ESTUDIOS SOBRE LA ECONOMIA ESPAÑOLA

Instability in cointegration regressions: Evidence from inflation rate convergence in EU countries

Simon Sosvilla-Rivero

Irene Olloqui

EEE 53

INSTABILITY IN COINTEGRATION REGRESSIONS:
EVIDENCE FROM INFLATION RATE CONVERGENCE IN EU COUNTRIES*

Simón Sosvilla-Rivero
(FEDEA and Universidad Complutense de Madrid)
Irene Olloqui
(FEDEA and Universidad de Zaragoza)

July 1999

ABSTRACT

We use cointegration tests that determine endogenously the regime shift to test for bilateral inflation rate convergence in the European Countries in the 1961-1997 period. When applying cointegration tests that do not allow for structural breaks, only for seven of the fourteen countries examined we find evidence of a long run relationship between their inflation rates and the German inflation rate. In contrast, our innovative approach provides strong evidence in favour of such relationship for all countries, except for Greece and Portugal.

JEL classification numbers: C22, E31, F15

KEY WORDS: Inflation, Cointegration, Structural change

* Corresponding author:
Dr. Simon Sosvilla-Rivero
FEDEA
Jorge Juan, 46
28001 Madrid
Spain
Phone: +34 914 350 401
Fax: +34 915 779 575
E-mail: simon.sosvilla@fedea.es

1. Introduction

The question of whether inflation rates are linked across countries has important implications on the interdependence of domestic monetary policies, the validity of purchasing power parity, etc. Unsurprisingly, the search for the answer has registered a renewed interest in the eve of monetary integration in the European Union (UE).

The aim of this paper is to contribute to this growing literature by offering further evidence on short-run and long-run relationships between inflation rates in the EU countries. To that end, and in contrast with previously published papers, we make use of recently-developed cointegration techniques that allow for structural shifts in the cointegration vector. These shifts could be due to changes in the *modus operandi* of the monetary policy, institutional changes, etc.

We think that our paper is interesting from the methodological point of view, since economists are becoming more aware of the importance that structural changes can have on their analysis when searching for simple and interpretable models to describe the fundamentals of economic relationships. In this sense, this paper could illustrate how the formal consideration (through adequate statistical procedures) of eventual structural breaks may be useful for a more correct specification of an econometric model. The emphasis is on linear regression models with cointegrated variables, since conventional cointegration tests do not allow for changes in regime and might lead to biases tests for the null hypothesis of no cointegration in favour of acceptance.

We use data for the fifteen EU countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. The inflation rates are constructed using the Consumer Price Index (CPI). The data are annual and cover the 1961-1997 period. They are taken from the OECD Statistical Compendium on CD-ROM. Given the central role of Germany in the UE [see, e. g. , Herz y Roger (1992) and Bajo-Rubio, Sosvilla-Rivero and Fernández-Rodríguez. (1997)], we focus on analysing the bilateral relationship between the inflation rates of these countries and the German inflation rate.

The paper is organised as follows. In Section 2 we present the results of applying the conventional cointegration analysis, while in Section 3 we report the results obtaining when considering structural breaks. Finally, Section 4 summarizes our conclusions.

2. Cointegration tests without structural breaks

According to Granger Representation Theorem (see, Engel and Granger, 1989), a cointegrated system of variables can be represented as an Error Correction Model (ECM), and *viceversa*. As suggested by Kremers, Ericsson and Dolado (1992), we can use this relationship as a robust alternative test for cointegration to the traditional residual based tests for cointegration. After determining the order of integration of the variables¹, we follow Banerjee, Dolado and Mestre (1998) and model simultaneously the short-run and long-run adjustment processes, testing the statistical significance of the error correction coefficient λ in the ECM

¹ We applied the unit root tests proposed in Phillips and Perron (1988). The results (not shown here, but available from the authors upon request) allow us to conclude that all series are I(1).

representation:

$$\Delta \pi_t = \sum_{i=0}^k \varphi_i \Delta \pi_{t-i}^* + \lambda [\pi_{t-1} - \beta \pi_{t-1}^*] + \epsilon_t \quad (1)$$

where π_t is the domestic inflation rate and π_t^* is the German inflation rate². Results of estimating equation (1) using nonlinear least squares (NLS) are reported in Table 1³. As can be seen, for Austria, Belgium, Finland, Italy, Luxemburg, the Netherlands and Spain the null hypothesis of no error correction is rejected, suggesting a long run relationship between the inflation rates of these countries and Germany. In contrast, for the remainder countries (Denmark, France, Greece, Ireland, Portugal, Sweden and the United Kingdom) we do not find such relationship⁴.

Finally, we also report some diagnostic test for normality, first-order autoregressive conditional heteroscedasticity, and fourth-order residual autocorrelation (N, ARCH and LM, respectively), which do not show any sign of misspecification, except for the absence of normality in the cases of Belgium, France, Italy, Spain and Sweden that could be indicating eventual structural breaks.

3. Cointegration tests with structural breaks

Gregory and Hansen (1996) generalized the usual residual based cointegration tests, allowing for a broader view of cointegration when they consider an alternative hypothesis in which the cointegration vector suffers shift at an unknown time. The results of applying this test allowing up to two structural breaks (not shown here, but available from the authors upon request) suggest the existence of several structural breaks.

As in the previous section, we test for cointegration using the ECM representation, this time adapted for the presence of structural breaks:

$$\Delta \pi_t = \sum_{i=0}^k \varphi_i \Delta \pi_{t-i}^* + \delta_1 D(TB1)_t + \delta_2 D(TB2)_t + \lambda [\pi_{t-1} - \beta_1 \pi_{t-1}^* - \beta_2 DUI_{t-1} - \beta_3 DU2_{t-1}] + \epsilon_t \quad (2)$$

² Note that there is not a drift in the long-run relationship, since it was never significant in a cointegrating regression when applying the fully-modified Wald test proposed in Phillips and Hansen (1990).

³ Simulation experiments in Phillips and Loretan (1991) and Inder (1993) show that this one-step estimation technique performs better than the Engel-Granger (1986) two-step method.

⁴ Similar results were obtained using the three-step ECM procedure suggested by Engle and Yoo (1991) (see, Olloqui and Sosvilla-Rivero, 1999).

where TBi denotes the break date ($i=1,2$) detected by the Gregory and Hansen test, $DUI_t = 1$ if $t > TBi$ and 0 otherwise, and $D(TBi)_t$ represents an impulse variable that takes the value 1 if $t = TBi + 1$. Results of NLS estimations of equation (2) are reported in Table 2. As can be seen, now for all countries, except for Greece and Portugal, we find evidence of a long run relationship between their inflation rates and the German inflation rate⁵. Note also that the diagnostic tests indicate that the estimated equations represent the data-generating process reasonably well.

Finally, it should be notice that if we do not consider the possibility of structural breaks, the results in the last column of Table 1 would suggest that there has not been long-run convergence in inflation rates, as the hypothesis of a cointegrating vector (1, -1) is rejected for all countries. In contrast, as shown in the last column of Table 2, if we consider structural breaks, the null hypothesis of the sum of coefficients in the long run relationship is equal to one is not rejected in all countries, except Greece, therefore suggesting that here has been long-run convergence in inflation rates in the last part of the sample.

4. Concluding remarks

In this paper we have provided some new evidence on the relationship between inflation rates in the EU countries, using annual data on CPI covering the 1961-1997 period. We depart from previously published papers by making use of recently-developed cointegration techniques that allow for structural shifts in the cointegration vector.

Our results suggest that, if we apply cointegration tests without structural breaks, only for seven of the fourteen countries examined (Austria, Belgium, Finland, Italy, Luxemburg, the Netherlands and Spain) we find evidence of a long run relationship between their inflation rates and the German inflation rate. In contrast, if we introduce the possibility of structural breaks, we find evidence of such relationship for all countries, except Greece and Portugal.

Therefore, we have illustrated how the formal consideration (through adequate statistical procedures) of eventual structural breaks may be useful for a more correct specification of an econometric model.

⁵ Again, similar results were obtained using the three-step ECM procedure suggested by Engle and Yoo (1991) (see, Olloqui and Sosvilla-Rivero, 1999).

References

- Bajo-Rubio, O., Sosvilla-Rivero, S. and F. Fernández-Rodríguez, 1997, Asymmetry in the EMS: New evidence based on non-linear forecasts, Working Paper 97-24, FEDEA, Madrid.
- Banerjee, A., Dolado, J. J. and R. Mestre, 1998, Error-correction mechanism tests for cointegration in a single-equation framework, *Journal of Time Series Analysis* 19, 267-283.
- Engle, R. F. and B. S. Yoo, 1991, Cointegrated economic time series: An overview with new results, in: R. F. Engle and C. W. J. Granger, eds., *Long-run economic relationships* (Oxford University Press, Oxford) 237-266.
- Gregory, A. W. and B. E. Hansen, 1996, Residual-based test for cointegration in models with regime shifts, *Journal of Econometrics* 70, 99-126.
- Herz, B. and W. Roger, 1992, The EMS is a greater Deutschemark area, *European Economic Review* 36, 1413-1425.
- Inder, B., 1993, Estimating long-run relationships in economics: A comparison of different approaches, *Journal of Econometrics* 57, 53-68.
- Kremers, J. J. M., N. R. Ericsson, and J. J. Dolado, The power of cointegration test, *Oxford Bulletin of Economics and Statistics*, Vol. 54, 325-348.
- Olloqui, I. and S. Sosvilla-Rivero, 1999, Testing inflation rate convergence in EU countries, mimeo, FEDEA, Madrid.
- Phillips, P. C. B. and B. E. Hansen, 1990, Statistical inference in instrumental variables regression with $I(1)$ processes, *Review of Economic Studies* 57, 99-125.
- Phillips, P. C. B. and M. Loretan, 1991, Estimating long-run economic equilibria, *Review of Economic Studies* 58, 407-436.
- Phillips, P. C. B. and P. Perron, 1988, Testing for a unit root in time series regression, *Biometrika* 75, 335-346.

Table 1: One-step estimation of the ECM without structural change

Country	φ	λ	β	R^2	DW	LM(4)	N(2)	ARCH	F($\beta=1$)
Austria	0.60 (3.85)	-0.68 (-4.74)	1.19 (18.06)	0.75	2.28	1.28 (0.30)	0.1	2.51 (0.13)	8.36 (0.01)
Belgium	0.48 (2.60)	-0.43 (-4.32)	1.43 (11.21)	0.83	1.54	0.85 (0.50)	21	0.07 (0.80)	11.44 (0.00)
Denmark	0.60 (2.11)	-0.25 (-2.35)	1.74 (5.33)	0.7	2.21	0.44 (0.77)	0.3	2.70 (0.11)	5.12 (0.03)
Finland	0.64 (1.89)	-0.36 (-3.18)	1.98 (7.03)	0.72	1.7	0.81 (0.53)	0.6	1.29 (0.26)	12.10 (0.00)
France	0.66 (2.93)	-0.19 (-2.25)	1.77 (5.23)	0.85	1.78	0.59 (0.67)	22	0.01 (0.95)	5.20 (0.03)
Greece	1.16 (2.18)	-0.16 (-2.13)	3.67 (3.59)	0.78	1.97	1.45 (0.24)	2.4	1.68 (0.20)	6.81 (0.01)
Ireland	0.96 (2.64)	-0.26 (-2.57)	2.37 (5.73)	0.82	1.66	0.78 (0.55)	2.3	5.57 (0.02)	10.96 (0.00)
Italy	0.99 (3.04)	-0.23 (-2.80)	2.65 (6.26)	0.8	1.88	6.24 (0.16)	14	0.06 (0.80)	15.22 (0.00)
Luxemburgo	0.58 (3.61)	-0.42 (-4.08)	1.30 (11.57)	0.8	1.98	0.76 (0.56)	1	0.03 (0.85)	7.15 (0.01)
Netherlands	0.76 (3.59)	-0.50 (-3.62)	1.29 (10.40)	0.74	2.29	1.37 (0.27)	4.9	2.57 (0.12)	5.37 (0.03)
Portugal	0.49 (0.87)	-0.25 (-3.05)	3.65 (5.33)	0.77	2.3	0.64 (0.64)	13.6	0.59 (0.45)	14.97 (0.00)
Spain	0.47 (1.29)	-0.26 (-3.15)	2.73 (6.64)	0.78	2.24	0.80 (0.54)	13	0.49 (0.49)	17.74 (0.00)
Sweden	0.64 (1.91)	-0.31 (-2.53)	1.72 (5.65)	0.57	2.13	5.57 (0.68)	8.6	1.01 (0.32)	5.60 (0.02)
United Kingdom	1.16 (2.69)	-0.30 (-2.44)	2.37 (5.73)	0.69	1.73	10.1 (0.41)	3.5	1.92 (0.17)	6.54 (0.02)

Note: This table shows the estimation of equation (1) in the text, with t-ratio in parenthesis. The critical value for the t-statistic for λ is - 2,60 at the 5% level of significance (Banerjee *et al.*, 1998). N(2) is the Jarque-Bera test for normality, distributed as $\chi^2(2)$. LM(4) is the Breusch Godfrey test for fourth-order autocorrelation, ARCH is the Engle test for first-order ARCH and F($\beta=1$) is a test for the restriction $\beta=1$ (p-values for these tests are in parenthesis).

Table 2: One-step estimation of the ECM with structural change

Country	TB1	TB2	φ	δ_1	δ_2	λ	β_1	β_2	β_3	R ²	DW	LM(4)	N(2)	Arch	F($\Sigma \beta_i = 1$)
Austria	1979		0.54 (3.65)			-0.77 (-5.57)	1.30 (18.70)	-0.28 (-2.50)		0.79	2.32	1.48 (0.23)	3.46	0.24 (0.63)	0.02 (0.89)
Belgium	1972	1989	0.50 (3.27)			-0.70 (-7.13)	1.18 (9.63)	0.46 (3.10)	-0.90 (-5.44)	0.90	1.67	0.57 (0.69)	0.41	0.36 (0.55)	3.05 (0.09)
Denmark	1974 c	1989	0.73 (2.73)	-0.05 (-2.56)		-0.47 (-3.37)	2.10 (12.07)		-1.45 (-3.69)	0.83	1.95	0.44 (0.77)	0.25	0.01 (0.98)	0.98 (0.33)
Finland		1991	0.57 (1.75)		-0.04 (-1.95)	-0.56 (4.68)	2.16 (12.61)	-1.68 (-3.33)		0.79	1.96	1.26 (0.30)	0.51	0.04 (0.84)	1.18 (0.29)
France	1972	1989	0.86 (3.93)			-0.46 (-4.08)	1.30 (5.03)	-0.89 (-2.80)	1.52 (4.32)	0.89	1.67	2.81 (0.05)	1.59	191	1.15 (0.29)
Greece	1974	1981	1.02 (2.16)	-0.11 (-3.30)		-0.15 (-2.17)	4.69 (3.64)			0.84	1.62	0.93 (0.46)	0.02	0.17 (0.68)	
Ireland	1972	1988	1.37 (4.14)			-0.69 (-5.15)	1.74 (6.69)	1.21 (3.81)	-2.15 (-6.20)	0.89	1.90	1.26 (0.31)	0.98	3.27 (0.08)	0.47 (0.50)
Italy	1972	1989	1.42 (4.94)			-0.62 (-5.82)	1.45 (5.78)	1.89 (6.02)	-1.88 (-5.52)	0.89	1.81	1.74 (0.17)	1.78	0.78 (0.38)	2.55 (0.12)
Luxemburg	1974	1989	0.67 (4.38)	0.02 (1.92)		-0.97 (-5.43)	1.16 (15.19)	0.36 (3.44)	-0.64 (-5.38)	0.93	2.24	0.89 (0.49)	1.45	1.20 (0.28)	1.62 (0.21)
Netherlands	1969 c	1979	0.54 (4.04)	0.05 (5.35)		-0.90 (-8.64)	1.47 (27.02)		-0.58 (-6.59)	0.91	2.25	0.70 (0.59)	2.19	1.06 (0.31)	2.64 (0.11)
Portugal	1974 c	1989	0.42 (0.92)	0.13 (3.98)		0.20 (-2.94)	3.39 (4.54)		-2.74 (-1.50)	0.86	2.11	0.11 (0.10)	0.98	0.21 (0.64)	0.04 (0.83)
Spain	1975	1979	0.47 (1.25)		-0.04 (-1.32)	-0.48 (-4.12)	2.78 (8.27)	2.41 (2.95)	-3.22 (-3.67)	0.86	1.80	0.16 (0.95)	0.97	0.01 (0.99)	8.01 (0.01)
Sweden	1974	1990	0.87 (2.66)			-0.58 (-3.85)	1.47 (6.43)	0.84 (2.58)	-1.65 (-3.47)	0.68	1.98	0.30 (0.87)	0.93	0.22 (0.64)	0.63 (0.43)
United Kingdom	1973	1981	1.79 (3.77)	0.06 (2.16)		-0.61 (-3.50)	1.54 (3.97)	1.18 (2.36)	-1.20 (-2.52)	0.79	2.10	0.53 (0.71)	0.27	2.51 (0.12)	1.90 (0.18)

Note: This table shows the estimation of equation (2) in the text, with t-ratio in parenthesis. The critical value for the t-statistic for λ is - 3,36 at the 5% level of significance (Banerjee *et al.*, 1998). N(2) is the Jarque-Bera test for normality, distributed as $\chi^2(2)$. LM(4) is the Breusch Godfrey test for fourth-order autocorrelation, ARCH is the Engle test for first-order ARCH and $F(\Sigma \beta = 1)$ is a test for the restriction $\Sigma \beta = 1$ (p-values for these tests are in parenthesis).