The Impact of the European Monetary Union on Inflation Persistence in the Euro Area

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February 25, 2009

Abstract

This paper uses the European Monetary Union (EMU) as a natural experiment to investigate whether more effective monetary policy reduces the persistence of inflation. While inflation persistence measured by the order of fractional integration differed considerably across euro area countries before the start of EMU, inflation persistence seems to have converged since 1999. This allows to estimate the long-memory parameter of euro area inflation rates in a panel framework. In line with theoretical predictions, our results indicate that the persistence of inflation has significantly decreased in the euro area.

Keywords: Monetary Policy Effectiveness and Inflation Persistence; Panel Test for Fractional Integration;

JEL classification: C22, C23, E31

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1 Introduction

The analysis of inflation persistence has received increasing attention among economists. Central banks analyze the degree of inflation persistence in order to improve inflation forecasts and to assess the dynamic response of inflation to shocks. In particular, if the degree of inflation persistence is high, then shocks to inflation have long-lived effects which could impede the controllability of inflation. Therefore, in accordance with the predictions of New-Keynesian DSGE models, reduced inflation persistence might be the result of better monetary policy and an anchoring of inflation expectations.[1]

While there is a widespread belief that monetary policy effectiveness has increased over the last decades,[2] the empirical evidence on changes in inflation persistence has been rather elusive, see e.g. Mishkin (2008). For many countries, including the United States, detecting significant breaks in inflation persistence is complicated by the fact that monetary policy had changed only gradually and the identification of different policy regimes is not clear. By contrast, the introduction of the Euro and the common monetary policy of the European Central Bank (ECB) led to an obvious change in the monetary policy regime and to a marked improvement of monetary policy for many euro area countries. Therefore, this paper uses the European monetary union (EMU) as a natural experiment to investigate whether more effective monetary policy reduces the persistence of inflation.

Our empirical approach differs from earlier contributions in two main aspects. First, in contrast to the bulk of empirical work on inflation persistence in the euro area, we use country-specific and not synthetic euro-area wide inflation rates for the pre-EMU period. If monetary policy affects the persistence of inflation, using synthetic euro area inflation seems inappropriate. It ignores that monetary policy and, thus, inflation persistence had been very different across member countries before the monetary union.

The second aspect in which our paper differes from most studies con-

[1] For a discussion of the different sources of inflation persistence and its implications for monetary policy within the framework of a New Keynesian DSGE model, see e.g. Altissimo et al. (2006). This paper gives also an excellent survey of earlier evidence on inflation persistence in the euro area.

[2] For example, Blinder et al. (2008) show that the communication strategies of central banks have improved considerably since the early 1980s.

cerns the measure to establish a change in inflation persistence. The major part of the large and growing literature on inflation persistence regresses inflation on several of its own lags and takes the sum of the coefficients of lagged inflation as a measure of persistence. Changes in persistence are investigated by rolling regressions or time-varying coefficients. However, even modest changes in methodology - such as lengthening of the sample period or correcting for small-sample bias - can alter both the magnitude and the statistical significance of the estimated decline in persistence. In fact, the conclusion that the sum of lagged coefficients of euro area inflation has declined is still under debate, compare e.g. O'Reilly and Whelan (2005) and Beechey and Österholm (2009). We follow Kumar and Okimoto (2007) and Gadea and Mayoral (2006), who argue that this intuitive way of measuring persistence becomes problematic if the time series exhibits long memory.

Since Granger (1980) inflation has been the textbook example of a time series with long memory. Gadea and Mayoral (2006) showed that fractional integration can appear in inflation rates after aggregating individual prices from firms that face different costs of adjusting their prices. The fractional integration of inflation rates have been confirmed by e.g. Hassler and Wolters (1995) and Baillie et al. (1996). Yet, Kumar and Okimoto (2007) have been the first who established a *change* in U.S. inflation persistence using fractional integration techniques. There is no evidence available on the (changing) degree of fractional integration focusing on euro area inflation. In order to fill this gap, we will investigate whether the degree of fractional integration of inflation rates in euro area countries has actually declined since the start of the European monetary union as a result of the new, probably more effective monetary policy of the ECB.

For the pre-EMU period, sample size is not an issue and the order of fractional integration can be estimated for each member country separately by e.g. the exact local Whittle estimator proposed by Shimotsu and Phillips (2005). However, standard methods of fractional integration are not applicable during the EMU period simply because the Euro was introduced only ten years ago. In order to obtain an efficient estimate, despite the short time period, we will use the panel long memory estimation procedure advocated by Robinson (1995).

Efficiency gains in the panel estimation are largest if one can impose the restriction that all time series have the same order of integration. While this restriction may appear to be implausible in many applications, a common degree of inflation persistence across countries of a monetary union seems to be a rather natural assumption as long as inflation persistence is predominantly driven by the effectiveness of the common monetary policy. The panel long memory estimation has not been applied widely yet and we are one of the pioneers to exploit this technique. As a consequence, we perform Monte Carlo simulations to ensure the reliability and robustness of our empirical results.

To assess the impact of the European Monetary Union on inflation persistence, we compare the country-specific orders of fractional integration estimated over the pre-EMU period to the common order of integration of euro-area wide inflation during the EMU period. Our results indicate that euro area countries significantly gained by joining the EMU in terms of reduced inflation persistence. The order of fractional integration in the pre-EMU period was significantly positive in each country and was on average 0.32. In contrast to this, the common euro area long memory parameter is virtually zero since the common monetary policy of the ECB has been in place.

The remainder of the paper is organized as follows. In the next section we estimate inflation persistence for each of the founding member countries over the pre-EMU period and reconcile our results with those of the earlier literature. In Section 3, we briefly introduce the fractional integration panel estimator which we apply for the estimation of euro area inflation persistence over the EMU period. We check the robustness of our results using a Monte Carlo study and a sensitivity analysis. Conclusions are drawn in Section 4.

2 Inflation Persistence in the Euro Area over the pre-EMU Period

2.1 Data

Our empirical analysis employs seasonally adjusted monthly CPI data provided by the OECD for the following ten founding members of the euro

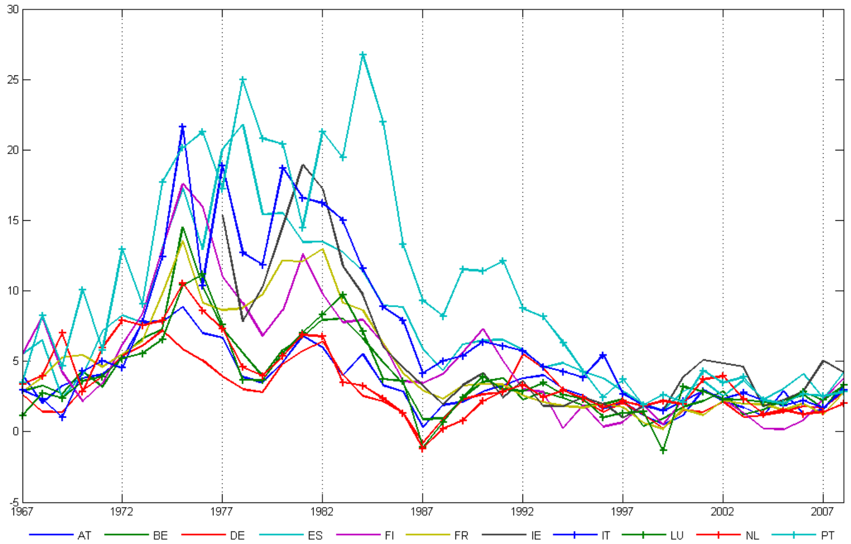

Figure 1. Annual inflation rates of EMU founding countries

area: Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Italy (IT), Luxembourg (LU), Netherlands (NL) and Portugal (PT). Ireland has to be omitted in the pre-EMU sample, because monthly CPI data for Ireland is only available since 1997. The pre-EMU sample starts in 1966 due to data availability and ends 1998 which gives us 395 observations for each country. Inflation in country g is defined as

$$\pi_{gt} = \log(CPI_{gt}) - \log(CPI_{gt-1}).$$

Figure 1 shows the time series of all country-specific inflation rates before and after the start of EMU in 1999. For most of the countries, the *level* of inflation is clearly higher before the introduction of the Euro than afterwards. It is less obvious, however, whether the common monetary policy of the ECB also contributed to a decrease of the *persistence* of inflation.

2.2 Inflation Persistence in the pre-EMU Period

Before the start of the European monetary union, each euro area country had its own monetary policy and, thus, a country-specific degree of inflation persistence. For the pre-EMU period, we therefore estimate the order of fractional integration of inflation for each country separately. Specifically, we apply the exact local Whittle estimator introduced by Shimotsu and Phillips (2005) which is consistent and asymptotically normally distributed for all values of d.

The estimated order of fractional integration can be spuriously high if shifts in the mean of the time series are ignored. Therefore, our estimates of the long-memory parameter controls for shifts in mean as proposed by Hsu (2005).

Table 1 presents the estimated order of fractional integration of pre-EMU rates of inflation in euro area countries under various assumptions about the number of mean shifts. Even when accounting for a mean shift, there is strong evidence for all countries that the rate of inflation exhibited long memory in the pre-EMU period. As expected, increasing the number of possible mean shifts, decreases the estimated order of integration.

The significance of a potential mean shift is established using the test statistic (HR) proposed by Hidalgo and Robinson (1996). In our application, the asymptotic normal distribution of the HR-test statistic is not valid because the break point is not exogenously given but found by a grid search. This search adds more uncertainty to the test statistic and renders its distribution flatter than under normality. Consequently, a break point that is found to be significant at a 10% level under normality might indeed not be significant. Assuming normality, we make sure that we do not miss a significant mean shift but acknowledge that we might allow for insignificant mean shifts. With the exception of Italy, the HR test typically indicates a single significant mean shift. In Belgium and the Netherlands the test finds two mean shifts but the impact of the second shift on the estimated d is only small. In the same vein, allowing for three or more mean shifts in the inflation series had only a minor effect on the estimated d. Furthermore, Table 5 in the Appendix reports the order of integration when accounting for the appropriate number of mean shifts for different values of the bandwidth. For each bandwidth, we rank the countries according to their estimated degree of inflation persistence. This ranking is only mildly affected by the choice of m.

In Table 1 we highlighted the estimates corresponding to the number

Table 1. The Order of Fractional Integration of the Rate of Inflation in the pre-EMU Period: The Role of Mean Shifts

	AT	BE	DE	ES	FI	FR	IT	LU	NL	PT
no mean shift										
$\hat{d}$	0.24	0.47	0.36	0.36	0.41	0.57	**0.54**	0.44	0.32	0.20
	[0.12,0.34]	[0.35,0.57]	[0.24,0.47]	[0.24,0.46]	[0.29,0.51]	[0.45,0.67]	[0.25,0.64]	[0.42,0.55]	[0.32,0.42]	[0.20,0.30]
one mean shift										
$\hat{d}$	**0.14**	0.42	**0.32**	**0.30**	**0.37**	**0.54**	0.51	**0.39**	0.18	**0.14**
	[0.02,0.26]	[0.30,0.54]	[0.20,0.44]	[0.18,0.42]	[0.25,0.49]	[0.42,0.66]	[0.39,0.63]	[0.27,0.51]	[0.06,0.30]	[0.02,0.26]
shift	1984:2	1985:3	1982:10	1986:1	1982:5	1982:4	1973:10	1985:11	1982:7	1985:3
two mean shifts										
$\hat{d}$	0.08	**0.35**	0.24	0.11	0.3	0.45	0.52	0.31	**0.13**	-0.06
	[-0.04,0.20]	[0.23,0.47]	[0.12,0.36]	[-0.01,0.23]	[0.18,0.42]	[0.33,0.57]	[0.40,0.64]	[0.19,0.43]	[0.01,0.25]	[-0.18,0.06]
shift 1	1984:2	1985:3	1982:10	1983:12	1982:5	1982:4	1973:10	1984:2	1982:6	1985:3
shift 2	1971:3	1973:9	1970:11	1973:2	1973:3	1973:3	1974:9	1973:9	1970:11	1973:3

Notes: The estimates of fractional integration accounting for mean shifts, $\hat{d}$, are based on a bandwidth $m = T^{0.70} = 65$. Alternative choices of $m \in \{T^{0.60}, T^{0.65}, T^{0.70}, T^{0.75}\}$ had neither an important impact on the estimated order of integration nor the timing and the significance of the mean shifts. 95% confidence intervals of $\hat{d}$ are shown in brackets. The estimates of d accounting for the appropriate number of mean shifts are highlighted. We account for a mean shift if the shift is significant at a 10% significance level.

of mean shifts suggested by the HR-test. Referring to these estimates, the orders of fractional integration vary between 0.13 (NL) and 0.54 (IT, FR) with partly non-overlapping confidence intervals. The remarkable differences in the estimated long-memory parameter across euro area countries clearly indicate that it would have been inappropriate to assume a homogeneous degree of inflation persistence before the common monetary policy of the ECB had been implemented.

How does the estimated pre-EMU inflation persistence relate to the perceived effectiveness of monetary policy? Comparing simple indicators of monetary policy effectiveness, like e.g. the long-run average of inflation, with the country-specific estimate of the order of fractional integration confirms that there is a tendency of low-inflation countries to exhibit low inflation persistence. Yet, there are some notable exceptions: in particular, the long memory parameter of Portugal seems surprisingly low.

2.3 Review of the Empirical Literature

Let us now compare our empirical findings to previous studies which relied on fractional integration to analyze inflation persistence in the pre-EMU period. We are aware of three papers that consider the complete set of the EMU founding countries. Most contributions restrict their attention to the United States or the G7 countries. Table 2 reports the estimates found in the empirical literature. The first columns of the Table indicate that estimates may differ across different papers for various reasons. In particular, some studies use different sample periods, different estimators or bandwidths, some allow for mean shifts and some do not.

In spite of all these differences, Table 2 suggests the following conclusions. First, in line with our results for the pre-EMU period, all papers provide clear evidence in favor of long memory in the rate of inflation for all countries under consideration. Second, with the exception of Gadea and Mayoral (2006), the estimated order of fractional integration across countries range between 0.1 and 0.6.[3] Third, the ranking of countries in terms of inflation

[3]Gadea and Mayoral (2006) are the only ones in our literature review who use quarterly data. This might be an explaination for their relatively high estimates of the orders of integration.

persistence is very similar across studies. For example, in line with the reputation of the Bundesbank's monetary policy, inflation persistence in Germany is lower than in Italy and France. Fourth, the estimates of Baum et al. (1999) (BBC) and Conrad and Karanasos (2005) (CK) confirm that the relation between monetary policy and inflation persistence may be masked by other features of the economy. For example, in line with our empirical results, BBC find that inflation persistence in Germany had been larger than in Portugal which seems to contradict the common view on the relative effectiveness of monetary policy in these countries. This indicates that cross-country comparisons of inflation persistence must take into account that monetary policy is not the only source of inflation persistence, see Altissimo et al. (2006).

Particularly before the 1990s, the economies of current euro area countries differed to a great extent and in many aspects. Since the mid-nineties, however, euro area countries converged not only in terms of the level of inflation. In accordance with the Maastricht treaty, convergence was further obtained with respect to e.g. fiscal policy, exchange rates, and long-term interest rates. Although there may be still room for improvement, compared to the pre-EMU period, the current degree of economic integration and harmonization in the euro area is substantial. Therefore, it seems plausible to assume that not only the level of inflation has converged for euro area countries but also its persistence. In the next section, we briefly review the panel estimator of fractional integration introduced by Robinson (1995), which will be used to estimate the common order of fractional integration of euro area inflation rates in the EMU period.

3 Inflation Persistence in the Euro Area

3.1 Panel Estimator of Fractional Integration

The panel estimator of fractional integration was proposed by Robinson (1995). Despite its long availability, the study of Andersen et al. (2003) seems to be the only one implementing the panel estimator.[4] This rare use of the panel estimator is probably due to the fact that efficiency gains are

[4] Andersen et al. (2003) analyze the long memory behavior of realized return volatilities.

Table 2. Previous Studies on European Inflation Persistence using Fractional Integration

Author(s)	Sample period	m	Shift	Method	AT	BE	DE	ES	FI	FR	IT	LU	NL	PT
KO	1960:5-1975:4	$T^{0.75}$	0	LW			0.33			0.43	0.51			
	1988:5-2003:4	$T^{0.75}$	0	LW			0.02			0.14	0.45			
	1974:5-1989:4	$T^{0.75}$	0	LW			0.36			0.54	0.46			
HW	1969:1-1992:12	$T^{0.66}$	0	P			0.41			0.60	0.60			
BBC	1971:1-1995:12	$T^{0.69}$	0	LW	0.21	0.51	0.43	0.35	0.36	0.55	0.50	0.36	0.35	0.32
Hsu	1957:1-1998:12	$T^{0.78}$	1	LW			0.19			0.42	0.47			
		$T^{0.78}$	2	LW			0.09			0.18	0.31			
CK	1962:1-2004:1		0	A-G		0.21	0.20	0.18	0.19	0.31	0.35		0.20	0.14
	1980:1-2004:1		0	A-G		0.15	0.21	0.38	0.14	0.19	0.29		0.13	0.22
GM	1957:1- 2003:4		0	P	0.78	0.83	0.94	0.90	0.74	0.75	1.19	0.74	0.86	0.80
			0	A	0.82	0.87	0.83	1.07	0.67	0.68	0.66	0.83	0.79	1.14
BCT	1947:1-1990:9		0	A-G			0.18			0.45	0.45			
This paper	1966:1-1998:12	$T^{0.70}$	0-2	LW	0.14	0.35	0.32	0.30	0.37	0.54	0.54	0.39	0.13	0.14

Notes: We abbreviated Kumar and Okimoto (2007) by KO, Hassler and Wolters (1995) by HW, Baum et al. (1999) by BBC, Hsu (2005) by Hsu, Conrad and Karanasos (2005) by CK, Gadea and Mayoral (2006) by GM, Baillie et al. (1996) by BCT. The local Whittle estimator is abbreviated by LW, the log-periodogram estimator by P and an ARFIMA(-GARCH) model is abbreviated by A(-G). For more details on"this paper" see Tables 1 and 5.

large only if one can impose the restriction that all time series have the same order of integration. This restriction, however, might be overly strong in many applications.

Robinson's panel estimator works essentially like a fixed effects or pooled mean-group estimator for the stacked log-periodogram regression. In a first step, the periodogram of each country g ($I_g(\lambda)$) is evaluated at harmonic frequencies up to the bandwidth m as usual. Then, the (summed) log periodogram $Y_{gk}^{(J)}$ of country g is defined as:

$$Y_{gk}^{(J)} = log \left\{ \sum_{j=1}^{J} I_g(\lambda_{k+j-J}) \right\} , \tag{1}$$

for $k = J, 2J, \ldots, m$ and $\lambda_{k+j-J} = 2\pi(k + j - J)/T$ are the harmonic frequencies. Note that, for $J > 1$, the log periodogram takes the sum of the periodogram evaluated at J adjacent harmonic frequencies, so that $Y_g^{(J)}$ is a vector of dimension $[\frac{m}{J}] \times 1$.

In a second step, the log periodogram regression is performed

$$Y_{gk}^{(J)} = c_g^{(J)} - d_g 2 log \lambda_k + U_{gk}^{(J)} , \tag{2}$$

yielding OLS estimates of d_g for each country. Following Robinson (1995),

$$\tilde{d}_g \xrightarrow{d} N \left(d_g, k_J \frac{1}{4m} \right)$$

where $\tilde{d}_g$ is the OLS estimate of regression (2) and $k_1 = \pi^2/6 = 1.645, k_2 = 1.289, k_3 = 1.185, ..., k_\infty = 1$. Thus, using $J > 1$ renders the estimation of d_g asymptotically more efficient. In finite samples, however, the appropriate choice of J is not obvious.

The panel estimate of d is obtained by the fixed effects estimator of (2) which imposes that d is equal for all countries while c_g is country specific.

3.2 Inflation Persistence in the Euro Area in the EMU-Period

3.2.1 Data

Let us now apply Robinson's (1995) panel estimator to investigate inflation persistence in the EMU period. Following the pre-EMU analysis, we use monthly, seasonally adjusted OECD data of CPI indices of the 11 EMU founding countries, see Section 2.1. Due to improved data availability, the EMU sample also contains data from Ireland. The EMU sample runs from 1999.01 until 2008.07, implying that the panel estimation is based on 11×115 observations.

3.2.2 How to Choose J and m: A Monte Carlo Exercise

A distinguishing feature of the panel estimator is the parameter J which governs the impact of adjacent harmonic frequencies on the estimated order of fractional integration. While using $J > 1$ renders the estimation of d *asymptotically* more efficient, the optimal choice of J in finite samples and its relation to the employed bandwidth is not clear. To shed more light on these issues, we conduct a Monte Carlo simulation where we simulate 11 independent fractional white noise series of length 115. In line with the assumption of the panel estimator, all series have the same long memory parameter d. We use 1000 iterations for each simulation and vary the common long memory parameter in the relevant range, i.e. $d \in \{0, 0.1, 0.2, 0.3, 0.4, 0.49\}$. The panel estimator has been applied for $J = 1, 2, 3, 4$ and various choices of the bandwidth $m = \{T^{0.60}, T^{0.65}, T^{0.70}, T^{0.75}\}$. In order to account for the bias as well as the variance of the estimators, the evaluation of the estimator was based on the mean squared error (MSE) of the estimates.

Table 6 in the Appendix reports the results of the Monte Carlo exercise. For our application, the main results can be summarized as follows. For a particular choice of m, the smallest MSE is obtained by choosing $J = 1$ or $J = 2$. Generally, the larger the true value of d, the better the performance of the estimator when $J = 1$ relative to $J = 2$. In particular, the smallest MSE in case that d_0 is between 0 and 0.30 is obtained by choosing $J = 2$ and $m = T^{0.75}$.

3.3 Empirical Results for the Euro Area

In Table 3, we present the results of the panel estimation of euro-area inflation persistence, measured by its order of fractional integration. In line with the results of our Monte Carlo simulation, the empirical results are robust with respect to the choice of the bandwidth and the parameter J of equation (1). Since the smallest MSE in the Monte Carlo study was obtained

Table 3. The Common Order of Fractional Integration of Euro Area Inflation in the EMU Period: Role of J and m

m, J	1	2	3	4
$T^{0.60}$	0.13	0.07	0.06	0.15
	[0.01, 0.25]	[-0.06, 0.20]	[-0.04, 0.16]	[0.05, 0.25]
$T^{0.65}$	0.06	0.03	0.07	0.05
	[-0.07, 0.20]	[-0.08, 0.14]	[-0.01, 0.15]	[-0.06, 0.15]
$T^{0.70}$	0.08	0.08	0.09	0.09
	[-0.02, 0.19]	[-0.01, 0.17]	[0.02, 0.17]	[0.00, 0.18]
$T^{0.75}$	0.07	**0.05**	0.06	0.06
	[-0.03, 0.17]	[-0.03, 0.13]	[-0.01, 0.13]	[-0.02, 0.13]

Notes: The table presents the fractional integration panel estimator, $\tilde{d}$, of all EMU founding members from 1999:1-2008:7. $\tilde{d}$ was estimated for different values of the bandwidth, m, and different values of the parameter J of equation (1). The 95% confidence interval is shown in brackets. The most appropriate choice of m and J, according to our Monte Carlo study, is highlighted.

for $J = 2$ and $m = T^{0.75}$ for small d, we rely on the estimate using those parameters. We therefore observe that the common order of integration of the 11 euro area countries is 0.05. In contrast to the results obtained for the pre-EMU period, the estimated order of fractional integration of euro area inflation is only small and not significantly different from zero for almost all combinations of m and J. Table 3 provides strong evidence that inflation persistence has decreased since 1999 for all euro-area countries. Our estimations suggest that the decrease in inflation persistence has been particular strong for France and Italy, but that there has also been a remarkable decrease in the order of fractional integration for Germany.

The panel estimator assumes that the order of integration of inflation is the same across 11 euro area countries in the EMU period. In order to test this assumption, we compute the Wald-statistic for $\tilde{d}_g$ when $J = 2$ and $m = T^{0.75}$, see Robinson (1995). We fail to reject the hypothesis of a common d at the 10%-significance level (p-value:0.32).

Finally, as a sensitivity analysis, we investigate whether a single country drives our empirical results. To that end, we re-estimated the order of fractional integration for the 11 subsets of countries obtained by excluding a single country from the analysis. Table 4 shows that the estimates obtained

Table 4. Inflation Persistence in the the EMU period: Sensitivity Analysis

	AT	BE	DE	ES	FI	FR
$\tilde{d}_*$	0.06	0.05	0.07	0.05	0.05	0.07
	[-0.02 0.14]	[-0.03 0.12]	[-0.01 0.15]	[-0.02 0.12]	[-0.02 0.13]	[-0.01 0.14]
	IE	IT	LU	NL	PT	
$\tilde{d}_*$	0.04	0.04	0.05	0.04	0.05	
	[-0.03 0.12]	[-0.05 0.12]	[-0.03 0.13]	[-0.05 0.12]	[-0.03 0.14]	

Notes: We report the panel estimate of fractional integration applied to 10 of the 11 EMU founding countries. The country which is left out is specified above the estimator. We use $J = 2$ and $m = T^{0.75}$ in the estimation in accordance with our Monte Carlo study. Note that all estimates are close to the full sample estimate of d: 0.05.

for the subsamples are very close to the estimate based on the complete set of countries, i.e. 0.05. This demonstrates that our results are robust and not driven by a single country.

4 Summary and Concluding Remarks

While there is no doubt that changes in inflation persistence should have a decisive impact on the conduct of monetary policy, the repercussions of monetary policy on inflation persistence are less clear. On the one hand, there are several contributions who found that inflation persistence has decreased in recent years, probably as a result of a more effective monetary policy, see e.g. Kim et al. (2004). On the other hand, there are studies, including e.g. Pivetta and Reis (2007), O'Reilly and Whelan (2005) and Gadea and Mayoral (2006), who find only little evidence of changes in inflation persistence for various countries.

In most of these papers, detecting significant breaks in inflation persistence is difficult because monetary policy had changed only gradually and the identification of different policy regimes is not clear. By contrast, the adoption of the common monetary policy of the European Central Bank (ECB) has led to a clear improvement of monetary policy for the bulk of euro area countries. To shed more light on the relationship between monetary policy and inflation persistence, this paper explored the impact of the European Monetary Union (EMU) on the persistence of inflation rates in euro area countries before and after the introduction of the Euro. Following e.g. Kumar and Okimoto (2007) and Gadea and Mayoral (2006) we modeled the inflation rate as fractionally integrated $I(d)$ process where persistence is determined by the long memory parameter d. In line with empirical literature, we found that inflation exhibits long memory ($d > 0$) in all euro area countries in the pre-EMU period.

For the analysis of inflation persistence in the relatively short EMU period, we employed the panel estimator introduced by Robinson (1995). Our results confirm that inflation persistence has significantly decreased in most of the euro area countries. In particular, in contrast to the evidence obtained for the pre-EMU period, we find that the common memory parameter d of euro area inflation rates is not significantly different from zero. This finding is very robust with respect to implementation details of the estimator and with respect to variations of the sample. Our empirical results therefore support the hypothesis that more effective monetary policy is able to reduce the persistence of inflation.

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Tables

Table 5. Inflation Persistence in the pre-EMU period: the role of the Bandwidth

	AT	BE	DE	ES	FI	FR	IT	LU	NL	PT
$m = T^{0.60} = 36$										
$\hat{d}$	0.15	0.47	0.39	0.44	0.5	0.62	0.75	0.44	0.14	0.35
	[-0.01,0.31]	[0.31,0.63]	[0.23,0.55]	[0.28,0.6]	[0.34,0.66]	[0.46,0.78]	[0.59,0.91]	[0.28,0.6]	[-0.02,0.3]	[0.19,0.51]
rank	2	8	5	6	9	10	11	7	1	4
$m = T^{0.65} = 48$										
$\hat{d}$	0.2	0.35	0.34	0.34	0.47	0.56	0.61	0.4	0.17	0.24
	[0.06,0.35]	[0.21,0.5]	[0.2,0.48]	[0.2,0.48]	[0.33,0.62]	[0.42,0.71]	[0.47,0.75]	[0.25,0.54]	[0.03,0.31]	[0.1,0.39]
rank	2	7	5	6	9	10	11	8	1	3
$m = T^{0.70} = 65$										
$\hat{d}$	0.14	0.35	0.32	0.3	0.37	0.54	0.54	0.39	0.13	0.14
	[0.02,0.26]	[0.23,0.47]	[0.19,0.44]	[0.18,0.42]	[0.25,0.49]	[0.42,0.66]	[0.42,0.66]	[0.27,0.51]	[0.01,0.25]	[0.01,0.26]
rank	2	7	6	5	8	10	11	9	1	3
$m = T^{0.75} = 88$										
$\hat{d}$	0.16	0.23	0.28	0.27	0.37	0.52	0.54	0.37	0.15	0.13
	[0.06,0.26]	[0.13,0.34]	[0.18,0.39]	[0.16,0.37]	[0.26,0.47]	[0.41,0.62]	[0.43,0.64]	[0.27,0.48]	[0.05,0.26]	[0.02,0.23]
rank	3	4	7	6	8	10	11	9	2	1
m_H										
$\hat{d}$	0.11	0.40	0.34	0.46	0.46	0.83	0.86	0.45	0.16	0.12
	[-0.01,0.22]	[0.25,0.56]	[0.2,0.48]	[0.31,0.62]	[0.33,0.59]	[0.6,1.06]	[0.58,1.14]	[0.29,0.61]	[0.06,0.26]	[0.02,0.22]
rank	1	6	5	8	9	10	11	7	3	2
m	70	41	49	42	54	18	12	38	97	96

Notes: The order of integration is computed for different values of the bandwidth, m, accounting for the significant mean shifts shown in Table 1. m_H is the bandwidth computed using the optimal bandwidth formula by Henry (2001). The 95%-confidence interval of $\hat{d}$ is reported in brackets. For each m, we report a ranking with respect to the estimated inflation persistence. This ranking is only mildly affected by the choice of m.

Table 6. MSE($\tilde{d}$) in Monte Carlo Study: role of m, J and d_0

m, J	1	2	3	4	1	2	3	4
	$d_0 = 0.00$				$d_0 = 0.10$			
$T^{0.60}$	3.71	**3.50**	4.04	5.65	**3.51**	3.79	4.74	7.23
$T^{0.65}$	2.51	**2.48**	2.86	2.77	**2.63**	2.67	3.52	3.60
$T^{0.70}$	2.00	**1.87**	2.13	2.31	1.83	**1.68**	2.16	2.52
$T^{0.75}$	1.45	**1.37**	1.46	1.60	1.44	**1.29**	1.53	1.84
	$d_0 = 0.20$				$d_0 = 0.30$			
$T^{0.60}$	**3.81**	4.24	6.54	11.97	**3.64**	4.99	9.69	20.48
$T^{0.65}$	**2.71**	2.89	4.62	5.51	**2.72**	3.74	7.69	10.67
$T^{0.70}$	**1.95**	2.05	3.38	4.62	**1.85**	2.46	5.08	8.30
$T^{0.75}$	1.67	**1.49**	2.06	3.03	1.61	**1.59**	2.73	4.84
	$d_0 = 0.40$				$d_0 = 0.49$			
$T^{0.60}$	**3.74**	7.45	16.59	36.02	**3.53**	9.97	25.50	58.12
$T^{0.65}$	**2.77**	5.11	12.99	19.39	**2.65**	6.65	19.10	30.02
$T^{0.70}$	**2.05**	3.23	8.24	14.54	**1.92**	3.99	11.78	22.26
$T^{0.75}$	**1.60**	1.66	4.09	8.16	**1.50**	2.20	6.37	13.50

Notes: The table reports the Mean Squared Error (MSE) of $\tilde{d}$ in the Monte Carlo simulation with 1000 replication. The simulated sample consists of 11 time-series of length 115 which are all integrated of order d_0. The MSE for different values of d_0, m and J are reported. Given certain values of m and d_0 but different values of J, the MSE is highlighted which is smallest. We multiplied the MSEs by 1000 for the presentation in this table in order to enhance readability.