Assessing Inflation Convergence in the European Union: Does Euro Membership Make a Difference?

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Abstract

This study offers a new perspective on the debate concerning inflation convergence in the Euro Area. A new pair-wise unit root testing procedure advocated by Pesaran (2007) is employed on all possible bivariate consumer price index differentials. Evidence in favour of long-run convergence is confirmed where the fraction of rejections in favour of stationarity exceeds the size of the individual tests. We find evidence of long-run inflation convergence across the EU though the speed of convergence is lower for current non-Euro Area countries.

Keywords: inflation convergence, unit roots, cointegration, pair-wise

JEL Classification: F31, F33, G15

1. Introduction

The convergence of inflation rates among European Union (EU) countries is an important issue for a number of reasons. A view shared among economists is that an adequate degree of structural similarity in real and nominal economic quantities among countries belonging to an optimum currency area or monetary union is required for political and economic stability (see, for example, Fratianni and von Hagen, 1992; Feldstein, 1997; Palomba, Sarno and Zazzaro, 2007). One such indicator is based on the movement of relative prices and inflation rates. In the context of the Euro Area, member countries no longer have the option of nominal exchange rate adjustment as a means of correcting macroeconomic imbalances and so a question arises as to whether relative price competitiveness will be

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restored in the face of macroeconomic shocks. The behavior and stability of national inflation rates has been of key concern for EU policymakers as member countries move towards ever-closer union. The 1992 Maastricht Treaty states that individual members' inflation rates should not be more than 1.5% higher than the average of the three lowest inflation rates in the European Monetary System. More recently, the European Central Bank (ECB) has argued that price stability is guaranteed if the yearly area-wide aggregate inflation rate (in terms of the harmonized index of consumer prices) is below, but close to, 2% over the medium term. Embodied in these conditions is the desire for inflation convergence among member states.

The early studies by Hall, Robertson and Wickens (1992), Koedijk and Kool (1992), Caporale and Pittis (1993), Thom (1995), Holmes (1998) and others provided some evidence that the Exchange Rate Mechanism (ERM) – a forerunner of moves towards a single currency – facilitated convergence in EU inflation rates, though with limited evidence in favor of German leadership determining EU inflation rates. While studies such as Kocenda and Papell (1997) provide strong evidence in favor of inflation convergence among those ERM members that did not deviate from mechanism, more recent work has suggested that inflation differentials have shown a divergent behavior and heterogeneity in persistence at country and regional level after the birth of the Euro in 1999 (Mentz and Sebastian, 2003; Beck, Hubrich and Marcellino, 2006; Busetti et al., 2007).

This main purpose of this paper is to examine long-run inflation convergence among the current twenty seven EU members over the period January 1999 onwards. Of the current EU membership, sixteen countries are members of the Euro Area. While the remaining eleven EU countries remain outside of the Euro Area, many of these harbor wishes to join the single currency. If inflation convergence is regarded as a desirable attribute for a prospective Euro Area member, then it is of interest to assess and compare and contrast the nature of inflation convergence for the Euro Area and the wider EU grouping. Indeed, a particular issue that this study addresses is whether long-run inflation convergence is greater or weaker when these two groupings are considered. Weaker (stronger) evidence of inflation convergence for the full sample of EU members might be used as a case against (for) Euro Area expansion. A priori, one might expect inflation convergence to be greater for the Euro Area countries as they strive to comply with the stability and growth pact while subject to a common monetary policy implemented by the ECB. However, limitations in terms of wage and price flexibility and labor mobility may work against inflation convergence.

The key contribution of this study to the literature is based on the application of a novel econometric approach advocated by Pesaran (2007) in testing for

convergence where a probabilistic definition of convergence is proposed. For N countries, unit root tests are conducted on $N(N-1)/2$ country-pair price differentials. Under the null hypothesis of non-stationarity or non-convergence in each unit root test, one would normally expect the fraction of price differentials for which the unit-root hypothesis is rejected to be close to the size of the underlying unit-root test (α). However, Pesaran (2007) argues that the null of non--stationarity for all country pairs can be rejected if the fraction of rejections exceeds α. This test is applicable when N is large relative to T (the time dimension of the panel). Although the underlying individual unit-root tests are not cross--sectionally independent, under the null of non-convergence (or divergence) it can be shown that the fraction of the rejections converges to α, as $N,T \to \infty$. In contrast to the existing literature on inflation convergence, this approach is compatible with the individual price series having unit roots, or other non-stationary common components and does not involve what can be a problematic choice of a single reference or base country in the computation of price differentials.

The paper is organised as follows. The following section offers more detail on the econometric methodology. The third section discusses the data and reports the results. For a dataset comprising the 16 Euro Area countries, the fraction of rejections exceeds the size of the ADF unit root tests that are employed thereby suggesting that long-run convergence is present across the Euro countries. The final section concludes.

2. Recent Literature

In light of the achievement of the Maastricht criteria, the fixing of Euro Area exchange rates in 1998 and the introduction of the Euro for interbank payment services in January 1999, one would expect Euro Area inflation rates to have converged during the period immediately preceding the advent of the Euro. This expectation is confirmed by numerous studies, including Rogers, Hufbauer and Wada (2001), Engel and Rogers (2004), Weber and Beck (2005), Busetti et al. (2007), and Rogers (2007), which agree that prices were less dispersed and inflation rates among Euro Area countries converged in the mid – 1990s. In contrast, research investigating the post-1998 period, including ECB (2003), Engel and Rogers (2004), Weber and Beck (2005), Busetti et al. (2007), Rogers (2007) and Fritsche and Kuzin (2008) conclude that the advent of the single currency resulted in the weakening of inflation convergence among the Euro Area countries and in an increase in their price dispersion. Notable exceptions to this include Honohan and Lane (2003), who report sharp convergence in inflation rates since 2002, and Lopez and Papell (2008).

In many of the above studies, the presence of mean-reversion in inflation differentials, usually defined against a base country such as Germany, has been used as an indicator of long-run consistency with the Maastricht and ECB requirements regarding inflation convergence. However, univariate unit root testing has provided mixed conclusions leading researchers to consider the application of panel data unit root testing as a means of overcoming low test power where studies are unable to reject a non-stationary null. For example, Busetti et al. (2007) study the convergence properties of inflation rates among the countries of the European Monetary Union (EMU) over the period 1980 – 2004 using ADF (Augmented Dickey-Fuller) unit root and KPSS stationarity testing. They accept the convergence hypothesis over the period 1980 – 1997, but find evidence of diverging behaviour over the period 1997 – 2004. In an attempt to enhance test power, Lopez and Papell (2008) employ a seemingly unrelated regression ADF approach and find strong evidence of inflation convergence soon after the implementation of the Maastricht treaty with a dramatic decrease in the persistence of the differential after the occurrence of the single currency.

Other attempts at employing panel data methods provide mixed conclusions. For example, Funke and Koske (2007) employ a range of tests, that includes Maddala and Wu (1999), Levin, Lin and Chu (2002), and Im, Pesaran and Shin (2003), of the law of one price. Using disaggregated consumer price data, they find evidence of price convergence for about 70% of all product groups. Although their results are sensitive to the choice of the numeraire country, they conclude that the law of one price is weaker among newer EU member countries than in more established members. Fischer (2007) applies panel unit root and cointegration tests to three measures of international price competitiveness for EMU countries and finds mixed evidence on whether or not competitiveness has converged. A caveat attached to most of the panel data studies is that there is no allowance for structural breaks in the data. Drine and Rault (2006), however, consider inflation convergence between the Euro Zone and its CEE (Central and Eastern Europe) partners is using panel data LM tests that incorporate structural shifts. They find strong rejections of the unit root hypothesis in the East--European countries for the 1995 – 2000 period. In an earlier paper, Pesaran et al. (2006) apply the pair-wise technique to a disaggregated price data for 19 commodity groups over an early study period 1981 – 1995 and find evidence in favour of PPP (Purchasing power parity). This study extends this work of Pesaran et al. (2006) in a number of important ways. First, the study period is focussed on the Euro era. Second, as discussed below, this study employs data for the harmonised consumer price index. This data series is a consistent price measure across EU members.

3. Methodology

When evaluating the degree of long-run convergence, cointegration itself is necessary, but not sufficient, for convergence if the underlying series are trend stationary. Long-run convergence requires the country price series be co-trended, in addition to being cointegrated with the cointegrating vector of the form (1, –1). The interest in this study is in stationarity of relative price indices and therefore a stronger notion of long-run convergence characterized as cointegration accompanied by a long-run unity coefficient. For any two log price series p_i and p_j, there is long-run convergence if the price differential $d_{ij} = p_i - p_j$ is a stationary series with a constant mean. To begin with, non-stationarity or non-convergence is tested for using an ADF regression with a constant and linear trend

$$\Delta d_{ijt} = \alpha_{ij} + \beta_{ij} d_{ij,t-1} + \gamma_{ij}\left(g_i - g_j\right)t + \sum_{s=1}^{l_{ij}} \delta_{ijs} \Delta d_{t-s} + \upsilon_{ijt} \qquad (1)$$

where g_i, g_j refer to the deterministic trends present in the individual price series, and the lag length l is determined according to the SIC or AIC. Where the non-stationary null is rejected, there then follows an assessment of the hypothesis $g_i - g_j = 0$ which implies that p_i, p_j may be co-trended, but $p_i - p_j$ is not trended.

To analyse price convergence across a large number of countries without being subject to the pitfalls that surround the use of price differentials measured relative to a particular chosen benchmark, it is possible to analyse the unit-root and trending properties of all $N(N-1)/2$ possible price differentials. While existing studies of inflation convergence has usually opted for Germany in choosing a single base or benchmark inflation rate, Funke and Koske (2007) highlight the sensitivity of their convergence results to the choice of benchmark inflation rate. Certainly, one could argue that cointegration is a transitive concept where stationarity of all national price differentials with respect to a common base country implies stationarity of all price indices with respect to each other. However, Ferré (2004) demonstrates that two variables, *Y* and *Z*, may each be cointegrated with a common stochastic trend, *W*, but standard tests reject cointegration of *Y* and *Z*. This paradoxical result is due to an interplay of the error terms of the relationships between the variables that affects the power of the standard test (specifically, in Ferré's case, of the Johansen cointegration trace test).[1]

[1] Further discussion on why the transitivity argument can break down is provided by Alexander and Barrow (1994).

Putting aside the issue of choosing a reference country, the pair-wise procedure offers further advantages over existing tests for convergence. In investigating the number of common shared trends driving national price indices, the Johansen (1988) maximum likelihood procedure and the Stock and Watson (1988) common trend framework would require the estimation of a complete vector autoregression system (VAR) for all 16 Euro Area members. The size and power of this test is can be compromised if the VAR is constrained to an unreasonably low order on account of data limitations. This pair-wise procedure avoids the need for an entire sequence of tests for the stationarity of a multivariate system. As indicated by Snell (1996), even if each test in the sequence had a reasonable chance of rejecting the false null, the procedure as a whole is will have low power.

4. Data and Estimation

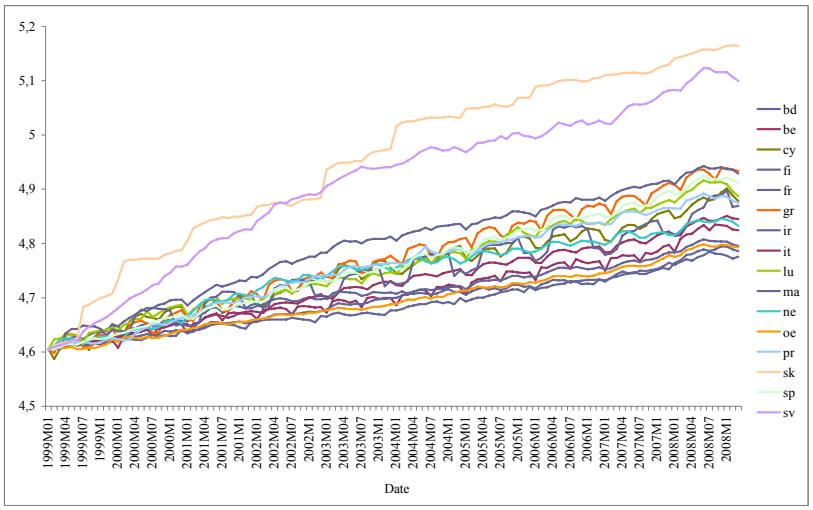
The data examined are monthly observations on the natural logarithm of the harmonized consumer price index for the current 16 Euro Zone countries which are Austria (OE), Belgium (BE), Cyprus (CY), Germany (BD), Spain (SP), Finland (FI), France (FR), Greece (GR), Ireland (IR), Italy (IT), Luxembourg (LU), Malta (MA), Netherlands (NE), Portugal (PR), Slovenia (SV) and Slovakia (SK). In addition to this, the study considers the remaining 11 EU members that are not currently part of the Euro Area namely, Bulgaria (BU), Czech Republic (CZ), Denmark (DE), Estonia (ES), Hungary (HU), Lithuania (LI), Latvia (LA), Poland (PO), Romania (RO), Sweden (SW) and the United Kingdom (UK)). The study period covers January 1999 to December 2008. The start date coincides with the introduction of the Euro for interbank payment purposes and follows November 1998 when Euro members irrevocably fixed their nominal exchange rates for the period leading up to the introduction of the Euro in cash form in January 2002.

Figures 1 and 2 present the log price level data for the Euro Area and non--Euro Area countries over the period January 1999 onwards and highlights both the variation in price levels along with signs of a general upward trend over time. Figures 3 and 4 present data on inflation rates. For both Euro and non-Euro Area countries, there is visual evidence that inflation rates have converged over the period of study. In this investigation, the use of differentials based on log price indices means that a test for a unit root in a log price differential is in fact a test for a unit root in the change in the log price index from base period. This is because the price indices contain base periods where the prices in any two countries could be equal by construction. Therefore, a rejection of non-stationarity is

consistent with mean reversion in inflation differentials and inflation convergence. Furthermore, given the absence of nominal exchange rate adjustment among Euro Area members, a rejection of non-stationarity is also consistent with relative long-run purchasing power parity.

F i g u r e 1

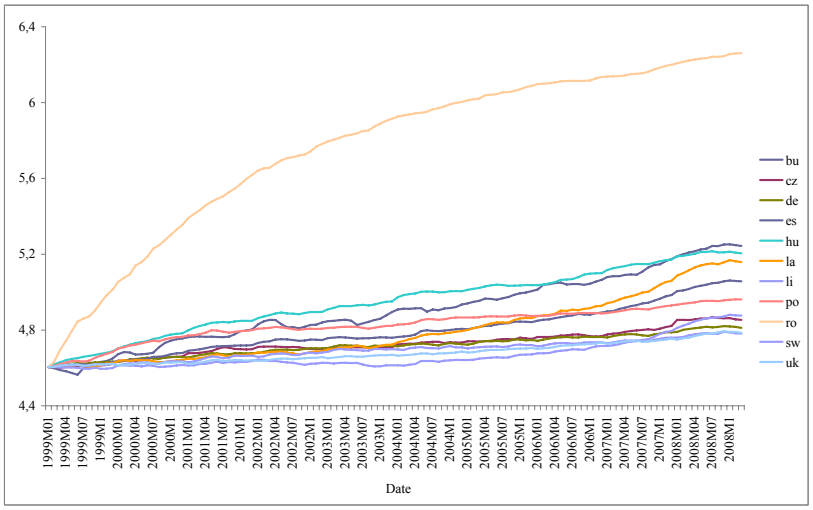
Log Harmonised Consumer Price Indices for Euro Members



Source: European Commission: <http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/introduction>.

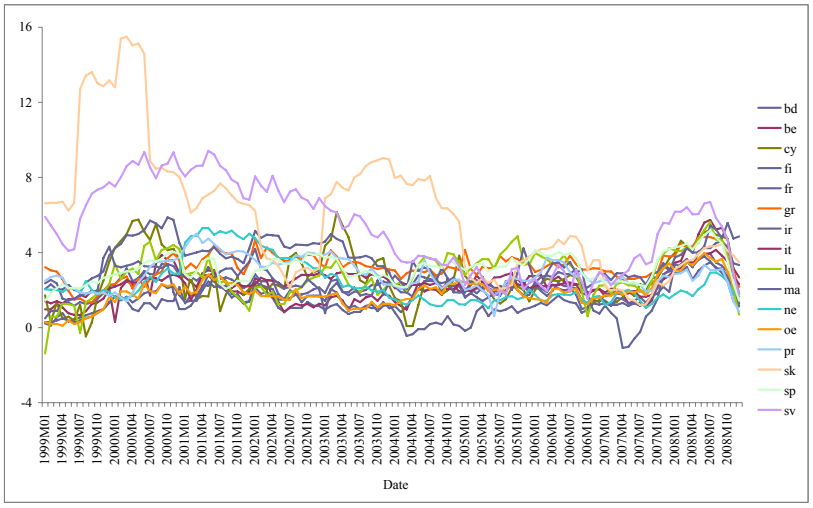
F i g u r e 2

Log Harmonised Consumer Price Indices for Non-Euro Members



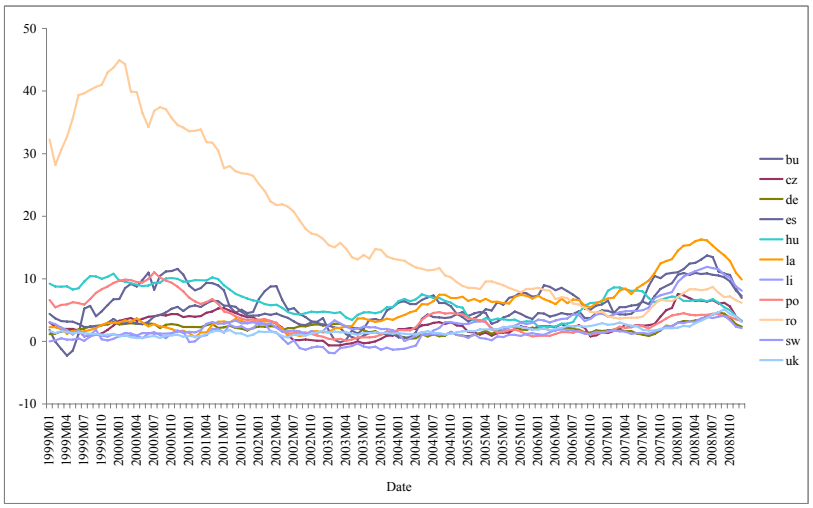
Source: European Commission: <http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/introduction>.

F i g u r e 3
Annual Inflation Rates for Euro Members



Source: Calculations based on data displayed in Figure 1.

F i g u r e 4
Annual Inflation Rates for Non-Euro Members



Source: Calculations based on data displayed in Figure 2.

Five groupings of EU countries are considered. These are the current 16 members of the Euro. For a basis of comparison, a second group is considered comprising the current 27 EU members Euro. A third grouping comprises the 6 countries that, prior to the creation of the Euro, comprised the D-Mark bloc

countries namely, OE, BE, BD, FI, NE, and DE. This grouping follows the spirit of earlier work such by De Grauwe (1989) and Herz and Roger (1992). A fourth grouping comprises the initial 12 members of the Euro Zone namely, OE, BE, BD, SP, FI, FR, GR, IR, IT, LU, NE and PR. Finally, there is a group comprising the 5 Euro members who joined the single currency after its outset namely, CP, GR, MA, SV and SK

The employment of data for 16 Euro Area countries means that unit root tests are conducted for 120 bivariate country pairs. Table 1 reports the findings from the pair-wise unit root tests based on equation (1). Using the AIC for lag length selection, the percentages of rejections are 19.2, 14.2 and 5% for unit root tests run at the 10, 5 and 1% significance levels respectively. Using the SIC, the percentages of rejections are greater. While these initial results indicate that the fraction of the rejections exceeds the size of the underlying unit-root tests and supports long-run trend-stationarity of inflation differentials in the Euro Area, it should be remembered that the individual ADF regressions are based on the inclusion of a deterministic trend. These results therefore offer only limited support for long-run inflation convergence because it is possible that the individual log price series still may be drifting apart over time. A more relevant question for inflation convergence is whether or not the individual log price series are co-trended. To investigate this, a co-trending restriction $g_i = g_j$ can be imposed on equation (1) and the pair-wise test re-run. If the linear deterministic trend is excluded from the ADF regressions, Table 1 reports that the percentage of rejections equals 32.5, 27.5 and 15.8% (AIC) and 35.8, 27.5 and 17.5% (SIC) for unit root tests at the 10, 5 and 1% significance levels respectively. Again, support is offered for long-run inflation convergence among Euro members but on the basis of mean- rather than trend-reversion.

We may now extend the analysis to examine a panel comprising all current 27 EU members which provides an analysis of 351 bivariate pairs. Excluding a deterministic time trend from the individual ADF regressions, one can see that the percentage of rejections exceeds the size of the individual tests at all significance levels thereby confirming long-run price convergence both within and outside the Euro Area. Against a background of stationarity, it is of interest to consider the half-life of deviations from long-run equilibrium. For Euro Area countries, Table 1 reports that the approximated half-life is 11.4 – 12.9 months. This calculation is considerably less than the 3 – 5 years half-life that has been suggested by Rogoff (1996) as well as the calculation of 19 – 19.7 months for the full sample of EU members.[2] The slower speed of adjustment that characterises

[2] The half-life is approximated using the average value of β_{ij} ($\bar{\beta}$): $HL = \left(\ln 0.5\right) \Big/ \ln\left(\bar{\beta}_{ij} + 1\right)$.

the full sample of 27 EU members is most probably reflective of the inclusion of non-Euro countries in the sample. Nonetheless, the analysis here suggests that the speed of adjustment is faster than studies such as Cihak and Holub (2005) who find that it may take about 10 – 25 years for new EU countries to converge to that of the more-established EU members. For Euro members, the results here are consistent with Funke and Koske (2007) who compute a half-life of about two years using disaggregated data.

T a b l e 1

Pair-wise Tests for Price Convergence

Dataset (ADF regression type)	*N*	*N*(*N* – 1)/2	10%	5%	1%	*HL*
Current Euro members (trend)						
SIC	16	120	20.833	16.667	10.000	3.806
AIC	16	120	19.167	14.167	5.000	3.965
Current Euro members (no trend)						
SIC	16	120	35.833	27.500	17.500	11.404
AIC	16	120	32.500	27.500	15.833	12.929
Current EU members (no trend)						
BIC	27	351	33.618	28.490	20.798	19.020
AIC	27	351	32.194	26.496	19.088	19.683
D-Mark Bloc (no trend)						
SIC	6	15	26.667	6.667	6.667	11.253
AIC	6	15	20.000	6.667	6.667	13.249
EMU-12 (no trend)						
SIC	12	66	13.636	7.576	1.515	18.593
AIC	12	66	12.121	9.091	3.030	19.537
Late Euro entrants (no trend)						
SIC	5	10	60.000	50.000	40.000	6.612
AIC	5	10	70.000	60.000	30.000	7.818

Notes: Estimation is for January 1999 to December 2008 inclusive providing 120 observations. *N* refers to the number of time series, *N*(*N* – 1)/2 refers to the number of bivariate pairs that can be computed from each data-set upon which ADF unit root tests are conducted, SIC and AIC refer to the information criteria used to select the optimal lag lengths in the individual ADF regressions, the data below the columns headed 10, 5 and 1% are the percentage of rejections of the unit root null hypothesis at each given test size and *HL* refers to the average approximated half-life of shocks from long-run equilibrium.

Source: All estimates are based on harmonised consumer price indices obtained from the European Commission <http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/introduction>.

Further analysis of the other groupings of countries provides some additional insights. An examination of the initial EMU-12 countries also provides supportive evidence in favour of inflation convergence. In this case, the half-lives are of the order 18.6 – 19.5 months which is greater than the approximation for the current 16 Euro Area members. If we then consider the sample comprising late Euro Area entrants, there is also evidence of inflation convergence but with half-lives of the order 6.6 – 7.8 months. This implies that addition of the late entrants to the Euro Area has served to facilitate inflation convergence and increase the speed

of adjustment towards long-run inflation in the Euro Area. This result might be seen in the context of Kocenda, Kutan and Yigit (2006) who find significant inflation and interest rate convergence of recent EU members with respect to EU standards, especially during the post-Euro period. However, this finding is in contrast to studies such as Fidrmuc and Korhonen (2003) who find convergence of GDP growth rates, inflation, and business cycles only for a small subgroup of the Euro Area. This is also in contrast to earlier studies such as Janackova (2000), Richards and Tersman (1996), and Backe et al. (2003) who investigate price--level convergence between the EU and the transition-economy candidates and find evidence of weak price-level convergence only. Other relevant studies include Kocenda (2001), Kutan and Yigit (2004; 2005), and Brada, Kutan and Zhu (2005) who study both nominal and real convergence. While Kocenda (2001) and, to a lesser degree, Kutan and Yigit (2004) find evidence of real and monetary convergence, Kutan and Yigit (2005) observe that price and monetary convergence of the new EU members to the core EU standards is quite idiosyncratic. Finally, Table 1 reports results for the D-Mark Bloc. The evidence here suggests that these countries have been characterised by long-run inflation convergence to the extent that the percentage of rejections of non-stationarity is larger than for the EMU-12 with a faster speed of adjustment.

Overall, these results indicate that long-run inflation convergence is not specific to the initial Euro Area membership. Indeed, the results here suggest that those countries that were late entrants to the Euro Area and those countries that were seen as D-Mark bloc members may actually offer stronger evidence of long-run inflation convergence with a faster speed of adjustment towards long--run equilibrium. In terms of policy regarding the recent admission of new entrants into the Euro Area, these findings suggest that fears based on inflation divergence with implications for defining appropriate monetary policy have so far been unfounded. However, while the more recent entrants into the Euro Area actually exhibit a faster speed adjustment towards long-run inflation equilibrium, it is likely that the admission of further entrants from within the EU may slow down the speed of long-run inflation convergence. In the face of macroeconomic shocks affecting an expanded Euro Area, the findings here suggest that policymakers will need to acknowledge a slower rate at which price competitiveness within the Euro Area is restored.

Conclusion

Using a methodology based on the pair-wise unit root testing of log price differentials over the Euro period, this paper finds support for inflation convergence insofar as the proportion of rejections of non-stationarity exceeds the size of the

individual tests. This implies that in a probabilistic sense, European Union national inflation rates exhibit long-run convergence and behave consistently with the objectives of the European Central Bank. This finding applies to Euro Area members as well as the full set of current EU members. While the results here suggest that Euro Area membership makes a difference insofar as the speed of adjustment towards long-run equilibrium is fastest in the case of these countries, the admission of further countries into the Euro Area is likely to slow the speed of adjustment down quite considerably. This suggests that ECB policymakers may need to be more wary of the differential speeds at which Euro Area members respond to common shocks.

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