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Inflation Differentials in the Euro Area: Did the ECB Care?

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Inflation Differentials in the Euro Area: Did the ECB Care?

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Abstract

Compared to inflation differentials among regions in the United States, EMU inflation differentials are larger and more persistent. Based on augmented monetary policy reactions functions, this paper addresses the question whether the presence of pronounced inflation differentials in combination with low average inflation rates has influenced monetary policy decisions of the ECB. The paper finds statistical evidence that the ECB took inflation differentials into account which may reflect the fear of deflation in low inflation countries like Germany.

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1. Introduction

Six years after the launch of the euro, inflation differentials among participating countries still exist. Although they converged in the run-up to European Monetary Union (EMU), they diverged around 1999, before they somewhat narrowed down again thereafter. Nevertheless, stylized facts show that inflation differentials within EMU remain larger and more persistent than those between regions of the United States and during the deutschmark era before 1999 between the different *Länder* of Germany. The European Central Bank (ECB) emphasizes that it pays due attention to the presence of inflation differentials within the euro area (ECB, 2003 and 2005). It can also be anticipated that the accession process further increases possible inflation differentials.

Potential reasons for the observed inflation differentials are manifold and have been extensively discussed in the literature (see, for example, Altissimo et al., 2005). Moreover, the economic consequences - positive or negative - have been highlighted (Hofmann and Remsperger, 2005). There seems to be a consensus that monetary policy within EMU cannot offset inflation differentials between member countries because there is no room for regional or national considerations. However, it may well be that the ECB, in deciding on its monetary policy, takes inflation differentials into account. Against this background, this paper examines the question whether the presence of relative pronounced inflation differentials has influenced the behavior of the ECB since the launch of the euro. With average inflation above target and considerable inflation differentials, some countries may experience quite low levels of inflations or even approach a situation of deflation. Then, although aggregate inflation calls for restrictive monetary policy, the ECB might have been reluctant because of the "fear of national deflation" with possible contagion effects spreading through the euro area.

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The rest of the paper has the following structure. Section 2 presents some stylized facts on inflation differentials in the euro area. Section 3 discusses possible causes of the observed inflation differentials. Section 4 includes measures of inflation differentials into interest rate reaction functions in order to find statistical evidence whether such differentials have influenced the interest rate policy of the ECB. Finally, section 5 concludes.

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2. Inflation Differentials in the Euro Area: Some Stylized Facts

Inflation differentials have significantly declined in the euro area in the run-up to EMU. Figure 1 shows that the unweighted cross-country standard deviation of annual national inflation rates measured by the Harmonized Index of Consumer Prices (HIPC) has decreased significantly.[1] Most of this process can be attributed to the process of convergence and reflects the fact that individual countries needed the reach lower rates of inflation in order to qualify for EMU. After establishing the EMU, the inflation differentials tended to increase again. As this was also a period when the aggregated rate of inflation in the euro area rose somewhat, one could expect that the increase in dispersion was mainly driven by an increase in levels. However, the data do not support this view. The correlation between the standard deviation of inflation rates and the aggregate euro area inflation is about 0.18.[2] Figure 1 also shows the inflation dispersion of the US measured by the unweighted standard deviation of inflation rates in the four US Census Regions Northeast, South, Midwest and West. The US standard deviation fluctuates around 0.5 percentage points, whereas the unweighted euro area standard

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[1] Alternative measures for the inflation dispersion are the weighted cross-country standard deviation, the maximum span of inflation rates, and the coefficient of variation. All these measures, however, display the same qualitative picture. See ECB (2003, Annex 1) for a discussion of possible divergence measures.

[2] The ECB (2003, p. 46) also expresses the view that there is no comovement in inflation rate levels and its dispersion.

deviation is about twice as high since 1999.[3] Regarding projections of the evolution of the inflation rate differentials, no clear cut picture emerges from fitting the data with detrending methods like a Hodrick-Prescott filter. Due to the usual endpoint problems of such methods, projections heavily depend on the chosen endpoint of the data series. Whether the inflation rate differentials within the EMU will converge to the levels observed in the US will depend on various structural features within the EMU. These are discussed in more details in the section 3.

< INSERT FIGURE 1 ABOUT HERE >

Inflation differentials in the euro area also appear to be more persistent than in the US in the sense that many countries have systematically maintained either a positive or a negative inflation gap against the euro area average since the introduction of the euro. Table 1 shows the national inflation differentials against the euro area average. It reveals that, since 1999, seven out of twelve countries have inflation rates that are constantly either above or below the euro area average. Some of the differentials are of relative large size (i.e., larger than one percentage point) over prolonged periods of time. Looking at the US, inflation differentials larger than one percentage point and lasting for more than two years have occurred only in a few specific cases. This leads the ECB to the statement that "[t]he persistence of inflation differentials seems, thus, to be a specific feature of the euro area" (ECB, 2005, p. 63).

[3] An alternative available measure for the US inflation dispersion is the unweigthed standard deviation of CPI inflation for 14 metropolitan areas. This measure is somewhat higher than for the four Census Regions (see ECB, 2005, Chart 1). However, since these metropolitan areas are much smaller than most euro area countries, the four Census Regions are probably the more appropriate base for a comparison.

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< INSERT TABLE 1 ABOUT HERE >

The differences between inflation rates among euro area countries also involve an important sectoral dimension. The HICP consists of five main sub-components: services, non-energy industrial goods, energy, processed food, and unprocessed food. Due to their high weights, about two thirds of the overall HICP consist of the first two sub-components. According to an analysis of the ECB (2005), the service sector shows 50 percent more inflation dispersion than the sector of non-energy industrial goods, which reveals that, within the euro area, cross-country inflation differentials in the tradable sector are much lower than differentials in the services sector.[4] However, the available evidence by and large indicates that there is no one single factor that explains the existence and the persistence of inflation differentials in the euro area. The following section provides a survey on the potential origins of the inflation differentials.

3. Causes of Inflation Differentials within a Currency Area

In this section, we briefly discuss possible causes of inflation differentials in a monetary union and, in turn, the potential economic consequences that arise from them. Identifying the underlying causes of inflation differentials is not an easy task, because in a large monetary union like the euro area, a number of factors are likely to contribute to the observed inflation differentials. Three types of factors can be distinguished: transitory factors related to the process of convergence; permanent factors related to national economic structures; and policy-induced factors related to diverging national policies or to divergent regional responses to euro area-wide policies.

[4] See also ECB (2003, p. 6).

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Transitory factors related to the process of convergence among EMU members have contributed and are still likely to contribute in the near future to the dispersion of inflation rates in the euro area. This is the case for at least three reasons. First, the convergence of nominal and real interest rates among the countries to levels that previously were observed only in the low inflation countries before EMU together with the high degree of capital market integration within the euro area may has contributed to a surge in aggregate demand in the formerly high interest rate countries. This has exerted sustained upward pressure on prices, particular in the non-tradable and services sector (ECB, 2005). Second, the implementation of the Single European Market together with the introduction of a single currency has certainly contributed to a marked decline in price level dispersion, mainly in the tradable goods sector. This convergence is likely to have contributed to some degree to the inflation differentials at least in the first years of EMU. Rogers (2002) estimates that the price level dispersion in 1999 contributed to the observed annual HICP inflation dispersion at the end of 2002 and amounted to around 16 percent of the overall inflation dispersion. Third, the Balassa-Samuelson effect (BSE) might have also contributed to the inflation dispersion in EMU. Even with tradable goods prices being similar in EMU member countries, productivity differences account for differences in nontradable goods prices and, thus, for differences in overall inflation rates. However, as productivity convergence has already been substantial in EMU, the size of the BSE for the current member countries is likely to diminish over time and recent calculations suggest that its size is fairly small.[5]

[5] See, for example, the annual report of the "Sachverständigenrat" – the German Council of Economic Advisors – for 2001. See additionally ECB (2003, p. 32 Table 5) for a summary of available studies. Those studies, however, consider periods prior to the EMU and tend to overstate to actual contribution of the BSE, since productivity convergence was considerably stronger prior to the EMU. On average, the studies imply that the BSE results in a standard deviation of 0.6.

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Nevertheless, it may become more relevant in the future when new EU member countries join EMU.

Permanent factors related to national economic structures may have also contributed to inflation differentials in EMU. One such structural factor relates to national differences in the consumption preferences among households. This heterogeneity in preferences is reflected in the fact that the shares of the various goods and services in national consumption and value added differ between member countries. Consequently, they have different weights in the various sub-indices of the national HICPs.[6] Since the same product has different weights in the respective national HICP, a pure 'composition effect' can, thus, lead to different inflation rates even if individual product prices show the same dynamics. However, empirical evidence indicates that this factor constitutes only a relatively minor reason for the inflation dispersion. The German Council of Academic Advisers (Sachverständigenrat, 2001) calculated that the 'composition effect' explains only 2 percent of the measured inflation variance in the euro area in 2000.

Another structural feature that is likely to contribute to the divergence of inflation rates is the degree of openness, and related to this the composition of EMU-external trade. According to this argument, countries within EMU face different inflationary pressure from exchange rate depreciation and/or from a price increase of imported goods and raw material. Indeed, Honohan and Lane (2003) find that country-specific exchange rate effects matter to some degree for inflation differentials.[7] More generally,

[6] For example, the category 'meat' has a weight of 3 percent in the Austrian HICP and 5.5 percent in the Spanish HICP.

[7] Employing pass-through regressions Campa/Gonzalez/Minuez (2006) find that differences in the degree of transmission of a common exchange rate movement into consumer prices among the euro area countries do exist. For example, they calculate an average pass-through rate to consumer prices for the euro area to be about 0.5 with country-specific rates that range from 0.2 for Italy to 1.5 for Ireland. Furthermore, they demonstrate that most of the differences among member countries are due to the distinct degree of openness rather than to the heterogeneity in the structure of imports. In an applied

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the process of adjustment to changing economic conditions is a source of inflation differentials in the euro area. If the degree of price and wage rigidities which are responsible for the path of adjustment differs between EMU members the inflation dynamics will also differ. Empirical evidence of the quantitative importance of these rigidities is rarely available and is a focus of current research (see Angeloni et al., 2004).[8]

The last group of reasons for inflation differentials consists of policy-related factors. Both area-wide and regional policies might contribute to the degree of heterogeneity in the euro area. In particular, fiscal policy is such a source. For example, changes in administered prices, which account for about 6 percent of the HICP, and changes in indirect taxes can contribute to inflation differentials at least in the short run. In addition, the use of national fiscal instruments potentially reinforces inflation differentials. Finally, monetary policy, although centralized in EMU, can contribute to inflation dispersion via different transmission across member countries, e.g. through different structures of the banking sector. Clausen and Hayo (2006), for example, find evidence for asymmetries in the interest rate transmission within the EMU for France, Germany and Italy.

In sum, inflation differences can arise for a variety of reasons. However, it is widely recognized that assigning monetary policy the role of directly addressing these inflation differentials would clearly overburden a central bank. However, central banks might take into account the issue of inflation differentials more indirectly. The ECB (2003, p. 6) states:

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analysis Cunningham/Haldane (2002) use calibrated simulations to demonstrate the impact of alternative specifications of import-price pass-through on the monetary policy transmission mechanism.

[8] In a semi-structural modelling approach Clausen and Hayo (2006) find asymmetries in the effects of output gaps on inflation within EMU member countries. This can also be seen as an indication for the existence of structural differences in the EMU.

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> *"A particular concern for the ECB`s monetary policy strategy is to avoid that the presence of unavoidable inflation differentials* […] *could push lower-inflation regions within the euro area towards inflation levels that could complicate the process of economic adjustment in the presence of downward nominal rigidities. Therefore, the ECB's monetary policy strategy attributes a secondary role to inflation differentials when calibrating the safety margin for admissible inflation in the euro area. In this respect, the ECB's explicit aim of maintaining euro area inflation below but close to 2% is regarded as sufficient to address those concerns."*

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This quote indicates that the ECB is indeed concerned about inflation differentials in the euro area and attributes a "secondary role" to them. Motivated by this observation, the subsequent section examines the ECB's monetary policy in order to identify statistically robust responses of the ECB to the observed inflation differentials.

4. The Reaction of the ECB to Inflation Differentials

All major central banks in industrial countries currently conduct monetary policy by using market-oriented instruments in order to influence the short-term interest rate (Borio, 1997). Since the seminal paper of Taylor (1993), it has become common to describe this interest setting behavior of central banks in terms of monetary policy reaction functions. In its plain form, the so-called Taylor rule states that the short-term interest rate which, in this analysis, represents the instrument of a central bank reacts to deviations of inflation and output from their respective targets. Clarida et al. (1998) proposed a forward-looking variant of the Taylor rule which takes into account the pre-emptive nature of monetary policy as well as interest smoothing behavior of central banks. This particular type of reaction function has become very popular in applied empirical research on Taylor rules. A number of studies demonstrated that the ECB's monetary policy over the course of the first years of single monetary policy in the euro area can also satisfactory be explained by this kind of reaction functions. Among them are Fendel/Frenkel (2006), Fourçans/Vranceanu (2004), and Hayo/Hofmann (2006).[9]

Following Clarida et al. (1998) the baseline policy rule takes the form:

$$(1) \qquad i^* = \bar{i} + \alpha_1 E_t(\pi_{t+k} - \pi^*) + \alpha_2 E_t(y_{t+q} - y_{t+q}^*),$$

where i^* is the desired level of the nominal short-term interest rate, and $\bar{i}$ is its long-run equilibrium level. The second term on the right-hand side is the expected deviation of the k-period ahead inflation rate (π) from the target rate (π*) which is assumed to be constant over time. The third term is the expected deviation of output (y) from its natural level (y*) q periods ahead (i.e., the output gap). The coefficients α_1 and α_2 represent the intensity with which the desired interest rate of the central bank reacts to the inflation and the output gap. The assumption of interest rate smoothing behavior leads to

$$(2) \qquad i_t = (1-\rho) i_t^* + \rho i_{t-1} + \upsilon_t,$$

[9] Altavilla/Landolfo (2005) use a Markov-switching approach in order to analyze whether the ECB reacts asymmetrically. The authors do indeed find that the phase of the business cycle is an important matter in the ECB's monetary policy decisions. Furthermore, Fendel/Frenkel (2005) employ augmented monetary policy reaction functions and show that the ECB also takes into account information from the term structure of interest rates.

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where the parameter ρ (with $0 \le \rho < 1$) describes the degree of interest rate smoothing behavior and υ_t represents an i.i.d. exogenous random shock to the interest rate. Combining (1) and (2) leads to

$$(3) \qquad i_t = (1-\rho)\left(\bar{i} + \alpha_1 E_t(\pi_{t+k} - \pi^*) + \alpha_2 E_t(y_{t+q} - y_{t+q}^*)\right) + \rho i_{t-1} + \upsilon_t .$$

In order to arrive at a testable relationship, the unobservable terms in equation (3) have to be eliminated. Therefore, we rewrite equation (3) as:

$$(4) \qquad i_t = (1-\rho)\alpha_0 + \alpha_1(1-\rho)\pi_{t+k} + \alpha_2(1-\rho)\left(y_{t+q} - y_{t+q}^*\right) + \rho i_{t-1} + \varepsilon_t ,$$

where

$$\alpha_0 = \bar{i} - \alpha_1 \pi^* \quad \text{and} \quad \varepsilon_t = \upsilon_t - \alpha_1(1-\rho)\left(\pi_{t+k} - E_t \pi_{t+k}\right) - \alpha_2(1-\rho)\left(y_{t+q} - E_t y_{t+q}\right).$$

Furthermore, we assume that

$$(5) \qquad E_t\left[\varepsilon_t \middle| I_t\right] = 0 .$$

Here I_t is the central bank's information set available at time *t*. Equation (5) simply states that the central bank uses its best possible guess about future inflation and output in its interest rate decisions.

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In order to estimate equation (4), we employ the following data. The sample period is 1999:01 to 2005:06. For euro area output, we use monthly data on industrial production taken from the IMF International Financial Statistics. The short-term interest rate is the EONIA (European Overnight Index Average) as reported by the ECB. Inflation is measured by the HCPI provided by Eurostat. The output gap is based on natural output calculated by a linear trend.[10]

Following the common approach of the literature for testing reaction functions, we implement the GMM estimation methodology using the correction for heteroscedasticity and autocorrelation of unknown form.[11] In addition, we chose Bartlett weights to ensure positive definiteness of our estimated variance-covariance matrix. We set k =12 and q = 3 in equation (4) and use the constant as well as the lagged values of the output gap and the inflation rate and the short-term interest rate as the core set of instruments.[12] Specification (1) in Table 2 displays the forward-looking Taylor rule in its conventional form as shown in equation (4). All parameters are in the expected range. In particular, the reaction coefficient on inflation is greater than unity, indicating that the *Taylor principle* holds. We use this result as our benchmark.

<INSERT TABLE 2 HERE>

[10] We find that that monetary policy reaction functions for the ECB are robust against changes in detrending method. This confirms the result of Fendel/Frenkel (2005).

[11] Huang/Lin (2006) propose an alternative estimation approach based on a dynamic ordered probit model with time-varying parameters carried out via recent advances in Bayesian simulation approach, namely, the Markov chain Monte Carlo.

[12] More specifically, we use the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the short term interest rate and the inflation gap. This instrument set displays the core set of instruments that is present throughout all subsequent regressions. In the following we only report the instruments that we add the this core set of instruments in particular regressions. The J-statistics which are not reported here indicate that we chose a valid set of instruments for all subsequent regressions.

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Starting from the benchmark regression, we include in additional estimations a measure of inflation differentials. To this end, we proceed along two alternative avenues. The first one is to modify the EMU average inflation gap measure in equation (4) when inflation differentials occur. The second avenue is to include an explicit measure of divergence as an individual explanatory variable in the reaction function.

We start with the first and indirect way of accounting for inflation divergence and calculate two different measures for the "divergence-adjusted inflation gap". The first measure is calculated by dividing the expected inflation gap of regression (1) by one plus the actual unweighted standard deviation of inflation. A standard deviation of zero would then mean that we divide the aggregate inflation gap by one, which leaves it unchanged. The higher the standard deviation is, the smaller is the modified inflation gap. Hence, higher inflation divergence then translates into a smaller inflation gap in the reaction function.

Why should larger inflation divergence have the same effect on the behavior of a central bank as a lower inflation rate? Imagine a monetary union in which all members have an expected inflation rate of, say, three percent. Given a target rate of inflation of, say, two percent, the aggregate inflation gap is one percent and the central bank then probably applies some restrictive monetary policy measures. Now imagine again an aggregate expected inflation rate of three percent but with the following distribution of inflation rates among member countries of the currency union: 50 percent of the member countries display an inflation rate of three percent, 25 percent a rate of 5 percent and the remaining 25 percent a rate of unity. Although the aggregate measure is identical as in the first case considered above, one could expect that the central bank is more reluctant to close the inflation gap in the second case, because applying restrictive

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policy measures could lead to deflation in the low inflation countries.[13] Thus, the ECB cannot counteract inflation divergence directly through monetary measures but it could respond differently to aggregate inflation in the presence of inflation differentials.

Regression (2) in Table 2 reports the estimation results based on the modified inflation gap. The reaction coefficient of this estimate is still significant. This can be interpreted as support for the effect of inflation differentials on the behavior of the ECB as outlined above. We also calculate a second measure of the "divergence-adjusted inflation gap". This measure is calculated by dividing the expected inflation gap of regression (1) by one plus the coefficient of variation. The estimation of the reaction function that uses this modified inflation gap is shown as regression (3) in Table 2. The results show that the reaction coefficient remains significant indicating the robustness of the result.

Since the value of R^2 from regression (1), which is already very high, does not change significantly when including the modified inflation measures in regressions (2) and (3), it is not possible to finally judge whether the new inflation variables contribute to the explanatory power of the model. However, the high R^2 seems to be mainly driven by the presence of the smoothing term. Although including the smoothing term is consistent with the standard formulation for monetary policy reaction functions, we also examine alternative formulations that do not allow for interest rate smoothing. We instead use the change in the interest rate as the left-hand side variable which is then explained by a constant, the expected inflation gap and the expected output gap:

[13] The Japanese experience points to adverse effects of deflation so that a "fear of deflation" seems justified. Among others, Morana (2005) argues that monetary policy played a pivotal role for Japanese deflation and that a more expansionary monetary policy stance of the Bank of Japan could have stopped the deflation in Japan.

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(6) $$i_t - i_{t-1} = \alpha_0 + \alpha_1 \pi_{t+k} + \alpha_2 \left(y_{t+q} - y_{t+q}{}^* \right) + \varsigma_t$$

where

$$\alpha_0 = \bar{i} - \alpha_1 \pi^* \quad \text{and} \quad \varsigma_t = \upsilon_t - \alpha_1 \left(\pi_{t+k} - E_t \pi_{t+k} \right) - \alpha_2 \left(y_{t+q} - E_t y_{t+q} \right).$$

Table 3 presents the results. Since we consider the regressions in Table 3 as complements to the specifications in Table 2 we denote corresponding specifications with the same number but add an "a" to denote "alternative". All coefficients are again significant and of the expected sign, i.e., positive, for the inflation variable and the output variable. Due to the missing smoothing parameter, the R^2 values are much smaller compared to the standard formulations in Table 2. However, comparing their sizes shows that using the modified measures of the inflation gap in specifications (2a) and (3a) improves the overall explanatory power of the model.[14]

< INSERT TABLE 3 HERE >

Judging whether the reaction to the expected inflation gap becomes indeed more reluctant given the information of a higher divergence of actual inflation rates is not possible from the regressions in Tables 2 and 3. Given that the coefficient of the inflation is significant in both the benchmark and in the modified specification, we can

[14] We also re-estimated the regressions based on formulation (4) and forced the smoothing parameter ρ to be zero. As the R^2 values of the estimations (using the three alternative inflation measures) are significantly lower than for the specifications in Table 3, we do not present the results here. However, also in these cases an improvement in the R^2 when employing the modified measures for the inflation gap was also present.

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only say that including inflation diversion in the inflation gap does not deteriorate the Taylor rule estimates. However, it does not yet show which way the ECB reacts to inflation differentials. In order to find out the sign of reaction of the ECB we need to proceed along the second route and add a measure of divergence as an individual explanatory variable. We therefore augment the benchmark regression equation (4) by adding a measure of inflation divergence (Div_{t+l}) as a separate variable according to:

$$(7)\ i_t = (1-\rho)\alpha_0 + \alpha_1(1-\rho)\pi_{t+k} + \alpha_2(1-\rho)\left(y_{t+q} - y_{t+q}*\right) + \alpha_3(1-\rho)Div_{t+l} + \rho i_{t-1} + \vartheta_t\ ,$$

where

$$\vartheta_t = \upsilon_t - \alpha_1(1-\rho)\left(\pi_{t+k} - E_t\pi_{t+k}\right) - \alpha_2(1-\rho)\left(y_{t+q} - E_t y_{t+q}\right) - \alpha_3(1-\rho)\left(Div_{t+l} - E_t Div_{t+l}\right).$$

In contrast to regressions (2) and (3), we allow for a forward-looking specification of the divergence measure. We use four different measures of inflation divergence and show the results in Table 4.

<INSERT TABLE 4 HERE>

Regression (4) uses the 12-month ahead unweighted standard deviation of the inflation rates of the euro area countries as a measure of divergence. The reaction coefficient of the divergence measure is significantly negative. The inflation reaction coefficient stays significantly positive, but displays a far larger value compared to the benchmark regression. The negative coefficient for the divergence measure can be interpreted in the

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following way: higher expected inflation divergence makes the ECB more reluctant to raise interest rates for any given level of expected inflation gap. This result turns out to be robust to changes in the divergence measure. In specification (5), we use the squared standard deviation in order to account for possible non-linearity in the ECB's reaction towards divergence. Specifications (6) and (7) include the coefficient of variation in linear and squared form, respectively. Again, the "reluctance-effect" is significant.[15]

We also re-estimate the specifications (4) through (7) by excluding the smoothing term and use the change in the interest rate as the left-hand side variable instead. As before, excluding the smoothing term allows us to better proof the additional explanatory power of the inflation divergence term. The results are shown in Table 5. All parameters are again significant and of the expected sign. The R^2 values indicate again that the inflation differentials have additional explanatory power, particularly in squared form.

<INSERT TABLE 5 HERE>

We also examine whether the reluctance effect described before has been present from the very beginning of EMU. To this end, we re-estimate the previous specifications for the sub-period of 1999:01 to 2003:05. The endpoint of this period coincides with the announcement of the redefinition of the ECB`s strategy, which – according to the statement of the ECB – should address the issue of inflation divergence

[15] On top of the core set of instruments we instrument the expected standard deviation of inflation rates and the expected coefficient of variation rates by their first six lags, respectively. For the squared forms of the two divergence measures we add a one before squaring them because they contain values smaller than unity. We also tried the contemporaneous divergence measures in some additional regressions but the effects were not significant in those cases and we, therefore, abstain from reporting them.

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coupled with the fear of (national) deflation. Table 6 presents the estimation results based on the coefficient of variation as the measure of inflation divergence.[16]

<INSERT TABLE 6 HERE>

Regression (8) corresponds to the benchmark regression (1) and shows a significant response to the expected inflation gap according to the *Taylor principle*. However, employing the "divergence-adjusted inflation gap" in specification (9) shows a less significant effect for the sub-sample. The direct inclusion of the divergence measure in a linear as well as in a quadratic form in specifications (10) and (11) turns out to be statistically insignificant.[17] These results provide some indication that the "reluctance effect" in the ECB's interest rate setting behavior was not present from the very beginning but emerged in the course of declining aggregate inflation rates.[18]

5. Conclusions

Our study examines whether inflation differentials may have had an effect on how the ECB responded to inflation gaps in the euro area. We use different ways of how inflation differentials could be taken into account in a central bank's reaction function and also examine whether the behavior of the ECB has been the same from the beginning. The results point indeed to an influence of inflation differentials on monetary policy in the euro area. With higher inflation divergence, the ECB was more reluctant to

[16] We also performed the regressions based on the unweighted standard variation but results turned out to be quite identical. For the sake of brevity, these results are not presented.
[17] Again the first six lags of the divergence measure were employed as additional instruments in regressions (10) and (11).
[18] We also tested more explicitly for the presence of structural breaks over the whole sample period but did not get statistically robust results of a regime shift. The same results were obtained when we examined the specification in the alternative form with interest rate differences on the left-hand side.

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fight an overall inflation gap. A possible reason could be that the ECB feared that restrictive monetary policy could easily lead to deflation in low-inflation countries if it took a very tough stance on fighting overall inflation. This view is supported by our finding that the ECB displayed this “reluctance effect” particularly in more recent years during which some member countries of the euro area had inflation rates that, once adjusted for the causes of a bias (e.g., quality effects and the influence of new products) were already close to zero.

A task for future research is to develop a theoretical macro model that starts from a central bank loss that explicitly incorporates to inflation differential to derive an optimal interest rate rule that also includes such a variable. Along the same lines, calibrated exercises could be performed to verify how a greater or a smaller differential affects the reaction coefficients.

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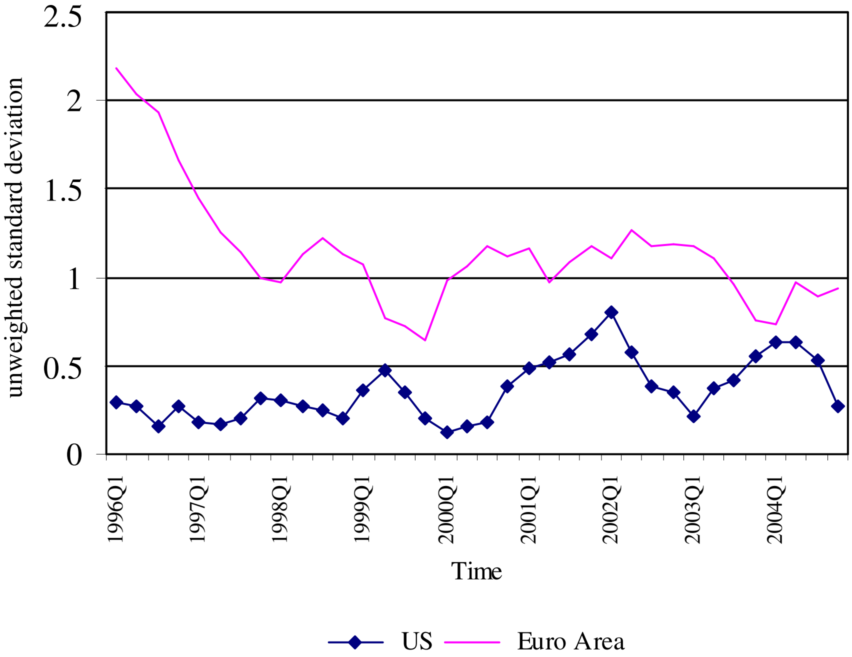
Figure 1: Dispersion of Inflation Rates in the euro Area and the US, 1996 – 2004



(unweighted standard deviation, quarterly data)

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Table 1: Differentials in Annual HICP Inflation Relative to Euro Area Average

(in percentage points)

	1999	2000	2001	2002	2003	2004	2005
Belgium	0.0	0.6	0.1	-0,7	-0.6	-0.3	0.3
Germany	-0.5	-0.7	-0.4	-0.9	-1.0	-0.4	-0.3
Greece	1.0	0.8	1.3	1.7	1.4	0.9	1.3
Spain	1.1	1.4	0.5	1.3	1.0	0.9	1.2
France	-0.6	-0.3	-0.6	-0.3	0.1	0.2	-0.3
Ireland	1.3	3.2	1.6	2.5	1.9	0.2	0.1
Italy	0.5	0.5	0.0	0.3	0.7	0.1	0.1
Luxembourg	-0.1	1.7	0.1	-0.2	0.5	1.1	1.6
Netherlands	0.9	0.2	2.8	1.6	0.2	-0.8	-0.7
Austria	-0.6	-0.1	0.0	-0.6	-0.8	-0.2	-0.1
Portugal	1.0	0.7	2.1	1.4	1.2	0.4	0.0
Finland	0.2	0.8	0.3	-0.2	-0.8	-2.0	-1.4

Source: European Central Bank

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Table 2: Standard Taylor Rule Estimation Results

Coefficient	Regression (1)	Regression (2)	Regression (3)
ρ (smoothing parameter)	0.861***	0.889***	0.850***
	(0.017)	(0.014)	(0.013)
α_0 (constant)	- 1.258	- 0.263	0.055
	(1.088)	(1.010)	(0.792)
α_1 (inflation$_{t+12}$)	1.672***		
	(0.476)		
α_1 (inflation$_{t+12}$/(1+ std.dev$_t$)		2.285***	
		(0.861)	
α_1 (inflation$_{t+12}$/(1+ coef. of var$_t$)			1.483***
			(0.487)
α_2 (output gap$_{t+3}$)	0.576***	0.773***	0.637***
	(0.051)	(0.047)	(0.06)
No. of observations	66	66	66
Adj. R^2	0.961	0.975	0.968
DW	1.605	1.784	1.494

Notes: Standard errors are in parentheses. (*), (**) and (***) indicate significance at a level of 10%, 5% and 1%, respectively.
Instruments in all regressions are a constant, the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the short term interest rate and the inflation gap.

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Table 3: Regressions Based on the Change in the Short-term Interest Rate

Left-hand side variable: change in the interest rate	Regression (1a)	Regression (2a)	Regression (3a)
α_0 (constant)	-0.372** (0.164)	- 0.336*** (0.107)	-0.143** (0.058)
α_1 (inflation$_{t+12}$)	0.163** (0.075)		
α_1 (inflation$_{t+12}$/(1+ std.dev$_t$)		0.280*** (0.098)	
α_1 (inflation$_{t+12}$/(1+ coef. of var$_t$)			0.256** (0.115)
α_2 (output gap$_{t+3}$)	0.021** (0.010)	0.031*** (0.007)	0.018** (0.009)
No. of observations	66	66	66
Adj. R^2	0.221	0.262	0.263
DW	2.029	2.117	2.031

Notes: Standard errors are in parentheses. (*), (**) and (***) indicate significance at a level of 10%, 5% and 1%, respectively.
Instruments in all regressions are a constant, the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the inflation gap.

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Table 4: Results of Augmented Regressions

Coefficient	Regression (4)	Regression (5)	Regression (6)	Regression (7)
ρ (smoothing parameter)	0.911***	0.920***	0.909***	0.911***
	(0.014)	(0.019)	(0.019)	(0.020)
α_0 (constant)	- 3.253**	3.995***	2.872	13.913**
	(1.588)	(0.946)	(4.164)	(6.367)
α_1 (inflation$_{t+12}$)	3.919***	3.938***	2.96**	2.701**
	(0.966)	(1.428)	(1.32)	(1.371)
α_2 (output gap$_{t+3}$)	0.703***	0.708***	0.604***	0.625***
	(0.100)	(0.109)	(0.118)	(0.124)
α_3 (std.dev$_{t+12}$)	- 3.196***			
	(1.186)			
α_3 ([1+std.dev$_{t+12}$] ^2)		- 1.157***		
		(0.438)		
α_3 (coef. of var.$_{t+12}$)			- 16.963**	
			(8.644)	
α_3 ([1+coef. of var.$_{t+12}$]^2)				- 6.719**
				(3.275)
No. of observations	66	66	66	66
Adj. R^2	0.965	0.975	0.968	0.968
DW	1.650	1.699	1.426	1.430

Notes: Standard errors are in parentheses. (*), (**) and (***) indicate significance at a level of 10%, 5% and 1%, respectively.

The following instruments were used in all regressions: a constant, the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the short term interest rate and the inflation gap. Regressions (4) and (5) additionally contain the first six lags of the standard deviation of inflation rates. Regressions (6) and (7) additionally contain the first six lags of the coefficient of variation of inflation rates.

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Table 5: Results of Augmented Regressions Based on the Change in the Short-term Interest Rate

Left-hand side variable: change in the interest rate	Regression (4a)	Regression (5a)	Regression (6a)	Regression (7a)
α_0 (constant)	- 0.131	-0.128	-0.171	0.056
	(0.204)	(0.204)	(0.178)	(0.266)
α_1 (inflation$_{t+12}$)	0.156***	0.156***	0.191***	0.179***
	(0.063)	(0.063)	(0.051)	(0.061)
α_2 (output gap$_{t+3}$)	0.031***	0.031***	0.019***	0.021**
	(0.011)	(0.011)	(0.007)	(0.009)
α_3 (std.dev$_{t+12}$)	- 0.227***			
	(0.088)			
α_3 ([1+std.dev$_{t+12}$] ^2)		- 0.057***		
		(0.021)		
α_3 (coef. of var.$_{t+12}$)			- 0.707**	
			(0.307)	
α_3 ([1+coef. of var.$_{t+12}$]^2)				- 0.247**
				(0.113)
No. of observations	66	66	66	66
Adj. R^2	0.251	0.273	0.311	0.303
DW	2.237	2.252	2.179	2.181

Notes: Standard errors are in parentheses. (*), (**) and (***) indicate significance at a level of 10%, 5% and 1%, respectively.
The following instruments were used in all regressions: a constant, the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the inflation gap. Regressions (4a) and (5a) additionally contain the first six lags of the standard deviation of inflation rates. Regressions (6a) and (7a) additionally contain the first six lags of the coefficient of variation of inflation rates.

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Table 6: Results for Sub-Sample 1999:01 to 2003:05

Coefficient	Regression (8)	Regression (9)	Regression (10)	Regression (11)
ρ (smoothing parameter)	0.822*** (0.041)	0.879*** (0.014)	0.853*** (0.029)	0.855*** (0.029)
α_0 (constant)	- 2.402 (2.162)	1.180 (0.886)	0.331 (2.849)	2.163 (3.706)
α_1 (inflation_{t+12})	2.688*** (1.015)		2.211** (0.985)	2.197** (0.999)
α_1 (inflation_{t+12}/(1+coef. of var._{t})		0.962* (0.549)		
α_2 (output gap_{t+3})	0.305*** (0.081)	0.645*** (0.059)	0.409*** (0.066)	0.413*** (0.0672)
α_3 (coef. of var._{t+12})			- 5.043 (3.521)	
α_3 ([1+coef. of var._{t+12}]^2)				- 1.947 (1.278)
No. of observations	53	53	53	53
Adj. R^2	0.916	0.964	0.934	0.934
DW	1.072	2.176	1.397	1.404

Notes: Standard errors are in parentheses. (*), (**) and (***) indicate significance at a level of 10%, 5% and 1%, respectively.
The following instruments were used in all regressions: a constant, the first six lags as well as the ninth and the twelfth lag of the output gap and the first, the third, the sixth, the ninth and the twelfth lag of the short term interest rate and the inflation gap. Regressions (10) and (11) additionally contain the first six lags of the coefficient of variation of inflation rates.

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