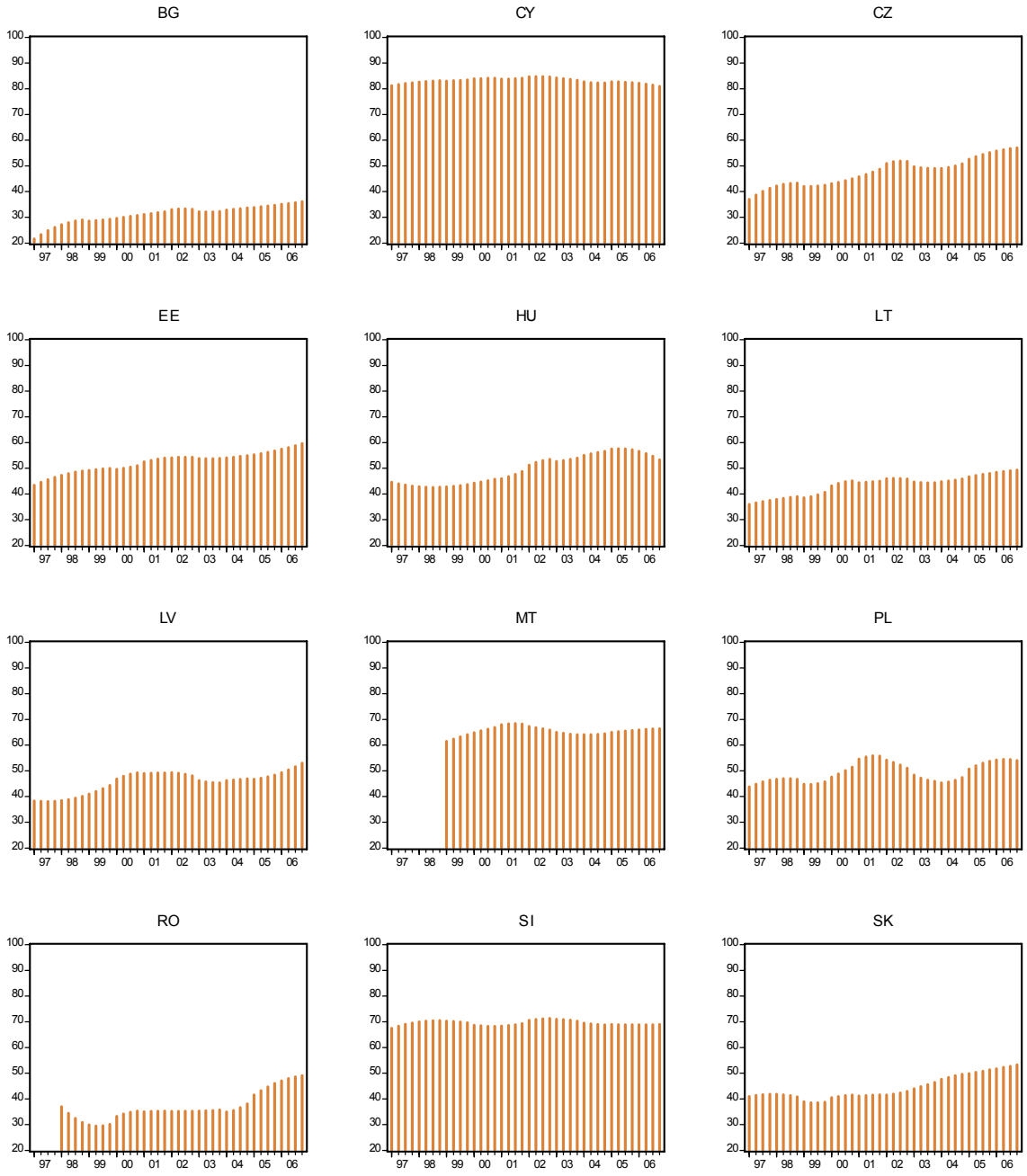
Notes: HP stands for Czech output gap obtained by Hodrick and Prescott filter; QPM indicates Czech output gap as obtained by Kalman filter in the Quarterly Projection Model of the CNB; in percentage; period 1997-2006.
Source: Author's calculations based on *EUROSTAT* data; database of the CNB.

Figure 22: Fiscal stance in the NMS, 1997-2006



Notes: Positive (resp. negative) values denote government surplus (resp. deficit); the retrieved annual data were transformed to quarterly data in EViews by low to high frequency method (quadratic-match average); percentage of GDP.
Source: Author's calculations based on *EUROSTAT* data.

Figure 23: Comparative price level indices of GDP in the NMS, 1997-2006



Notes: Price level is based on comparative price level indices from EUROSTAT; the retrieved annual data were transformed to quarterly data in EViews by low to high frequency method (quadratic-match average); EU15=100.
Source: Author's calculations based on *EUROSTAT* data.