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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

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.[1] 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 EMU 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).[2]

The perpetuation of the inflation differentials within the euro area raises some interesting issues. Firstly, the persistence of inflation differential within the euro area

[1] The single currency was expected to remove market segmentation, enhance market competition and therefore would make the law of one price work in the medium term.

[2] The purpose of this change is "to maintain a sufficient safety margin to guard against the risks of deflation" (ECB 2003a: 79). However, if inflation is a monetary phenomenon, as the ECB seems to believe when justifying the first pillar of its monetary policy scheme, there should not be room for deflation because the Central Bank could always produce inflation by increasing the money supply. If the Central Bank has the tools to avoid excess money, it should also be able to avoid the reverse situation. If this is not the case, then what's the point in keeping an eye on the rate of growth of the M3 in the long run (the first pillar)?

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.[3] 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

[3] 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'S 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 (EMU) experiment. By the time 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.[4] But even after the launching of the euro and the introduction of the single monetary policy uncertainty still remains. There is 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). These two elements are crucial for the implementation of the monetary policy.

Even though "model uncertainty" is claimed, the ECB does have an implicit economic model in its monetary framework. This model takes into account the existence of a high correlation between money and inflation and assumes that money

[4] 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.

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 et al., 2001, particularly chapter 1). These assumptions are present in the "two pillars" of the ECB's monetary policy.[5] 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.[6] 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 et al., 1999; Svensson, 1999; Gross 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 et al., 2001: 108) and that the use of a simple rule would not allow the central bank to take into account "all potential sources of information" which is relevant for monetary policy decisions (Issing et al., 2001).

[5] For a fuller description see Issing et al. (2001), chapter 7.

[6] The reference value was set in terms of an annual rate of growth of 4.5 per cent for the whole 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).

Although most central banks deny following a deterministic monetary policy rule, there exists a large (and growing) empirical literature[7] 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. Analytically, the rule can be expressed as:

$$i_t = \hat{r} + \hat{p} + f_p(p_t - \hat{p}) + f_x x_t \qquad (1)$$

where i_t is a money market interest rate under the control of the monetary authority, $\hat{r}$ is the equilibrium or natural real interest rate, $\hat{p}$ is the inflation target, p_t is the current rate of inflation and $x_t \equiv y_t - y_t^n$ is the output gap, being y_t and y^n the current and potential output, respectively. The parameters ϕ_π and ϕ_x indicate the response of monetary authority against deviations of the inflation rate from its target and variations in the output gap.

[7] See, for example, Gerlach and Schnabel (2000), Taylor (1999), Clarida et al. (1998 and 2000), Nelson (2000), Batini and Haldane (1999) and Angeloni and Dedola (1999).

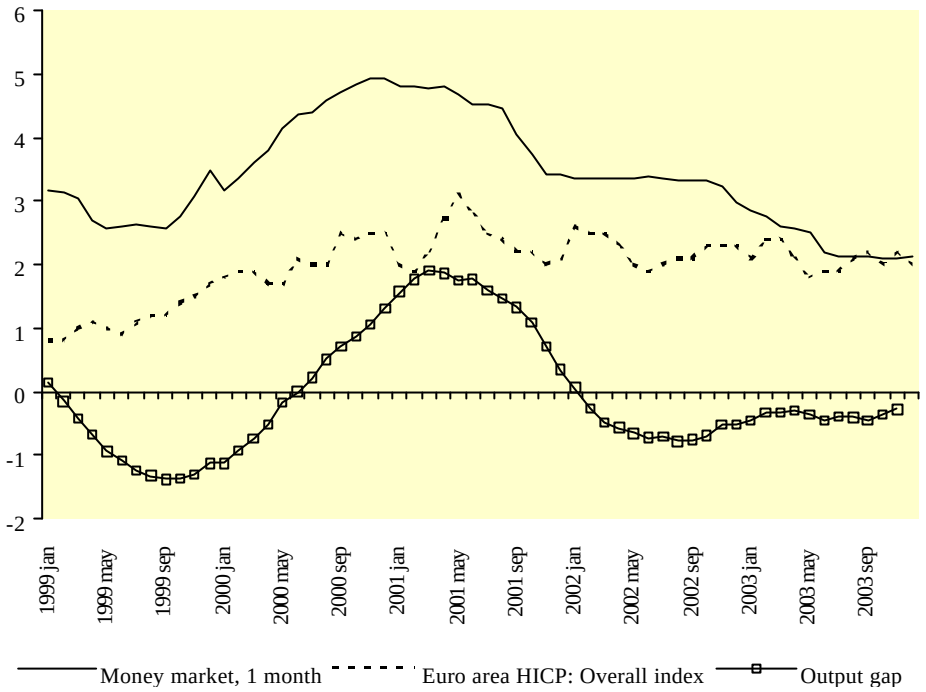
In this regard, it is worth remembering that "the primary objective of the ESCB is to maintain price stability".[8] But the EU treaty also points out that "without prejudice of the objective of price stability the ESCB shall support the general economic policies in the Community with a view to contributing to the achievement of the objectives of the Community as laid down in Article 2.[9] 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, and also between the interest rate and the output gap.[10] The second correlation is much higher (0.77) than the first one (0.44).

[8] Article 105 of the EU Treaty.

[9] 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".

[10] We employed the industrial production index as an output variable and the Hodrick-Prescott filter as the method to extract the potential output. Output gap is measured as the twelve months average, intending to provide a smooth indicator of this variable.

FIGURE 1.- Interest rates, inflation and output gap in the Euro area

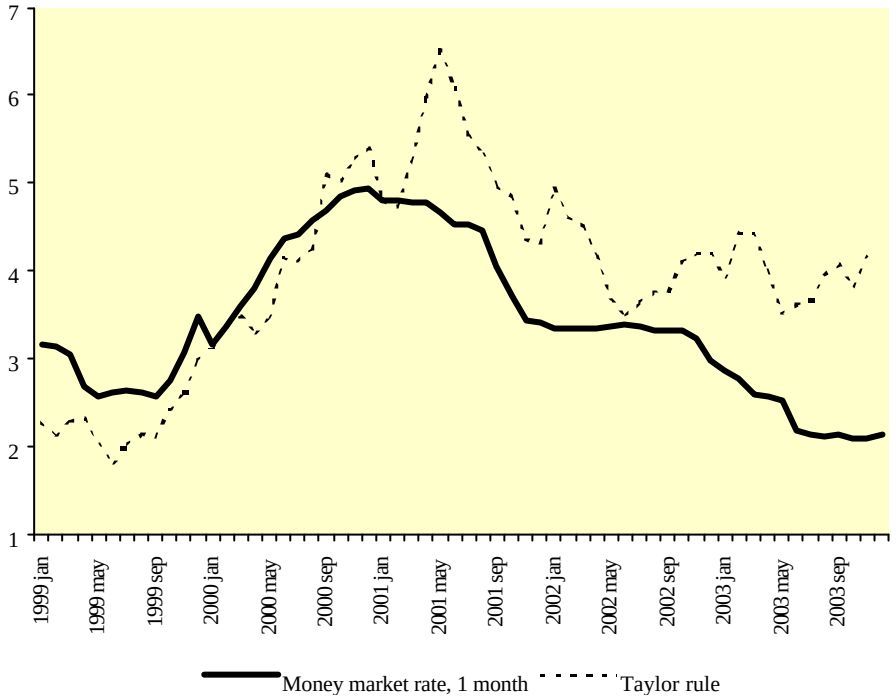


Source: *European Central Bank*

The same information is shown in Figure 2, where the money market interest rate and the benchmark interest rate performed by the Taylor rule is depicted.[11] According to Figure 2, 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 be really implementing a one size interest rate policy for the euro area. How important are the inflation differentials within the Euro area? Are they 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.

[11] In relation to expression (1), Taylor (1993) assumed the following values for the different parameters in the rule: $\hat{r} = \hat{p} = 2$, ϕ_π=1.5 and ϕ_x=0.5.

FIGURE 2.- Taylor's rule and the market interest rate



Source: *European Central Bank and own results*

3. FACTORS UNDERLYING REGIONAL INFLATION DIFFERENTIALS AND THEIR PERSISTENCE

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.[12] The second one assumes that regional divergences in terms of output gaps might cause higher inflationary pressures in those economies with advanced business cycles.[13] 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 dependant of the evolution of nominal exchanges rates, thus 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 levels would experience higher inflation rates than those with higher price level at the initial stage. A key factor that can spur price level convergence is price transparency. At the same time, price transparency can be enhanced by the completion of the internal market, by the introduction of a single currency or by the shortening of the geographical distance. The convergence in price levels in the euro countries has been studied, among

[12] These factors can have a real or a financial nature. For a recent survey of this issue in the European Monetary Union, see Angeloni et al. (2002).

[13] An explanation of the inflationary Spanish experience based on these factors can be found in Ledo et al. (2002).

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[14], 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.[15] The relevance of the Balassa-Samuelson effect has also been confirmed by Alberola and Tyrväinen (1998), Canzoneri et al. (1999), De Grauwe and Skuldeny (2000) and Olivera (2003), 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.

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 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 national monetary policies persistently targeting at different inflation objectives. At the same time, a single currency enhances

[14] See Balassa (1964) and Samuelson (1964).

[15] 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 growth slower than wage inflation.

price transparency, reducing the scope for persistent differences in the pricing policy followed by firms.

However, several reasons have been put forward to explain why inflation differentials persistence may be more important within a currency union than among independent countries. First, the setting of a single nominal interest rate for the whole euro area would mean a different real interest rates for those member countries with higher inflation rates. If the inflation rates go up during expansions because of the higher demand pressure, the resulting lower real interest rate might amplify the business cycle and, therefore, inflation. Second, and partly derived from the former, a booming region with a higher inflation rate and a lower real interest rate may experience higher increases in both nominal and real housing prices which, in turn, may stimulate consumption through the balance sheet effects.[16]

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 point out that international price discrimination (pricing-to-market policies) reduce the scope for the expenditure-switching effect to work (see Obstfeld (2002) for a recent survey on this topic). Bergin (2003) proposes a pricing-to-

[16] The recent developments of the housing markets both in Spain and Ireland could support this explanation.

market model for a monetary union[17] and concludes that inflation differentials can appear in a monetary union and persist a long time, even in tradable products, due to the market power of firms that engage in price discrimination among different markets.

Although we have focussed 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 on 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 there exist 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. In these settings, it is expected to observe less persistent inflation differentials as 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 of different regions of two long-established currency unions: the United States and Spain.

[17] An aspect that deserves being highlighted is the relevance of the analytical way 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 keeping nearer to the initial development of pricing to market in the microeconomic literature.

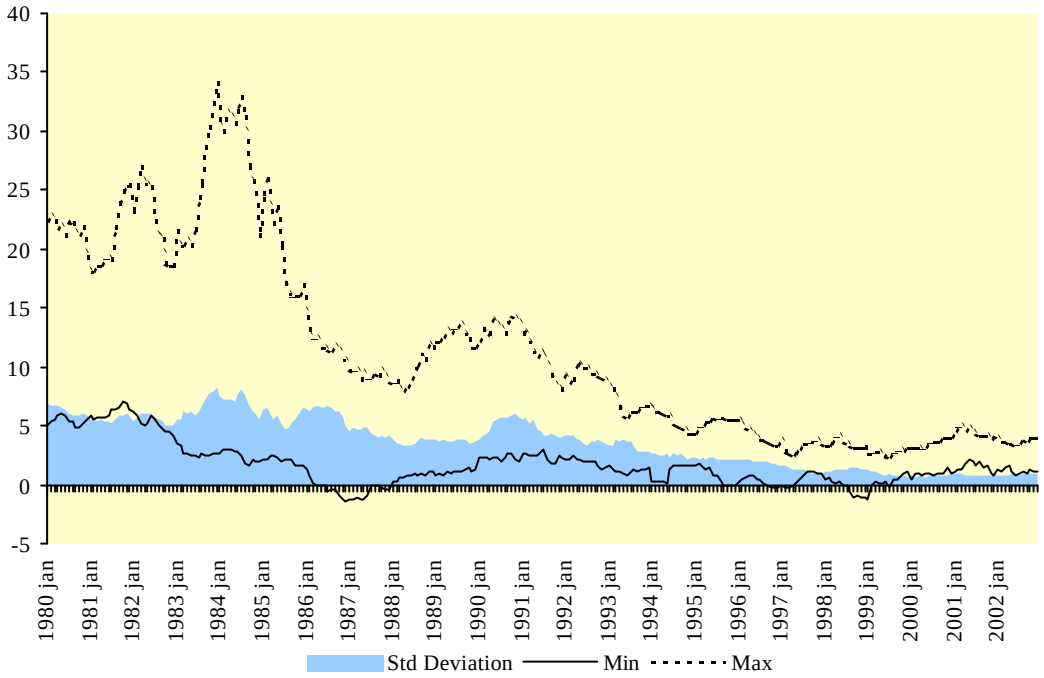
4. REGIONAL INFLATION DIFFERENTIALS IN CURRENCY UNIONS. SOME EMPIRICAL EVIDENCE FOR THE EMU COUNTRIES AND THE REGIONS IN SPAIN AND THE UNITED STATES

This section studies the regional inflation differentials and their persistence between the euro countries, the Spanish regions and some regions of the United States. Since some analysts have suggested that it is still too soon as to evaluate whether the ECB has succeeded in achieving the price stability goal (the EMU 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 15 countries belonging to the European Union was retrieved from *Main Economic Indicators* (OECD, 2003). Spanish regional data for the 17 Autonomous Communities was extracted from the *Spanish National Statistics Institute* (INE), while data for 14 USA´s Metropolitan Statistical Areas (MSA) was retrieved 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 December 2002.

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 rate 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.

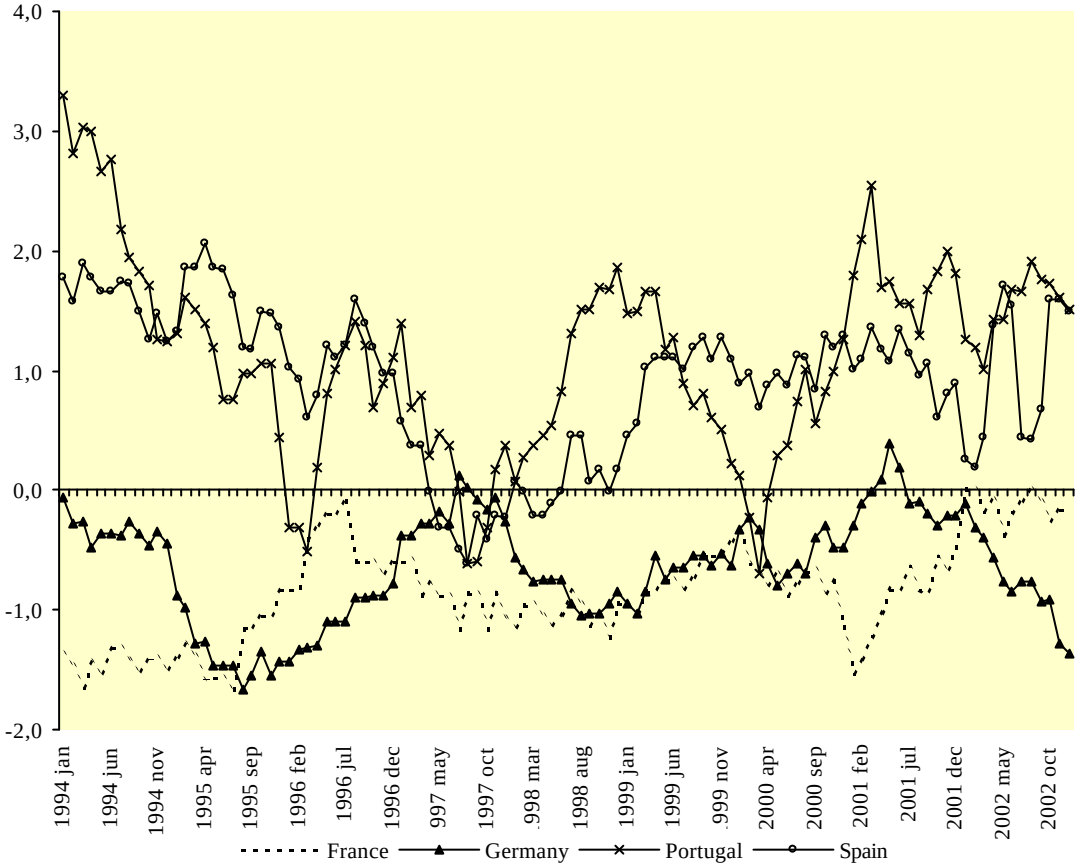
FIGURE 3.- Evolution of inflation rates in EMU countries



Source: *Main Economic Indicators, OECD*

As a consequence of that, inflation differentials could be expected to 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, like Portugal or Spain, where the inflation rate has persistently remained well above the euro area rate (see Figure 4). Conversely, there is a group of countries (like France or Germany) which has persistently experienced lower inflation rates. Interestingly, inflation rates were quite close among the selected countries in 1997 and 1998, coinciding with the evaluation of the Maastricht criteria, but they started to diverge when the third stage of EMU was set up.

FIGURE 4.- Differentials in inflation rates in some European countries
(with respect to EU15)



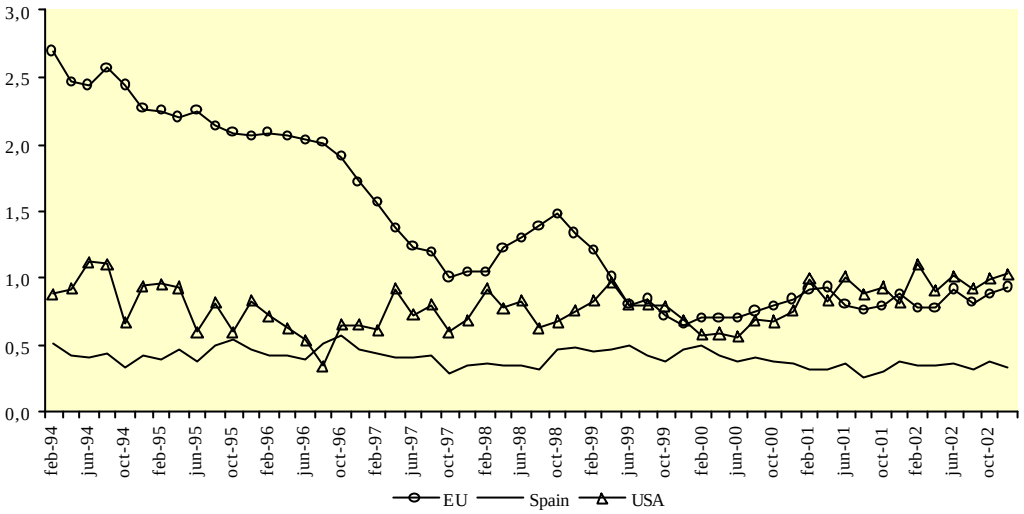
Source: *Main Economic Indicators, OECD*

The above-mentioned trends in inflation rates have raised some concerns for the 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. To check out this possibility, we include Figures 5 and 6, which present the 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 2002, 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

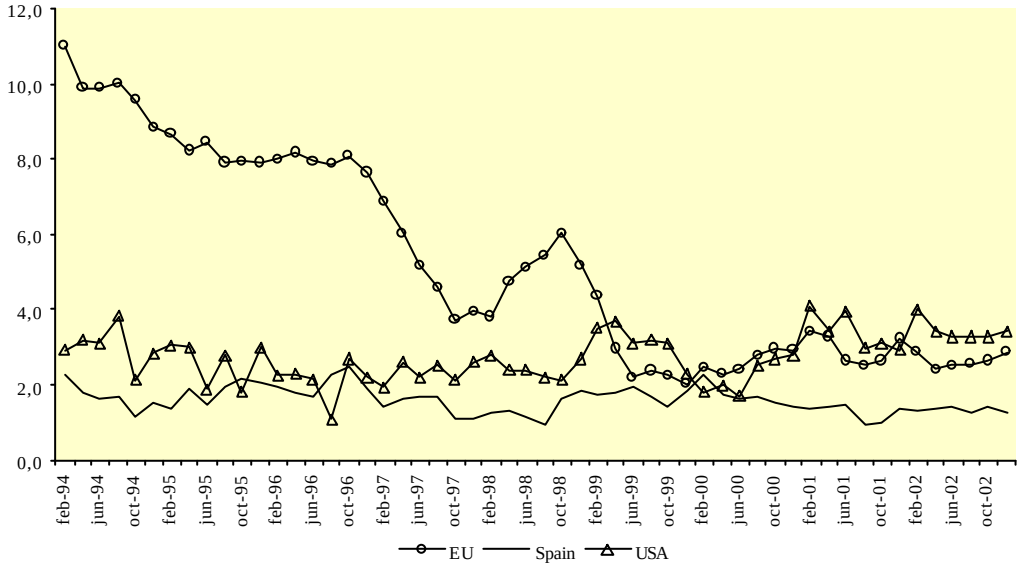
important role played by the fulfilment of the Maastricht criteria and the monetary unification in the reduction of inflation differentials. However, they do not totally disappear with the implementation of a single monetary policy. As it can be seen in Figures 5 and 6, there is significant inflation dispersion in all the currency unions considered in this paper. Additionally, some important differences can be highlighted across the unions studied. In particular, the inflation dispersion for the euro area and the United States is around twice as much 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 similitude 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 too different from the ones observed in the United States.

FIGURE 5.- Standard deviation of inflation rates in EMU countries, the Spanish regions and some USA regions



Source: *Main Economic Indicators, INE and BLS*

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



Source: *Main Economic Indicators, INE and BLS*

Although inflation differentials do not seem to be a specific problem of the euro area, their degree of persistent might be. It would be a problem for the conduct of the single monetary policy, thus its analytical study is crucial for understanding the challenges that the European Central Bank has to face. We will distinguish two different aspects related to inflation persistence. 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.[18]

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:

$$\left(p^{i} - p^{area}\right)_{t} = a + r\left(p^{i} - p^{area}\right)_{t-1} + e_{t} \qquad (2)$$

where $(\pi^{i} - \pi^{area})$ is the inflation differential for the country *i* with respect to the reference area considered, α and ρ are the parameters to be estimated and ε_t is assumed to be 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. Additionally, the value of ρ determines the speed of the convergence process.

The unit root tests test the null hypothesis H_0: $\rho = 1$, against the one-sided alternative H_1: $\rho < 1$. Our paper employs 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).

Alternatively, stationary tests test the null hypothesis H_0: $\rho < 1$. In our paper, we apply the KPSS test proposed by Kwiatkowski et al. (1992). The combination of

[18] In this case, we employ the Harmonised Consumer Price Index (HCPI) data from Eurostat for the euro area countries, which is available from 1995.

different kinds of 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. By means of this comparison we aim 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 of the United Sates. 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 test 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	**	Mixed-evidence
Finland	*	**	NO	NO	NO	Mixed-evidence
France	NO	NO	NO	NO	**	Non-stationary
Germany	NO	NO	NO	NO	**	Non-stationary
Greece	NO	NO	NO	NO	**	Non-stationary
Italy	NO	NO	NO	NO	**	Non-stationary
Luxembourg	*	*	NO	NO	*	Mixed-evidence
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.

Additionally, the degree of persistence of the different series was 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 ρ and its analytical expression is as follows: $HL = \left(\frac{\ln 0{,}5}{\ln \boldsymbol{r}} \right)$. 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 ρ value for each of the series, we will take its pooled value as representative for the whole group so we can obtained ρ 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 2.- Unit root and stationary test of inflation differentials in the Spanish and the United States regions (1980:01-1998:12)

	Unit root tests				Stationary test	Conclusion
	ADF	PP	DF-GLS	ERS	KPSS	
Spanish regions						
Andalucia	**	**	NO	**	*	Mixed-evidence
Aragon	**	**	NO	*	NO	Stationary
Asturias	*	**	**	NO	NO	Stationary
Baleares	*	**	NO	**	NO	Stationary
Canarias	*	*	**	**	NO	Stationary
Cantabria	**	**	NO	**	NO	Stationary
Castilla y León	*	**	*	**	NO	Stationary
Castilla La Mancha	NO	**	NO	NO	NO	Mixed-evidence
Cataluña	NO	**	*	*	NO	Stationary
Com. Valenciana	**	**	NO	NO	NO	Mixed-evidence
Extremadura	**	**	*	**	NO	Stationary
Galicia	*	**	NO	**	NO	Stationary
Madrid	**	**	**	NO	NO	Stationary
Murcia	NO	**	NO	**	NO	Mixed-evidence
Navarra	**	**	**	**	**	Mixed-evidence
País Vasco	NO	*	NO	NO	NO	Mixed-evidence
La Rioja	**	**	NO	NO	NO	Mixed-evidence
United States regions						
New York	*	**	NO	NO	NO	Mixed-evidence
Chicago	**	**	NO	*	NO	Stationary
Los Angeles	NO	**	NO	NO	*	Non-stationary

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

The higher estimated speed of convergence for the Spanish and, to a lesser extent the United States, could be explained by appealing to the arguments expressed in section 3 above, mainly the existence of a single monetary policy among the Spanish and the United States regions and the higher transparency in price comparisons. However, the remainder factors underlying a higher persistence of inflation differentials within currency unions seem to have played a minor role.

Although the results above mentioned are interesting, the study of persistent inflation differentials across currency unions may provide a more useful insight in this issue. In this vein, Table 3 summarises some measures of persistence of inflation differentials 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 short sampling of the data does not recommend applying unit root tests in order to determine the stationary properties of inflation differentials. For that reason, 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).

TABLE 3.- Persistence in inflation differentials among the EMU countries, the Spanish regions and some regions in the United Sates: 1999-2003				
		AR(1)	AR(2)	AR(4)
EMU	**Average**	**0.812**	**0.725**	**0.543**
	Maximum	0.941	0.919	0.946
	Minimum	0.712	0.561	0.309
United States	**Average**	**0.756**	**0.552**	**0.416**
	Maximum	0.911	0.807	0.647
	Minimum	0.549	0.149	0.050
Spain	**Average**	**0.763**	**0.607**	**0.380**
	Maximum	0.937	0.890	0.781
	Minimum	0.570	0.250	-0.333

		Sum of coefficients from AR of order	
		Sixth	Twelfth
EMU	**Average**	**0.856**	**0.717**
	Maximum	0.974	0.951
	Minimum	0.738	0.497
United States	**Average**	**0.752**	**0.297**
	Maximum	0.974	0.926
	Minimum	0.405	-0.754
Spain	**Average**	**0.734**	**0.523**
	Maximum	0.935	0.956
	Minimum	0.359	-0.106

Source: *Eurostat, INE and BLS*

For all the measures calculated, the European inflation rates seem to diverge more persistently than in Spain and in the United States.[19] This result contrast with those previously obtained in this paper for inflation dispersion in currency unions because, in this case, persistence of inflation differentials seems to be an intrinsic feature of euro area economies.

In order to offer an explanation for this behaviour, we must be aware that the factors underlying persistent inflation differentials have to be, to a certain degree, independent of the factor underlying inflation dispersion within regions of a currency union. This conclusion is derived from comparing the results obtained for the European Monetary Union and the United States. As argued before, regional inflation dispersion

[19] We used three MSA for the United States; that is, the three MSA for which monthly data were available.

in these areas tends to be similar across time. However, inflation differentials persistence is higher within the European Monetary Union.

In section 3, we proposed two possible explanations for the diverging degrees of persistence in regional inflation differentials. A first factor was differences in the degree of economic policy centralisation, but this reason was also used to explain the dispersion in regional inflation rates within currency unions. A second reason was differences in nominal rigidities in the goods and labour markets. Interestingly, this factor can generate a different degree of inflation persistence without implying a higher dispersion in regional inflation rates.

For understanding how differences in nominal rigidities can produce more persistent inflation differentials within a currency union, suppose a symmetric shock affecting the whole currency union, which induces changes in prices or wages. Although the impact of the shock depends basically on real factors, its persistence is closely related to nominal rigidities. Nominal rigidities do not affect *the total impact* of the shock, consequently, it is not expected to affect the inflation dispersion within the union. Notwithstanding, nominal rigidities play a role in the dynamic response of the economy to the initial shock. The inflation rate in those regions characterised by a higher degree of nominal rigidities will respond more sluggish to the initial shock. In fact, the higher the differences in the degree of nominal rigidities observed among the regions of a currency union, the more persistent the regional inflation differentials will be. To the extent that it is reasonable to expect that nominal rigidities are more similar among the Spanish and the United States regions than among the Euro countries, we have an argument to explain why inflation differentials persistence is higher in the European Monetary Union when compared to Spain and the United States.

This argument could be supported by the evidence provided 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 mayor countries of the euro area, as measured by the duration of prices being fixed. In particular, they point out that for Germany, the Netherlands and France, the degree of price stickiness seems to be lower to that observed in both Italy and Spain. In the same perspective, Nickell (2003) suggests that labour market institutions wildly diverge across the European economies, which could produce differentiated patterns in the rigidities of the labour markets.

5. CONCLUSIONS

The primary objective of the ECB is to achieve and maintain price stability in the medium term, where by price stability is meant an inflation rate below but close to 2 per cent. The empirical evidence shows that this objective was fulfilled during the first years of EMU, but not after 2000, since inflation rate has stayed above that value. However, it could be argued that this does not necessarily mean that the ECB has failed to achieve its goal, since price stability is assumed to be achieved in the medium term and some authors have quite rightly pointed out that the ECB "has not provided any operational definition of what is meant by *the medium term*" (Galí, 2003).

In a former paper we provided empirical evidence on the convergence in inflation rates for the majority of the EU economies for the period 1980-2002, although the convergence in inflation rates seemed to stop from late 90's, once the inflation rate reached a very low level (Rodriguez-Fuentes and Olivera-Herrera, 2003). New empirical evidence presented in this paper reveals the existence of a high persistence in inflation differentials among the current members of the euro zone during the 80's and 90's. This persistence is much higher than that observed for other long-established currency

unions, such as the existing in between the Spanish regions and the regions of the United States. So the main challenge consists on explaining why inflation dispersion is similar within the European Monetary Union and some regions in the United States, while its persistence is higher in the former. As a tentative explanation, we have proposed the diverging degrees of nominal rigidities observed across the regions of those areas. However, we acknowledge that much further and substantial research on this topic is needed.

Although the causes are still unclear, it is evident that the persistence of inflation differentials among euro countries would raise the possibility for the single monetary policy not to suit every euro country, particularly because the ECB would not be really implementing the "one size interest rate policy" claimed for the euro area.

In addition, inflation differentials in Europe could also raise in the near future because of the EU enlargement. Although most of the new EU Member States have succeeded in reducing inflation rates[20] in the past, they all have much lower income levels. It is expected therefore that these new members experience intense growth in the near future, so the catching-up process could lead to higher inflation rates, which might produce (and perpetuate) "more regional tension" for the single monetary policy.

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[20] Actually, the average inflation differential for the period 1996-2002 was 7.27 percentage points, whereas for year 2002 was only 0.80.

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