MONETARY POLICY AND INFLATION PERSISTENCE IN THE EUROZONE

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ABSTRACT: The primary goal of the European Central Bank’s (ECB) monetary policy is to achieve price stability. Whereas during the 1980s and 1990s there was a rapid and strong convergence in terms of price differential among the Euro countries, particularly in those countries with higher inflation rates in the past, single monetary policy has proved to be quite inefficient in continuing this trend and has not achieved further reductions in inflation rate differentials within the euro zone. Since the ECB sets the official interest rate according to the average inflation of the euro area, the persistence of such price differentials within the area would mean that the “one size interest rate policy” would not fit all. This paper studies empirically the inflation rate differentials and their persistence in some currency unions with the aim to draw some conclusions for the working of the ECB monetary policy.

KEYWORDS: monetary policy; inflation persistence; currency unions

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1. INTRODUCTION

It is well known that the primary goal of the European Central Bank’s (ECB) monetary policy is to achieve price stability. Empirical evidence shows that during the 1980’s and 1990’s there was a rapid and strong convergence in terms of price differential among the euro countries, particularly in those countries with higher inflation rates in the past. Nevertheless, convergence in inflation rates has stopped and ended since the mid 90’s and this fact has raised fears that the single monetary policy is not adequate for a number of countries (Björksten and Syrjänen 2000). This latter possibility was not a major concern during the first years of the single monetary policy since the average rate of inflation was low and its dispersion among the European Monetary Union (EMU) countries was expected to be soon removed by the introduction of the single currency. However, even the ECB now acknowledges that inflation differentials across regions are a natural feature of the monetary union, and that monetary policy cannot influence them (ECB 2004: 53).

Actually, the persistence in inflation differentials within the euro area was one of the arguments considered by the ECB to explain why it has officially refused to bring inflation below its 2 per cent objective and finally adopted the new target of an ‘inflation rate below, but close to, 2% over the medium term’ in year 2003 (ECB 2003a).

The perpetuation of the inflation differentials within the euro area raises some interesting issues. Firstly, the persistence of inflation differential within the euro area...
might mean that inflation is not *always* and *everywhere* a monetary phenomenon, so the single monetary policy would not be efficient in fighting inflation within the euro area.\(^4\) Secondly, since the ECB sets the official interest rate according to the average inflation rate of the euro area, the persistence of such price differentials within the euro area would mean that ‘one size does not fit all’ and this might have important economic consequences, particularly for the euro countries with structurally lower inflation rates (ECB 2004: 54). For this reason the ECB has pointed out that ‘it is necessary for monetary policy to consider the size, persistence and determinants of inflation differentials in assessing the area-wide inflation dynamics’ (ECB 2003b: 6). This paper addresses the implications that persistence in inflation differentials might have for the European single monetary policy. In particular, the paper studies empirically the inflation rate differentials and their persistence in some currency unions with the aim to draw some conclusions for the working of the ECB monetary policy. Section two briefly outlines the ECB’s monetary framework. The aim of this section is to describe the role that inflation plays in the ECB’s monetary strategy, particularly in the context of the monetary policy rules current debate (Taylor 1993). Section three identifies the theoretical factors that might explain regional inflation differentials and inflation persistence within a currency union. Section four analyses regional inflation differentials in two long established currency unions (Spain and the United States) and confronts these results with the EMU experience. Finally, section five offers some

\(^4\) Of course, the ECB could always reply that inflation is a monetary phenomenon only in the long run, so it is still too soon to say anything about monetary policy effectiveness in Europe (actually, the single monetary policy has been working only since 1999). However, there is empirical evidence showing that the correlation between money and inflation is weak for the low inflation countries, and that “country specific factors have a significant influence on the strength of such relationship” (De Grauwe and Polan, 2001). King (2002) provides evidence on the strong correlation between monetary growth and inflation in the long-run, although in the short run this correlation is less evident, but he also points out that “correlation, of course, is not causation”.
conclusions and explores some implications for the conduction of the single European monetary policy.

2. THE ECB MONETARY STRATEGY AND THE ROLE OF INFLATION

The ECB’s monetary strategy was formally defined by its Governing Council in October, 1998, and consists of a ‘framework and the procedures that the central bank uses to translate relevant information into monetary policy decisions’ (Issing et al. 2001: 2). Contrary to simple monetary policy rules, such as the so-called Taylor’s rule (Taylor 1993), ‘the ECB’s monetary strategy is presented as an information-processing framework’, and as such, ‘it cannot be expressed in a simple mathematical function’ (Issing et al. 2001: 4-5).

It has been pointed out that the ECB cannot follow a fixed (or known) rule because of the uncertainties that surround the European Monetary Union experiment. At the time when the ECB’s monetary policy ‘architecture’ was designed, in 1998, there was uncertainty about the institutional change that the introduction of the single currency would mean.⁵ But even after the launching of the euro and the introduction of the single monetary policy uncertainty still remains. Uncertainty about the response given by economic agents (parameter uncertainty) and the nature of the ‘true’ economic model (model uncertainty) of the euro area (Issing et al. 2001: 100) are considered to be crucial for the implementation of the monetary policy.

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⁵ That institutional change had straightforward and substantial implications for the continuity and availability of reliable statistical information which would be crucial for the decision-making process at the ECB, for example.
Even though ‘model uncertainty’ is claimed, the ECB does have an implicit economic model in its monetary framework.\(^6\) This model takes into account the existence of a high correlation between money and inflation and assumes that money causes inflation in the long run. However, the ECB also acknowledges that the correlation between money and prices vanishes in the short run. Monetary policy has real effects because of the existence of imperfect information, competition or economic rigidities, either real or financial (see Issing \textit{et al.} 2001, particularly Chapter 1). These assumptions are present in the ‘two pillars’ of the ECB’s monetary policy.\(^7\) According to the principle that money causes inflation in the long run, the first pillar monitors monetary aggregates and the ECB has a specific reference value for the rate of growth of the M3 in the long run.\(^8\) On the contrary, the second pillar focuses on short-term price developments. The ECB monitors a wide range of economic and financial indicators to carry out this task.

The prominent role assigned to monetary aggregates in the first pillar has led some authors to question the ECB’s monetary strategy (see Begg \textit{et al.} 1999, Svensson 1999 and Gross \textit{et al.} 2000). These critics point out that the existence of two pillars does not provide a clear explanation of the ECB’s strategy and that financial innovation reduces the reliability of the first pillar. However, there are some authors who defend the strategy by pointing out that ‘the two pillars symbolise the still insufficient knowledge concerning the functions of the macro-economy and the characteristics of the transmission process’ (Issing \textit{et al.} 2001: 108) and that the use of a simple rule would not allow the central bank

\(^6\) A comprehensive analysis of the implications of model uncertainty for monetary policy transmission can be found in Dow (2004a).

\(^7\) For a fuller description see Issing \textit{et al.} (2001), Chapter 7.

\(^8\) The reference value was set in terms of an annual rate of growth of 4.5 per cent for the entire euro area. Interestingly, this value was worked out by using the quantity theory of money, assuming a 2 per cent rate of growth for prices, a 2-2.5 per cent rate of growth for GDP and a declining trend in the income-money velocity of circulation (ECB 1999).
to take into account ‘all potential sources of information’ which is relevant for monetary policy decisions (Issing et al. 2001).

Although most central banks deny following a deterministic monetary policy rule, there exists a large and growing collection of empirical studies\(^9\) showing that simple monetary rules, such as the one proposed by Taylor (1993), are capable of reproducing central banks’ monetary policy decisions on interest rates. Regarding the euro area, Taylor (1999) recently concluded that ‘the simple benchmark rule, such as the one I proposed in 1992, with some adjustment in the response coefficients, would be worth considering as a guideline for the ECB’. Gerlach and Schnabel (1999) also found that ‘average interest rates for the EMU countries in 1990-98, with the exception of the exchange market turmoil in 1992-93, moved very closely with the average output gap and inflation as suggested by the Taylor rule’. More evidence in this regard can be also found in the papers by Alesina et al. (2001), von Hagen and Brückner (2002), Breuss (2002) and Galí (2003), among many others.

These empirical results are not surprising since the Taylor rule assumes that central banks set the official interest rate according to the deviation of both inflation and output from their targets (Taylor 1993). Analytically, the rule can be expressed as follows:

\[
i_t = \bar{r} + \phi_\pi (\pi_t - \bar{\pi}) + \phi_x x_t
\]

where \( i_t \) is a money market interest rate under the control of the monetary authority, \( r \) is the equilibrium or natural real interest rate, \( \pi \) is the inflation target, \( \pi_t \) is the current rate of inflation and \( x_t = y_t - y^n_t \) is the output gap, being \( y_t \) and \( y^n_t \) the current and potential output, respectively. The parameters \( \phi_{\pi} \) and \( \phi_x \) indicate the response of monetary authority against deviations of the inflation rate from its target and variations in the output gap.

In this regard, it is worth remembering that ‘the primary objective of the ESCB is to maintain price stability’.\(^{10}\) But the EU treaty also points out that ‘without prejudice of the objective of price stability the ESCB shall support the general economic policies in the Community with a view to contributing to the achievement of the objectives of the Community as laid down in Article 2’.\(^{11}\) It is not surprising, therefore, that the ECB takes into account not only the inflation rate, but also a variable reflecting the economic pulse of the area, such as the output gap, when setting the official interest rates for the euro area. Figure 1 confirms this fact by showing a high correlation between the market interest rate and the inflation rate for the euro area as well as the interest rate and the output gap.\(^{12}\) The second correlation is much higher (0.51) than the first one (0.22).

\(^{10}\) Article 105 of the EU Treaty.
\(^{11}\) Article 2 states that: ‘The Community shall have as its task … to promote throughout the Community a harmonious and balanced development of economic activities, sustainable and non-inflationary growth respecting the environment, a high degree of convergence of economic performance, a high level of employment and social protection, the raising of the standard of living and quality of life, and economic social cohesion and solidarity among Member States’.
\(^{12}\) We employed the industrial production index as an output variable and the Hodrick-Prescott filter as the method to extract the potential output.
The same information is shown in Figure 2, where the money market interest rate and the benchmark interest rate performed by the Taylor rule are depicted. Figure 2 shows that the Taylor rule matches reasonably well with the money market interest rate, particularly up to 2001. It is evident, therefore, that both inflation and output gap play an important role in the determination of the interest rates in the euro area. However, whereas the interest rate is equal for all countries, inflation rates may vary from one country to another. Temporal or small variations would not be a concern. However, if the regional variations in inflation rates were both sizeable and permanent, then the ECB would not really be implementing a one size interest rate policy for the euro area. How important are the inflation differentials within the Euro area? Are they

13 In relation to expression (1), Taylor (1993) assumed the following values for the different parameters in the rule: $r = \pi = 2$, $\phi_\pi = 1.5$, and $\phi_x = 0.5$. 
also persistent? To what extent is the EMU different to other established currency areas? These issues will be addressed in the remaining part of the paper.

3. INFLATION DIFFERENTIALS AND PERSISTENCE IN CURRENCY UNIONS: SOME THEORETICAL EXPLANATIONS

The identification of the factors explaining the evolution of regional inflation differentials in Europe has been a topic of major concern in the last years. In fact, the existence of inflation differentials within the EMU area was considered to be a crucial element in the recent evaluation of the performance of the single monetary policy (see ECB 2003a).
Factors explaining regional inflation differentials in a currency union may be better understood if they were grouped according to their temporal dimension. According to this categorization, we will distinguish, on the one hand, those factors influencing inflation differentials in the short run and, on the other hand, those acting in the medium to long term. Three arguments are usually provided in order to explain inflation differentials within a currency union in the short run. The first one concerns the different impact that the single monetary policy may have on inflation when regional differences in terms of the monetary transmission mechanism exist.\textsuperscript{14} The second one assumes that regional divergences in terms of output gaps might cause higher inflationary pressures in those economies with advanced business cycles.\textsuperscript{15} The third argument sustains that inflation differentials within a currency union arise because of the regional differences in terms of openness. For example, differences in national oil dependency might spur inflation differential when oil prices go up. Another example is that the inflation rate in the most open economies will be more dependent on the evolution of nominal exchange rates, therefore the depreciation of nominal exchange rates could increase inflation differentials among the members of a currency union.

There are also factors which explain regional inflation differentials in the medium to long run. One factor is the price level differences which might exist between the regions of a currency union. If price levels differ across countries in the currency union, the expected convergence of prices to a common level could give rise to differences in inflation rates in the transition period since the countries with lower price

\textsuperscript{14} These factors can be of a real or financial nature. For a recent survey of this issue in the European Monetary Union, see Angeloni \textit{et al.} (2002).

\textsuperscript{15} An explanation of the inflationary Spanish experience based on these factors can be found in Ledo \textit{et al.} (2002).
levels would experience higher inflation rates than those with higher price levels at the initial stage. The convergence in price levels in the euro countries has been studied, among others, by Hendrikx and Chapple (2002), Honohan and Lane (2003), Rogers (2002), Rogers et al. (2002), ECB (2003b) and Kent (2003). Their empirical results tend to confirm the relevance of price level convergence on the path of inflation differentials among European countries in the last years. However, as argued in Rogers et al. (2002), other forces explain most of the current cross-country differences in the euro area inflation.

Another potential explanation for the inflation differentials within a currency union can be found in the Balassa-Samuelson hypothesis\textsuperscript{16}, whereby countries with lower productivity in the traded sector experience more rapid productivity growth on the path of convergence. The adjustment process leads to a higher rate of wage inflation in the economy as a whole, and hence a positive inflation differential.\textsuperscript{17} The relevance of the Balassa-Samuelson effect has also been confirmed by Alberola and Tyrväinen (1998), Canzoneri et al. (1999), and De Grauwe and Skuldeny (2000), although the empirical evidence provided in these papers does not rule out the possibility for other factors to affect inflation differentials within the euro area.\textsuperscript{18}

Whereas the determinants of inflation differentials in currency unions have been a common topic for research in the last years, inflation persistence has received far less attention. This might be explained by the fact that persistence in inflation rates was

\textsuperscript{16} See Balassa (1964) and Samuelson (1964).

\textsuperscript{17} Wage inflation is proportional to productivity growth in the traded sector. However, in the non-traded sector prices have to rise because productivity is assumed to grow slower than wage inflation.

\textsuperscript{18} Olivera (2003) provides evidence for Spain.
expected to be removed in the medium term, either by the implementation of the single monetary policy or by cross border arbitrage among different markets. A single monetary policy avoids the existence of several national monetary policies that target different inflation objectives. At the same time, a single currency enhances price transparency, reducing the scope for persistent differences in the pricing policy followed by firms.

Two reasons have been suggested to explain why inflation differentials persistence may be more important within a currency union than among independent countries. One possibility is that the setting of a single nominal interest rate for the euro area would mean different real interest rates for those member countries with higher inflation rates. If the inflation rates increase during upturns because of higher demand pressure, the resulting lower real interest rate might amplify the business cycle and, therefore, inflation. The second explanation is partly derived from the first one: a higher inflation rate and a lower real interest rate in a booming region may increase both nominal and real housing prices which, in turn, may stimulate consumption through balance sheet effects.\footnote{The recent developments of the housing markets both in Spain and Ireland could support this explanation.}

A controversial question with regard to the persistence of inflation differentials within a currency union is the role that the real exchange rate might play in the adjustment process. It is commonly assumed that a booming regional economy is expected to experience a real appreciation in its exchange rate because of the changes in relative prices between the domestic market and the rest of the union. If firms cannot
segment markets, the reduction in the external demand (derived from the real appreciation) will mitigate the economic boom, and therefore contributes to the adjustment process (Arnold and Kool 2002). However, recent contributions in the field of international economics suggest that international price discrimination (pricing-to-market policies) reduce the scope for the expenditure-switching effect to work (see Obstfeld 2002). Bergin (2003) proposes a pricing-to-market model for a monetary union and concludes that inflation differentials can appear in a monetary union and persist a long time, even in tradeable products, due to the market power of firms that engage in price discrimination among different markets.

Although we have focused on differences in the degree of persistence of inflation differentials within the regions of a monetary union and across independent countries, there are also several reasons why the persistence of inflation differentials can vary across currency unions. A first argument points to the existence of different degrees of economic policy centralisation. For example, a higher degree of budgetary centralisation can ameliorate demand pressures in different regions of the monetary union. Another argument highlights the role of nominal rigidities in the goods and labour markets. Let us assume two currency unions. In one currency union we observe a better coordination between firms and workers, thus nominal price and wage rigidities are similar across its regions. In the other currency union the coordination is lower. Less

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20 An aspect that must be mentioned is the relevance of the analytical approach employed to introduce the pricing-to-market behaviour in the model. As Bergin (2003) states, the models that generate pricing to market by assuming that goods prices are sticky in the currency of the importer are unable to explain pricing to market in the context of a monetary union. However, models that use translog preferences (as the one proposed by Bergin, 2003) rely neither on multiple currencies nor sticky prices. For this reason, they can generate pricing to market in currency unions. These models have the advantage of remaining closer to the initial development of pricing to market in the microeconomic literature.
persistent inflation differentials are expected to be observed in this scenario as the coordination between firms and workers increases.

So far we have surveyed some of the arguments put forward to explain the existence of inflation differentials within a currency union, along with those suggested to explain their degree of persistence. The next section explores these questions from an empirical point of view in order to answer a set of questions. We employ a dataset of EMU countries, before and after forming the currency union and among different regions of two long-established currency unions: the United States and Spain.

4. INFLATION DIFFERENTIALS AND PERSISTENCE IN CURRENCY UNIONS: SOME EMPIRICAL EVIDENCE

This section studies the regional inflation differentials and their persistence between the euro countries, the Spanish regions and some regions in the United States. Since some analysts have suggested that it is still too soon to evaluate whether the ECB has succeeded in achieving the price stability goal (the single European monetary policy started in year 1999), the comparison with the results achieved in some other longer-established currency unions, such as Spain or the United States, might offer some clues in this regard.

Inflation data for the European Union was collected from the International Monetary Fund (IMF) database International Financial Statistics. Spanish regional data for the 17 Autonomous Communities were extracted from the Instituto Nacional de Estadística (INE), while the data for the 14 USA Metropolitan Statistical Areas (MSA)
was taken from the *Bureau of Labor Statistics* (BLS). All data are monthly, except for 11 MSA where bimonthly data are available, and extends from January 1980 to October 2005.

The trend of inflation rates among the EMU countries shows a convergence pattern since the beginning of the 80’s. The high inflation economies have achieved outstanding results in terms of the reduction in inflation rates, particularly from the mid 90’s. This success is to a large extent explained by the political determination of some countries to meet the Maastricht criteria. Figure 3 shows the maximum and minimum inflation rates among the EMU countries, and also the standard deviation for the whole area. The observed reduction both in the maximum rate and in the standard deviation reveals the underlying convergence process in terms of inflation rates in the euro area.
The trend shown in Figure 3 could lead some authors to expect that inflation differentials would definitively disappear with the establishment of the single currency. However, a closer look at the inflation trends in some countries does not seem to support this assumption. In particular, there is a group of countries, such as Portugal or Spain, where the inflation rate has persistently remained well above the euro area rate (see Figure 4). Conversely, there is another group of countries (France or Germany) which has persistently experienced lower inflation rates. It is interesting to note that inflation rates were quite close among these countries in 1997 and 1998, coinciding with the evaluation of the Maastricht criteria, but they started to diverge when the third stage of EMU took place.
Figure 4.- Inflation differentials in some European countries 
(with respect to EU15)

The above-mentioned trends in inflation rates have raised some concerns for European policy makers. Some authors have pointed out that the differences observed for the Euro area can also be found in other long-established monetary unions, such as the United States, Germany or Spain. Figures 5 and 6 are included to study this possibility, and present standard deviation and the absolute spread in inflation rates for the euro area countries, the Spanish regions and some regions in the United States. The time period considered extends from 1994 to 2003, thus we focus on a recent period where nominal stability has been a political priority.
There are three features worth mentioning in both cases. A first trend confirms the existence of convergence in inflation rates among the euro economies which stops at the beginning of 2000 and rises slightly afterwards. This result is consistent with the important role played by the fulfilment of the Maastricht criteria and the monetary unification in the reduction of inflation differentials. However, differences in inflation rates have not totally disappeared with the implementation of the single European monetary policy. As can be seen in Figures 5 and 6, significant inflation dispersion is present in all the currency unions considered in our analysis. However, some relevant differences exist when comparing the three currency unions. In particular, the inflation dispersion for the euro area and the United States is almost twice as much as the value for the Spanish regions. The higher dispersion for the inflation rates in the EMU area and the United States could be explained by the lower degree of economic policy centralisation achieved in terms of fiscal, labour and product market policies and also by the higher geographical distance in comparison to the Spanish regional case (see ECB 2003b). The close similarity between the euro area and the United States after the introduction of the euro put into question the relevance of some exclusive explanation to the observed inflation differentials within the euro area, among them, the differences in terms of price and productivity levels. The most interesting conclusion which can be derived from Figures 5 and 6 is that inflation differentials are not a specific problem of euro area members, since the size of inflation differentials observed at present in the euro area is not so different from the ones observed in the United States.
The empirical evidence reveals that inflation differentials are not an exclusive feature of the euro area, since they also exist in the other two case studies. However, this description does not necessarily apply for the persistence in inflation. It would thus be interesting to determine whether (and why) persistence in inflation among the euro countries is higher than in the other two currency unions, as well as to study its potential consequences for the implementation of the single monetary policy. In order to study inflation persistence, we will proceed as follows. First, the degree of persistence of inflation differentials will be compared among the regions belonging to a monetary union and the euro area countries before the beginning of stage three of EMU. Second, we will test for the existence of different degrees of persistence across currency unions.
Data for the euro area countries, the Spanish regions and some regions of the United States during the period 1999-2003 will be used.\textsuperscript{21}

Figure 6.- Absolute spread in inflation rates in EMU countries, the Spanish regions and some USA regions

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure6}
\caption{Absolute spread in inflation rates in EMU countries, the Spanish regions and some USA regions}
\end{figure}

In order to address the first issue, we have employed a set of unit root and stationary tests. To understand the mechanics of these tests, consider the following simple autoregressive process of order one AR(1) for the inflation rates differentials:

\begin{equation}
\left(\pi^i - \pi^{\text{area}}\right)_t = \alpha + \rho \left(\pi^i - \pi^{\text{area}}\right)_{t-1} + \varepsilon_t
\end{equation}

where \((\pi^i - \pi^{\text{area}})\) is the inflation differential for country \(i\) with respect to the reference area considered, \(\alpha\) and \(\rho\) are the parameters to be estimated and \(\varepsilon_t\) is assumed to be

\textsuperscript{21} We employed the Harmonised Consumer Price Index (HCPI) data from Eurostat for the euro area countries, which is available from 1990 on.
white noise. If $|\rho| \geq 1$, the inflation differential is a non-stationary process and therefore no convergence is expected to take place. On the contrary, if $|\rho| < 1$, the inflation differential is a stationary series and convergence is expected to take place. The value of $\rho$ also determines the speed of the convergence process.

The unit root tests studies the null hypothesis $H_0: \rho = 1$ against the one-sided alternative $H_1: \rho < 1$. We employ different unit root tests proposed in the literature, such as the Augmented Dickey-Fuller test (Dickey and Fuller 1979), the Phillips-Perron test (Phillips and Perron 1988), the Dickey-Fuller test with GLS detrending (Elliot et al. 1996) and the Elliot, Rothemberg and Stock optimal point test (Elliot et al. 1996).

Stationary tests are used to test the alternative null hypothesis $H_0: \rho < 1$. We have also applied the KPSS test proposed by Kwiatkowski et al. (1992). This combination of different tests allows us to obtain a more robust conclusion about the convergence (or no convergence) of inflation differentials in the long run.

We compare the stationary properties of inflation differentials among some European countries, the Spanish regions and some regions of the United States before the start of EMU. Data availability limits the time period considered from January 1980 to December 1998. The aim of this comparison to find some clues to answer the question of whether inflation differentials are more persistent among countries with independent monetary policies than among regions within a currency union.
Tables 1 and 2 sum up the results of applying the stationary and unit root tests to the inflation differential series for the euro area countries and the regions in Spain and some regions in the United States. With regard to persistence in inflation, the results confirm the existence of a higher persistence in inflation differentials among the current euro area countries. Table 1 suggests that the non-stationary behaviour of inflation differentials cannot be rejected in most cases (in eight countries out of the eleven considered). In the remainder cases, the evidence is mixed; that is, we cannot clearly determine the nature of the data.

| Table 1.- Unit root and stationary tests of inflation differentials in Euro area countries (1980:01-1998:12) |
|-------------------------------------------------|-------------------------------------------------|-----------------|
| Unit root tests                                      | Stationary test                                | Conclusion       |
| ADF    | PP     | DF-GLS | ERS   | KPSS  |                               |
| Austria | NO     | NO     | NO    | NO    | ** Non-stationary              |
| Belgium | *      | *      | NO    | NO    | ** Inconclusive                |
| Finland | *      | **     | NO    | NO    | Inconclusive                   |
| Germany | NO     | NO     | NO    | NO    | ** Non-stationary              |
| Italy   | NO     | NO     | NO    | NO    | ** Non-stationary              |
| Luxembourg | *   | *      | NO    | NO    | * Inconclusive                 |
| Netherlands | NO | NO    | NO    | NO    | ** Non-stationary              |
| Portugal | NO     | NO     | NO    | NO    | ** Non-stationary              |
| Spain   | NO     | NO     | NO    | NO    | ** Non-stationary              |

Notes: One and two asterisks represent statistical significance at a 5 and 1 per cent level, respectively.

The degree of persistence of the different series was also calculated from the ADF test obtained, using for this purpose the half-life of the adjustment process for each country. The half-life statistic depends on the value of \( \rho \) and its analytical expression is as follows: \( HL = \left( \frac{\ln 0.5}{\ln \rho} \right) \). The expression gives us a measure of the time that a series needs to return to its equilibrium once it is affected by a shock. As we have a different estimated \( \rho \) value for each of the series, we will take its pooled value as representative.
for the whole group so we can obtain $\rho$ values for each of the two groups considered: the European countries and the regions in Spain and in the United States. The differences between the estimated values are very important. Hence, whereas for the European countries the half-life is approximately 22 months, for the Spanish and the United States regions it is only 4.5 months.

<table>
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<tr>
<th>Table 2.- Unit root and stationary tests of inflation differentials in the Spanish and the United States regions (1980:01-1998:12)</th>
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<tr>
<td>**</td>
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<tr>
<td>Andalucia</td>
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<tr>
<td>ADF</td>
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<tr>
<td>Spanish regions</td>
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<tr>
<td>New York</td>
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<td>United States regions</td>
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Although these results are interesting, the study of persistent inflation differentials across currency unions may provide more useful insights in this issue. Accordingly, Table 3 summarises some measures within the euro area countries, the Spanish regions and some regions of the United States for the period 1999-2003.
Although monthly data are available, the limited sampling of the data does not recommend applying unit root tests in order to determine the stationary properties of inflation differentials so alternative statistics were used to assess the degree of persistence. On the one hand, we calculate the autoregressive coefficient of different orders (first, second and forth) for the inflation differentials among the regions and the currency area as a whole. On the other hand, and following Batini (2002), Kozicki and Tinsley (2002) and Kieler (2003), the persistence of inflation differentials was measured as the sum of coefficients from an estimated autoregressive model of inflation differential, considering two alternative autoregressive orders (sixth and twelfth).

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<tr>
<th></th>
<th>AR(1)</th>
<th>AR(2)</th>
<th>AR(3)</th>
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<tbody>
<tr>
<td><strong>EMU</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.789</td>
<td>0.617</td>
<td>0.551</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.958</td>
<td>0.896</td>
<td>0.854</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.408</td>
<td>0.031</td>
<td>-0.021</td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.714</td>
<td>0.600</td>
<td>0.463</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.941</td>
<td>0.887</td>
<td>0.822</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.396</td>
<td>-0.056</td>
<td>-0.123</td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.928</td>
<td>0.828</td>
<td>0.735</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.432</td>
<td>0.011</td>
<td>-0.089</td>
</tr>
</tbody>
</table>

Table 3.- Persistence in inflation differentials among the EMU countries, the Spanish regions and some regions in the United States: 1999-2003

<table>
<thead>
<tr>
<th></th>
<th>AR(1)</th>
<th>AR(2)</th>
<th>AR(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMU</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.804</td>
<td>0.701</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>0.988</td>
<td>0.934</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.312</td>
<td>0.174</td>
<td></td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.742</td>
<td>0.591</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>0.939</td>
<td>0.932</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.268</td>
<td>-0.241</td>
<td></td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.669</td>
<td>0.496</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>0.915</td>
<td>0.927</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.426</td>
<td>-0.016</td>
<td></td>
</tr>
</tbody>
</table>

Source: Eurostat, Instituto Nacional de Estadística (INE) and Bureau of Labor Statistics (BLS). Own calculations.
The European inflation rates seem to diverge more persistently than in Spain and in the United States for all the measures calculated. Consequently, persistence in inflation differentials seems to be an intrinsic feature of the euro area economies.

A possible explanation for the higher persistence in inflation differentials in the European Monetary Union is that nominal rigidities might be more similar among the Spanish and the United States regions than among the Euro countries. This argument could be supported by the evidence in other works. For example, Benigno and López-Salido (2002) suggest that there are important differences in the degree of price stickiness in the five major countries of the euro area. In particular, they point out that for Germany, the Netherlands and France, the degree of price stickiness seems to be lower than that observed in both Italy and Spain. In line with this work, the contributions of Leith and Malley (2003), Sondergaard (2003), Banerjee and Batini (2004) and Rumler (2005) confirm this general conclusion, although some differences in the ordering of the countries are found. Further, the microeconomic evidence provided by the Inflation Persistence Network (sponsored by the European System of Central Banks) highlights the existence of relevant heterogeneity in the frequency of price changes across countries. According to the results reported in the survey conducted by Dhyne et al. (2005), the degree of price stickiness is higher in countries like Spain or Italy, contrary to Germany and France.

From another point of view, Nickell (2003) suggests that labour market institutions diverge across the European economies, which could produce differentiated

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22 We used three MSA for the United States; that is, the three MSA for which monthly data were available.
patterns in the rigidities of the labour markets. Campolmi and Faia (2004), Olivera (2005) and Walsh (2005) study the effects of these rigidities on inflation dynamics.

5. CONCLUSIONS

The empirical results reported in section three suggest that the single monetary policy has been quite inefficient in reducing inflation differentials among the euro member economies. In fact, our empirical evidence shows that from year 2000 on inflation has remained above its 2 per cent objective and that inflation differentials among the euro area countries have not been removed despite monetary unification. In addition, persistence in inflation differentials in Europe seems to be much stronger than that observed in other long-established currency unions (Spain and the United States). The persistence of inflation differentials among the euro area countries not only questions the assumption that inflation in Europe is exclusively a monetary phenomenon, but also that the European Central Bank is implementing a ‘one size’ interest rate policy for the euro area. These two aspects might have important consequences for the macroeconomic performance of some regions/countries in the euro area.

REFERENCES


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