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Euro-zone Inflation Rates: Stationary or Regime-wise Stationary Processes

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Abstract

This study investigates the stationary behavior of the inflation rates for the Euro-zone members and some neighboring countries, for the 1957:2 to 2007:3 period. The analysis uses univariate unit root tests with enhanced small-sample performances that allow up to two breaks in the intercept, namely those of Elliott et al. (1996) and Lopez (2008). The results strongly reject the unit root null hypothesis for all the countries. Furthermore, they demonstrate that some of the Euro-zone inflation rates are stationary and others are regime-wise stationary. While such results may reconcile some of the literature findings and provide empirical evidence that the Maastricht criterion is respected, they also highlight the importance of accounting for breaks when studying these series. Finally, none of the identified breaks take place in the post Euro era.

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1 Introduction

The Maastricht treaty requires that the Euro-zone inflation rates converge at the advent of the common currency and thereafter. Numerous studies such as Rogers et al. (2001), Engel and Rogers (2004), Weber and Beck (2005), Faber and Stokman (2005) and Busetti, et al. (2007) find evidence of inflation convergence within the Euro-zone in the mid-nineties. However, studies for the post-Euro period vary drastically in their conclusions from sharp convergence since 2002 (Honohan and Lane (2004)) to divergence starting in late 1998 (Duarte (2003)). Furthermore, looking at the inflation rate literature in general, Chadha and Dimsdal (1999) and Levin and Piger (2006), among others, suggest that the neglect of structural breaks in the inflation rate may lead to false evidence of unit root behavior when the process is really regime wise-stationary.

As an alternative, the paper investigates European inflation rates for a longer period than most of the existing studies and allows up two breaks in the intercept. Focusing on the 1957:2-2007:3 period, the analysis uses univariate unit root tests that perform well on extended data sets to investigate the stationary behavior of the series. More specifically, we use the unit root test proposed by Elliott et al. (1996) and its extension to one and two breaks in the intercept proposed by Lopez (2009). The rejection of the unit root null is then interpreted as evidence of stationarity or regime-wise stationarity, respectively.

All the inflation rates considered exhibit evidence of some type of stationary behavior. Among the eighteen European countries considered, seven (five of which are members of the Euro-zone) show strong evidence of stationarity, while ten (six of which are members of the Euro-zone) demonstrate strong evidence of regime-wise stationarity. Furthermore, only Spain necessitates the addition of more than one break to exhibit strong rejection of the unit root null.

The results reveal clear stationary behavior for all the inflation rates considered and reconciles the empirical evidence with the Maastricht requirement. However, the type of stationarity for the Euro-zone countries varies from standard mean reversion to mean reversion allowing one or two changes in the mean. These findings imply that ignoring the presence of breaks when studying the Euro-zone inflation rates may lead to spurious results regardless of whether the analysis is univariate or multivariate.

Section 2 presents the data and tests used, while Section 3 discusses the results before concluding in Section 4.

2 Method

Issues of convergence are commonly addressed using unit root tests, hence we consider the following two tests in this analysis. Elliott et al.(1996) propose an improved version of the ADF test, namely the DF-GLS unit root test, that performs well in small samples. Lopez (2009) suggests a version of the DF-GLS test that allows up to two changes in the intercept. In both papers, the tests rely on the GLS-transformation of the data and are performed as follows:

Suppose y_t, the inflation rate of a country, is described by the stochastic process:

$$\begin{aligned} y_t &= d_t + u_t \\ u_t &= \alpha u_{t-1} + v_t \end{aligned}$$

where $d_t = \psi' z_t$, z_t is a set of deterministic components, $\{v_t\}$ is an unobserved stationary zero-mean error process, and $u_0 = 0$. For any series y_t with deterministic components z_t, the transformed data $\tilde{y}_t$ and $\tilde{z}_t$ are defined by $\widetilde{y}_t = (y_1, y_2 - ay_1, ..., y_T - ay_{T-1})'$, and $\tilde{z}_t = (z_1, z_2 - az_1, ..., z_T - az_{T-1})'$ for $(t = 1, ..., T)$. The local alternative $a = 1 + \frac{\bar{c}}{T}$ is calculated with $\bar{c} = -7$ in the demeaned case. [1]

Using the notation $1(.)$ to define the indicator function and TB_j, $j = 1, 2$ the break date, we can write three definitions for the deterministic term z_t, depending on the test considered:

(i) $z_t = \{1\}$, for the DF-GLS$_\mu$ test with no change in the intercept.

(ii) $z_t = \{1, 1(t > TB_1)\}$, for the DF-GLS$_\mu^{1TB}$ test with one change in the intercept. That is, the dummy variable is equal to 1 for $t > TB_1$.

(iii) $z_t = \{1, 1(t > TB_1), 1(t > TB_2)\}$, for the DF-GLS$_\mu^{2TB}$ test with two changes in the intercept. That is, the dummy variables are equal to 1 for $t > TB_1$ for the first break and for $t > TB_2$ for the second break.

The GLS-transformed data is then defined by:

$$y_t^d = y_t - \tilde{\beta} z_t \tag{1}$$

where $\tilde{\beta}$ is the least-squares estimate of the regression of $\tilde{z}$ on $\tilde{y}$. Finally, the DF-GLS$_\mu^{jTB}$ test, with $j = 0, 1, 2$, runs the following regression:

$$y_t^d = \rho y_{t-1}^d + \sum_{i=1}^{k} c_i \Delta y_{t-i}^d + \varepsilon_t \tag{2}$$

The standard hypotheses, $H_0 : \rho = 1$ versus $H_1 : \rho < 1$, are tested, via the t-statistic $t^{GLS} = \frac{\hat{\rho}-1}{se(\hat{\rho})}$.

Whether the model assumes none, one or two changes in the intercept, the testing procedure remains the same. First, the deterministic terms are selected. That is, for each potential break date, the data are GLS-transformed following Equation (1). Then Equation (2) is estimated with the truncation lag parameter, k, selected via Modified Akaike Information Criteria. The breaks are selected so that they maximize the evidence against the unit root hypothesis.[2]

[1] Elliott et al. (1996) show that $\bar{c}$ = -7 corresponds to the tangency between the asymptotic local power function of the test and the power envelope at 50% power in the case with a constant. Furthermore, the focus here being the stationarity or the regime-wise stationarity of the series, there is no trend in the deterministic term.

[2] The break date can be located anywhere, except in the first and last 10% of the data. Furthermore, a minimum of two periods must separate two breaks.

3 Results

The Quarterly inflation rates (CPI based) are calculated for the twelve European Monetary Union members (as of 2003), the remaining European Union members (Denmark, Sweden, and the UK), Norway, Switzerland and the Eurozone. The CPI for the periods 1957:1 to 2007:3 period are collected from the IMF database. The Eurozone data set starts only in 1998:2. Then we test for stationarity with the DF-GLS$_\mu$ test, and for regime-wise stationarity with the DF-GLS$_\mu^{iTB}$ test $i = 1$ or 2. Table 1 reports the results.

Two points are addressed. What is the impact of adding one break and testing for regime-wise stationarity rather than stationarity? What is the impact of adding one extra break, hence testing for regime wise stationarity allowing for two changes in the intercept?

The results of the DF-GLS$_\mu$ and the DF-GLS$_\mu^{1TB}$ tests show that most of the series are at least regime-wise stationary with one change in the intercept. Indeed, ten series demonstrate evidence of stationarity while the seven out of the remaining eight are able to reject the unit root hypothesis if one change in the intercept is included. Furthermore, adding one break in the intercept strengthens the evidence against the non-stationarity null to at least 5% for Finland, Greece, Ireland, Luxembourg, Norway, the Eurozone, UK and Switzerland.

Similarly, a comparison of the results when one and two breaks are allowed highlights the impact of the additional break. While the rejection of the unit root null is stronger for two countries, only Spain requires the additional break to demonstrate evidence against the unit root.

Finally, if we define any rejection at the 5% significance level or better as a strong rejection of the null hypothesis, then the results can be summarized in two subsets: the stationary, and the regime-wise stationary inflation rates. Seven countries out of the eighteen considered show strong evidence of inflation stationarity: four are Euro-zone members (Belgium, Germany, Greece, Ireland), Luxembourg, Switzerland and the UK. Nine out of the eleven remaining show strong evidence of regime-wise stationarity around one break in the intercept: five Euro-zone countries (Austria, Finland, France, Netherlands, Portugal), Denmark, Sweden, Norway and the Eurozone. Finally, only Spain requires the presence of two breaks in the intercept to display strong evidence of regime-wise stationarity, while Italy is the sole country that shows weak evidence of regime-wise stationarity by rejecting the unit root null at 10%.

All the (statistically significant) breakdates stand in the 60s, 70s and 80s, corresponding to periods of appreciation/depreciation of major European currencies, financial and economic instability, and changes in monetary and fiscal policies. Among the Euro countries, only Portugal and Italy observe a change around the Maastricht treaty, yet none of the breaks take place after the advent of the Euro.

4 Conclusion

The paper investigates the stationary behavior of European inflation rates. Considering a longer span of data than in the previous literature, the analysis employs univariate unit root tests that behave well in small samples while allowing up to two breaks in the intercept, namely those of Elliott et al. (1996) and Lopez (2009).

The testing procedure used rejects the unit root null hypothesis for all the series examined, demonstrating either evidence of stationarity or of regime-wise stationarity. More specifically, the inflation rates within the Euro-zone countries reveal strong stationary behavior. Indeed, the inflation rates of Belgium, Germany, Greece, Ireland and Luxembourg are strictly stationary, while the inflation rates of Austria, Finland, France, Netherlands, Portugal and Spain are regime-wise stationary. Furthermore, all the breaks that are significant occur before the mid 90s, providing empirical evidence that the inflation rates are stable throughout the remaining period that includes the post Euro era.

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Table 1: European Inflation Rates from 1957:1-2007:3

	DF-GLS$_\mu$		DF-GLS$_\mu^{1TB}$			DF-GLS$_\mu^{2TB}$			
	$t-stat_\rho$		$t-stat_\rho$		TB_1	$t-stat_\rho$		TB_1	TB_2
European Monetary Union members									
Austria	−0.19	-	−2.32	**	*1962:2*	−2.51	**	*1962:1*	*1965:1*
Belgium	−4.30	***	−2.13	**	1972:3	−2.55	***	1971:3	1985:1
Finland	−1.90	*	−2.70	***	1989:2	−2.93	***	1983:4	1994:3
France	−1.47	-	−2.13	**	*1987:1*	−2.18	**	*1965:1*	*1980:1*
Germany	−2.44	**	−2.20	**	*1983:2*	−3.67	***	*1971:1*	*1983:4*
Greece	−1.99	**	−2.98	***	1974:4	−4.01	***	1973:1	1992:1
Ireland	−2.15	**	−2.64	***	1985:3	−3.48	***	*1975:3*	*1981:4*
Italy	−0.92	-	−1.90	*	*1985:2*	−1.78	*	*1963:3*	*1994:1*
Luxembourg	−2.15	**	−3.01	***	*1966:1*	−3.23	***	*1966:3*	*1972:3*
Netherlands	−1.58	-	−3.45	***	*1962:2*	−2.67	***	*1965:2*	*1978:3*
Portugal	−0.95	-	−2.15	**	1992:2	−2.19	**	*1967:2*	*1992:2*
Spain	−1.46	-	−1.66	–	*1962:3*	−2.58	**	*1972:2*	*1983:4*
Eurozone	−1.66	*	−9.26	***	1999:1	−1.89	*	1999:1	1999:4
European Union members but non European Monetary Union members									
Denmark	−1.07	-	−3.47	***	1985:2	−3.92	***	1962:3	1981:2
Sweden	−1.54	-	−3.39	***	1987:3	−5.04	***	*1970:4*	*1991:4*
UK	−2.14	**	−2.49	***	1985:4	−3.49	***	*1972:1*	*1985:1*
European countries non-European Union members									
Norway	−1.69	*	−3.13	***	*1986:3*	−3.51	***	1963:3	1986:3
Switzerland	−2.40	**	−2.68	***	1993:1	−3.78	***	*1965:1*	*1993:2*

*, **, *** represent the rejection of the null hypothesis at 1%, 5% and 10%.

The critical values are from MacKinnon (1996) for DF-GLS$_\mu$, and from Lopez (2009) for DF-GLS$_\mu^{TB}$

The breakdates that are statistically significant are in italic