University of Economics, Prague
Faculty of International Relations
Economics of Globalization and European Integration

Inflation differentials in the Eurozone

Master thesis

Author: Zuzana Hlinková
Supervisor: Prof. dr. André Van Peock
Academic Year: 2013/2014

Abstract

This thesis focuses on the statistical and econometrical analysis of inflation differentials in thirteen Eurozone countries in the period from 1999 to 2013. Within the scope of the statistical analysis, the evolution of inflation, inflation dispersion, and unit labour costs in the euro area as well as in thirteen member countries is examined. Another part provides an evidence on inflation differentials time series behaviour. The QLR test detects a presence of break for every country, however the break dates do not fit the timing of the financial crisis. Both ADF and Hadri test agree on the lack of convergence, whereas Levin, Lin and Chu test finds that each time series is stationary. Moreover, an idea that the standard unit root tests may be affected by a nonlinear behaviour of inflation differentials is considered. Subsequently, the possible sources and implications of inflation differentials are discussed following a distinction into transitory, permanent, and policy induced factors. The last chapter employs Arellano-Bond estimation in order to determine which factors explain inflation differentials. The results point out to the prevalence of country specific structural factors such as product market regulation. In addition, inflation persistence, economic climate, differences in cyclical positions, and indicators of external position also significantly affect inflation differentials, however its contribution is just minor compared to PMR. Finally, deregulation of the product market through the elimination of state control, barriers to entrepreneurship, and barriers to trade and investment is proposed. Nevertheless, the data suggest that some kind of deregulation is already underway.

Key words: Inflation differentials, absolute convergence, unit labour costs, inflation, inflation dispersion, ECB, Eurozone, stability tests, unit root tests, general-to-specific approach, structural factors, equilibrating forces, Balassa-Samuelson effect, price level equalisation, economic climate, external position, inflation persistence, convergence, differences in cyclical positions, financial crisis, product market regulation, product market deregulation.

Declaration of authorship

I, Zuzana Hlinková hereby declare that the thesis "Inflation differentials in the Eurozone" was written by myself, and that all presented results are my own, unless stated otherwise. The literature sources are listed in the Literature review section.

Prague, September 30th, 2014

signature

Aknowledgements

I would like to express my sincerest thanks to Prof. dr. André Van Poeck for his guidance, support, patience and valuable recommendations.

Table of Contents

Introduction 8
1. Dynamic properties of euro area inflation differentials 10
   1.1. Inflation rate in the Eurozone 10
   1.2. Inflation dispersion in the Eurozone 12
   1.3. Inflation rate in the Eurozone member countries 13
   1.4. Inflation differentials in the Eurozone member countries 15
   1.5. Unit labor costs in the Eurozone member countries 16
   1.6. "Adjusters", "surplusers" and possible scenarios 18
   1.7. Conclusion of the chapter 18
2. Testing the convergence and the stability of inflation differentials 20
   2.1. Terminology 20
   2.2. Summation of empirical evidence 20
   2.3. Testing for breaks 21
      Quandt likelihood ratio statistic 21
      Performing the QLR test 23
   2.4. Univariate stability tests: Augmented Dickey-Fuller test 23
      Performing the ADF test 24
   2.5. Multivariate stability tests 25
      The multivariate test selection 25
      Hadri stationarity test 25
      Levin, Lin and Chu unit root test 26
   2.6. Is there a better model to test the stability of inflation differentials? 27
      Finding of Gregoriou, Kontonikas, & Montagnoli 27
   2.7. Conclusion of the chapter 28
3. Sources and implications of inflation differentials 29
   3.1. Sources of inflation differentials 29
   3.2. Implications: Why is it such an issue? 31
   3.3. Conclusion of the chapter 32
4. Econometric analysis of the determinants of inflation differentials 33
   4.1. Estimation methodology - Dynamic panel data model 33
      Arellano-Bond estimator 33

4.2. Variables of the model 34

4.3. Estimation results 37

4.4. Product market (de)regulation 41

4.5. Conclusion of the chapter 43

Conclusion of the thesis 45

Literature review 47

List of Figures, Tables, and Pictures

Figure 1.1.: Boom followed by crisis and unemployment 10
Figure 1.2.: Inflation rate in the Eurozone from 1997 to 2013 12
Figure 1.3.: Inflation dispersion in the Eurozone from 1997 to 2013 13
Figure 1.4.: Inflation rates in thirteen Eurozone countries 14
Figure 1.5.: Inflation differential in thirteen Eurozone countries from 1997 to 2013 16
Figure 1.6.: Unit labour costs change from 1997 to 2013 17

Table 1.1: Euro area average inflation of adjusters compared to surplusers 18
Table 2.1.: Summary of empirical evidence 22
Table 2.2: QLR statistics, 2000m01 – 2014m07 23
Table 2.3: ADF tests, 2000m01 - 2014m07 24
Table 2.4: Hadri LM test for ID, 2000m01 – 2014m07 26
Table 2.5: Levin, Lin, Chu test, 2000m01 – 2014m07 27
Table 4.1: Dependent variable, explanatory variables, theory, data description and its source 36
Table 4.2: The nature of explanatory variables 37
Table 4.3: Estimation results: Arellano-Bond estimator with robust standard errors 40
Table 4.4: Specific model, determinants of Eurozone inflation differentials 41
Table 4.5: PMR indicator in the EU and the US 43

Picture 4.1 : Composition of the PMR indicator 42

List of Abbreviations

HICP	Harmonised Index of Consumer Prices
EU	European Union
VAT	Value Added Tax
ULC	Unit Labour Costs
ECB	European Central Bank
QLR	Quandt Likelihood Ratio
ADF test	Augmented Dickey-Fuller test
TRAMO	Time series Regression with ARIMA noise, Missing values and Outliers
KPSS test	Kwiatkowski–Phillips–Schmidt–Shin test
OLS	Ordinary Least Squares
AIC	Akaike Information Criterion
EMU	European Monetary Union
ESTAR model	Exponential Smooth Transition Autoregressive model
LM	Lagrange Multiplier
EPL	Employment Protection Legislation
PMR	Product Market Regulations
GDP	Gross Domestic Product
CCI	Consumer Confidence Indicator
HAC	Heteroskedasticity Autocorrelated Consistent
EZ	Eurozone
EA	Euro Area

Introduction

The similarity in inflation rates constitutes one of the necessary conditions that an OCA is required to meet in order to work as designed. If this condition is not met, the area should not be eligible to adopt a common currency. In the absence of the possibility of exchange rate adjustments at the national level, it would be troublesome to correct resulting external imbalances (Mongelli, 2005). This condition has been built into the Maastricht convergence criteria via stating that that the HICP inflation should not exceed the HICP reference value (Drastichova, 2013). However, the lower bound is not specified nor there is a mechanism of sanctions preventing national inflation rates from diverging after the accession.

Inflation differentials accompany the Eurozone thorough its existence. Although the inflation dispersion had a decreasing tendency from the year 2000 to 2007, the financial crisis has likely entailed an exacerbation of the inflation dispersion. The future evolution seems to follow an upward trend. The inflation differentials may emerge for several reasons. Transitory factors causing inflation differentials are related to the process of convergence of national price levels or productivities and should by definition die away autonomously. Hence, these factors need not to be worrisome. On the other hand, permanent factors that arise from the heterogeneity among member states´ regional structures constitute further more serious issue. These factors will certainly not fade away without an intervention correcting the regional structures. Consequently, to identify the driving forces behind inflation differentials is crucial in order to design the best policy response that would try to assure the homogeneity required to create an OCA.

Likewise, it is important to examine time series properties of inflation differentials so as to determine whether the impact of the idiosyncratic shocks has permanent or just temporary nature. The finding that the effects are persistent would question the viability of the Eurozone since it would not be consistent with the definition of the OCA. On the other hand, a temporary nature would mean that inflation differentials result from the equilibrating processes and do not constitute an obstacle for the conduct of common monetary policy. (Gregoriou, Kontonikas, & Montagnoli, 2011)

The ECB cannot address inflation differentials directly since its primary goal is price stability exclusively. However, the ECB is truly aware of the threat embodied in inflation differentials and take them into account while setting the safety margin for admissible inflation in the Eurozone. (Fendel & Frenkel, 2010) The famous Tinbergen rule states stat at least one policy instrument is needed in order to reach each policy objective. In case of the ECB, the instrument is the intersect rate policy which strive to influence the area-wise inflation rate. Therefore, an additional instrument would have to be employed if the inflation differentials are to be addressed. (Darvas, & Wolff, 2014)

The "one size fits all" policy does not have to fit all provided that the Eurozone does not form homogenous OCA. The nominal interest rate is set on the basis of the average euro area figures, however, the real interest rate differs among the members in the presence of inflation differentials. A country going through a boom often experiences higher inflation rate. It implies lower real interest rate which provides further incentive for boosting the demand (via investment and consumption). The cyclical disparities among members would therefore be even deepened. Another source of imbalances, working in the opposite direction, stems from the real exchange rate channel. The logic is that the competitiveness of a country having higher inflation rate is diminished and its current account is worsened; see for example Busetti (2007).

In an effort to answer the question indicated above, the paper is organised as follows. In section one we perform statistical analysis of inflation, inflation differentials, and unit labour costs since the start-up of the EMU to 2013. In chapter two we examine time series behaviour of inflation differentials. Univariate ADF test and multivariate Hadri and Levin, Lin and Chu tests are employed for this purpose. Using QLR statistic, the hypothesis that the financial crisis constituted a structural break in the dynamics of inflation differentials is tested. Chapter three assesses the potential causes and implication of inflation differentials in the Eurozone. Chapter four aims at econometric analysis of determinants of inflation differentials in the Arellano-Bond estimation framework. The relevance of the theories described in the previous chapter is tested and the policy implications are discussed. The last part concludes.

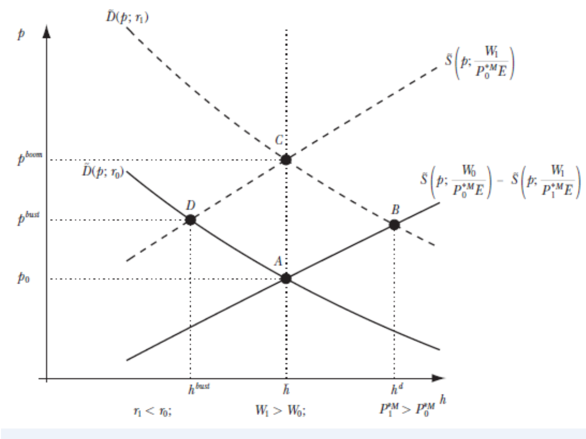
1. Dynamic properties of euro area inflation differentials

This part describes an evolution of inflation, inflation dispersion, inflation differentials, and unit labour costs covering the period from 1997 to 2013 in thirteen member countries that entered the Eurozone in 1999 (with exceptions specified in brackets) – Belgium, Germany, Ireland, Greece (2001), Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland and Slovenia (2007). In each graph the yellow line represents the year of adoption of the Euro and the green line indicates the beginning of the financial crisis (2008). Finally, the blue line marks a zero level. The final part presents a division into “adjusters” and “surplusers” categories.

1.1. Inflation rate in the Eurozone

Inflation rate has been measured as a year-to-year change of HICP of euro area countries from 1997 to 2013. Figure 1.1. displays an average euro area inflation rate. One can observe a sharp increase in inflation immediately after the start of single monetary policy. Values close to 2 percent were characteristic to the period from 2001 to 2007 which corresponds to the ECB’s primary goal of price stability. The ECB define the price stability as “a year-on-year increase of the HICP for the euro area close to but below 2 percent”[1] (Pentecost, 2013). The inflation target is marked by the black line. However, there still is an existence of doubts whether this target has not been set too low and whether the ECB is not failing it price stability mandate (Ubide, 2013). Schmitt-Grohe, & Uribe (2013) went further and set the optimal short term inflation rate at 4 % – this rate should deflate real wages and ease the consequences of the financial crisis.

Figure 1.1.: Boom followed by crisis and unemployment



Source: Schmitt-Grohe, Uribe (2013), p. 203.

In the period from 2008 to 2009 there was a dramatic fall preceded by a considerable increase in the Eurozone inflation rate coinciding with the beginning of the financial crisis. With reference to Figure 1.1., this can be explained (Schmitt-Grohe, & Uribe, 2013) by “boom-bust” episodes taking place in the periphery of Europe. Let us assume that the point A represents the situation in 2000 when the Euro was adopted. Consequently, borrowing rates declined sharply, especially in peripheral countries. This entailed a shift of the demand of nontradables up and to the right crossing the supply curve at the point B. As the labour supply is represented by the vertical line, it is clear that labour demand exceeded labour supply at the point B. Hence, nominal wages began to rise – moving the supply schedule up and left in order to reach the new equilibrium at the point C, where both wages and relative prices are higher and economy enjoys full employment. The point C could represent the “booming period” at the peak of the business cycle in the second quarter of the year 2008. It explains the increase in inflation at the threshold of the crisis. The empirical evidence proves that this theory fits the case of the euro area before 2008 – inflation rate rose rapidly

[1] Before the year 2013 the target was defined just as „below 2 %“.

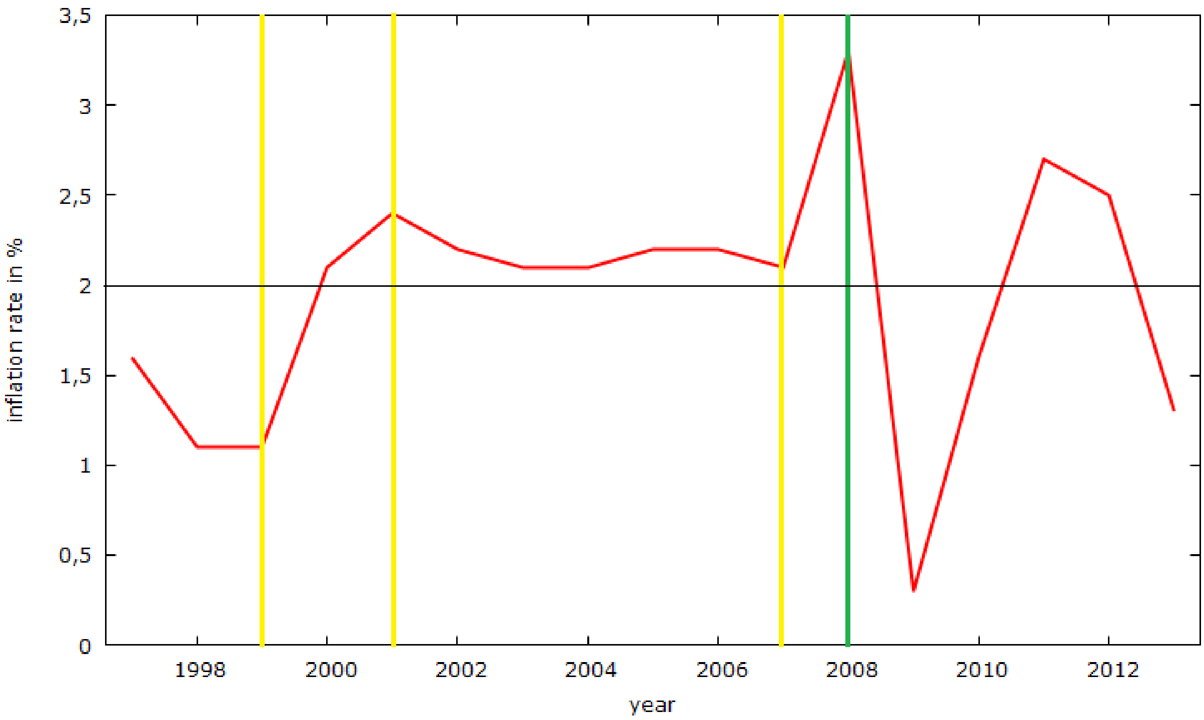
(see Figure 1.2.) and so did the labour costs (see Figure 1.6.). In accordance with Ubide (2014), the spike in inflation in the year 2008 arose from the acceleration in commodity prices.

In 2010 and 2011 inflation went steadily up again followed by a decrease in inflation down to 1.34 % observed in 2013. The following trend is apparently downwards. According to Ubide (2013, p. 1) "markets expect some small probability of deflation in 2014 and average inflation over the next five years in the 1.25 to 1.5 % range". It is also worth remarking that the currently low inflation is not generated by several outliers, but inflation is low in all observed countries (see Figure 1.4.). As pointed out by Darvas, & Wolff (2014), deflationary tendencies ought to be worrisome since it may lead to difficulties with servicing the high debt and to hampering the recovery and growth due to the higher real exchange rate. They also suggested that an unemployment may increase provided that the nominal rigidities are present in the region.

That is why the ECB has recently announced a series of extraordinary liquidity operations. So called targeted longer-term refinancing operations are aimed at supporting lending to the real economy, boosting inflation, and improving the functioning of the monetary transmission mechanism (Reuters, June 05, 2014). However, there are concerns that these measures may fall flat until there is more conditionality preventing the bankers from using the "cheap money" to buy, for example, relatively riskless sovereign debts with high yields (Gore, 2014; Jones, 2014). Furthermore, the main refinancing rate together with the rate on overnight deposits and emergency borrowing rate were lowered (Carrel, 2014). Also, the outright purchase in the ABS market is under preparations (Reuters, 2014) and Quantitative easing is suggested to be employed in case of further decline of inflation rate (Shankar, 2014; Speciale, & Tartar, 2014). However, these macroprudential policy measures are unlikely to be effective in addressing inflation differentials (Darvas, & Wolff, 2014).

The following phase till 2009 can also be explained with reference to the "boom-bust" concept – specifically, the phase of boom followed by crisis and unemployment. When the recession hit in 2008, borrowing conditions deteriorated significantly. This is reflected in the shift of the demand curve back down to its initial position (see Figure 1.1.). Now we would be at the point D, not A, because nominal wages are not downwardly flexible and cannot fall as rapidly as needed to restore equilibrium at the point A. As a result, involuntary unemployment emerges and the downward rigidity prevents the economy from restoring full employment. (Schmitt-Grohe & Uribe, 2013) This explanation, based on the fact that inflation is demand driven, is also supported by the ECB (2012).

Figure 1.2.: Inflation rate in the Eurozone from 1997 to 2013

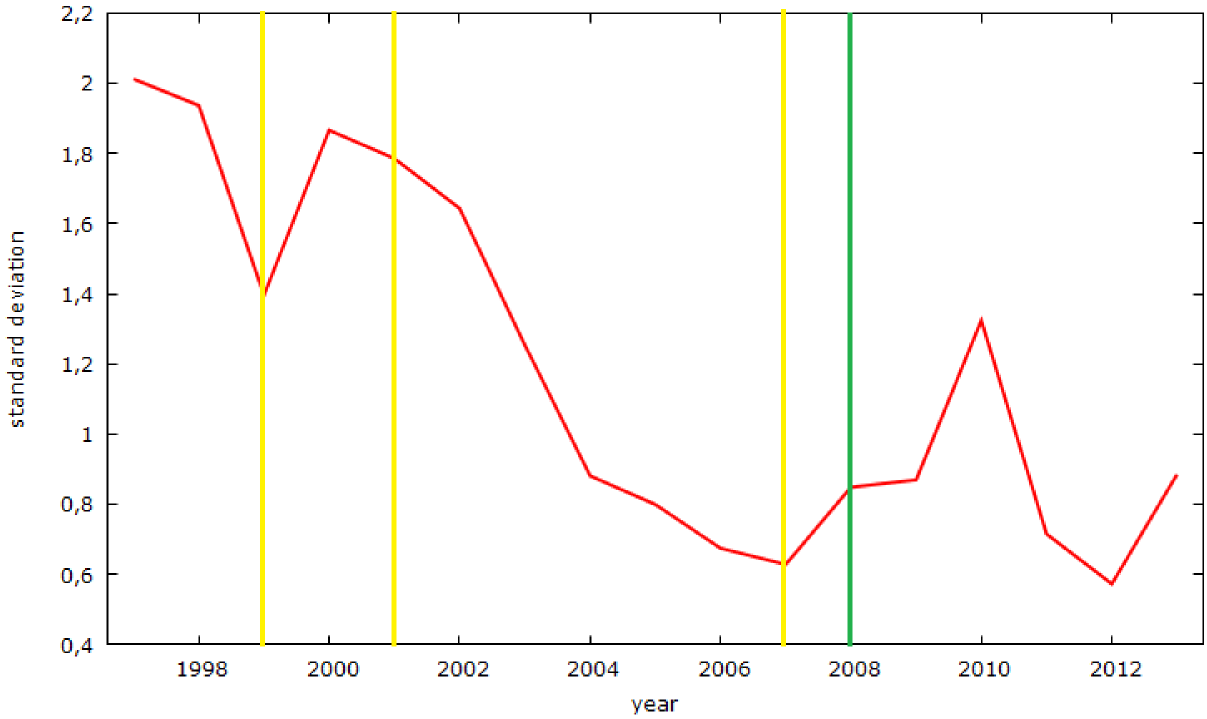


Source: Eurostat – HCPI indices, own computation.

1.2. Inflation dispersion in the Eurozone

Figure 1.3. demonstrates an evolution of inflation dispersion over the period from 1997 to 2013. Standard deviation computed for thirteen Eurozone countries was used as a measure of inflation dispersion. The figure shows that standard deviation reached 1.4 % in the year 1999 when 11 countries adopted the Euro. This was followed by quite significant increase reaching its peak in 2000 when the dispersion approached 2 %. After the year 2000, the Eurozone experienced a gradual decrease in inflation dispersion with a local minimum at 0.6 % in 2007. The period from 2007 to 2010 was characterised by a sharp growth culminating around 1.4 %. It seems that Greece joining in 2001 did not cause any significant disturbance in the euro area inflation dispersion. Although there was an increase in 2007 coinciding with admission of Slovenia, it should rather be ascribed to the outset of financial crisis or maybe to the combination of these two factors. One can notice that the dispersion tended to decline again from 2010 to 2012. The evolution after the year 2012 suggests an upward tendency to the future.

Figure 1.3.: Inflation dispersion in the Eurozone from 1997 to 2013



Source: Eurostat – HCPI indices, own computation in MS Excel and GRETL.

1.3. Inflation rate in the Eurozone member countries

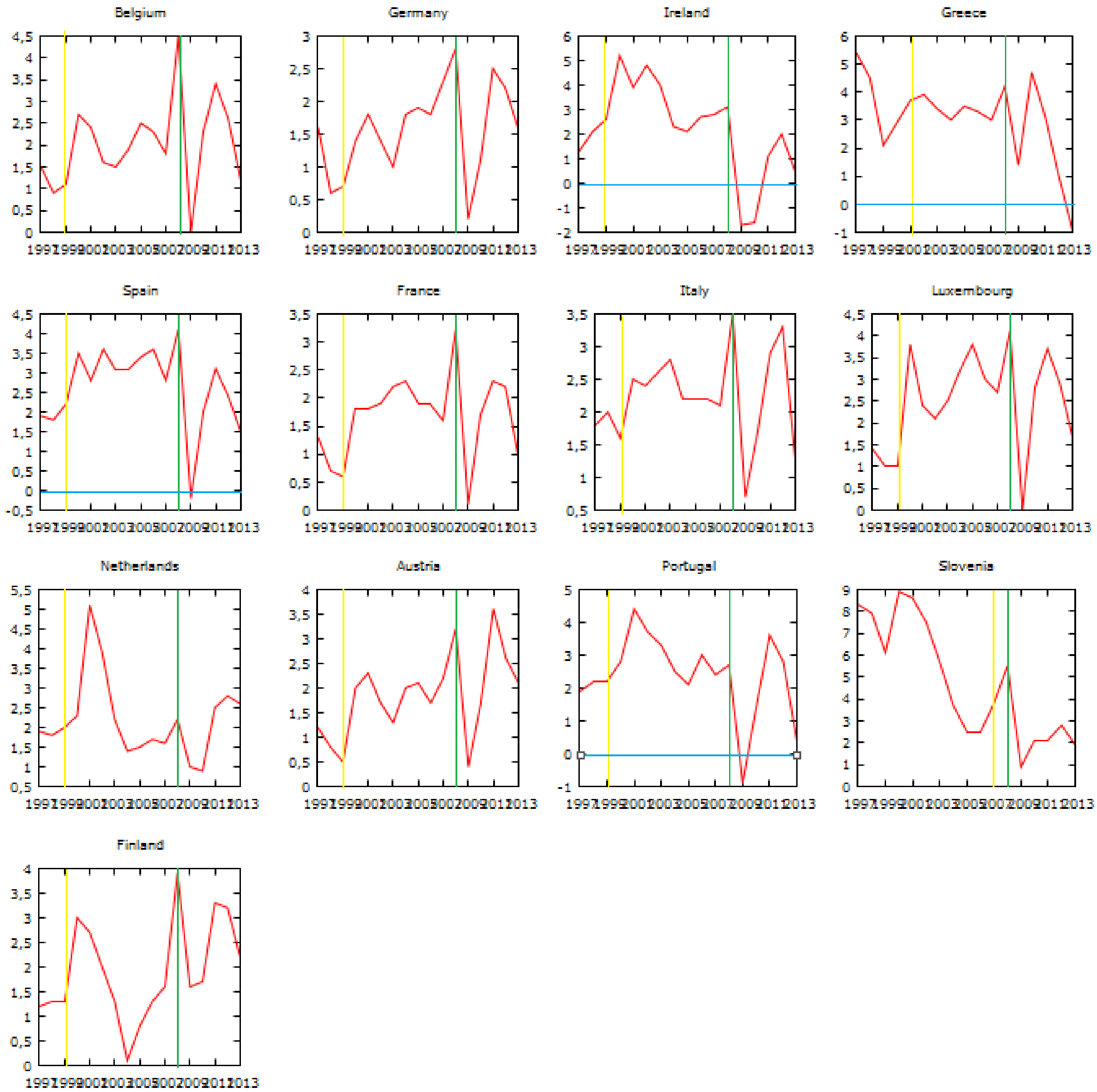
Figure 1.4. reflects an evolution of inflation in thirteen euro area countries from 1997 to 2013. Although euro area inflation rate ranged constantly around 2 %, large and persistent differences across countries were present. As pointed out by Morsy & Jaumotte (2012), the difference between minimum and maximum inflation reached 3 % on average. The distinct price falls preceding the adoption of the common currency can be attributed to the rapid fiscal consolidation that took place in an effort to meet the convergence criteria (Paleta, 2012).

A division into low inflation and high inflation countries suggests itself when looking at the axis Y. Among the members of the high inflation group would certainly be Ireland, Greece, Spain, Portugal, Luxembourg, and Slovenia. It is argued that competitiveness of these countries deteriorated due to sustained inflation differentials and also the catch up growth was hampered through lowering the price competitiveness of exports (Morsy & Jaumotte, 2012; Senjur, 2010). The higher inflation, which reduced the real interest rate and made the borrowing cheaper, was the reason behind the boosted demand and increased credit before the crisis in these countries (Darvas, & Wolff, 2014). Its antithesis would definitely be Germany (with inflation below the 2% target for most of the period), France, Austria, and Finland.

According to Senjur (2010), the introduction of the common currency in 2002 did not cause any significant inflationary pressures in the majority of the Eurozone countries. On the other hand, Slovenia experienced a very different evolution when the Euro was introduced in 2007 – inflation rate unexpectedly jumped from 2.5 % to 3.6 % in 2007 and to 5.7 % in 2008. Taking into account that the empirical evidence is weak due to the very short period involved, it still seems that the mechanism for adjusting to asymmetric shocks has changed as a result of giving up the national exchange rate policy. In Slovenia, inflation was accelerated by the catch-up price effect resulting in the natural rate of unemployment to be higher compared to the rest of the Eurozone. The positive inflation differentials could be handled through demand and income management – by managing relative ULC[2]. This is what happened in Slovenia after 2007 - low ULC were the major determinant of its export competitiveness. Nevertheless, it is argued that this situation is not really sustainable in the long run. (Senjur, 2010)

At the first glance, it seems that the year 2008 meant a dramatic change in inflation dynamics across all countries in the sample. A sharp decrease took place in 2008 but inflation started to rebound after 2009.

Figure 1.4.: Inflation rates in thirteen Eurozone countries



Source: Eurostat – HCPI indices, own computation, GRETL software.

[2] This measure is called an internal devaluation.

1.4. Inflation differentials in the Eurozone member countries

Inflation differentials were computed as a difference between country specific inflation rates and aggregate Eurozone inflation rate. We can use the following formula to define inflation differential:

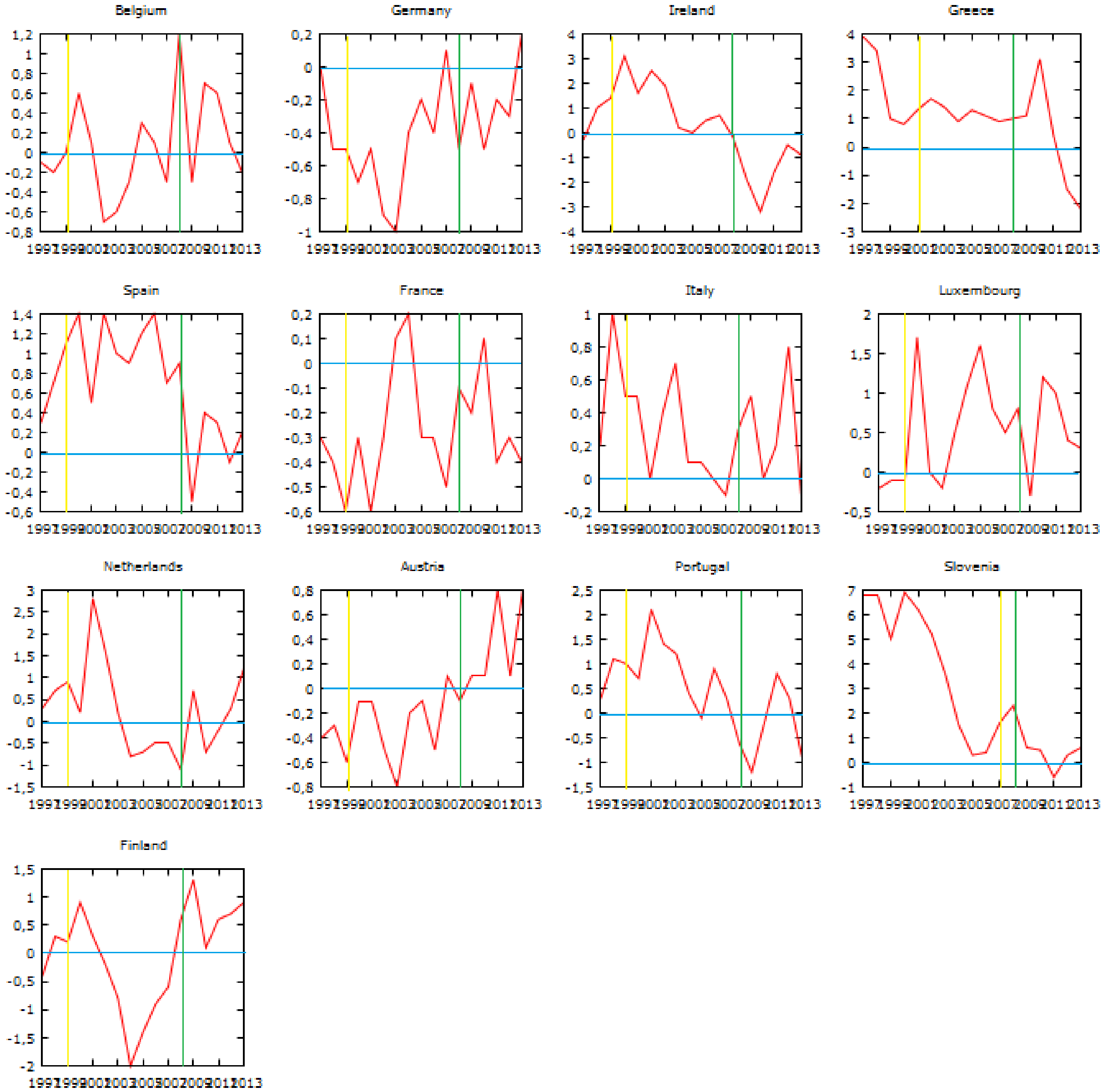
$$\Delta\pi_{i,t} = \pi_{i,t} - \pi_{EA,t}$$

The Figure 1.5. shows an evolution of inflation differentials in thirteen youngest Eurozone countries from 1997 to 2013. Inflation differentials started to show lower dispersion at the start-up of the EMU in 1999. This may be interpreted as a reaction to Maastricht convergence criteria and the obligation of Eurozone candidates to meet one out of five adherence criteria. This condition states that "HICP inflation shall be no more than 1.5% higher, than the unweighted arithmetic average of the similar HICP inflation rates in the three EU member states with the lowest HICP inflation" (Pentecost, 2013, ch. 6, p. 21). From April 2011 to March 2012, for example, the reference value of this criterion was 3.1 % (Press release, 2012). As pointed out by Honohan and Lane (2003, quoted in Busetti et al., 2007) a depreciation of the Euro could account for the increase in inflation differentials in several countries right after the start-up of the EMU.

Quite clear is again the division into the low inflation and high inflation countries just by observing the location of the zero level line or the scale of axis Y. As pointed out by Morsy & Jaumotte (2012, p. 6), inflation differentials in the period from 1999 to 2008 were "broad-based, with differences in services inflation playing a key role" (especially in high inflation countries). Nevertheless, goods inflation contributed significantly as well although it may be mainly thanks to its larger weights in the consumption basket than that of services. Regarding the high inflation countries, the positive inflation differentials were caused both by strong core inflation (excluding items facing volatile price movements (Investopedia, 2014)) and food price inflation. The exception is Luxembourg where inflation was driven mainly by food and energy prices. (Morsy, & Jaumotte, 2012) "The analysis shows that high employment protection legislation and intermediate collective bargaining played a major role in the persistent inflation differentials in Greece, Portugal, and Spain over 1999 - 2010, whereas contribution of product market regulation was negligible" (Morsy, & Jaumotte, 2012, p. 14). In case of Ireland, the positive inflation differential could not be explained by inefficient labour market institutions. On the other hand, more efficient labor market institutions, highly coordinated bargaining system and lower employment protection helped Germany keep inflation low. (Morsy, & Jaumotte, 2012). However, this statement is questioned by Akyol, Neugart, & Pichler (2013).

The moderation of inflation after the crisis in 2008 did only manage to substantially correct the accumulated inflation differentials in Ireland. Inflation differentials became negative in Portugal and Spain, nevertheless, this anomaly lasted just very short time and the inflation differentials have returned to its previously positive values in 2010. It is believed that significant increases in energy prices and in VAT contributed to the return to positive numbers. In Greece, inflation differentials remained positive till 2011 when it decreased sharply. However, any of the high inflation countries (with exception of Ireland) did not achieve to diminish its accumulated price differences with the euro area. (Morsy & Jaumotte, 2012)

Figure 1.5.: Inflation differential in thirteen Eurozone countries from 1997 to 2013



Source: Eurostat (2014), own compilation using Gretl software.

1.5. Unit labour costs in the Eurozone member countries

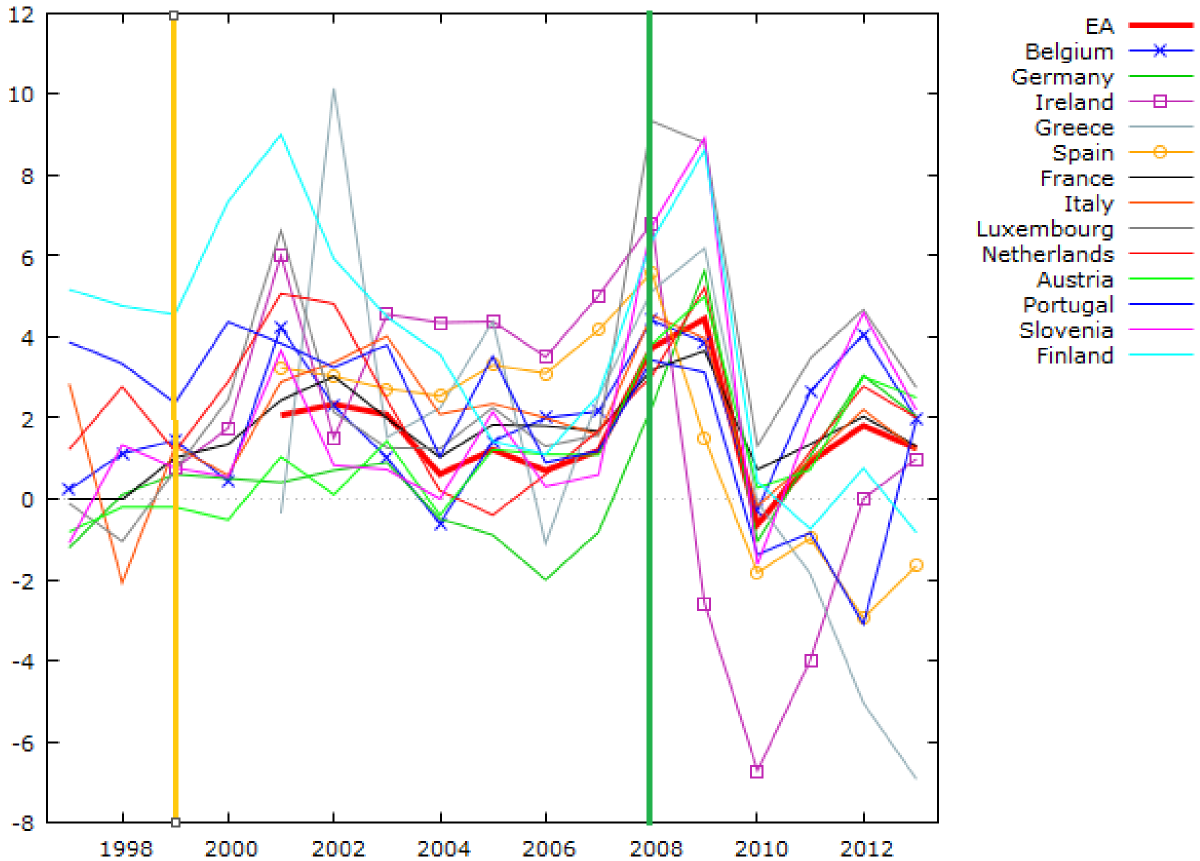
As Morsy & Jaumotte (2012) pointed out, a large part of inflation from 1999 to 2008 was driven by a change in the ULC, particularly in high inflation countries. The authors suggested to decompose inflation into the contribution of labour costs, profits, and net taxes in order to reveal the driving forces behind the supply side. Similarly, the ECB (2012) claim that the main part of inflation differentials from 2002 to 2012 came from the ULC and the gross operating surplus. The correlation between inflation and ULC growth has been strong especially since 2008. Thus, the countries such as Germany, experiencing lower inflation rates, were the ones that started to correct for previously very high growth of ULC. (ECB, 2012) "However, the significant ULC correction in the adjusting countries has not been fully translated into lower domestic inflation, partly owing to the resilience of profit margins."(ECB, 2012, p. 82)

In case of Spain and Greece, the positive inflation differentials were caused either by dynamic growth in ULC and operating surplus in the period from 2002 to 2008, whereas high inflation in Ireland and Portugal stemmed from the ULC dynamics alone. Its strong dynamics, particularly in Ireland, Greece, and Spain, can be ascribed to a relatively high increase in compensation per employee. The period after 2008 was marked by a distinctive downward correction of ULC in Ireland, Greece, Spain, and Portugal. This was done through substantial wage reductions in Ireland, Greece, and Portugal. On the other hand, Italy did not perform any significant ULC adjustment in the second period – the fall in productivity was not followed by a downward adjustment of wages. (ECB 2012)

The Figure 1.6. displays an evolution of the ULC as a year-on-year change in the period from 1999 to 2013 across thirteen euro area countries. It shows that the evolution of ULC within euro area followed very similar pattern. There was a notable increase in the ULC after the Euro introduction followed by a gradual decrease up to the financial turmoil years when the ULC reached its peak to be ensued by a sudden fall. The drop was pronounced especially for the southern countries such as Portugal, Spain, Greece, and for Ireland. With the exception of Greece, it seems that the values are returning to its pre-crisis level.

According to the Darvas, & Wolff (2014) the first nine years of the common currency were characterised by an excessive increase in the ULC and inflation in several member countries. The resulting subdued real interest rate stimulated an emergence of bubbles in these high inflation countries.

Figure 1.6.: Unit labour costs change from 1997 to 2013



Source: Eurostat, own computation using GRETL software.

1.6. "Adjusters", "surplusers", and possible scenarios

Table 1.1. demonstrates a division of the euro area members into "adjusters" and "surplusers". The "adjusters" group is composed of countries struggling with issues of competitiveness and the need to adjust through disinflation – let us assume it is Spain, France, Italy, Portugal, Greece, Cyprus, and Ireland. On the other side are "surplusers" – the rest of the euro area countries not dealing with any competitiveness problems. The pre-crisis levels of inflation both in adjusters and surplusers countries enabled to generate euro area inflation in accordance with the ECB´s price stability mandate. Nevertheless, the situation in 2013 has changed considerably. Both surplusers and adjusters are experiencing lower inflation rates, thus, the euro area inflation is not able to meet the price stability target. The period from 2010 to 2013 was characterised by tax hikes causing temporarily higher inflation rates. Assuming that adjusters will continue in their efforts to regain competitiveness and that surplusers will not boost their inflation rates, the probability of moving the euro area inflation back to 2 % is very low. Picturing the optimistic scenario (highlighted with the red line), where the adjusters would run inflation of 1 percent, the surplusers would have to reach inflation of about 3.2 % in order to attain the targeted euro area inflation rate. Such a high future inflation is, however, improbable because even during the first decade of the Euro the rate was just half. Even if the surplusers experienced the level of inflation similar to that during the first decade, the euro area would achieve inflation just about 1.3%, which is not compatible with the price stability. (Ubide, 2014)

Table 0.1: Euro area average inflation of adjusters compared to surplusers

Date	Adjusters	Spain	Surplusers	Germany	Euro Area
1998–2007	2.5	3.0	1.8	1.4	1.9
2010–13	2.1		2.3		2.1
December 2013	0.6		1.5		0.9
2014–16, scenarios	1.0		1.4		1.2
	1.0		1.4		1.2
	1.0		1.8		1.3
	1.0		2.0		1.4
	1.0		2.5		1.6
	1.0		3.2		1.9
	1.4		1.4		1.4
	1.4		1.6		1.5
	1.4		1.8		1.6
	1.4		2.0		1.7
	1.4		2.5		1.9

Note: Adjusters include Spain, France, Italy, Portugal, Greece, Cyprus, and Ireland; surplusers include the rest of euro area countries.
Source: Eurostat and author's calculations.

Source: Ubide (2014, p. 9)

1.7. Conclusion of the chapter

This chapter examined the dynamic properties of euro are inflation differentials. The analysis of the evolution of the inflation rate was supported by "boom-bust" episodes concept. Further, inflation dispersion was found to exhibit a decreasing tendency for the majority of the period examined with a sudden upsurge likely brought about by the financial crisis. The future trend was predicted to be increasing. While analysing inflation rates and inflation differentials in thirteen Eurozone countries, one could notice large and persistent differences. Furthermore, the year 2008 seemed to constitute a break in inflation for all the countries. The composition

of the inflation in several countries was also discussed.
Finally, the evolution of the ULC was described since it is believed to represent one of the main drivers of inflation. The ULC were found to follow a similar pattern by the majority of the countries.

To conclude, the graphical analysis indicated certain tendency to divergence, however, it is necessary to test this hypothesis empirically. Similarly, the hypothesis that the year 2008 represented a break should be examined closer.

2. Testing the convergence and the stability of inflation differentials

This chapter provides an evidence on inflation differentials time series behaviour. Firstly, the QLR statistic is performed in order to verify the hypothesised structural break triggered by the financial crisis. Afterwards, ADF test as a representative of univariate unit root tests is used to examine the process of convergence of inflation differentials. Finally, the convergence and the stability are tested with the help of multivariate tests. The Hadri stationarity test is performed so as to determine whether the convergence was present over the sample period. The analysis is completed with Levin, Lin and Chu panel unit root test.

These test are applied on thirteen Eurozone countries in the period from January 2000 to July 2014. The data on monthly change of HCPI used to construct monthly inflation differentials extracted from Eurostat will be used throughout this chapter. The data were seasonally adjusted by TRAMO analysis in Gretl. The contribution of this paper to the existing literature lies mainly in extending the period examined to July 2014, inclusion of Slovenia into the sample, and assessing the impact of the financial crisis. Moreover, the idea that inflation differentials may be characterised by nonlinear behaviour is considered.

2.1. Terminology

First of all, the terminology has to be clarified. Convergence in this context can be defined as a permanent convergence towards the same level of inflation (or inflation differential) across the Eurozone member countries. Absolute convergence describes a situation when all the countries converge towards the same level of inflation. In different words, this would mean a tendency towards zero inflation differential. With conditional convergence, each country can converge to its own steady-state, where these are allowed to differ. (Pentecost, 2013) Obviously, this thesis is interested in absolute convergence only.

Furthermore, a distinction between stationarity and unit root tests has to be made since the meaning of these tests is often erroneously interchanged. Stationarity tests are designed to detect whether the time series have already converged – whether the difference between them tends to remain stable. On the other hand, unit root tests are used to verify whether two or more variables are in the process of converging. To put it differently, convergence is analysed by testing the null hypothesis of unit root, whereas stability is examined by testing the null of stationarity. (Busetti et al., 2007)

To determine time series properties of inflation differentials is of vital importance. Detecting a unit root in the respective time series would suggest that the idiosyncratic shocks influencing the country´s inflation rate have persistent effects. The question whether the euro area constitutes an OCA is likewise related to this finding. Moreover, the alleged convergence in the pre-euro period would be put into question. On the other hand, the conclusion that inflation differentials are characterised by a stationary process would imply that the current asymmetries are just temporary phenomena and therefore do not require any structural interventions. (Gregoriou, Kontonikas, & Montagnoli, 2011)

2.2. Summation of empirical evidence

The issue of inflation time series behaviour has been of interest of many papers which employed mainly unit root and cointegration methods. One can see an overview of the results quoted in the related literature in the Table 2.1. It can be seen that the majority of these tests agreed that the inflation differentials were converging in the pre-Euro period. On the contrary, the nature of the dynamics after the introduction of the Euro is ambiguous. That is the reason why this paper focuses on the later period.

2.3. Testing for breaks

One of the objectives of this paper is to determine whether the financial crisis constituted a structural break in the inflation differentials dynamics. This will be verified using Quandt likelihood ratio statistic – test designed for testing for a break at an unknown break date. Accordingly to the result, the period would be divided and the following tests would be performed for each period separately.

Quandt likelihood ratio statistic

The QLR statistic is a modification of a Chow test. The Chow test tests the null hypothesis of no break using binary variable interaction regression. Let us consider a model with intercept and a single lag on Y and X where τ stands for the hypothesized break date and D(τ) for the binary variable which is 0 before and 1 after the break date. The model looks as follows (Stock & Watson, 2011):

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \delta_t X_{t-1} + \gamma_0 D_t(\tau) + \gamma_1 [D_t(\tau) x Y_{t-1}] + \gamma_2 \left[D_{t(\tau)} x X_{t-1}\right] + u_t$$

Under the null hypothesis of no break, the terms involving the break binary variable do not enter the equation, that is $\gamma_0 = \gamma_1 = \gamma_2 = 0$. Under the alternative, at least one of the $\gamma' s$ is nonzero. F-statistic is used to test the hypothesis that $\gamma_0 = \gamma_1 = \gamma_2 = 0$ against the alternative of at least one nonzero coefficient γ.

Furthermore, when the date of hypothesised break is known only within a range, the Chow test can test for breaks within the chosen range and then use the largest F-statistic to test for a break at known date as usual. The critical values for the QLR statistic are available from a special distribution since it is different from individual F-statistics. The distribution depends on the number of restrictions being tested and $\frac{\tau_0}{T}$ and $\frac{\tau_1}{T}$ – the endpoints of the chosen subsample expressed as a fraction of the total sample size. A common practise is to use 15% trimming – that is set for τ_0 = 0,15 T and for τ_1 = 0,85 T. The trimming is employed in order to avoid the endpoints being too close to the beginning or the end of the sample.

Table 2.1.: Summary of empirical evidence

Year of publication	Author	Period	Method	Result, conclusion	Comments	Source
1997, 1998, 2002	Siklos, Wohnar; Holmes; Amián, Zumaquero	1974 - 1995	cointegration tests	convergence		Gregoriou, Kontonikas, Montagnoli (2011); Pirovano, Van Poeck (2011)
1997	Kocenda, Papell	pre-euro period	panel ADF unit root test	convergence		Gregoriou, Kontonikas, Montagnoli (2011)
2002	Holmes	1983 - 1990	panel data unit root and cointegration tests	convergence		Busetti et al. (2007)
2003	Beck, Weber	1981 - 2001	beta and sigma convergence analysis	**inflation dispersion among European regions is higher than in the US or in Japan**		Busetti et al. (2007)
2004	Angeloni, Ehrmann	after the introduction of the Euro	esmination of stylized multi country structural model	**the persistence of ID is determined by the level of ID persisence at the country level**		Busetti et al. (2007)
2006	Busetti et al.	pre-euro period	univariate and multivariate unit root tests	convergence		Gregoriou, Kontonikas, Montagnoli (2011); Pirovano, Van Poeck (2011)
2006	Busetti et al.	after the introduction of the Euro	univariate and multivariate unit root tests	divergence	evidence of divergence between 1998 and 2004 in particular	Gregoriou, Kontonikas, Montagnoli (2011); Pirovano, Van Poeck (2011)
2005	Beck, Weber	1991 - 2004	beta and sigma convergence	convergence	evidence of convergence at very limited speed	Pirovano, Van Poeck (2011)
2004	Rodriguez-Fuentes et al.	1980 - 1988	ADF; ADF with GLS detrending; the Elliot, Rothemberg and Stock optimal point; Phillips-Perron; KPSS test	divergence	evidence of nonstationarity in 8 out of 11 EMU countries	Gregoriou, Kontonikas, Montagnoli (2011)
2011	Gregoriou, Kontonikas, Montagnoli	1996 - 2009	the nonlinear unit root test of Kapetanios et al.	convergence		Gregoriou, Kontonikas, Montagnoli (2011)

Performing the QLR test

The range in which we expect the break date to be located was determined on the grounds of visual analysis of the Figure 1.4 and 1.5. It seems that some kind of break occurred at the outset of the financial crisis around the year 2008 – let us assume to find the break in the period from 2007m01 to 2008m05. Nevertheless, since the common practise is to use a range with 15% trimming, the test has been performed over the period from 2002m03 to 2012m04. Since the option of HAC standard errors was chosen, a slight modification of the test follows. “If the model uses a robust estimator for the covariance matrix, the test statistic is a Wald chi-square value based on a robust estimator of the covariance matrix for the augmented regression” (Diaz-Emparanza, 2008).

With reference to the Table 2.2., the null hypothesis of no break can be rejected at the 5% significance level for all the time series. However, detected breaks are neither located in the expected range, nor there is a single break date for all the countries. The most frequent break date, with 6 incidences, is February 2006. The second, two times repeated break date, is February 2003. The rest did not find any match. We can conclude that the financial crisis did not constitute a structural break in the inflation differentials dynamics. It seems that the pre-crisis economic climate in the year 2006 rather than the crisis itself gave rise to the change in inflation differentials behaviour, at least in Greece, Spain, France, Italy, Luxembourg, the Netherlands, and Austria. Consulting the Figure 1.3., it can be seen that inflation dispersion also begun to increase just around the year 2006. Nevertheless, the detected break dates are not uniform, that is why the period will not be divided for the purpose of following tests.

Table 2.2.: QLR statistics, 2000m01 – 2014m07

country	break date	lag order	asymptotic p-value	chi-square	maximum Wald test
Belgium	2005m05	46	0.00000	1.79769e+308	1.79769e+308
Germany	2003m08	22	0.00000	1.79769e+308	1.79769e+308
Ireland	2003m02	6	0.04032	22.517	22.517
Greece	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Spain	2011m04	5	0.02961	21.5184	21.5184
France	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Italy	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Luxembourg	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Netherlands	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Austria	2006m02	57*	0.00000	1.79769e+308	1.79769e+308
Portugal	2012m04	13	4.46e-031	186.352	186.352
Slovenia	2003m02	8	1.343e-006	52.2613	52.2613
Finland	2004m08	7	8.219e-013	81.0544	81.0544

*the maximum of lags possible to select in GRETL

Source: Eurostat (2014), authors’ statistical analysis using Gretl.

2.4. Univariate stability tests: Augmented Dickey-Fuller test

Widely used Augmented Dickey-Fuller test developed by Dickey and Fuller (1979) was chosen to test whether the inflation differentials time series contain a unit root. In other words, we check whether the inflation differentials were converging over the period 2000m01 – 2014m07.

The basis of the ADF test is the autoregressive model of order p. The regression is specified as follows (Stock, & Watson, 2011):

$$\Delta Y_t = \beta_0 + \delta Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \gamma_2 \Delta Y_{t-2} + \ldots\ldots + \gamma_p \Delta Y_{t-p} + u_t$$

where the β_0´s represent constants and u_t is a random disturbance term. Any serial correlation in u_t is prevented by stating the equation in the first difference form (Gregoriou, Kontonikas & Montagnoli, 2011). Subsequently, the equation is estimated by OLS. The test calculates the Student´s T-statistic for the null hypothesis that $\delta=0$ against the one-sided alternative so that $\delta<0$. The null hypothesis is the one of unit root whereas the alternative states stationarity. The test must use the true distribution provided by Dickey and Fuller as it does not have a normal distribution even for large samples. The number of lags may be estimated by Bayes or Akaike Information Criterion. (Stock, & Watson, 2011; Jayet, 2014)

Performing the ADF test

Since this paper is interested in testing the hypothesis of absolute convergence, it is recommended to consider the model without constant, e.g. all β_0´s = 0. Moreover, the exclusion of intercept term is proved to increase the power of the test. (Busetti et al., 2007) Therefore, the test is performed excluding both intercept and trend. The number of lags was determined automatically by Gretl software on the basis of modified AIC. The estimates of γ´s were required to be negative and significantly different from zero in order to reject the null hypothesis (Gregoriou, Kontonikas, & Montagnoli, 2011).

The results shown in the Table 2.3. suggest that a unit root is present in eight out of thirteen time series examined – for Belgium, Germany, Greece, France, Italy, Luxembourg, the Netherlands, and Austria the null hypothesis can be accepted. On the other hand, there is an evidence of the process of convergence for Ireland, Spain, Portugal, Slovenia, and Finland since the null hypothesis can be rejected at the 5% significance level. To sum up, there is an evidence of unit root behaviour of inflation differentials for the majority of analysed Eurozone countries.

Table 2.3: ADF tests, 2000m01 - 2014m07

Country	t-stat	p-value	lag order
Belgium	-1.116	0.2408	46
Germany	-1.41805	0.1458	22
Ireland	-2.18051	0.02814*	6
Greece	-0.591554	0.4614	78
Spain	-3.00278	0.002609*	5
France	0.157576	0.7319	74
Italy	-0.377719	0.5486	63
Luxembourg	-0.0993308	0.6495	71
Netherlands	-0.814892	0.3632	78
Austria	-1.01807	0.2781	83
Portugal	-2.63581	0.00814*	13
Slovenia	-2.38411	0.01656*	8
Finland	-2.48608	0.01251*	7

*reject H_0 at 5% significance level

Source: Eurostat (2014), authors' statistical analysis using Gretl.

2.5. Multivariate stability tests

The stability testing of inflation differentials may also be carried out with help of panel unit root and stationarity tests which have become widely used in recent years. "Testing for stationarity in a panel framework increases the power of the test (the probability that the test rejects the null hypothesis when it is actually false) as the number of cross-sections grows, leading the distribution of the test to approach normality" (Pirovano & Van Poeck, 2011, p. 9).

The multivariate test selection

In order to decide which test to use for testing the stability of inflation differentials in a panel data framework, a study by Hlouskova & Wagner (2006) comparing the first generation tests (designed for cross-sectionally independent panels) was analysed. The panel unit root tests included in the study were developed in following papers: Levin, Lin and Chu (2002), Harris and Tzavalis (1999), Breitung (2000), Im, Pesaran and Shin (1997 and 2003), and finally, two panel stationarity tests developed in Hadri (2000), and Hadri and Larson (2005). Tests which are not standardly available in commercial software were dropped out.

The paper clearly concludes that panel stationarity tests by Hadri (2000) and Hadri and Larson (2005) tend to perform very poorly. This finding is connected with the poor performance ascribed to Kwiatkowski et al. test (1992) which constitutes the Hadri´s tests building stone. Notwithstanding this finding, the test could be useful for its different explanatory power compared to unit root tests. The results of the simulations have led to a conclusion that Levin, Lin and Chu (2002), and Breitung (2000) tests are the best alternatives considering its smallest size distortions and good power performance – that is why this test was chosen over others. (Hlouskova, & Wagner, 2006) However, the condition of cross-country independence assumed by the majority of these panel unit-root tests is unlikely to be satisfied. As a result, size distortions and power loss of these tests can be pronounced (Busetti et al., 2007).

Hadri stationarity test

The Hadri (2000) test is a residual-based Lagrange multiplier test which is, in fact, a generalization of the KPSS test from time series to panel data. The null hypothesis states that there is no unit root in any of the series in the panel and the alternative that at least one unit root is present in the panel. A representation of a Hadri test without a trend will be considered. The model based on OLS residuals of y_{it} on a constant is specified as follows (Baltagi, 2008):

$$Y_{it}=r_{it} + \varepsilon_{it} \qquad i= 1,\dots\dots,N;\ t=1,\dots\dots,T$$

Where $r_{it}=r_{i,t-1} + u_{it}$ is a random walk, ε_{it} and u_{it} are mutually independent normal that are i.i.d. across i and over t. If we substitute backward, we can get:

$$y_{it} = r_{i0} + \sum_{j=0}^{t} u_{ij} + \varepsilon_{it} = y_{it} = r_{io} + v_{it}$$

where $v_{it} = \sum_{s=1}^{t} u_{is} + \varepsilon_{it}$. The null hypothesis of stationarity can be translated into zero variance of u_{it} – we test whether σ_u^2 equals to zero. It would also imply that v_{it} = ε_{it}. The LM statistics is the following:

$$\frac{\frac{1}{N}\left(\sum_{i=1}^{N}\frac{1}{T^2}\sum_{t=1}^{T}S_{it}^2\right)}{\widehat{\sigma_\varepsilon^2}}$$

where $S_{it} = \sum_{s=1}^{t}\hat{\varepsilon}_{is}$ is the partial sum of OLS residuals and $\widehat{\sigma_\varepsilon^2}$ is a consistent estimate of σ_ε^2under the null hypothesis.

The results of the test in two specifications without trend are reported in the Table 2.4. – with and without an assumption of cross sectional dependence (variant robust/ not robust to heteroskedasticity across panels). Allowing for cross sectional dependence should mitigate the drawbacks of this test. However, both alternatives lead to the same conclusion that is a rejection of H_0 claiming that all panels are stationary. In different words, this test points to the fact that some panels contain a unit root and that the time series have not converged yet. This finding is consistent with the conclusion of ADF test.

Table 2.4: Hadri LM test for ID, 2000m01 – 2014m07

Test specification	Test statistic	P-value
Cross sectional independance	42.1249	0.0000
Cross sectional dependance	33.0198	0.0000

Source: Eurostat (2014), authors' statistical analysis using Stata 12.

Levin, Lin and Chu unit root test

Levin, Lin and Chu (2002) suggested a new panel unit root test in order to improve the power of the test which is said to be limited for individual unit root tests. They proposed the null hypotheses so that each time series contains a unit root against the alternative that each time series is stationary. The lag order is allowed to vary across individual time series. The test is performed in a three-step procedure (Baltagi, 2008):

First of all, ADF test for each cross section is run on the equation:

$$\Delta y_{it} = \sigma_i y_{i,t-1} + \sum_{L=1}^{p_i}\Theta_{iL}\Delta y_{i,t-L} + \alpha_{mi}d_{mt} + \varepsilon_{it} \qquad m = 1, 2, 3$$

where d_{mt} indicates the vector of deterministic variables and α_{mi} the corresponding vector of coefficients for model m = 1, 2, 3. In particular, d_{1t} ={empty set}, d_{2t} = {1} and d_{3t} = {1, t}.

Then we run auxiliary regressions:

1. Δy_{it} on $\Delta y_{i,t-L}$ and d_{mt} so as to obtain the residuals $\hat{e}_{it}$ and
2. $y_{i,t-1}$ on $y_{i,t-1}$ and d_{mt} to obtain the residuals $\hat{v}_{i,t-1}$

The next step requires to standardize the residuals by performing:

$$\tilde{e}_{it} = \frac{\hat{e}_{it}}{\hat{\sigma}_{\varepsilon i}}$$

$$\tilde{v}_{i,t-1} = \frac{\hat{v}_{it}}{\hat{\sigma}_{\varepsilon i}}$$

where $\hat{\sigma}_{\varepsilon i}$ stands for standard error from each ADF test. The last step is to run pooled OLS regression:

$$\tilde{e}_{it} = \sigma\tilde{v}_{,i,t-1} + \tilde{\varepsilon}_{it}$$

The null hypothesis is that σ = 0. The main weakness of this test is the assumption of cross-sectional independence. Furthermore, the null hypothesis is very restrictive and does not allow for any intermediate option but each time series containing a unit root. However, its power performance is believed to be good compared to the other panel unit root tests (Hlouskova & Wagner, 2006).

The test was performed in specification without constant and trend. The lag selection was based on the results from ADF test based on modified AIC for each time series. Clearly, the null hypothesis that each time series contains a unit root may be rejected at any significance level with reference to the extremely low p-value. Although the test concludes that each time series is stationary, which is incompatible to our previous findings, the over restrictiveness of the alternative and the assumption of cross sectional independence should be kept in mind.

Table 2.5: Levin, Lin, Chu test, 2000m01 – 2014m07

coefficient	t-share	z-score
-0.88543	-10.432	-10,4214 [0,0000]

Source: Eurostat (2014), authors' statistical analysis using Gretl.

2.6. Is there a better model to test the stability of inflation differentials?

As Kruse (2011) and Kilic (2011) point out, a unit root may be falsely found by standard unit root tests when the true data generating process exhibits nonlinearities. This may be the case of inflation differentials if the hypothesis that the greater the inflation differential, the higher the speed of adjustment towards the EMU average, is considered (Gregoriou, Kontonikas, & Montagnoli, 2011). Likewise, the power of these unit root tests proved to be quite or even dramatically low in confrontation with nonlinear alternatives (Kilic, 2011). On top of that, yearly inflation differentials which are said to be more persistent may bias the unit root test (Gregoriou, Kontonikas, & Montagnoli, 2011).

On that account Kapetanios et al. (2003), Park and Shintani (2005), Rothe and Sibbertsen (2006), and Kruse (2008) developed a model that should be freed from these flaws – non-linear exponential smooth transition autoregressive model with lagged level as the transition variable under the alternative (Kilic, 2011). The increase in power is suggested to be quite important in comparison with other tests (Kilic, 2011; Kruse, 2011). Furthermore, the higher the speed of nonlinear adjustment, the better the model should perform. (Kilic, 2011)

Finding of Gregoriou, Kontonikas, & Montagnoli

Gregoriou, Kontonikas, & Montagnoli (2011) performed both linear and nonlinear unit root tests. The standard linear tests (ADF and Ng Perron) results are in accordance with the findings of this paper – that "the inflation differentials are fully persistent in the majority of the Eurozone members with the alarming implication that common monetary policy leads to permanently diverging real interest rates" (Gregoriou, Kontonikas, & Montagnoli, 2011, p. 538).

Before running the nonlinear test, the authors used nonlinearity testing procedure formulated by Terasvitra (1994) so as to detect nonlinear mean reverting behaviour in inflation differentials time series[3]. The null of linearity was rejected in all cases apart from Greece and Luxembourg. After the application of the ETAR unit root test, the conclusion was quite different – the inflation differentials were found to be characterised by a stationary mean reverting process. The paper concludes that if we allow for nonlinearity, the persistence in inflation differentials is significantly lower. The structure of inflation differentials hand in hand with the lower power of standard linear unit root tests should be taken into consideration and findings of this paper should definitely not be ignored. (Gregoriou, Kontonikas & Montagnoli, 2011)

2.7. Conclusion of the chapter

This chapter aimed at assessing inflation differentials time series behaviour. First, the QLR test detected a break in every respective time series, however, the break dates did not correspond to the range defined for the financial crisis. Therefore, the hypothesis of break triggered by the financial crisis was not confirmed. The ADF detected a presence of unit root in eight out of thirteen Eurozone countries. The Hadri LM stationarity test suggested a unit root in some of the panels and found that the time series have not converged yet. Nevertheless, these findings were not supported by Levin, Lin and Chu test which rejected the null that each time series contains a unit root against the alternative that each time series is stationary. The inconclusive character of these findings can be ascribed to certain limitations of both Hadri and Levin, Lin and Chu tests which should not be neglected when evaluating its outcomes. Furthermore, a method of nonlinear unit root testing of inflation differentials proposed by Gregoriou, Kontonikas, & Montagnoli was introduced. After allowing for nonlinear characteristic of inflation differentials, the test found that all of the nonlinear time series were characterised by stationary mean revering process. This finding suggests that the results from all the previous standard unit root tests may be affected by a nonlinear behaviour of inflation differentials.

Since the presented results may seem very confusing, we should wait with making the final conclusion after the regression analysis, which should tell us more about the nature of inflation differentials. Identifying whether inflation differentials are explained by equilibrating forces or rather country specific structural factors could help to determine which test and model can be trusted.

[3] Twelve oldest Eurozone countries were included into the study.

3. Sources and implications of inflation differentials

This chapter focuses on introducing the main theories explaining inflation differentials. Moreover, implications of the inflation differentials persistence are put forward and discussed. According to Hofmann, & Remsperger (2005) the persistence of inflation differentials represent a threat putting the viability and public acceptance of the Eurozone in danger if it does not prove to be self-correcting. "Understanding the causes of the inflation differentials and the adjustment mechanisms at work amplifying/limiting their spread is of major importance"(Hofmann & Remsperger, 2005, p. 2). In order to design adequate monetary policy, inflation differentials requires to be analysed cautiously (ECB, 2012).

3.1. Sources of inflation differentials

Inflation differentials may emerge for multiple reasons. Initially, the literature inclined to Balassa-Samuelson effect being the major explanation. (Altissimo, Benigno, & Rodriguez Palenzuela, 2011) „However, this narrow focus on a single explanatory factors was gradually superseded by broader explanations in which the observed inflation differentials were accounted for by more complex interactions (…). " (Altissimo, Benigno, & Rodriguez Palenzuela, 2011, p. 190). Clearly, it is not easy to identify the sources of inflation differentials since the Eurozone forms extremely complex and complicated organism.

Fendel & Frenkel (2009) propose to distinguish three types of factors behind the existence of inflation differentials: transitory factors related to the process of convergence, permanent factors related to the national economic structures, and policy induced factors related to diverging national policies or to divergent regional responses to euro-area wide policies. Alternative approach preferred by the ECB (2012) suggests a division according to the time horizon. In this case we should distinguish longer-term or structural factors, medium-term or business cycle factors, and shorter-term or one-off factors. Nevertheless, we will follow the former one since both divisions overlap.

Transitory factors stem from the process of convergence and equilibrating forces among the EZ members. Convergence in the price levels of tradable goods and services is to be expected thanks to the international competitiveness mechanism which works on an arbitrage principle. The cheaper a specific commodity is compared to other countries, the stronger the international demand for this product and the weaker the demand for more expensive substitutes produced in other countries. (ECB, 2012). The stronger demand will push the price of previously cheaper commodity up until the price equalizes. Although the role of price level equalization declined since the start of the EMU (Statrev, 2008, quoted in Pirovano & Van Poeck, 2011), this factor will very likely continue to play a role in explaining the dispersion of inflation rates in the future for several reasons (Fendel & Frenkel, 2009).

First**,** both equalization of nominal interest rates and higher degree of capital market integration boosted aggregate demand in formerly high interest rate countries and in turn created an upward pressure on prices, especially in the nontradable and service sector. Second, the price level dispersion has been decreased as a reaction to the implementation of Single European Market hand in hand with the introduction of a common currency. (Fendel & Frenkel, 2009)

Finally, Balassa-Samuelson effect, which „may appear in economies with uneven labour productivity growth between their tradable and non-tradable sectors"(ECB, 2013, p. 2), may also contribute to inflation dispersion. This effect works as follows. In theory, the law of one price and international competition should ensure an equalization of prices in the tradable sector through the afore-mentioned arbitrage process. Higher productivity in the tradable sector implies also higher real wages through rising nominal wages. Consequently, under the assumption of perfect labour mobility within a country, nominal wages in the nontradable sector are pushed up by higher nominal wages in the tradable sector. Considering the case that labour productivity growth was lower in the nontradable sector, prices in that sector would increase faster in order to prevent real wage growth from outpacing labour productivity growth, putting upward pressure on inflation. (ECB, 2012) To sum up, likewise the tradable sector, we can also observe convergence of non-tradable goods prices induced by real income catch-up effects (Hofmann & Remsperger, 2005). Although the Balassa-Samuleson effect size is likely to decrease due to the productivity convergence which is taking place among current Eurozone members, „…it may become more relevant in the future when new member countries join EMU"(Fendel & Frenkel, 2009, p. 1295). Similarly, Horvath & Koprnicka (2008) suggest that real convergence factors dominate over cyclical variations within the new member states[4].

Another source of inflation differentials captured by permanent factors related to national economic structures such as heterogeneity in consumption preferences among households. It is reflected by different weights of various sub-indices of the national HICPs – hence, different inflation rates may occur even if individual prices show the very same dynamics. (Fendel & Frenkel, 2009) "However, the resulting difference in inflation rates represents just a minor reason for the inflation dispersion"(Fendel & Frenkel, 2009, p. 1295). Another example covered by structural factors is a degree of openness and adjustment to changing economic conditions. Inflation differentials can persist across countries, if economic structures are different and wages or prices thus adjust with different degree of flexibility as a reaction to a shock (ECB, 2012).

The latest research on the degree of price and wage rigidities suggests that „high employment protection, intermediate coordination in collective bargaining and high union density increase the persistence of inflation differentials" and that „reforming labour market institutions may improve the functioning of the euro area by reducing the risk of persistent inflation differentials" (Morsy, & Jaumotte, 2012, p. 1). However, Akyol, Neugart, & Pichler (2013) found that German "Hartz reforms", stated as an example of such reforms, could hardly be linked to the well-functioning German labour market. Rather, the wage moderation itself was identified as the cause of its extraordinary labour market performance. According to Morsy & Jaumotte (2012) and new-keynesian models, the marginal costs of firms can be considered to be the main driver of inflation via its impact on real wages. Furthermore, they compared labour market institutions in the euro area with the United States and found them to be less efficient and causing relatively higher inflation persistence in the EA. Therefore, labour and product market characteristics seem to be important variable when addressing inflation differentials.

Policy-related factors may be another reason why the inflation differentials occur. The degree of heterogeneity in the euro area can be increased thanks to area-wide or regional policies. The difference in fiscal policies caused by changes in administered prices or indirect taxes can serve as an example of such a policy. Monetary policy, although managed for the whole euro area, can also

[4] Countries which accessed in 2004 and 2007.

assist in strengthening the inflation differentials. If the structures of banking systems differ, the transmission across member countries does not have to be identical. Either the use of national fiscal instruments or different transmission of the monetary policy across member countries could reinforce inflation differentials. (Fendel, & Frenkel, 2009) This is supported by Clausen, & Hayo (2006, quoted in Fendel, & Frenkel, 2009) who found an evidence of asymmetries in the interest rate transmission for France, Germany, and Italy.

Notwithstanding all, one-off factors should not be dropped out. These sources of inflation differentials, generated by the temporary supply and demand shocks, are often short lived. For example, one-off commodity price shock can have different impact on price levels in individual countries or there may be uneven changes in administered prices and indirect taxes. Besides afore-mentioned asymmetric shocks, a temporary shock hitting all the countries alike may give rise to inflation differentials as well since the reaction to such a shock may be very different. The reaction may vary due to differences in consumption patterns, economic structures or differences in the degree of inflation persistence. Whether inflation differentials persist and become rather medium-term is dependent to knock-on effects on wages and prices that may lead to a change in inflation expectations. (ECB 2012; Hofmann, & Remsperger, 2005)

3.2. Implications: Why is it such an issue?

One of the conditions the optimal currency area should meet in order to be viable is the similarity in national inflation rates. The external imbalances that would possibly stem from persistent divergence in national inflation rates would not be corrected by an exchange rate realignment since the nominal exchange rate is fixed and cannot be moved freely on the basis of national needs (Hofmann, & Remsperger, 2005). According to Gregoriou, Kontonikas, & Montagnoli (2011) inflation differentials can be characterised by both procyclical and counter-cyclical properties. Procyclicality works through the real interest rate channel. “Since all countries face the same short-term nominal interest rate set by the Eurosystem, persistent inflation differentials across euro area countries will give rise to equally persistent short-term real interest rate differentials”(Hofmann, & Remsperger, 2005, p. 2). The demand in a country with strong economic growth and high inflation is therefore boosted even further as its consumption and investment are stimulated by the subdued real interest rate. Inflation differentials may then last longer than they would otherwise (ECB 2012; Gregoriou, Kontonikas, & Montagnoli, 2011). The opposite scenario applies to a country with lower economic growth experiencing lower inflation rates. To sum up, if the business cycles in the Eurozone are not synchronized or have different scales, a pro-cyclical working of the real interest rate may emerge (ECB 2012). As a result, different monetary policy may be suitable for each country in the Eurozone. Thus “one size fits all” policy, which takes into account only aggregate figures, may be too tight for low inflation countries or overly loose for countries experiencing high inflation. (Hofmann, & Remsperger, 2005)

On the other hand, the real exchange rate channel entails counter-cyclical behaviour of inflation differentials. Competitiveness of a country with a high inflation rate is diminished and economic growth is hampered. Busseti et al. (2007, p. 8) point out that „the answer to whether inflation differentials are pro-cyclical or counter-cyclical will largely depend on the magnitude and persistence of inflation differentials“.

The correction of such imbalances may be painful without the possibility of national exchange rate adjustment. The process may look as follows: the nominal interest rate may be increased by local financial constraint. Moreover, the demand and growth would be further hindered by the competitiveness mechanism. As a result, the initial inflationary pressure would be suppressed at the expense of resulting cyclical downturn and higher unemployment. The subsequent regaining of the competitiveness may be difficult due to the nominal rigidities. Also, labour mobility is limited in the euro area which making from the inflation differentials even more problematic issue (compared to the US). (Darvas, & Wolff, 2014)

Inflation differentials do not have to be always worrisome – it may partly reflect a catch-up process or it can result just from temporary shocks. On the other hand, structural inefficiencies in domestic product, labour or the other factor markets may amplify or make the impact of shocks more persistent. The positive inflation differentials in peripheral countries cumulated into the losses of competitiveness are worsening their current account through the disadvantaged position of their tradable goods. The usual tool to solve this problem would be a currency devaluation. Without an autonomous exchange rate policy, internal devaluation could represent a substitute solution that might offset the losses of competitiveness. Nevertheless, this measure is to be feared since it may put the cohesion of the euro area at risk. (Morsy, & Jaumotte, 2012)
Weisbrot, & Ray (2010) also strongly questioned internal devaluation as an instrument to manage competitiveness issues. A statement that Latvia went through a successful internal devaluation is negated in their paper and its detrimental effects on export sector and investment climate are highlighted.

3.3. Conclusion of the chapter

To conclude, multiple reasons may stand behind the emergence of inflation differentials. Transitory factors, permanent factors and policy induced factors driving the inflation divergence were distinguished. The overall impact on the given economy may work in either procyclical or counter-cyclical direction. Procyclicality works through the real interest rate channel, whereas counter-cyclicality stems from the real exchange rate channel. The magnitude and the persistence of inflation differentials determine which effect will dominate.

4. Econometric analysis of the determinants of inflation differentials

Although inflation differentials can be caused by many country-specific factors, it is vitally important to identify factors with a common nature in order to better design policy measures at an area-wide level (ECB, 2012). This chapter aims at examining and testing the relevance of the main theories that address inflation differentials in the dynamic panel data framework. The structure of the chapter is as follows. First, the estimation methodology is specified and variables of the model are described. Regression analysis employing general-to-specific approach is performed and its outcomes are evaluated. A discussion over the implications of the findings completes the chapter.

4.1. Estimation methodology - Dynamic panel data model

The linear dynamic panel data model including the first lag of dependent variable as a covariate and containing unobserved panel-level effects was chosen since it seems to fit the nature of the dataset very well. The model can be specified as follows (Baltagi, 2008):

$$y_{it} = \delta y_{i,t-1} + x'_{it}\beta + u_{it} \qquad \text{i = 1,…,N; t = 1,…,T}$$

where δ denotes a scalar, x'_{it} is 1 x K and β is K x 1. The u_{it} follow a one-way error component model

$$u_{it} = \mu_i + v_{it}$$

Both μ_i and v_{it} are i.i.d. and independent of each other as well as among themselves. Two difficulties connected with a persistence over time are characteristic to the model specification above. The first one arises from the autocorrelation caused by the lag of dependent variable included among the regressors. The problem stems from the fact that $y_{i,t-1}$ is correlated with the error term. This leaves the OLS estimator biased and inconsistent even if the v_{it} are not serially correlated. The second one is brought about by the individual effects that result from the heterogeneity among individuals. Further attention is dedicated to Arellano-Bond estimator – a method designed in order to deal with these flaws. (Baltagi, 2008)

Arellano-Bond estimator

Arellano and Bond (1991) proposed a model where the orthogonality conditions between lagged values of y_{it} and the disturbances v_{it} are exploited in order to get additional instrument variables. To obtain a consistent estimate of δ, the first difference form of the equation which should be freed from the individual effects is introduced (Baltagi, 2008):

$$y_{it} - y_{i,t-1} = \delta\left(y_{i,t-1} - y_{i,t-2}\right) + \left(v_{it} - v_{i,t-1}\right)$$

For t = 3, for example, y_{i1} is a valid instrument, since it is correlated with $\left(y_{i,2} - y_{i,1}\right)$ but uncorrelated with $\left(v_{i3} - v_{i,2}\right)$ as long as v_{it} are not serially correlated. If one continued forward following the example, an additional valid instrument with each forward period would be obtained. The vector of valid instruments would be $(y_{i1}, y_{i2}, \dots., y_{i,T-2})$. (Baltagi, 2008)

After eliminating the panel-level effects by taking the first difference, further lags of the dependent variable are suggested to be used in order to instrument the lagged dependent variable included as a covariate. Arellano and Bond (1991) proposed a framework designed to identify how many lags of predetermined and endogenous variables can be used as valid instruments and how to create the instrument matrix in combination with differences of strictly exogenous variables. Based on this instrument matrix, one-step and two-step GMM estimators were derived, where the one-step version of the model with robust standard errors is used in context of this thesis. (xtabond, 2014)

As indicated above, identifying the nature of explanatory variables is crucial in order to derive the instrument matrix properly. For that reason, a distinction between predetermined, endogenous, and strictly exogenous variables should be made. "A variable is said to be strictly exogenous if an idiosyncratic shock at time t does not have any effect on the regressor at time s > t" (Pirovano, & Van Poeck, 2011, p. 18). Stated differently, if $E(x_{it},v_{is}) = 0$ (Baltagi, 2008), then all the x_{it} are valid instruments and the first difference of all the exogenous variables can be added into the instrument matrix (xtabond, 2014).

If the regressor is predetermined rather than strictly exogenous with E(xit,vis) ≠ 0 for s < t, and zero otherwise, then only instruments up to $x_{i,s-1}$ are valid at the period s (Baltagi, 2008). Consequently, only lagged levels are used as instruments (xtabond, 2014). In the context of this thesis, a variable is said to be predetermined "if an unobserved shock in a country´s inflation differential can affect the regressor at future points in time" (Pirovano, & Van Poeck, 2011, p. 18).

We might suspect a variable to be endogenous if $E(x_{it},v_{is}) \neq 0$ for all s ≤ t but $E(x_{it},v_{is})=0$ for s > t. The difference from the predetermined variable is only that endogenous variable allows for correlation between x_{it} and v_{is} at time t. Likewise the lagged dependent variable, lagged levels of endogenous variables are included in the instrument matrix. (xtabond, 2014)

4.2. Variables of the model

This chapter has been inspired by the work of Pirovano, & Van Poeck (2011). The variables used in their paper as regressors were adopted, however the values were updated and extended to the year 2013. Moreover, Slovenia has been included into the sample and several new variables were added on the grounds of authors´ literature research. These new variables are: Current account balance, Government deficit, Consumer confidence indicator, and Unit labour costs.

The dataset is composed of thirteen Eurozone member countries and covers the period from 1999 to 2013. The dependent variable of the model is the inflation differential of country *i* towards the Euro area average. The model can be defined as (Pirovano, & Van Poeck, 2011):

$$\Delta(\Delta\pi_{it}) = \delta_1 \Delta\left(\Delta\pi_{i,t-1}\right) + \Delta x'_{it}\beta + \Delta\varepsilon_{it}$$

Where the term $\Delta\pi_{i,t-1}$ - the first lag of inflation differential stands for ***inflation differentials persistence***. The x'_{it} represents a vector of explanatory variables. The covariates should mirror the main theories described in Chapter 4. The u_{it} is a composite error term encompassing country fixed effect and idiosyncratic shock.

External positon has been approximated using variables Imported inflation, Trade, and Current account balance. Since the Imported inflation is expected to increase inflation differentials, the positive sign of the coefficient is predicted. Trade exposure measures the impact of currency movements and trade patterns on the inflation differentials. A positive coefficient is expected since depreciation of the Euro towards Dollar ought to increase domestic inflation via an increased price of imports (Pirovano, & Van Poeck). Furthermore, Current account balance was included so as to measure external sustainability in the manner of Hammermann, & Flanagan (2009). In an effort of the central bank to reduce current account deficit by devaluating the currency, the inflation rate may be raised through higher import prices. Hence, the sign should be negative.

In addition, a covariate reflecting the ***price level equalisation*** was included. The country with initially lower price level should be characterised with higher inflation differential due to the "catch-up" effect. That is why the expected sign of the coefficient is negative. ***The Balassa-Samuelson effect*** has been approximated by a difference between labour productivity growth in manufacturing and services sector. We expect the coefficient to be positive since countries undergoing higher productivity growth should also experience higher inflation (via wage formation mechanism). These two variables capure the transitory factors.

Variables such as Government expenditure (+), Governmental revenue (-), Government balance (-), Government deficit (+), and Primary balance differential (+) should cover ***fiscal stance*** of a country. These variable have to be treated cautiously since simultaneous inclusion into the regression could result in multicollinearity. The expected signs, which are specified in brackets, are based on the principle – the more restrictive fiscal policy, the lower inflation differentials.

The differences in cyclical positions are accounted for by variables Output gap and Unemployment. We predict the sign of *Output gap* to be positive since countries with higher growth are expected to experience higher inflation. On the other hand, *Unemployment* is believed to possess a negative sign provided that inflation is demand driven.

Structural factors are covered by the index of Employment protection legislation and Product market regulation index. The former measures the strictness of employment protection related to regular contracts[5]. The later describes the degree to which policies promote or inhibit competition in areas of the product market where competition is viable. (OECD, 2014) The logic that the higher the value of these indicators, the higher the persistence of inflation differentials (Morsy, & Jaumotte, 2012) implies positive signs of the coefficients.

Although ***economic climate*** was not taken into account by any of the theories described in the Chapter 3, the consumer confidence and expectations may determine the magnitude of the final demand which in turn may influence inflation and inflation differentials. Following the logic that demand is strengthened by solid economic climate, the sign of CCI should be positive. Finally, ***Unit labour costs*** were included among regressors since it was identified to be the main force behind inflation and inflation differentials persistence by Morsy, & Jaumotte (2012) as well as by the ECB (2012). Clearly, the expected sign is positive. A summation of the variables, its detailed construction and source are reported by the Table 4.1.

[5] The index incorporates three aspects of dismissal protection: procedural inconveniences that employers face when starting the dismissal process, notice periods and severance pay, which typically vary by tenure of the employee, and difficulty of dismissal. The EPL ranges from 0 to 6.

Table 4.1: Dependent variable, explanatory variables, theory, data description and its source

Variable	Expected sign	Theory	Description	Source
$\Delta\prod_{i,t}$	x	Dependent variable	Inflation has been computed as a yearly change of HCPI. Inflation differetials have been constructed by substracting the Euro Area average inflation from country i´s inflation rate in year t.	Eurostat
$\Delta\prod_{i,t-1}$	+	Persistence of ID	Constructed as lagged vaue of $\Delta\prod$i,t.	Eurostat
Imp_price_{it}	+	External position - imported inflation	Price index of imports of goods and services. Constructed as a percentage change over previous period, based on 2005=100 and the Euro.	Eurostat
$Trade_{it}$	+	External positon - trade exposure/currency movemenents	Interaction term constructed by multipying the $/€ bilateral exchange rate by the share of extra-EU imports in total imports.	Eurostat
CA_balance	-	External position	Current account balance as a percentage of GDP.	OECD Economic Outlook No 95
$log\left(\frac{P_{i,t0}}{P_{EA,t0}}\right)$	-	Equalising effects/Price level convergence	Constructed as logarithm of the price level ratio of country *i* and the Euro Area in 1999.	Eurostat
$(n_{man,t} - n_{serv,t})$	+	Equalising effects/Balassa-Samuelson theorem	Constructed as a difference between labor productivity growth in manufacturing and services sector where labour productivity growth has been computed as a ratio of contribution to GDP of manufacturing and services sector (gross value added) and the number of weekly hours worked in each sector. The service sector includes real estate, financial intermediation, hotels, restaurants, wholesale, and retail.	Eurostat
$Govbal_{it}$	-	Fiscal stance	General governement balance as a percentage of GDP.	Eurostat
Gov_exp_{it}	+	Fiscal stance	Total general government expenditure as a percentage of GDP.	Eurostat
Gov_rev_{it}	-	Fiscal stance	Total general government revenue as a percentahe of GDP.	Eurostat
$Primbal\_diff_{it}$	-	Fiscal stance	Difference between coumtry *i*´s primary balance and the Euro Area average in percentage of GDP.	OECD Economic Outlook No 95
Gov_def_{it}	+	Fiscal stance	General governement deficit as a percentage of GDP.	Eurostat
$\tilde{y}_{i,t} - \tilde{y}_{EA,t}$	+	Differences in cyclical positions	Constructed as a difference between country i´s output gap and the Euro Area average.	OECD Economic Outlook No 95
$Unemp_{it}$	-	Differences in cyclical positions/demand effect	Average yearly rate of unemployment in country i.	Eurostat
EPL_{it}	+	Structural factors	Employment prorection legislature measures the strictness of employment protection related to regular contracts, ranges from 0 to 6.	OECD Statistics
PMR_i_{it}	+	Structural factors	Index of product marker regulations contructed by lineary interpolating five years data on PMR. The scales is from 0 to 6.	OECD Statistics
Consumer confidence indicator	+	Economic climate	Consumer confidence indicator constructed as an avergage of seasonaly adjusted monthly CCI.	Eurostat
ULC	+	ULC as the main driver of inflation	Unit labor costs based on year 2005.	Eurostat

As clarified above, to determine how of each variable reacts to idiosyncratic shocks is key in order to define the instruments correctly. The Table 4.2. represents a summary of such a specification distinguishing between predetermined, endogenous, and strictly exogenous variables.

Table 4.2: The nature of explanatory variables

Explanatory variable	Variable specification
Imp_price_{it}	predetermined
$Trade_{it}$	endogenous
CA_balance	predetermined
$log\left(\frac{P_{i,t0}}{P_{EA,t0}}\right)$	endogenous
$(n_{man,t} - n_{serv,t})$	endogenous
$Govbal_{it}$	predetermined
Gov_exp_{it}	predetermined
Gov_rev_{it}	predetermined
$Primbal\_diff_{it}$	predetermined
Gov_def_{it}	predetermined
$\tilde{y}_{i,t} - \tilde{y}_{EA,t}$	endogenous
$Unemp_{it}$	predetermined
EPL_{it}	endogenous
PMR_i_{it}	endogenous
Consumer confidence indicator	endogenous
ULC	predetermined

Source: Authors´ own analysis

4.3. Estimation results

In the manner of Pirovano, & Van Poeck, the regressions were performed in Stata 12 using the command xtdpd[6]. The general-to-specific method (Campos, J, Ericsson, & Hendry, 2005) was employed in order to eliminate the least significant variables from the general model up to the specification where all the explanatory variables are statistically significant at least at the 10% level. The results of the general regressions in different specifications while controlling for inflation persistence and Imported inflation are presented in the Table 4.3. Each numbered row refers to a separate regression with an estimated coefficient in the first line and the respective p-value obtained from robust standard errors in the second line.

The Sargan test of overidentifying restrictions, sometimes called the J-statistic, checks the exogeneity of instrument variables. The null hypothesis states that all the instruments are exogenous. The Sargan test can be computed for a homoscedastic term only and tends to overreject in the presence of heteroskedasticity. (Stock, & Watson, 2011). For this reason, vce(gmm) is chosen instead of vce(robust) prior to performing the Sargan test. Nevertheless, the issue of overrejection is not of our concern as the null can be accepted for all the specifications. The bottom lines present the output of the Arellano-Bond test for first- and second-order autocorrelation in the first-differenced errors. The null hypothesis states no autocorrelation. The moment conditions used in our model require the rejection of the null for the first-order and non-rejection for the second-order

[6] The reason for choosing the xtdpd over the command xtabond is that it allows more flexibility in the estimating time invariant regressors and it can also treat predetermined variables with more complicated structures (xtdpd, 2014).

autocorrelation in order to be valid. (xtabond, 2014) Overall, the results are ideal, there is no evidence of model misspecification.

It can be seen that the coefficients of the first lag of inflation differentials are significant at the 1% level at every specification. Therefore, the assumption ***of inflation persistence*** as well as the positive sign were confirmed with average inflation of 0.5278 transmitted into the subsequent period. The coefficient of Imported inflation was correctly expected to be positive, however it is significant just in seven out of sixteen specifications at the 1%, 5% or 10% significance levels. Likewise, the variable Trade turned out statistically insignificant at every conventional level. Apart from that, the sign was negative. On the contrary, Current account balance, completing the set of indicators measuring the ***external position***, was found significant at the 10% level possessing a negative coefficient. In line with our expectations, it suggests that positive current account balance tends to lower inflation differentials though by a negligible amount.

The proxy for ***price level equalisation*** came out to be the least significant variable. Although the sign was predicted correctly, the null cannot be rejected at any tolerable significance level. This questions the findings of Fendel, & Frenkel (2009) and the ECB (2012), although the ECB declared that this factor became and would continue to be less prominent in the future. Similarly, ***the Balassa-Samuelson effect*** proved to be insignificant for the period under examination. Also, the negatively oriented sign is inconsistent to our hypothesis. This finding is consistent to Fendel, & Frenkel (2009) who predicted the size of this effect to decrease. Out of the indicators related to ***fiscal stance***, only Government balance, Government expenditures, and Government deficit were declared to be significant – all of them at the 5% significance level. Furthermore, the signs of the coefficients of Government balance and Government expenditures are somehow contradictory to our previous expectations. The covariates describing ***differences in cyclical positions*** appeared to be significant with Unemployment decreasing and Output gap increasing inflation differentials. Hence, the intuition behind the signs was correct. This corresponds to Hammermann, & Flanagan (2009), and Busetti et al. (2007) who highlighted the importance of the differences in cyclical positions in explaining inflation differentials.

Both PMR and EPL indicators reflecting the ***structural factors*** were found significant at the 5% and 10% significance level, respectively. The positive coefficients suggest that inflation persistence is enforced with the higher level of both EPL and PMR. This finding is in agreement with Morsy, & Jaumotte (2012) who put forward that a high level of EPL increase the persistence of inflation differentials. The ***economic climate*** expressed by the CCI was recognised to be significant at the 5% level, although its positive contribution following the common logic is just minor. Finally, the last regression specification showed the significance of the variable ***ULC***, although just at the 10% level.

After reducing the model in line with the general-to-specific method, the model which regression results are reported in the Table 4.4. was obtained. Controlling for inflation persistence and imported inflation, five variables turned out to explain inflation differentials in the Eurozone. The PMR index was found of overhelming importance with a positive coefficient reaching 0.7204. Also, the lagged inflation differential, Output gap, Current account balance and Imported inflation, work in the same direction, though its impact is negligeable. On the contrary, Unemployment and Consumer confidence indicator tend to decrease the dependent variable. The negative sign of Unemployment is in compliance with prior expectations, however, the negative effect of the CCI goes against common logic. Overall, variables related to fiscal stance and equalibrating forces such as price level convergence or Balassa-Samuelson effect were dropped out of the model. The right part of the Table 4.4. summarizes the relevance of the main theories in explaining inflation differentials. Apparently, structural factors play the major role followed by determinants of external position and differences in cyclical positions. These factors clearly are not self-correcting and this finding therefore has wider implications.

In order to correctly assess the implications of our findings, we should not forget that only thirteen out of eighteen Eurozone countries were included in the sample. As pointed out by Horvath, & Koprnicka (2008), inflation differentials within newer union member countries are still accounted for by rather equalising than structural factors. Similarly, this may be applied for newer Eurozone members that are not included in the sample. Nevertheless, we can expect that the structural factors would dominate again since the process of price level and productivity convergence will be losing its power over time. That is why we will dare to generalise the implications for the whole Eurozone. In addition, the fact that there was a break detected for every time series should not be forgotten. However, since there was not a uniform break date for all the countries, the regression could not be divided into two parts. On the basis of these findings, the focus should be turned to product market characteristic, synchronisation of economic cycles, economic climate, and the indicators of external position.

Table 4.3: Estimation results: Arellano-Bond estimator with robust standard errors

	Dependent variable: inflation differential $\Delta\Pi_{i,t}$																			
	Specification																	Sargan test	AR test: 1st order	AR test: 2nd order
	Idependent variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Prob > chi2	Prob > z	Prob > z
	Constant term	-0.0128	-0.0946	0.1390	2.4145	2.8968	-0.0158	0.1480	-0.0437	-0.0144	0.6586	0.1272	-3.5889	-0.9332	0.0739	0.2070	1.3655			
	p-value	0.821	0.619	0.082*	0.009***	0.303	0.710	0.078*	0.455	0.781	0.009***	0.520	0.057*	0.058*	0.692	0.085*	0.086*			
	Lagged ID	0.7125	0.7114	0.6616	0.6381	0.0382	0.7101	0.6571	0.7068	0.6141	0.6285	0.7118	0.5408	-0.9332	0.6924	0.6785	0.6756			
	p-value	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***			
1	**Imp. price index**	0.0419	0.0307	0.0343	0.0309	0.6969	0.0394	0.0338	0.0479	0.0325	0.0377	0.7118	0.0166	0.0196	0.6924	0.0291	0.0386	149.8464	-2.8571	-0.2304
	p-value	0.058*	0.021**	0.107	0.146	0.083*	0.089*	0.121	0.009***	0.117	0.05**	0.058*	0.466	0.301	0.119	0.186	0.047**	0.112	0.004	0.818
2	**Price level equal.**		-6.71335															151.318	-2.8882	-0.1275
	p-value		0.555															0.261	0.004	0.899
3	**Gov. balance**			0.04175														161.9609	-2.7316	-0.3616
	p-value			0.016**														0.133	0.006	0.718
4	**Gov. expenditures**				-0.0501													161.672	-2.7625	-0.3558
	p-value				0.011**													0.136	0.006	0.722
5	**Gov. revenues**					-0.0650												159.13	-2.924	-0.1908
	p-value					0.308												0.169	0.004	0.849
6	**Primary balance def.**						-0.0498											152.9794	-2.8864	-0.1857
	p-value						0.24											0.269	0.004	0.853
7	**Govern. deficit**							0.04401										162.6399	-2.7058	-0.3722
	p-value							0.012**										0.125	0.007	0.710
8	**Balasssa Samuelson**								-0.7855									148.8411	-2.8289	-0.1371
	p-value								0.379									0.124	0.005	0.891
9	**Output gap**									0.0916								144.0019	-2.7723	-0.2208
	p-value									0.063*								0.189	0.006	0.825
10	**Unemployment**										-0.0777							157.9679	-2.8044	-0.1522
	p-value										0.006***							0.185	0.005	0.879
11	**Trade**											-0.0363						147.8825	-2.9952	-0.2993
	p-value											0.383						0.135	0.003	0.765
12	**EPL**												1.4021					138.5562	-2.8844	0.1758
	p-value												0.073*					0.192	0.004	0.860
13	**PMR iterpolated**													0.6062				143.6738	-2.9802	0.0213
	p-value													0.038**				0.163	0.003	0.983
14	**Current account**														-0.0998			152.9485	-2.8944	-0.2184
	p-value														0.091*			0.138	0.004	0.827
15	**$OCI_{i,t}$**															0.0144		146.461	-2.7948	-0.0991
	p-value															0.034**		0.154	0.005	0.921
16	**Unit labor costs**																-0.0131	162.5895	-2.8724	-0.2391
	p-value																0.091*	0.125	0.004	0.811

***statisticially significant at the 1% level　　**statisticially significant at the 5% level　　*statisticially significant at the 10% level

Source: authors´ computations in Stata 12

Table 4.4: Specific model, determinants of Eurozone inflation differentials

Dependent variable: $\Delta \Pi_{it}$

Idependent variable	
Constant	**-0.8738**
p-value	0.191
$\Delta \Pi_{i,t-1}$	**0.2774**
p-value	0.000***
Imp_price$_{it}$	**0.0285**
p-value	0.093*
CA_balance	**0.1424**
p-value	0.035**
Consumer confidence indicator	**-0.0102**
p-value	0.070*
PMR_i$_{t}$	**0.7204**
p-value	0.056*
Unemp$_{it}$	**-0.0716**
p-value	0.011**
$\tilde{y}_{i,t} - \tilde{y}_{EA,t}$	**0.1250**
p-value	0.000***
Sargan test	174.3461
Prob > chi2	0.0613
AR test: 1st order	-3.0014
Prob > z	0.0027
AR test: 2nd order	-0.2037
Prob > z	0.8386

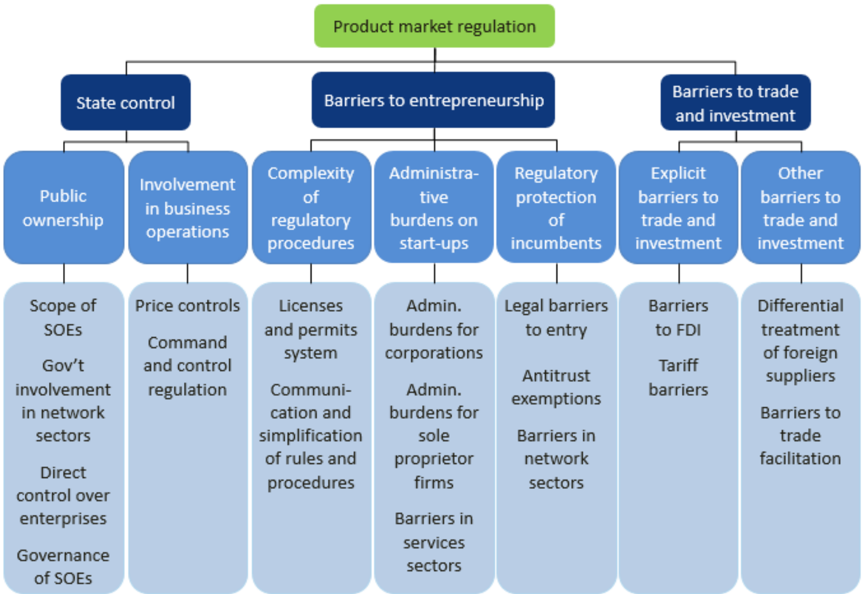
Idependent variable	
Constant	**-0.8738**
p-value	0.191
Peristence of ID	**0.2774**
p-value	0.000***
External position	**0.1709**
Economic climate, structural factors	**0.7102**
Differences in cyclical positions	**0.0533**
Sargan test	174.3461
Prob > chi2	0.0613
AR test: 1st order	-3.0014
Prob > z	0.0027
AR test: 2nd order	-0.2037
Prob > z	0.8386

Source: authors' computation using Stata 12.

4.4. Product market (de)regulation

The PMR indicator definitely deserves deeper focus since its impact on persistence of inflation differentials proved to be extremely strong. By managing this variable in a desired direction – it means deregulation – the inflation differentials could be controlled or even mitigated. First, the composition of the PMR indicator should be described more in detail in order to clarify what exactly does it express. The OECD (2014) has constructed the PMR indicator to comparably measure the economy-wide regulatory and market environments. Its main components are: degree of state control, barriers to entrepreneurship, and barriers to trade and investment. The further composition of the index is shown in the Picture 4.1. It seems that the index reflects mainly the degree of product marker liberalisation and competition.

Picture 4.1 : Composition of the PMR indicator



Source: OECD (2014).

We can proceed further and take a look at how do the particular countries stand in terms of product market regulation. Out of the Eurozone members (highlighted with blue colour), Greece, Slovenia, France, Luxembourg, Netherlands, Ireland and Spain can be characterised by the highest values of the PMR indicator. This is in compliance with the finding that these countries experience higher inflation (with the exception of France) and positive inflation differentials. However, it is worth-noting that the values of the indicator tend to decrease from the year 1998 for all the countries. Non-eurozone countries (brown colour) compared to Eurozone members do not exhibit any significant differences. Therefore, the future hypothetical accession of these countries into the Eurozone should not worsen inflation differentials persistence that is caused by this factor. Interesting may be a comparison with the United States which are suggested to experience lower inflation differentials (Morsy, & Jaumotte, 2012) and likewise are characterised by a very low PMR indicator.

Table 4.5: PMR indicator in the EU and the US

Country	1998	2003	2008	2013
Austria	2.12	1.61	1.37	1.19
Belgium	2.30	1.64	1.52	1.39
Finland	1.94	1.49	1.34	1.29
France	2.38	1.77	1.52	**1.47**
Germany	2.23	1.80	1.41	1.29
Greece	2.75	2.51	2.21	**1.74**
Ireland	1.86	1.58	1.35	**1.45**
Italy	2.36	1.80	1.49	1.26
Luxembourg	.	1.60	1.44	**1.46**
Netherlands	1.82	1.49	0.96	0.92
Portugal	2.59	2.12	1.69	1.29
Slovenia	.	.	1.89	**1.70**
Spain	2.39	1.79	1.59	**1.44**
Slovak Republic	.	1.93	1.57	1.31
Czech Republic	2.63	1.87	1.50	1.39
Denmark	1.65	1.48	1.31	1.22
Estonia	.	.	1.38	1.33
Hungary	2.65	2.08	1.40	1.31
Sweden	1.88	1.50	1.64	**1.55**
United Kingdom	1.32	1.10	1.21	1.09
Bulgaria	.	.	.	**1.57**
United States	1.50	1.30	1.11	.

Source: OECD (2014), authors´ compilation.

Diverging inflation dynamics may be harmful when it stems from country specific structural inefficiencies in the product market. The effects of these factors are claimed (Morsy, & Jaumotte, 2012) to be deeper and more persistent compared to the other factors such as differences in cyclical positions. Positive inflation differentials may be detrimental to country *i*´s competitiveness and the real interest rate channel can entail deepening of the disparities in national economic cycles. Thus, product market deregulation should have a beneficial impact in this matter. Nevertheless, the five-year data on the PMR suggests that some kind of deregulation is underway. As pointed out by Biroli, Mourre, & Turrini (2010) the tendency to deregulation ongoing in the recent year has contributed to the reduction in the persistence of inflation differentials. In addition, these reforms carried out under the EU Single Market Programme were proved (Griffith, Harrison, & Simpson, 2010) to be linked to increased competition, innovation, and productivity growth.

To conclude, product market reforms such as elimination of state control, barriers to entrepreneurship, and barriers to trade and investment should not cease to take place provided that the persistent inflation differentials are to be managed. To analyse the particular effect of components of the PMR on inflation differentials could constitute a subject for further research.

4.5. Conclusion of the chapter

To conclude, the econometric analysis revealed alarmingly high importance of the country specific structural factors in explaining inflation differentials. It follows that the persistence that stems from this nature is not self-correcting. The dominance of structural factors may be diminished in the future thanks to the ongoing deregulation, however, it is expected to keep playing a significant role in the future. To link the econometric analysis with the stability and unit root testing, it seems that the reason why both ADF test and Hadri test were not able to detect convergence is the prevalence of structural factors which create an obstacle for spontaneous convergence. However, this result does not comply with the result of the Levin, Lin and Chu test neither with the theory proposed by Gregoriou, Kontonikas, & Montagnoli.

Conclusion of the thesis

This thesis aimed at answering the question whether the inflation differentials in the Eurozone are explained by transitory, or rather permanent factors. This question could also be formulated as whether or not the Eurozone forms an Optimal Currency Area. The inflation differentials are not regarded as harmful if they are brought about by transitory equilibrating processes stemming from initially uneven price or productivity levels. Finding that transitory factors prevail would mean that inflation differentials are self-correcting and that they will fade away without any policy intervention. A worse scenario would be to reveal that inflation differentials still persist due to structural factors such as segmented markets or imperfect competition. Since these factors are determined by a country specific evolution and are rigid in their nature, they would make the inflation differentials persist provided that any structural intervention correcting the heterogeneity or structural inefficiencies among the member states does not take place.

The first chapter examined the dynamic properties of euro area inflation differentials. In particular, we made a graphical analysis of average euro area inflation and inflation dispersion, as well as inflation, inflation differentials and unit labour costs in thirteen Eurozone countries. The analysis suggested that some degree of divergence is present - inflation differentials did not seem to exhibit mean reverting behaviour and the inflation dispersion suggested to have an upward trend in the future. Moreover, a hypothesis that the financial crisis represented a structural break in inflation differentials dynamic was put forward on the basis of outcomes of this chapter.

The second chapter was designed in order to empirically test the presumptions made in the previous chapter. First of all, the QLR statistic tested a presence of a break at an unknown date and found a break for every respective time series. However, the identified break dates neither corresponded to the range where the financial crisis was supposed to be located, nor they corresponded to each other. The most frequent break date was February 2006, that is why we rejected the hypothesis and attributed the break to the “pre-crisis” economic climate characterised by booming economies rather than to the crisis itself. Stability and unit root test were introduced to examine inflation differentials time series behaviour. The ADF test found a unit root in eight time series whereas the panel Levin, Lin and Chu test concluded that all the time series are stationary. Hadri test found that the time series have not converged in the period examined. Moreover, alternative model proposing that result of the standard unit root tests may be influenced by nonlinear behaviour of inflation differentials were put forward. Overall, the finding of this chapter were somehow contradictory and inconclusive.

The third chapter served as a prerequisite for the subsequent regression analysis. Theories addressing the potential sources of inflation differentials were explained and the implications were indicated. We distinguished transitory, permanent and policy induces factors behind the existence of inflation differentials. Also, two effects operating through real interest rate channel and real exchange rate channel were identified. These effects work in the opposite direction and the magnitude and the degree of persistence of inflation differentials determine which effect will dominate.

To determine which factors prevail and whether the Eurozone policymakers should worry about this phenomenon was a task for regression analysis. Arellano-Bond estimation in the dynamic panel data framework was employed in order to identify determinants of inflation differentials. The results generated by general-to-specific method showed an alarming prevalence of product market regulation in explaining inflation differentials. Also, the lagged inflation differentials, indicators of external position, economic climate, and differences in cyclical positions were found to significantly (although negligibly) influence the dependent variable.

The finding that the structural factors have such an overwhelming impact on inflation differentials is quite disturbing and it calls for an action. However, the deeper analysis of this indicator showed that there already is some dynamics – that some kind of deregulation has been taking place since 1998. These reforms were carried out under the Single Market Programme and are claimed to help to diminish inflation differentials as well as to contribute to increased competition, innovation and growth. Notwithstanding this finding, the value of PMR for all the EZ countries is still high compared to the US where the inflation differentials are lower. The countries suffering from the adverse effects of product market regulation are especially Greece, Slovenia, France, Luxembourg, the Netherlands, Ireland, and Spain. It is not a coincidence that these countries are the members of the high-inflation group experiencing positive inflation differentials. According to the ECB (2012), inflation differentials arising from structural inefficiencies have to be tackled at national levels, not by the single monetary policy.

Another issue is that neither the EU nor the EZ does not form a fiscal union. The ECB (2012) propose to strengthen fiscal framework since inappropriate fiscal policies contributed to pronounced procyclicality and generated inflationary pressures and inflation differentials in several countries. The adoption and implementation of the new rules is required to proceed rapidly as well as the implementation of the new European governance framework.

Moreover, the question whether the ECB should dispose with an additional policy instrument in order to address inflation differentials was brought in. Currently, the ECB employs more policy instrument in an effort to meet its mandate. Moreover, since there are concerns about the ongoing deflationary tendencies, the ECB has been allowed to use macroprudential powers. It is believed that these powers may also help to hamper excessive credit developments in regions experiencing above-average inflation. However, the ECB should be cautious and assess properly the source of inflation imbalance and the necessity of the intervention. There is a risk that the introduction of country-specific macroprudentials tools could provoke political-economy conflicts with national interests. To conclude, although these tools could manage country specific inflation needs, its implementation is might be troublesome in practise. (Darvas, & Wolff, 2014)

In addition, influencing the other significant variables such as external position, economic climate and differences in cyclical positions could also help to manage inflation differentials. However, the policy interventions should focus mainly on the structural factors.

Literature review

1. Akyol, M., Neugart, M., & Pichler, S. (2013). Were the Hartz Reforms Responsible for the Improved Performance of the German Labour Market? *Economic Affairs (Institute Of Economic Affairs)*, 33(1), 34-47.
2. Altissimo, F., Benigno, P., & Rodriguez Palenzuela, D. (2005). Long-Run Determinants of Inflation Differentials in a Monetary Union. *Moneda Y Credito*, (220), 205-247.
3. Altissimo, F., Benigno, P., & Palenzuela, D. (2011). Inflation Differentials in a Currency Area: Facts, Explanations and Policy. *Open Economies Review*, 22(2), 189-233. doi:http://dx.doi.org.zdroje.vse.cz/10.1007/s11079-010-9189-6
4. "Asset price bubbles: how they build up and how to prevent them?" *ECB*. N.p., n.d. Web. 21 July 2014, from http://www.ecb.europa.eu/press/key/date/2011/html/sp110503.en.html
5. Baltagi, B. H. (2008). *Econometric analysis of panel data* (4th ed.). Chichester, UK: John Wiley & Sons.
6. Biroli, P., Mourre, G., & Turrini, A. (2010). Adjustment in the Euro area and Regulation of Product and Labour Markets: An Empirical Assessment.
7. Busetti, F., Forni, L., Harvey, A., & Venditti, F. (2007). Inflation Convergence and Divergence within the European Monetary Union. *International Journal Of Central Banking*, 3(2), 95-121.
8. Campos, J., Ericsson, N. R., & Hendry, D. F. (2005). General-to-specific modeling: an overview and selected bibliography.
9. Carrel, P. (2014, September 4). ECB cuts rates to ward off euro zone deflation threat. *Reuters*. Retrieved September 9, 2014, from http://www.reuters.com/article/2014/09/04/us-ecb-rates-decision-idUSKBN0GZ1A120140904
10. Core Inflation Definition | Investopedia. (n.d.). *Investopedia*. Retrieved July 16, 2014, from http://www.investopedia.com/terms/c/coreinflation.asp
11. Darvas, Z., & Wolff, G. (2014). So far apart and yet so close: Should the ECB care about inflation differentials? *Bruegel*, 1. Retrieved September 29, 2014, from http://www.bruegel.org/publications/publication-detail/publication/848-so-far-apart-and-yet-so-close-should-the-ecb-care-about-inflation-differentials/?utm_source=Bruegel+Update&utm_campaign=774dedb655-Bruegel+Update&utm_medium=email&utm_te
12. Diaz-Emparanza, I. (n.d.). Chow Test in Gretl. *Gretl-users*. Retrieved September 30, 2014, from http://lists.wfu.edu/pipermail/gretl-users/2008-November/002796.html
13. DRASTICHOVÁ, M. (2013). Convergence in the EU related to the Maastricht criteria. *16*(4), 207-225. doi:10.7327/cerei.2013.12.02
14. ECB. (2012). Inflation differentials in the euro area during the last decade. Monthly bulletin.
15. ECB launches targeted LTRO, intensifies preparation for ABS buys. (2014, June 5). *Reuters*. Retrieved August 13, 2014, from http://www.reuters.com/article/2014/06/05/us-ecb-tltro-idUSKBN0EG1TX20140605
16. Fendel, R. R., & Frenkel, M. M. (2009). Inflation Differentials in the Euro area: Did the ECB Care*? Applied Economics*, 41(10-12), 1293-1302.

17. Gore, G. (2014, June 13). TLTRO to boost banks more than economy. *Reuters*. Retrieved August 13, 2014, from http://in.reuters.com/article/2014/06/13/tltro-banks-idINL5N0OU2LK20140613
18. Gregoriou, A., Kontonikas, A., & Montagnoli, A. (2011). Euro area Inflation Differentials: Unit Roots and Nonlinear Adjustment. *Journal Of Common Market Studies*, 49(3), 525-540.
19. Griffith, R., Harrison, R., & Simpson, H. (2010). Product Market Reform and Innovation in the EU. *Scandinavian Journal Of Economics*, 112(2), 389-415.
20. Hakkio, C. S. (2008). PCE and CPI Inflation Differentials: Converting Inflation Forecasts. *Federal Reserve Bank Of Kansas City Economic Review*, 93(1), 51-68.
21. Hammermann, F., & Flanagan, M. (2009). What Explains Persistent Inflation Differentials across Transition Economies? *Economics Of Transition*, 17(2), 297-328.
22. Harmonised Indices of Consumer Prices (HICP). (n.d.). *Introduction*. Retrieved July 12, 2014, from http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/introduction
23. Hlouskova, J., & Wagner, M. (2006). The Performance of Panel Unit Root and Stationarity Tests: Results from a Large Scale Simulation Study. *Econometric Reviews*, 25(1), 85-116.
24. Hofmann, B., & Remsperger, H. (2005). Inflation Differentials among the Euro area Countries: Potential Causes and Consequences. *Journal Of Asian Economics*, 16(3), 403-419. doi:http://dx.doi.org.zdroje.vse.cz/10.1016/j.asieco.2005.04.009
25. Horvath, R., & Koprnicka, K. (2008). Inflation Differentials in New EU Member States: Empirical Evidence. *Finance A Uver/Czech Journal Of Economics And Finance*, 58(7-8), 318-328.
26. Jayet, H. (Director) (2014, October 1). Time series. *Special Topics in Applied Econometrics.* Lecture conducted from University of Antwerps, Antwerps.
27. Kilic, R. (2011). Testing for a Unit Root in a Stationary ESTAR Process. *Econometric Reviews*, 30(3), 274-302.
28. Kruse, R. (2011). A New Unit Root Test against ESTAR Based on a Class of Modified Statistics. *Statistical Papers*, 52(1), 71-85. doi:http://dx.doi.org.zdroje.vse.cz/10.1007/s00362-009-0204-1 Lütkepohl, H. (2004). Applied time series econometrics. Cambridge, UK: Cambridge University Press.
29. Mongelli, F. (2005). What Is European Economic and Monetary Union Telling Us about the Properties of Optimum Currency Areas? *Journal Of Common Market Studies*, 43(3), 607-635.
30. Morsy, H., & Jaumotte, F. (2012). Determinants of Inflation in the Euro area: The Role of Labor and Product Market Institutions. 35 pages.
31. OECD Statistics . (n.d.). *OECD Statistics* . Retrieved September 28, 2014, from http://stats.oecd.org/
32. Paleta, T. (2012). Maastricht Criteria of . . . Divergence? Review Of Economic Perspectives, 12(2), 92-119.
33. Pentecost, E. (2013). Monetary policy in EMU. *The Economics of European Integration* (pp. 1-34). Antwerps: Universiteit Antwerpen.
34. Pirovano M., & Van Poeck A. (2011). *Eurozone inflation differentials and the ECB*. University of Antwerp. Faculty of Applied Economics.
35. PRESS RELEASE. (2014, July 3). *ECB: ECB announces further details of the targeted longer-term refinancing operations.* Retrieved August 11, 2014, from http://www.ecb.europa.eu/press/pr/date/2014/html/pr140703_2.en.html

36. Schmitt-Grohe, S., & Uribe, M. (2013). Downward Nominal Wage Rigidity and the Case for Temporary Inflation in the Eurozone. *Journal Of Economic Perspectives*, 27(3), 193-212. doi:http://dx.doi.org.zdroje.vse.cz/10.1257/jep.27.3.193
37. Senjur, M. (2010). Differential Inflation, Phillips Curves, and Price Competitiveness in a New Euro-Member Country. *Economic Change And Restructuring*, 43(4), 253-273. doi:http://dx.doi.org.zdroje.vse.cz/10.1007/s10644-010-9090-8
38. Shankar, S. (2014, July 14). Draghi's Latest ECB Program, TLTRO, Might Bring In Nearly $1T For Banks: Survey. *International Business Times*. Retrieved August 13, 2014, from http://www.ibtimes.com/draghis-latest-ecb-program-tltro-might-bring-nearly-1t-banks-survey-1627052
39. Speciale, A., & Tartar, A. (2014, July 14). Draghi Seen Handing $1 Trillion to Banks in ECB Offer. *Bloomberg.com.* Retrieved August 11, 2014, from http://www.bloomberg.com/news/2014-07-13/draghi-seen-delivering-1-trillion-free-lunch-to-banks.html
40. Stock, J. H., & Watson, M. W. (2011). *Introduction to econometrics (3rd ed.)*. Boston: Addison-Wesley.
41. TLTRO to stall bank funding plans. (2014, July 25). *Reuters.* Retrieved August 13, 2014, from http://www.reuters.com/article/2014/07/25/ecb-banks-idUSL6N0PX4GS20140725
42. Ubide, A. (2014). Is the European Central Bank Failing Its Price Stability Mandate? Policy Brief, *Peterson Institute for International Economic.* N U M B E R P B 1 4 - 5, 1-20. Retrieved March 2, 2014, from http://www.piie.com/publications/pb/pb14-5.pdf
43. Weisbrot, M., & Ray, R. (2010). Latvia's Recession: The Cost of Adjustment With An 'Internal Devaluation'. 19 pages.
44. xtabond — Arellano–Bond linear dynamic panel-data estimation. (n.d.). *Stata*. Retrieved September 18, 2014, from http://www.stata.com/manuals13/xtxtabond
45. xtdpd — Linear dynamic panel-data estimation. (n.d.). *Stata*. Retrieved September 20, 2014, from http://www.stata.com/manuals13/xtxtdpd.pdf