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Inflation Differentials  
before and after the EMU

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*Econometrics*

# Inflation Differentials before and after the EMU

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## **Abstract**

This paper examines regional inflation divergence within the European EMU aiming at characterizing the properties of inflation differentials. The empirical evidence suggests that a process of price level convergence in the EMU is well on its way.

*Keywords:* EMU, inflation differentials, economic integration, smooth transition.

*JEL classification:* C52, E31, F15, F36.

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## 1. Introduction

Inflation differentials within a monetary union have seldom received major attention. This has been mainly due to three factors. First, if the aim of a Central Bank (such as in the European Economic and Monetary Union, EMU) is to guarantee price stability for the area as a whole, it is ineffective against possible regional divergences. Second, economic theory states that the creation of a common currency area should lead to a productivity, wage and price convergence<sup>1</sup> (real convergence or *catching-up*). Moreover, inflation differentials within a monetary union can arise also from different national policies, cyclical factors and heterogeneous economic, institutional and financial structures.<sup>2</sup> As a matter of fact the presence of inflation differentials in a new monetary union should be expected but need to be monitored.<sup>3</sup> Reasons for concern do exist: “[...] if one country were to show a sizeable, growing and unsustainable divergence in inflation from the level in other euro area countries [...]” (ECB, 2000) it may decide to quit the Union as a result of its negative evaluation of the consequences that the lack of national monetary independence has on the national economy. Since participation is not mandated by a Constitution (as in the US) this possibility, albeit extreme, is always open.

Aim of this paper is to suggest some empirical tools of analysis illustrating their ability to ascertain not only the presence but also the persistence and stability of regional inflation differentials in the EMU. The main conclusions point to the fact that convergence in price levels among European countries is well on its way.

## 2. Empirical analysis and results

The relationship between the movements of Nominal Exchange Rates (NERs) and prices is so important that the fulfillment of criteria on exchange rate stability and the convergence of inflation rate differentials played a major role in the Treaty on the European Union. For the purpose of this paper, we

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<sup>1</sup>Several theories explain this phenomenon, cf. the Heckscher-Ohlin-Samuelson model, the new growth theory and the Balassa-Samuelson model.

<sup>2</sup>Cf. Hendrikx and Chapple (2002) or European Central Bank –ECB–(1999).

<sup>3</sup>Cf. ECB (1999), (2000), and (2001) and Duisenberg (2000).

will consider annual data on a variable  $\pi_x^*$  defined as

$$\pi_x^* = \pi_x + \Delta e_{DM/cx}$$

where  $\pi_x$  is the inflation rate of a generic country  $x$  (a CPI-based measure) and  $e_{DM/cx}$  is the NER defined as number of Deutsche Marks for one unit of the currency  $cx$  of country  $x$ . The available sample is 1991:01 (post-German unification) to 2002:08 on a monthly basis (OECD-MEI).  $\pi_x^*$  can be seen as the annual rate of change of the price of a national basket converted in Deutsche Marks: we will refer to it as *augmented inflation rate*.<sup>4</sup>

The evolution of the *augmented* inflation rates can be characterized in what concerns the stability of the rates within one country across time (turbulence in the adjustment process) and the position of one country relative to the others (stability of the ranking of the countries with respect to the rates).

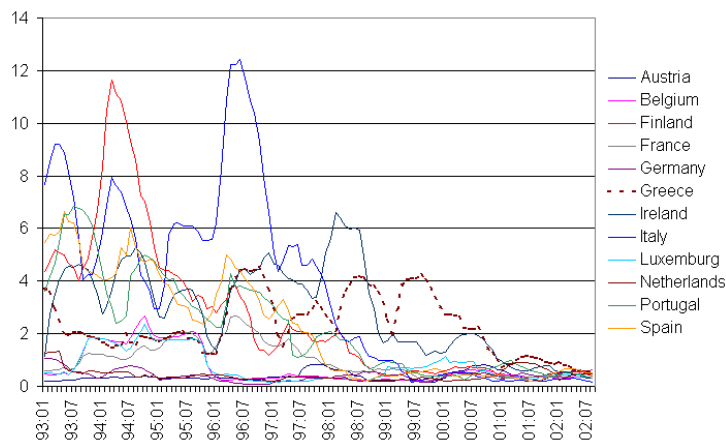


Figure 1: Square root of rolling variances of *augmented* inflation rate differentials computed over a 13-month period

To the first end, we construct a *rolling variance* variable over 13 months (current and previous 12). The series for each country of the current EURO-12 area are reported in Figure 1: the stability of the *augmented* inflation rates is achieved in the latter part of the sample by most countries with a notable exception being constituted by Greece – which in fact joined the EMU at a

<sup>4</sup>A corresponding variable was created using the Harmonized CPIs showing a very similar behavior; the available sample period in this case is shorter (1995:01-2002:08).

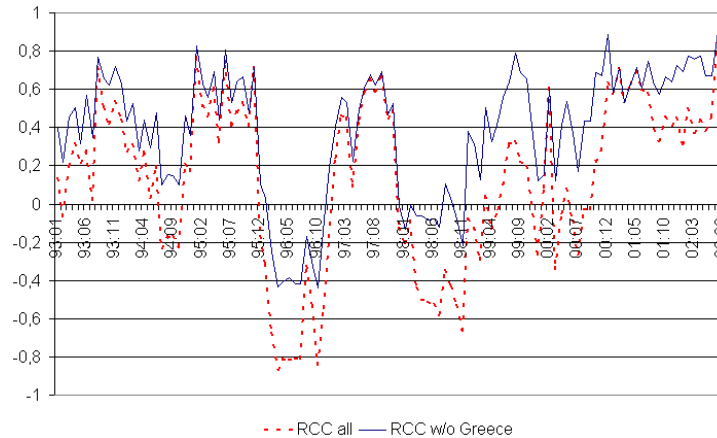


Figure 2: Spearman's Coefficient computed on the differences between current and one-year-lagged rankings of countries relative to *augmented* inflation rates

later time (Jan. 2001). We will therefore conduct the analysis both with and without Greece to highlight this difference in behavior.

In order to address the evolution of the relative position of countries, we can calculate the Spearman's Rank Correlation Coefficient (RCC) on an annual basis.<sup>5</sup> The relevance of this measure is due to the fact that it can give very useful information about the *catching-up* of *price levels*. A necessary condition for the catching-up to take place, indeed, is that the presence and persistence of inflation differentials go along with the persistence in the relative ranks of the inflation rates of EMU countries for a period long enough to complete the phenomenon. In this sense, Figure 2 seems to provide a support to the catching-up theory and to the different behavior induced by the presence of Greece.

As the descriptive analysis conducted so far suggests that the EMU-effect on the convergence of inflation rates probably came to an end before the official beginning of the monetary union, it is of interest to investigate whether there was a sort of *structural break* in some measures of inflation differentials within the euro-area. We have considered here the high-low range (HLR) and

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<sup>5</sup>The RCC has been obtained by comparing the ranks of the inflation rates of EMU countries in a given month with their ranks measured 1-year before (other shorter lags were considered without major changes – the one-year-lag RCC turns to be less sensitive to seasonal effects).

the standard deviation<sup>6</sup> (STD). Both variables are considered including and not including Greece (labelled -all, respectively, -G). Given the confidence we can place in the existence of a change, the methodology proposed by Lin and Teräsvirta (1994, LT) seems to be suitable to determine the nature of the structural change in the series considered, whether it is smooth or changing discretely.

Table 1: Tests for structural change on High-Low Range and on Standard Deviation across countries – Lin and Teräsvirta (1994) tests

Dependent variable	Parameter constancy			Specification hypothesis		
	$LM_1$	$LM_2$	$LM_3$	$H_{0,3}$	$H_{0,2}$	$H_{0,1}$
HLR-all	0.0449	0.0169	0.0109	0.1211	0.0681	0.0449
HLR-G	0.0184	0.0068	0.0081	0.2064	0.0602	0.0184
STD-all	0.0103	0.0125	0.0230	0.3653	0.1721	0.0103
STD-G	0.0146	0.0099	0.0198	0.3818	0.0993	0.0146

P-values of  $LM_1$ ,  $LM_2$ ,  $LM_3$ . Model specification tests are based on AR(5) models for HLR-all and HLR-G and AR(3) models for the STD-all and STD-G. All models include a constant term.

LT consider the Smooth Transition AutoRegressive (STAR) models developed by Teräsvirta (1994) assuming that the transition variable is a function of time. The procedure consists in the identification of an autoregressive linear model for the series analyzed and, then, in a test of constancy on parameters. The test statistics ( $LM_1$ ,  $LM_2$ ,  $LM_3$ ) used to this aim are obtained from auxiliary regressions respectively computed for three different specification of the transition function<sup>7</sup>. In the first three columns of Table 1 the p-values of the  $F$  version of the tests are reported. As expected, the null hypothesis of parameter constancy against smooth transition time-varying parameters is rejected at 5% significance level. The search among the different specifications of the transition function is achieved through a sequence of  $F$ -tests<sup>8</sup> (reported in the last three columns of Table 1). A monotonic

<sup>6</sup>In its unweighted form: one alternative would be to consider weights related to the size of the countries (see ECB, 2000), a perspective not pursued here as it is of lesser interest.

<sup>7</sup>Two different logistic functions - monotonic and non-monotonic - from which the  $LM_1$  and the  $LM_3$  is derived and an exponential function, from which the  $LM_2$  statistic is derived. For details see LT.

<sup>8</sup>For details refer to LT.

logistic function performs better for all the series. The estimated transition functions<sup>9</sup> are reported in Figure 3.

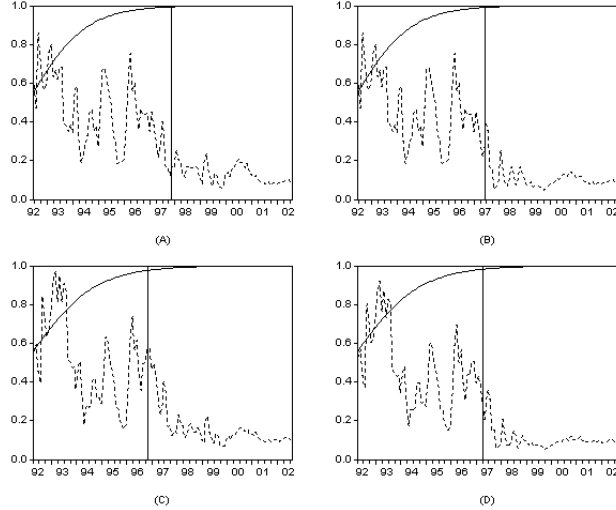


Figure 3: **Structural breakpoints.** In all graphs the dotted line refers to the series (rescaled) considered, the continuous line refers to the estimated transition function, and the vertical line represents the breakpoint found with the Hansen (1997) procedure. Graphs (A), (B), (C), and (D), respectively, refers to : the general range case; the range without Greece case; the general standard deviation case; the standard deviation without Greece case.

The transition to a regime characterized by more stability in the augmented inflation rate (i.e. inflation and exchange rate) seems undoubtedly to have occurred smoothly. Removing Greece from the cross-section strengthens the results as one would expect. Concentrating therefore on the two variables on the pool that excludes Greece (HLR-G and STD-G) we want to ascertain the characteristics of the series in the latter period. With the goal of identifying a suitable sub-sample on which we may conduct stationarity test, we need to decide on a starting period. To avoid arbitrariness (the LT procedure does not allow us to do so), the run of structural break points test (Quandt’s “Sup” test, 1960, and Andrews and Ploberger, 1994 “Exp” and “Ave” tests with p-values computed with Hansen, 1997, procedure – not reported for sake of space) indicate in 1997:06 for HLR-G and in 1997:04 for

<sup>9</sup>All the estimates were performed by GAUSS 3.2 for *Windows*. Results are available from the author upon request.

STD-G. Changing the starting sample period to neighboring months, however, does not have considerable impact on the subsequent results.

The stationarity tests of the series without Greece are reported in Table 2: the conclusion seems that regional inflation differentials in the EMU have reached stability at an early stage, well before the formal introduction of EMU.

Table 2: Unit root tests

Variable	Original Sample	ADF			White Heterosk.♣
		obs	Lags	Intercept	
HLR-G	97:06-02:08	52	10	-2.78*	0.01
STD-G	97:04-02:08	54	10	-2.83*	0.19
Variable	Phillips Perron♠	Uncond. mean	Half-life†	Adj.◇ unc. mean	Adj. half-life
HLR-G	-3.49**	3.62 (PP)	1.33	4.5	2.36
STD-G	-3.83***	1.01 (ADF)	1.27	1.33	2.99

\* We reject the null at 10%. \*\* We reject the null at 5%. \*\*\* We reject the null at 1%. ♣ p-values of the F-statistic reported for the White Heteroskedasticity test. ♠ The p-values reported refer to the test regression with intercept. † The time deviations from the unconditional mean need to halve. ◇ Derived from the autocorrelation coefficients adjusted with Kendall's (1954) formula.

## 4. Conclusions

This paper aims at providing useful elements for the understanding of the characteristics of regional inflation divergence within the EMU. The evidence reported sheds light on several interesting features of the phenomenon. First of all, there is a clear evidence confirming initial intuitions: EMU participation perspectives seemingly had a successful impact on the convergence of inflation rates before the official beginning of the monetary union; Greece has to be excluded from the analysis because it joined to the Union only in 2001. Second, the high-low range series and the standard deviation series in the latter part of the sample have achieved stability. In particular, if the adjusted unconditional means reported in Table 2 are used to make a comparison with the inflation data on 26 areas of United States<sup>10</sup> (mean

<sup>10</sup>Calculated from annual CPI series for the years from 1998 to 2001 available from the



of high-low ranges equal to 3.73 in the US versus 4.5 in the EMU; mean of standard deviation equal to 0.81 in the US versus 1.33 in the EMU), they don't seem to be unreasonably high. Another important conclusion is the evidence of a clear increase in the persistence of the relative ranks of the EMU-countries inflation rates. This last result along with the previous one provides important evidence in favor of the process of price level convergence in the EMU being under way, thus confirming the conclusions achieved in a different framework by Rogers (2001).

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