Inflation Differentials among the Euro Area Countries: Potential Causes and Consequences

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*The views expressed in this paper are those of the authors and do not necessarily represent the views of the Deutsche Bundesbank.

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1. Introduction

The Optimum Currency Area (OCA) literature identifies several conditions that must at least in part be met for a currency union to be viable.[1] One of them is sufficient similarity in the national rates of inflation. This precondition is necessary since in a currency union nominal exchange rates are irrevocably fixed, and therefore external imbalances building up in the wake of persistent divergences in national inflation rates cannot be corrected by an exchange rate realignment.

However, since the start of EMU, persistent differentials in national price developments continue to exist in the euro area. The accumulated effect of these differentials is already reflected in quite significant shifts in real exchange rate indicators of some of the euro area countries. Besides the implications of inflation differentials for external price competitiveness, some commentators have recently also uttered concern that these inflation differentials may also give rise to self-exciting internal imbalances. 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. As a result, the Eurosystem's monetary policy may be overly tight for countries already experiencing low inflation and excessively loose for countries experiencing high inflation rates.

As the Eurosystem's mandate is to safeguard price stability in the euro area as a whole, it will not base its monetary policy decisions on inflation developments in single countries and will take them into consideration only to the extent they influence the aggregate figures for the euro area. Besides, the Eurosystem does not dispose of any instruments to selectively address inflation developments in single member countries. However, persistent inflation differentials may at one point impair public acceptance of EMU and may eventually put the viability of monetary union at risk if they do not prove to be self-correcting, especially since the monetary union is not backed by a political union. For this reason, understanding the causes of the observed inflation differentials and the adjustment mechanisms at work amplifying/limiting their spread is of major importance. In this paper we address both issues by reviewing the existing literature and presenting some new evidence. The plan of the paper is as follows: In Section 2 we review the development of inflation dispersion in the euro area since the start of

[1] See Mongelli (2002) for an overview.

EMU in historical and international perspective. In Section 3 we assess the potential causes of the observed inflation differentials in the euro area. In Section 4 we analyse the significance of the various potential causes of inflation differentials and their macroeconomic implications in a stylised New Keynesian model of the euro area countries. Section 5 concludes.

2. Inflation dispersion in the euro area

In the run-up to EMU in the 1990s, inflation dispersion in the euro areas has declined substantially. Figure 1 shows the development of the unweighted cross-country standard deviation[2] of annual national rates of inflation in the Harmonised Index of Consumer Prices (HICP), which measures the average dispersion of national HICP inflation rates around the unweighted cross-country mean, since 1988.[3] The graph shows that the standard deviation dropped from a level of above 5 percentage points in 1990 to a record low of below 1 percentage point in 1999. Since then the standard deviation fluctuates around this level. The graph also shows that HICP inflation dispersion in the euro area was closely correlated with the overall level of euro area HICP inflation. This partly reflects the fact that qualification for participation of a country in EMU also depended strictly on its ability to achieve price stability before entering monetary union.[4]

A comparison with the development of inflation dispersion in the US suggests that inflation dispersion has historically been substantially lower in the US than in the euro area. Figure 2 shows the unweighted standard deviation of inflation rates in the four US Census Regions Northeast, South, Midwest and West together with the unweighted standard deviation for the euro area. The US standard deviation fluctuates around a level of about 0.5 percentage points. During the convergence to EMU, however, euro area inflation dispersion has converged towards US levels. Since 1999, the unweighted standard deviation in the euro area was on average only about 0.5 percentage points higher than that in the US.[5] It should be noted,

[2] Besides the unweighted standard deviation, alternative measures of inflation dispersion are the weighted cross-country standard deviation, the maximum span of inflation rates and the coefficient of variation. All these alternative dispersion measures give a very similar picture of inflation dispersion in the euro area and its evolution over time.

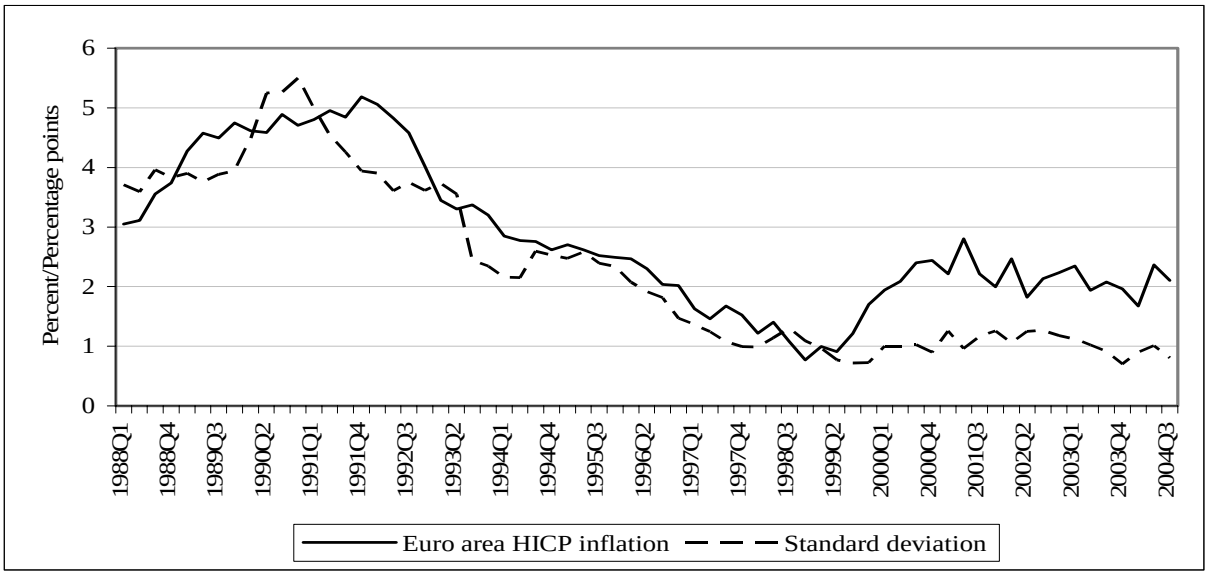
[3] Seasonally adjusted HICP data are available only from 1992Q1, so we used national CPI data to calculate inflation rates for the period 1988Q1 until 1992Q4.

[4] One of the Maastricht criteria which had to be met by a country in order to qualify for EMU was that HICP inflation was not more than 1.5 percentage points higher than average HICP inflation in the three countries with the lowest HICP inflation rates in the group of candidate countries.

[5] An alternative base for comparison would be the 14 US metropolitan statistical areas. The unweighted standard deviation of CPI inflation rates in these 14 metropolitan is somewhat higher than in the four Census

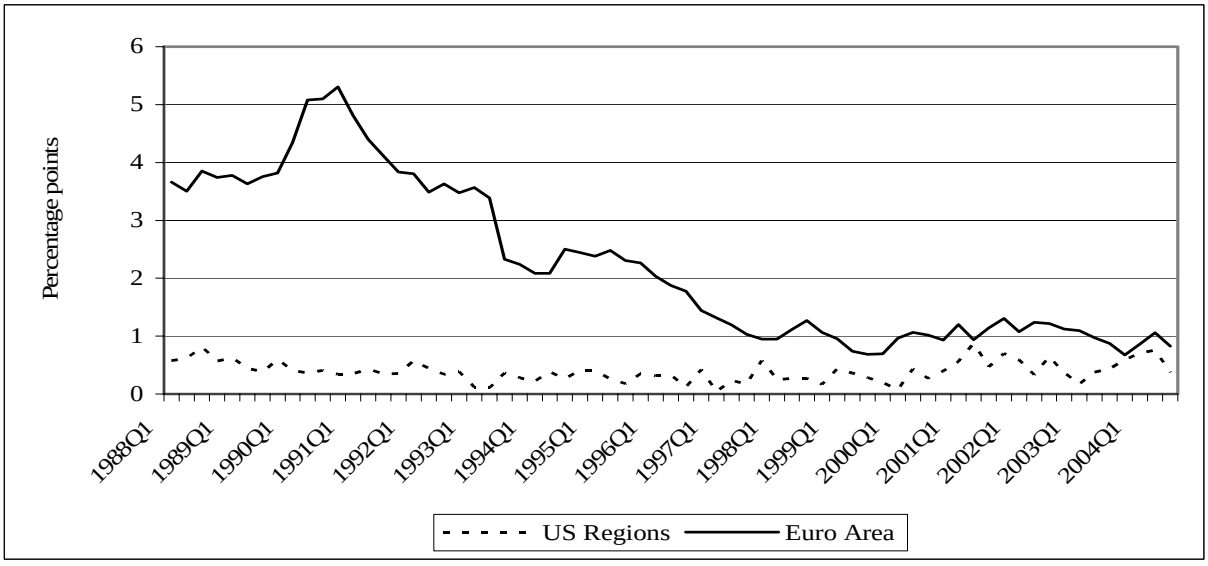
however, that consumer price indices for the euro area and the US are not directly comparable due to differences in coverage and methodology. For example, while owner occupied housing is covered in the US CPI, it is not in the euro area HICP.

Figure 1: Inflation dispersion in the euro area



Note: The standard deviation is the unweighted standard deviation of HICP inflation rates across countries. The inflation rate is measured in percent, the standard deviation in percentage points.

Figure 2: The standard deviation of regional inflation rates in the US and the euro area

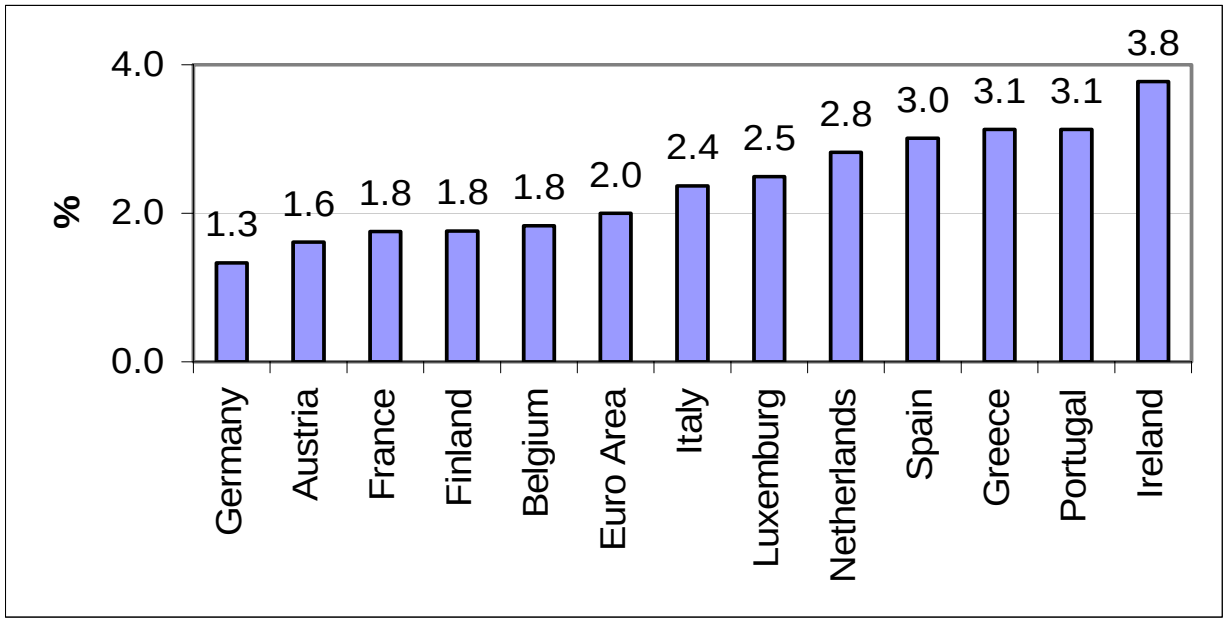


Note: Standard deviations are unweighted standard deviations of inflation rates across countries and regions. US Census Regions are West, Midwest, South and Northeast.

Regions (see Angeloni and Ehrmann, 2004, p. 26). However, since these metropolitan areas are much smaller than most euro area countries, the Census Regions are probably the more appropriate base for comparison.

Figure 3 shows the average level of HICP inflation in the euro area countries since the start of EMU. Compared to the euro area average of 2%, inflation was lower in Germany, Austria, France, Finland and Belgium, while it was higher in Italy, Luxemburg, the Netherlands, Spain, Greece, Portugal and Ireland. In the latter four countries inflation was even more than one percentage point higher than the euro area average. Inflation was lowest in Germany (1.3%) and highest in Ireland (3.8%), implying a maximum inflation differential of 2.5 percentage points.

Figure 3: Average annual inflation rates in the euro area since the start of EMU

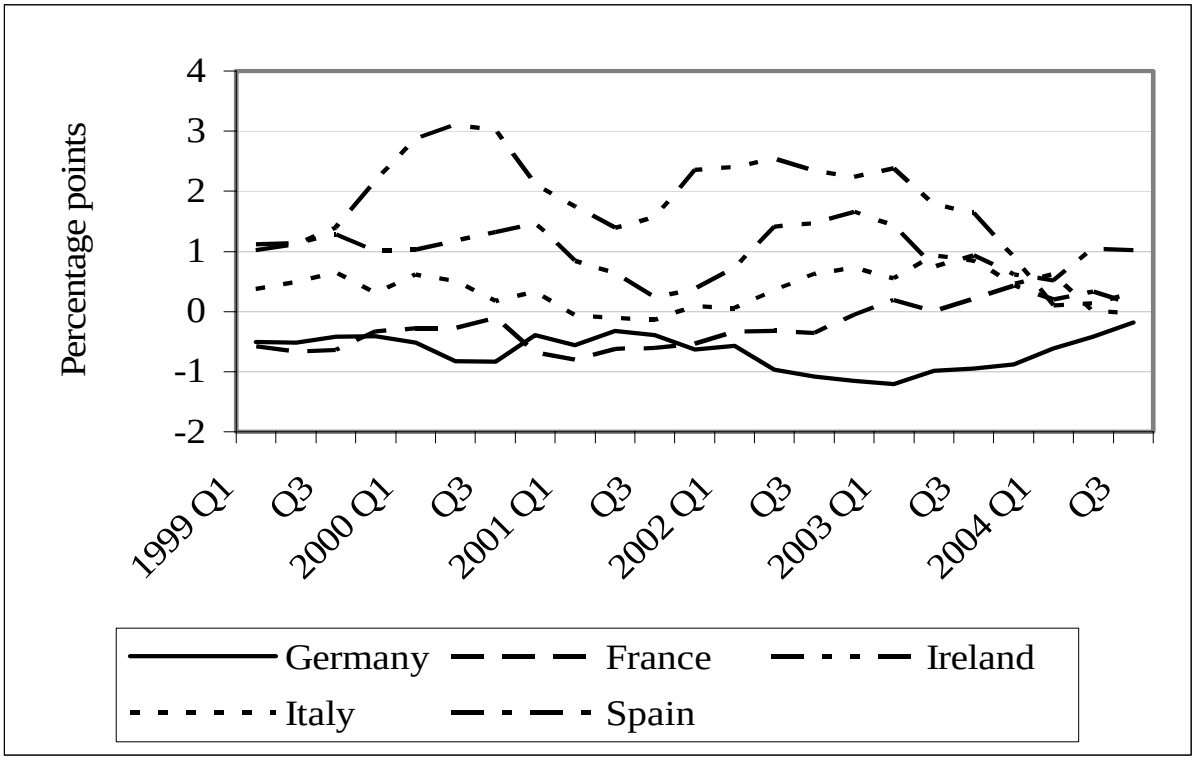


Note: The figure displays national averages of annual HICP inflation rates over the period 1999Q1 to 2004Q3.

Figure 4 shows the development of inflation differentials in the euro area for some selected countries, the four largest euro area economies Germany, France, Italy and Spain, and the country with the highest average inflation rate since the start of EMU, Ireland. The inflation differential is measured as the difference between the annual national HICP inflation rate and the annual euro area HICP inflation rate. The graphs reveal that inflation differentials in the euro area are characterised by a high level of persistence. Inflation in Germany was

continuously below the euro area average, while inflation in Italy, Spain and Ireland was steadily above average. French inflation was below the euro area average until the end of 2002 and then slightly above it. The graph also shows, however, that inflation rates converged recently. In the third quarter of this year, the German inflation rate was only about 0.2 percentage points below the euro area average, while inflation in Ireland and France was about 0.3 and 0.1 percentage points above it. Italian inflation was about the same as euro area inflation, only Spanish inflation was still significantly higher than the euro area average by about one percentage point.

Figure 4: Inflation differentials in the euro area since 1999

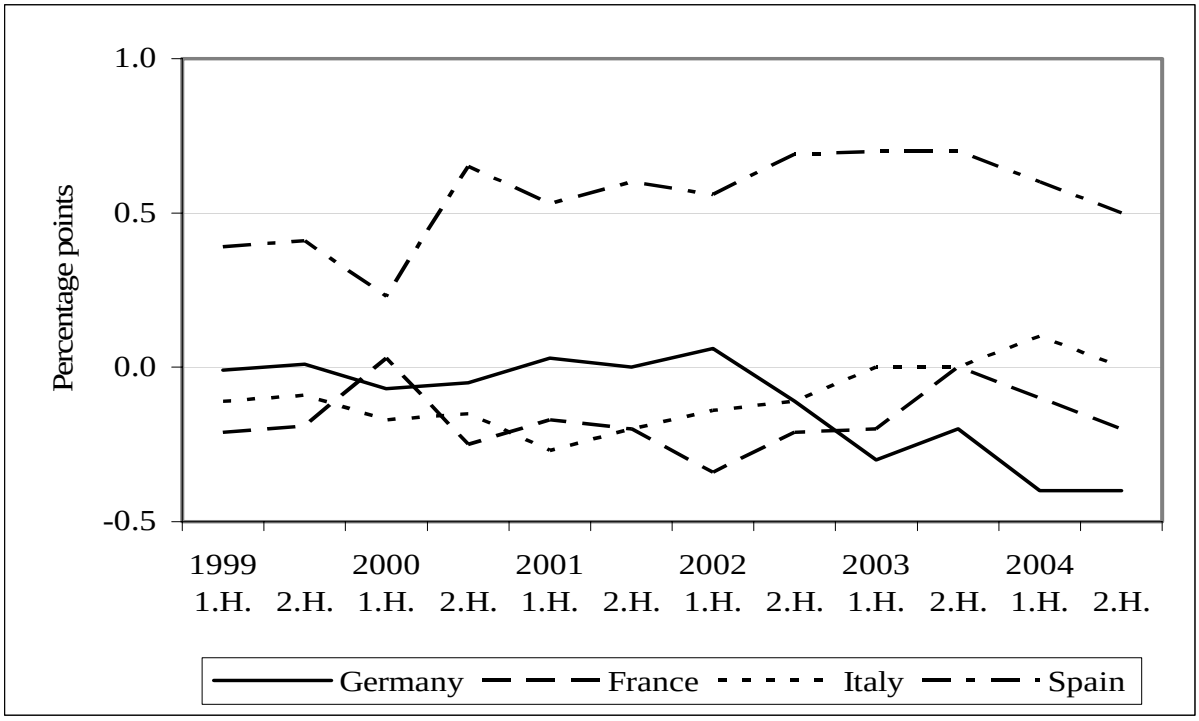


Note: The figure displays the spread between the respective national annual HICP inflation rate and the annual euro area HICP inflation rate.

Thus, inflation differentials in the euro area over the first years of EMU were characterised by a high level of persistence. The question is whether these inflation differentials are a long-lasting or rather a temporary phenomenon. Some indication on this can be obtained from long-run inflation expectations of market participants. Semi-annual data for long-run CPI inflation expectations, referring to the average rate of CPI inflation expected to prevail in six to ten years, are available for the euro area and the four largest euro area countries from

Consensus Forecasts.[6] Figure 5 shows how expected long-run inflation differentials in the four largest member countries of the euro area have developed since 1999. The graph reveals that the differences in inflation expectations are much smaller than the differences observed in actual inflation rates. According to the latest vintage of forecasts of October this year, market participants expect euro area inflation to be on average 2% in six to ten years. German inflation is expected to be about 0.4 percentage points lower than the euro area average. French inflation is seen to be about 0.2 percentage points below average. Spanish inflation is forecast to be about 0.5 percentage points higher than the average over the same horizon. Finally, inflation in Italy is expected to be at about the same level as euro area inflation over the longer term.

Figure 5: Long-run expected CPI inflation differentials in the euro area since 1999



Source: Consensus Forecasts, various issues; ECB calculations; own calculations. The graph displays the spread between the average national CPI inflation rate and the average euro area CPI inflation rate expected in 6-10 years.

[6] Data for the euro area are only available from 2003. Backdates of long-term euro area inflation expectations have been constructed by the ECB based on a weighted average of the data available for the four largest euro area economies Germany, France, Italy and Spain.

2. Potential causes of inflation differentials in the euro area: An overview

The potential causes of the inflation differentials observed in the euro area over the last couple of years are manifold. First, inflation differentials may be a structural phenomenon reflecting convergence of price levels in the currency union. Such price level convergence may arise due to convergence of tradable goods prices in the wake of further integration of euro area goods and services markets. The so called Balassa Samuelson effect implies on the other hand that there may also be convergence of non-tradable goods prices spurred by real income catch-up effects in the euro area. Second, persistent inflation differentials may also be caused by temporary supply and demand shocks. Asymmetric shocks, like a change in indirect tax rates or in fiscal stance, may give rise to persistent inflation differentials if there is a significant degree if persistence in inflation. But also temporary shocks which hit all member countries alike, e.g. changes in the euro exchange rate, may have a differential impact on inflation in the euro area countries because of differences in consumption patterns and economic structures or because of differences in the degree of inflation persistence across countries.

2.1. Price level convergence

Inflation differentials in a currency union may be a structural phenomenon arising from price level convergence, which may occur because of convergence of tradable goods prices as a result of increased trade integration and because of convergence of non-tradable goods prices in the wake of real income convergence. The available evidence shows that dispersion of tradable goods prices has decreased substantially in the 1990s with the completion of the single market. Rogers et al. (2001) report evidence showing that the dispersion of tradable goods prices between eleven euro area cities has fallen by more than 50% over the period 1990 till 1999. The start of EMU and the introduction of the euro in 2002 will have given additional impetus to the integration of the euro area goods markets by increasing price transparency, reducing transaction costs and eliminating exchange rate uncertainty. However, comparing convergence of regional goods and services price inflation rates in the euro area before and after the start of EMU, Weber and Beck (2003) find that the speed of convergence seems to have slowed down in the latter period, indicating that the convergence process may be nonlinear, depending on how far convergence has already proceeded.

Convergence of real incomes in the euro area, which is further promoted by the creation of the common currency and also directly supported by EC policies such as the cohesion fund, may also give rise to price level convergence in the non-tradable goods sector due to the so called Balassa Samuelson effect (Balassa, 1964; Samuelson, 1964). Productivity gains in a catching-up process tend to accrue mainly in the sector of tradable goods, which is more exposed to competition and more capital intensive. These productivity gains will be acccompanied by rising wages, as the sectoral wage should equal the sectoral marginal product of labour. Due to competition in goods markets and mobility of labour between the tradable and the non-tradable goods sector, there will be a tendency for nominal wages to equalize in both sectors. This implies in turn that non-tradable goods prices must rise faster than tradable goods prices in order to compensate for the higher nominal wages which are not met by productivity gains in this sector. As a result, countries with higher productivity growth in the wake of real income convergence would also be expected to experience higher rates of goods prices inflation than more mature economies with lower rates of productivity growth.

The implications of the Balassa Samuelson (BS) effect for EMU have received a great deal of attention in the academic and policy oriented literature. In Table 1 we summarise the findings of several studies assessing the quantitative implications of the BS-effect for euro area inflation rates for all euro area countries except for Luxemburg, for which results were not available. These studies assess the long-run relationship between the difference in non-tradable and tradable goods price inflation and the difference in labour productivity growth in the two sectors. Exceptions are IMF (1999) and IMF (2002), where the analysis is based on trends in total factor productivity and price developments in the industry and service sector respectively.

Following ECB (2003) we have calculated implied structural inflation rates for each country under the assumption of 2% average inflation in the euro area. Although the studies differ widely by specification, methodology and sample period, the results are broadly similar. In the second to last column of the table we report the average implied BS inflation rate over the different studies. Comparison with the actual average inflation rates over the EMU period suggests that there is a positive correlation between the structural inflation rate implied by the BS effect and average recent inflation performance. The figures suggest that Germany is the only country with a below average structural inflation rate. However, the difference to the euro area amounts to a mere half percentage point on average.

Table 1: Structural inflation rates implied by the Balassa-Samuelson effect (calculated based on the assumption of 2% inflation in the euro area)

	Alberola/ Tyrväinen (1998)	Canzoneri et al (2001)	Sinn/Reutter (2001)	De Grauwe/ Skudelny (2000)	IMF (1999)	IMF (2002)	Sachver-ständigenrat (2001)	Average implied BS effect	Average HICP inflation since 1999
Germany	1.3	1.0	1.0	1.7	1.5	1.9	1.5	1.5	1.3
France	1.7	2.4	2.3	1.6	2.8	1.9	1.8	2.1	1.8
Italy	2.4	2.8	2.5	2.4	2.7	1.9	2.4	2.4	2.4
Spain	3.1	2.4	2.5	2.0	-	2.3	2.6	2.4	3.0
Netherlands	2.3	-	2.4	2.0	1.6	2.3	2.5	2.2	2.8
Belgium	3.1	2.6	1.8	2.1	3.8	2.0	2.8	2.5	1.8
Austria	1.8	1.8	2.4	2.5	-	2.5	1.6	2.3	1.6
Greece	-	-	5.3	-	2.8	2.7	-	3.6	3.1
Portugal	-	-	1.8	2.1	4.3	2.3	1.7	2.4	3.1
Finland	2.4	2.4	3.7	1.4	2.9	2.3	2.3	2.5	1.8
Ireland	-	-	3.4	-	-	3.4	-	3.4	3.8

Source: ECB (2003) and own calculations based on the cited studies.

2.2. Persistent effects of temporary shocks

Temporary price shocks may impact differently on the euro area countries due to differences in consumption patterns and economic structures. Even fully symmetric price shocks may have a differential effect across countries due to the so called composition effect. The HICP is a weighted average of the HICP sub-indices for the different categories of goods and services. The weights of the different sub-indices reflects the weight of the different goods and services in the representative household's consumption bundle. Differences in cross-country consumption patterns will therefore give rise to differences in the HICP sub-index weights. As a result, inflation differentials may arise in the short-run because of different exposures to exogenous price shocks such as oil price shocks or the effect of animal diseases like the foot- and mouth disease and BSE. An analysis of the German Council of Economic Advisors (Sachverständigenrat, 2001) suggests that the composition effect is of secondary importance for euro area inflation differentials, contributing at most 0.2 percentage points to the observed inflation differentials.

Over and above asymmetric effects arising from differences in the composition of national HICPs, such price shocks may also have a different impact on the euro area inflation rates because of differences in economic structures. The effect of exchange rate and oil price changes may vary depending on a country's exposure to extra euro area trade and the oil intensity of production. Honohan and Lane (2003) report evidence based on a panel estimate for euro area inflation rates over the EMU period suggesting that inflation divergence in the euro area was probably to a significant extent attributable to differences in the impact of the depreciation of the euro in 1999 and 2000.

Short-run inflation differentials may also occur because of differences in cyclical positions, which may be the result of differential impacts of the price shocks mentioned above, but also because of differences in domestic demand shocks arising from e.g. differences in fiscal stance, or asymmetric effects of common demand shocks, such as differential effects of the common monetary policy arising from differences in financial and economic structures. These factors may give rise to cross-country variation in output growth and, as a result, to cross-country inflation differentials. Graphical evidence reported in ECB (2003) as well as the panel regression results of Honohan and Lane (2003) suggest that differences in cyclical positions

may be an important factor in explaining cross-country differences in inflation performance in the euro area since the start of EMU.

4. Causes and macroeconomic implications of inflation differentials in the euro area: Some evidence

The analysis of the previous section suggests that inflation differentials in the euro area are probably driven by multiple factors. The persistence of the observed inflation differentials described in section 2 seems to suggest that euro area inflation differentials are more likely to be the result of structural factors than of temporary supply and demand shocks. However, if inflation is persistent, temporary shocks with asymmetric effects may also give rise to highly persistent inflation differentials. The evidence from both reduced form and structural models of the inflation process in industrialised countries suggests that euro area inflation rates are characterised by a rather high level of persistence, although there is an ongoing academic debate on the appropriate measurement and interpretation of the observed levels of persistence.[7]

Directly related to the question of the causes of the persistent inflation differentials is the issue of their macroeconomic implications and consequences. Under the common monetary policy of the Eurosystem, countries with below average inflation rates will face above average short-term real interest rates, while countries with above average inflation rates will face below average real rates. This seems to imply that countries with a buoyant economy and higher than average inflation rates would enjoy further stimulus, while weaker economies with a lower than average inflation rate would be further weakened. This potentially self-exciting effect of persistent inflation differentials would be counterbalanced by a self-correcting real exchange rate effect. Countries with lower (higher) than average inflation rates enjoy a real depreciation (appreciation) vis-à-vis their euro area trading partners, which makes their economies more competitive and thus stimulates net exports. As the real exchange rate depends on the relative levels of domestic and foreign price or cost levels, the effects of inflation differentials on an economy's international price competitiveness accumulate over time, so that the real exchange rate effect should at some point dominate the real interest rate effect and trigger a reversion back to equilibrium.

[7] The significance and the underlying causes of inflation persistence are currently investigated in the Eurosystem's Inflation Persistence Network (IPN).

These considerations imply that both the causes and the macroeconomic implications of inflation differentials in the euro area have to be analysed in a structural framework which enables a joint assessment of the significance of each potential factor and adjustment mechanism. The modelling of the inflation processes in the euro area countries should take, as far as possible, the potential factors discussed in the previous section *and* the potential presence of inflation persistence into account. Likewise, the modelling of the repercussions of inflation differentials on economic activity should be based on a structural model of aggregate demand, comprising both the real interest rate and the real exchange rate effect.

New Keynesian style models have in recent years become a standard workhorse of structural macroeconomic analysis. On the supply side, the New Keynesian framework is based on the assumption of intertemporally optimal price setting by forward looking, monopolistically competitive firms (Taylor, 1980, Rotemberg, 1982, Calvo, 1983), which yields a purely forward-looking Phillips Curve. The modelling of the demand side in the New Keynesian framework is based on the assumption of intertemporally optimising households, which yields a purely forward-looking IS Curve, where the output gap depends on the expected future output gap and the ex-ante short-term real interest rate. The purely forward-looking specifications of the Phillips and the IS Curve have, however, proved unable to match the lagged and persistent response of output and inflation to demand and supply shocks. This caveat is of course crucial in the context of the analysis of inflation differentials. A simple way to cope with this problem is to introduce backward-looking terms in the Phillips and IS Curve by assuming that inflation expectations and consumption patterns partly depend on the experiences of the past. E.g. Gali and Gertler (1999) assume that a fraction of price setters apply a rule-of-thumb price adjustment rule and simply adjust their prices to past inflation. A common approach to introduce backward-looking terms in the IS Curve is to assume habit persistence in consumption, so that household utility also depends on lagged consumption (Fuhrer, 2000).

Recently, variants of the New Keynesian model have already been used to analyse inflation differentials in the euro area. E.g. Angeloni and Ehrmann (2004) build a stylised open economy version of the New Keynesian model for the twelve euro area countries estimated over the period 1998Q1 till 2003Q2. Their model comprises a hybrid Phillips Curve and a backward-looking IS Curve. Inflation depends on future expected inflation, lagged inflation,

the output gap and the change in the effective nominal exchange rate. Thus, they focus on cyclical factors and price shocks arising from fluctuations in the effective nominal exchange rate as the main drivers of inflation differentials. The output gap depends on the lagged output gap, the short-term real interest rate and the effective real exchange rate. Their model therefore incorporates the two mechanisms transmitting inflation differentials to the real economy discussed above.

Von Hagen and Hofmann (2004) focus on the implications of inflation differentials for economic activity in the euro area economies. They estimate backward looking IS Curves for ten euro area countries over the period 1993Q1 till 2002Q4 including, besides the national real interest rate and the real exchange rate, also the euro area real interest rate. They argue that, in an integrated market like the euro area, the real interest rate measured in euro area prices may also matter for aggregate demand, especially for investment decisions of export oriented firms. If firms sell exclusively to their domestic market, the national price level of their home country reflects average sales prices. If they sell to all markets in the euro area, applying pricing to market, it may rather be the aggregate euro area price level that matters for them. Von Hagen and Hofmann (2004) conclude, based on their findings, that the euro area real interest rate may be more important for aggregate demand than the national real interest rates.

Although they constitute important steps in the right direction, the analyses of Angeloni and Ehrmann (2004) and Von Hagen and Hofmann (2004) still bear various drawbacks, as potentially important additional factors affecting inflation differentials and their macroeconomic implications are not considered in these studies. First, the empirical evidence (Fuhrer and Rudebusch, 2004, Goodhart and Hofmann, 2004) suggests that there is a significant forward-looking component in empirical IS Curves. The analysis of Angeloni and Ehrmann and von Hagen and Hofmann is based on purely backward-looking IS Curves and thus not fully in line with the evidence mentioned above. We will in the following analysis allow for a forward-looking terms in both the Phillips and the IS Curve.

Second, the discussion of the previous section strongly suggests also to consider price level convergence as a potential driver of inflation differentials in the euro area. Angeloni and Ehrmann focus on differences in cyclical position and exchange rate pass-through without testing for the significance of price level convergence effects. In our model we also include

the 1999 PPP price level and the implied BS effect discussed in the previous section as proxies of potentially structural differences in inflation rates in the Phillips Curve.

Finally, besides the real interest rate, the real exchange rate and the euro area real interest rate, we also include the trade-weighted output gap in the IS Curve, as the empirical evidence suggests that such direct output spillover effects may matter. Von Hagen and Hofmann (2004) do not consider these direct spillover effects between the euro area countries. Their finding that it is the euro area real interest rate rather than the national real interest rate that matters for aggregate demand may be due to proxy effects arising from the omission of such a variable.

Following these considerations, we estimate the following specification of the hybrid Phillips and IS Curves for the euro area economies, which can be seen as a more general model of the euro area countries encompassing the models proposed by Angeloni and Ehrmann (2004) and von Hagen and Hofmann (2004):

$$(1)\quad \pi_{t,i} = c_{1,i} + \psi\overline{\pi}_t + \gamma E_{t,i}\pi_{t+1,i} + (1-\gamma)\pi_{t-1,i} + \lambda y_{t-1,i} + \kappa\Delta nex_{t,i} + \varepsilon_{t,i},$$

$$(2)\quad y_{t,i} = c_{2,i} + \alpha_1 E_{t,i} y_{t+1,i} + \alpha_2 y_{t-1,i} - \delta r_{t-2,i} + \mu rex_{t-1,i} + \chi y^{euro}_{t,i} + \varphi r^{euro}_{t-2,i} + \eta_{t,i},$$

where π is quarterly inflation in the Harmonised Index of Consumer Prices (HICP) and y is the output gap measured as the percent gap between real GDP and potential real GDP, calculated using a standard Hodrick-Prescott-Filter with a smoothing parameter of 1600.[8] $\overline{\pi}$ is a proxy for the structural inflation rate arising from price level convergence. r is the ex-ante real interest rate, i.e. the short-term nominal money market interest rate less four quarter CPI inflation in the following period.[9] nex is the nominal effective exchange rate and rex the CPI based real effective exchange rate. An increase in the effective exchange rates represents a depreciation. y^{euro} is for each country the trade-weighted output gap in the other euro area countries. r^{euro} is a measure of the real interest rate in the rest of the euro area,

[8] The Hodrick-Prescott Filter trend was calculated over the period 1991Q1-2004Q2.

[9] It is often argued that it is long-term rather than short-term real interest rates that matter for aggregate demand. Unfortunately, there are no data on long-run inflation expectations available for the majority of euro area countries, so that we were not able to include an ex-ante long-term real interest rate in the model.

calculated by subtracting for each country a trade weighted average of the annual inflation rates in the other euro area countries from the nominal interest rate.[10]

Our prior considerations suggest that we would expect to find a positive effect of the output gap and of the change in the nominal effective exchange rate on inflation. The 1999 price level would be expected to exert a negative influence on inflation, while the implied BS effect would be expected to exert a positive influence. For the IS Curve we would expect to find that the real interest rate variables have a negative and the real exchange rate and the output gap in the rest of the euro area have a positive effect on the national output gaps.

The Phillips Curve and the IS Curve were estimated for eleven euro area countries by panel Generalised Method of Moments (GMM) over the period 1999Q1 till 2004Q1. Luxemburg was not included in the panel as there were no quarterly GDP data available for this country. The panel estimates are thus based on a total of 231 observations. In order to rule out a long-run Phillips Curve trade-off we have imposed the restriction that the sum of the inflation lead and lag coefficients equals one. For the initial specification of the Phillips Curve we considered two proxies for the structural inflation rate of a country, the 1999 PPP price level relative to the euro area average[11] and the average implied Balassa-Samuelson (BS) effect from Table 1. As these variables are constant over time we estimate the Phillips Curve without fixed effects. The set of instruments comprises four lags of each right hand side variable (except for the trend inflation proxies) and two lags of real GDP growth and the change in the oil price. The first column of Table 2 presents the estimation results for the specification with the 1999 relative price levels, the second column the results for the specification with the implied BS-effect. Except for the structural inflation proxies, all coefficients are in both specifications correctly signed and significant at the 1% level. The 1999 price level and the implied BS effect come out insignificantly, the BS effect even wrongly signed. These findings do, however, not imply that we reject price convergence or the importance of the BS effect in the euro area. It rather means that over the relatively short sample period covered by our study, these effects were probably superimposed by the temporary effects of cyclical fluctuations and price shocks originating from fluctuations in the exchange rate.

[10] When we include the oil price as a regressor in the Phillips Curve it does not come out significantly.

[11] Comparative price levels are calculated based on Purchasing Power Parity (PPP) exchange rates against the US-$ using OECD data. The PPP relative price levels can be seen as a proxy for the scope of convergence of euro area price levels.

As the next step we re-estimate the Phillips Curve excluding the insignificant trend inflation proxies and allowing for cross-section fixed effects. The results are displayed in column three of Table 2. All coefficients remain correctly signed and significant at the 1% level. Inflation is significantly affected by the economy's cyclical position and the change in the nominal effective exchange rate. With a weight of 0.44 on the lagged inflation rate there appears to be a fairly high level of persistence in euro area inflation rates.

The IS Curve was estimated by fixed-effects panel GMM. The results, which are displayed in the first column of Table 3, show that all variables are correctly signed and significant at the 1% level except for the euro area real interest rate. We therefore repeat the regression excluding this variable. The results, which are reported in the second column of Table 3, show that the effect of the real interest rate, the effective real exchange rate and the euro area output gap on national output gaps is respectively significant at the 1% level. The real interest rate coefficient is about twice as large as the real exchange rate coefficient. This does not mean, however, that the self-exciting effect of inflation differentials dominates, because, as we have already pointed out above, the effect of inflation differentials on the real exchange rate accumulates over time. The estimation results suggest, however, that the direct demand effect of the trading partners' output gap has a stronger direct impact on a country's cyclical position than the real exchange rate. This implies that, besides the real exchange rate effect, there is an important additional stabilising mechanism working via direct output spillover effects. Also, both the lead and lag of the output gap are significant at the 1% level. With a coefficient of 0.25 on the lagged output gap there also appears to be a significant level of cyclical persistence in the euro area countries.

So far the analysis imposes a rather high level of symmetry by assuming that the structural parameters of the Phillips and the IS Curve are equal across countries. Unfortunately, estimating the structural equations separately for each country over the EMU sample period is not possible due to an insufficient number of observations. Extending the sample period to the pre-EMU period is also not an option as the convergence and subsequent transition to EMU may have given rise to breaks in the estimated relationships in some countries. As an alternative, we re-estimate the panels and allow some structural parameters to vary between sub-groups of countries. We focus on differences in the degree of inflation persistence and the

transmission of monetary policy, because these issues were and continue to be extensively discussed in the academic and policy oriented literature.

The degree of inflation persistence in the euro area countries may differ depending on differences in the past monetary policy regime. High and variables rates of inflation had in some countries given rise to widespread use of explicit and implicit indexing practices which may still influence the formation of inflation expectations today. As a result, inflation persistence may be higher in countries which experienced high and variable inflation rates and lower in countries which experienced comparatively low and stable inflation rates. In order to assess the relevance of this argument for the euro area we split the sample in two groups, one group of countries which have experienced relatively low and stable inflation rates in the past, comprising Germany, Austria, Belgium and the Netherlands, and another group comprising all other countries. We then re-estimate the panel of Phillips Curves and allow the persistence parameter to vary over the two groups. The results are displayed in the last column of Table 2 and suggest that there are quite striking differences in the degree of inflation persistence. In the group of countries with a history of low and stable inflation rates there is basically zero persistence. On the other hand, in the other group of countries the weight of the lagged inflation rate is higher than that of the inflation lead, implying a rather high degree of inflation persistence.[12]

Asymmetric monetary transmission in the euro area has been extensively discussed before the start of EMU and was subsequently analysed in depth by the Monetary Transmission Network (MTN) which has been set up by the Eurosystem. In their review of the research results produced by the MTN, Angeloni et al. (2003) conclude that monetary transmission may be weaker in Belgium, Finland, France, Germany, the Netherlands and Portugal than in the other euro area countries. Following Angeloni and Ehrmann (2004) we therefore allow the real interest rate coefficient to vary between this group and the rest of the euro area countries. The results are reported in the last column of Table 3. In accordance with the findings of Angeloni and Ehrmann (2004) we find weaker transmission in the former group of countries. However, the difference between the interest rate elasticities is not significant.[13]

[12] A Wald test rejects equality of the two persistence coefficients at the 1% level.
[13] A Wald test for equality of the two coefficients yields a p-value of 0.3.

Table 2: The Phillips Curve in the euro area countries

Specification	(1)	(2)	(3)	(4)
$\overline{\pi}_t$	-0.039 (0.118)	-0.038 (0.031)	-----	------
π_{t+1}	0.539*** (0.063)	0.558*** (0.067)	0.557*** (0.061)	------
π_{t+1}^{Low}			-----	0.996*** (0.123)
π_{t+1}^{High}			-----	0.447*** (0.056)
π_{t-1}	0.461*** (0.063)	0.442*** (0.067)	0.443*** (0.061)	
π_{t-1}^{Low}			-----	0.004 (0.123)
π_{t-1}^{High}			-----	0.553*** (0.056)
y_{t-1}	0.141*** (0.056)	0.144*** (0.056)	0.145*** (0.056)	0.174*** (0.049)
Δnex_t	0.116*** (0.043)	0.123*** (0.044)	0.078*** (0.033)	0.067** (0.029)
$\overline{R}^2$	0.77	0.77	0.78	0.77

*Note: Standard errors are in parentheses. *** denotes significance at the 1% level.*

Table 3: The IS Curve in the euro area countries

Specification	(1)	(2)	(3)
y_{t+1}	0.441*** (0.027)	0.441*** (0.026)	0.44*** (0.03)
y_{t-1}	0.237*** (0.042)	0.245*** (0.042)	0.248*** (0.042)
r_{t-2}	-0.08*** (0.032)	-0.06*** (0.018)	
r_{t-2}^{Strong}	-----	-----	-0.088*** (0.033)
r_{t-2}^{Weak}	----	-----	-0.016 (0.044)
rex_{t-1}	0.029*** (0.01)	0.03*** (0.01)	0.03*** (0.011)
y_t^{euro}	0.282*** (0.045)	0.275*** (0.045)	0.277*** (0.045)
r_{t-2}^{euro}	0.023 (0.033)	----	-----
$\overline{R}^2$	0.96	0.96	0.96

*Note: Standard errors are in parentheses. *** denotes significance at the 1% level.*

5. Conclusions

In this paper we review the development, potential causes and macroeconomic implications of inflation differentials in the euro area. We show that inflation dispersion has declined considerably in the run-up to EMU in the 1990s to levels similar but still somewhat higher than those observed in the US. A marked feature of inflation differentials in the euro area is their persistence, with a large group of countries continuously experiencing above average inflation and another group of countries continuously experiencing below average inflation since the start of EMU.

In order to assess the potential causes and macro implications of these persistent inflation differentials we have estimated a structural New Keynesian style model of the euro area economies over the EMU period. Our empirical analysis suggests that the observed inflation differentials since the start of EMU were mainly driven by differences in cyclical positions and fluctuations of the effective exchange rate combined with a rather high level of inflation persistence. Proxies of price level convergence do not come out significantly. This finding does, however, not imply that we reject price level convergence or the importance of the Balassa Samuelson effect in the euro area. It rather means that, over the relatively short sample period covered by our study, these effects were probably superimposed by the persistent effects of temporary demand and supply shocks.

The empirical results also show that aggregate demand in the euro area countries is significantly affected both by the short-term real interest rate and the effective real exchange rate. The finding of a significant real exchange rate effect in the euro area IS Curves suggests that, over the longer-term, inflation differentials will be self-correcting as the effects of inflation differentials on the real exchange rate accumulate over time, so that at one point reversion back to equilibrium will occur. Moreover, we find strong evidence of direct output spillover effects between the euro area countries. This finding implies that, even in the short-run, the scope for an amplification of inflation differentials via corresponding real interest rate differentials is likely to be limited.

Some studies have argued that optimum currency areas may be endogenous because of the integrating effects of a currency union.[14] The endogeneity argument has been put forward for

[14] See De Grauwe and Mongelli (2004) for an overview and assessment.

economic integration, financial integration, symmetry of shocks and of product and labour market integration. Our analysis suggests that there may also be endogeneity with respect to the persistence of inflation differentials in the euro area. We find that inflation persistence is significantly lower, virtually zero, in the group of euro area countries which have already experienced comparably low and stable inflation rates in the past, while it is rather high in the rest of the euro area countries. Given that the monetary policy of the Eurosystem is geared at delivering and maintaining low and stable inflation rates in the euro area, inflation persistence should also decrease in the other countries in the not too distant future. As a result, the persistent inflation differentials in the euro area may vanish eventually.

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