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REVISITING HYSTERESIS IN UNEMPLOYMENT FOR TEN EUROPEAN COUNTRIES: AN EMPIRICAL NOTE ON A MORE POWERFUL NONLINEAR (LOGISTIC) UNIT ROOT

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In this empirical note we use a more powerful nonlinear (logistic) unit root test advanced by Leybourne *et al.* (1998) to investigate the hysteresis in unemployment for ten European countries for the period 1961-2003. The hypothesis is confirmed for all the European countries for which Leybourne *et al.*'s (1998) nonlinear (logistic) unit root test is performed, except for Belgium and the UK.

Keywords: Hysteresis in Unemployment, European Countries, Logistic Unit Root Tests
JEL Classification: C22, C23

1. INTRODUCTION

The issue of unemployment has clearly become the most pressing problem for the majority of countries over the past decade. In the case of the European countries, the average unemployment rate has increased from less than 4% in the 1960s to over 10% in the 1990s. The dominant feature of unemployment is its high persistence even in times of relative booms. Since confirming the validity of the hypothesis of hysteresis in unemployment is critical for both empirical researchers and policymakers, what actually causes this higher persistence has been the focus of numerous theoretical and empirical studies. In considering the assumptions inherent in the hysteresis hypothesis in relation to unemployment, if unemployment follows an I (1) process, then the shocks affecting the series will have permanent effects, thus shifting the unemployment equilibrium from one level to another. Should this be the case, from a policy perspective, policy action is, indeed, required to return unemployment to its original level. On the other hand, if unemployment follows an I (0) process, the effects of the shock will merely be transitory, thus rendering the need for policy action less mandatory since unemployment will eventually return to its equilibrium level. The I (0) process has commonly been referred to as the natural rate of unemployment hypothesis (NAIRU), for it characterizes

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unemployment dynamics as a mean reversion process.

Because hysteresis is associated with non-stationary unemployment rates, unit root tests have been widely used to investigate its validity. For example, Blanchard and Summers (1986), for example, using data for France, Germany, the United Kingdom and the United States for the 1953 to 1984 period, were pioneers in presenting the first empirical study that employed conventional unit root tests to investigate the effect of hysteresis on unemployment. In so doing, they were unable to reject the non-stationarity of unemployment rates for the countries they studied except for the Untied States where they did find evidence of stationarity. A little later, Brunello (1990), using Japanese unemployment data for the 1955 to 1987 period, was unable to reject the null hypothesis of a unit root. Mitchell (1993) later used Perron's (1989) unit root test, which assumes one exogenously given structural break and similarly confirmed support for hysteresis in several OECD countries. Likewise, Jaeger and Parkinson (1994) reported results, again indicating that unemployment hysteresis exists in Germany, the United Kingdom and Canada, but not in the United States. On the other hand, Arestis and Mariscal (2000) applied the structural break univariate unit root test of Perron (1997) to unemployment rates from twenty-two OECD countries. Although their results are mixed, they mostly reject the unit root and hysteresis. Using data from 1970 to 1994, Roed (1996) empirically investigated the presence of unemployment hysteresis in 16 OECD countries and strongly suggested that hysteresis prevails in Australia, Canada and Japan, as well as in several European countries; however, once again, hysteresis was rejected in the case of the United States.

While most of the empirical studies to date support the existence of a unit root in unemployment, critics have claimed that this conclusion may be due to the low power of the conventional unit root tests employed. Recently, there has been a growing consensus that macroeconomic variables exhibit nonlinearities and, consequently, conventional unit root tests, such as the ADF test, have low power in detecting mean reversion. To solve this problem, stationarity tests based on a nonlinear framework must be applied.

This empirical note contributes to this line of research by determining whether hysteresis in unemployment is a characteristic of the European labor market. We test the hysteresis hypothesis in unemployment for 10 European country data sets using a more powerful nonlinear (logistic) unit root test advanced by Leybourne *et al.* (1998). Our empirical results strongly reject the unit root process for only two of the countries examined, indicating that hysteresis in unemployment holds true for 8 of the 10 European countries.

The remainder of this empirical note is organized as follows. Section 2 presents the data used, and Section 3 describes the methodology adopted, while also discussing the empirical findings and policy implications. Finally, Section 4 presents some concluding remarks.

2. DATA

This empirical note employs the 1961-2003 unemployment rates for ten European countries, namely Belgium, Denmark, France, Ireland, Italy, the Netherlands, Portugal, the UK, Norway and Finland. All the data are from the AREMOS database of Taiwan's Ministry of Education, and summary statistics are provided in Table 1. The unemployment data indicates that Ireland and Norway have the highest and lowest average unemployment rates, respectively. The Jarque-Bera test results meanwhile indicate that, except for Ireland, Norway and Finland, all the unemployment data sets are approximately normal. Figure 1 and Figure 2 plot the actual values and the fitted smooth transition of the unemployment rates for France and the UK, two leading countries in terms of their higher political and economic status in Europe, respectively. Due to space constraints, we do not report the figures for the remaining countries, but these are available from the authors upon request.

Table 1. Summary Statistics of Unemployment Data Sets: 1961-2003

Country	Mean	Std	Maximum	Minimum	Skewness	Kurtosis	J-B
Belgium	6.105	3.281	10.811	1.336	-0.197	1.564	3.968
Denmark	4.783	2.934	10.048	0.589	-0.079	1.731	2.931
France	6.654	3.857	12.399	1.163	-0.088	1.476	4.215
Ireland	9.390	4.358	16.809	3.900	0.435	1.654	4.603*
Italy	7.611	2.471	11.837	3.536	0.196	1.827	2.741
Netherlands	4.519	2.909	11.693	0.444	0.179	2.128	1.592
Portugal	5.004	2.233	8.709	1.619	0.007	1.550	3.766
UK	5.754	3.404	11.396	1.081	0.186	1.671	3.415
Norway	2.877	1.459	5.959	1.295	0.711	2.156	4.893*
Finland	6.204	4.608	17.031	1.197	0.944	2.842	6.437**

Notes: Std denotes standard deviation and J-B denotes the Jarque-Bera Test for Normality.*, ** and *** indicate significance at the 10%, 5% and 1% levels respectively.

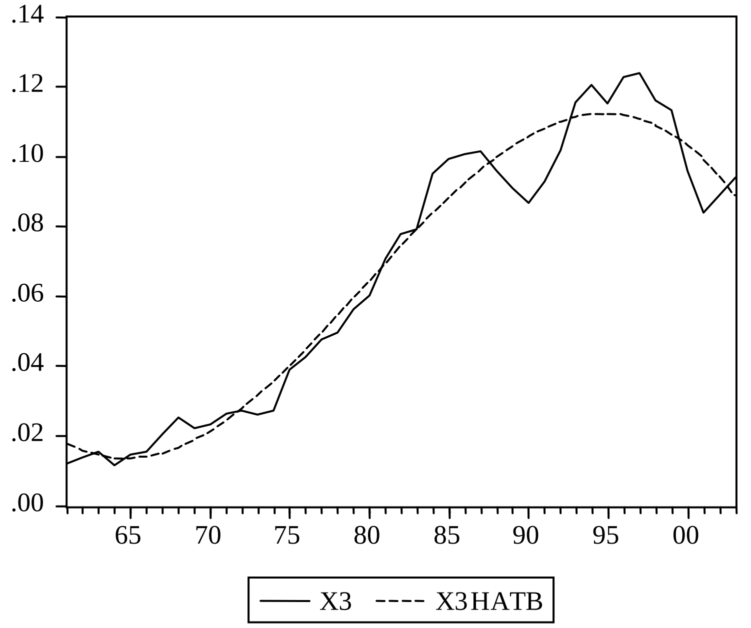

Figure 1. Actual Values of Unemployment and Fitted Smooth Transition-France

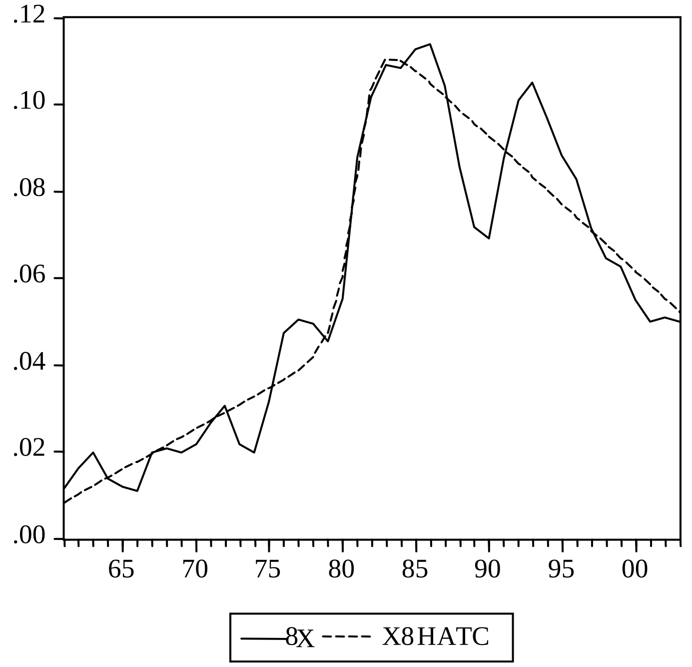

Figure 2. Actual Values of Unemployment and Fitted Smooth Transition-The U.K

3. METHODOLOGY

Following Leybourne *et al.* (1998), we consider the following three logistic smooth transition regression models:

Model A: $Y_t = \alpha_1 + \alpha_2 S_t(\gamma, \tau) + v_t$, (1)

Model B: $Y_t = \alpha_1 + \beta_1 t + \alpha_2 S_t(\gamma, \tau) + v_t$, (2)

Model C: $Y_t = \alpha_1 + \beta_1 t + \alpha_2 S_t(\gamma, \tau) + \beta_2 t S_t(\gamma, \tau) + v_t$, (3)

where v_t is a zero-mean I (0) process, and $S_t(\gamma, \tau)$ is the logistic smooth transition function, based on a sample of size T, where

$$S_t(\gamma, \tau) = [1 + \exp\{-\gamma(t - \tau T)\}]^{-1}, \quad \gamma > 0 . \tag{4}$$

While the S function controls the smooth transition between regimes, the parameter τ determines the timing of the transition midpoint; for example, for $\gamma > 0$, we have $S_{-\infty}(\gamma, \tau) = 0,\ S_{+\infty}(\gamma, \tau) = 1$ and $S_{\tau T}(\gamma, \tau) = 0.5$. The speed of transition is then determined by the parameter γ . If γ is small, then the transition is slow - $S_t(\gamma, \tau)$ takes a long period of time to traverse the interval (0,1). In the limiting case, with $\gamma = 0$, $S_t(\gamma, \tau) = 0.5$ for all *t*. On the other hand, for large values of γ , $S_t(\gamma, \tau)$ traverses the interval (0,1) very rapidly. As γ approaches $+\infty$, this function changes value from 0 to 1 instantaneously at time $t = \tau T$.

If we assume that v_t is a zero-mean I (0) process, then Model A implies that Y_t is stationary around a mean which changes from α_1 to $\alpha_1 + \alpha_2$. Model B also allows the intercept to change from α_1 to $\alpha_1 + \alpha_2$, but include a fixed slope term. Model C is the most flexible model, for it allows the intercept to change from α_1 to $\alpha_1 + \alpha_2$ and allows the slope parameter to change, with the same speed of transition, from β_1 to $\beta_1 + \beta_2$. If $\gamma < 0$, the initial and final model states are reversed but the interpretation of the parameters remains the same.

The tests of Leybourne *et al.* (1998) are based on the following hypothesis:

$$H_0 : Y_t = U_t, U_t = K + U_{t-1} + \varepsilon_t, U_0 = \varphi , \tag{5}$$

H_a : Model A, Model B or Model C, (6) where ε_t and v_t are both assumed to be stationary autoregressive moving average (ARMA) processes with zero mean. The test statistics are calculated in two steps:

Step 1. Using a nonlinear least squares (NLS) algorithm, estimate the deterministic component of the model and compute residuals ($\hat{v}_t$) from Models A, B or C.

Step 2. Compute the ADF statistic, the t-ratio associated with $\hat{\rho}$ in the ordinary least squares (OLS) regression,

$$\Delta\hat{v}_t = \hat{\rho}\hat{v}_{t-1} + \sum_{i=1}^{K}\hat{\theta}_i\Delta\hat{v}_{t-i} + \hat{\eta}. \tag{7}$$

The ADF statistics are denoted by S_α , $S_{\alpha(\beta)}$ and $S_{\alpha\beta}$, respectively, if the residuals are calculated from Models A, B or C. Leybourne, *et al.* (1998) provided critical values for the tests calculated using Monte Carlo simulation.

4. EMPIRICAL RESULTS

For purposes of comparison, we first apply several conventional unit root tests to examine the null of a unit root in the unemployment level for each country. We select the lag order of the test based on the Schwarz criterion (SC). The results in Table 2 clearly indicate that the ADF, DF-GLS (Elliott *et al.* (1996)), P-P and NP (Ng and Perron (2001)) tests all fail to reject the null of non-stationarity of unemployment for all 10 countries. The KPSS test also yields the same results. Table 3 presents Leybourne *et al.*'s (1998) nonlinear (logistic) unit root test results and the corresponding Model A, B, or C selected based on the Schwarz criterion. The empirical results strongly reject the unit root process for only two of the data series, indicating that a unit root in unemployment holds true for 8 out of the 10 countries studied here.[1] These results provide strong evidence in support of the hysteresis hypothesis given the European countries' unemployment data.

[1] The non-rejection by several conventional unit root tests and emphatic rejections by Leybourne *et al.*'s test (1998) points suggestively towards these being stationary around a smooth transition where, as was shown in Table 4, conventional unit root tests can have very lower power.

Table 2. Linear Unit Root Tests (ADF, DF-GLS, P-P, KPSS and NP)

Country	ADF	DF-GLS	P-P	KPSS	NP
Belgium	-1.894(1)	-1.413(1)	-1.359[3]	0.585[5]**	-4.668
Denmark	-1.796(1)	-1.376(1)	-1.503[1]	0.526[5]**	-4.034
France	-1.263(1)	-0.515(1)	-1.238[3]	0.738[5]**	-0.736
Ireland	-1.713(1)	-1.527(1)	-1.203[3]	0.415[5]**	-4.888
Italy	-1.727(1)	-0.009(1)	-1.073[0]	0.742[5]***	-2.411
Netherlands	-1.561(0)	-1.089(0)	-1.604[1]	0.373[5]**	-1.806
Portugal	-2.297(1)	-1.766(1)	-1.731[1]	0.403[5]**	-4.293
UK	-1.405(2)	-0.973(2)	-1.401[0]	0.500[5]**	-1.888
Norway	-1.509(1)	-1.295(1)	-1.022[0]	0.617[5]**	-5.293
Finland	-1.566(2)	-1.209(2)	-1.475[1]	0.623[5]**	-3.428

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively. The numbers in parentheses indicate the lag order selected based on the recursive t-statistic, as suggested by Perron (1989). The NP test was based on the MZa statistic.

Table 3. Nonlinear (Logistic) Unit Root Tests

Country	t-statistic	K	SC	AIC	Model
Belgium	-5.172**	1	-5.912	-6.117	B
Denmark	-4.234	1	-5.704	-5.908	B
France	-3.983	1	-6.533	-6.738	B
Ireland	-4.498	1	-5.293	-5.497	B
Italy	-4.398	1	-6.797	-7.043	C
Netherlands	-3.293	0	-6.059	-6.036	C
Portugal	-4.151	1	-6.032	-6.237	B
UK	-5.802**	1	-6.037	-6.283	C
Norway	-4.376	1	-7.469	-7.715	C
Finland	-3.854	1	-5.609	-5.856	C

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively. Critical values are taken from Leybourne, *et al.* (1998). SC and AIC indicate the Schwarz criterion and Akaike information criterion, respectively. K is the order of lag-length. Models A, B or C are selected based on both SC and AIC.

Table 4. Empirical Powers for Series Generated from the Estimated Smooth Transition Model for both Belgium and UK Unemployment (T=43)

	Model C		ADF		DF-GLS		P-P		KPSS	
K	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05
0	*0.95*	*0.93*	*0.16*	*0.13*	*0.27*	*0.26*	*0.22*	*0.21*	*0.34*	*0.31*
1	*0.92*	*0.87*	*0.12*	*0.09*	*0.25*	*0.19*	*0.18*	*0.16*	*0.29*	*0.25*

Notes: Detailed procedures see Leybourne *et al.* (1998). The values in bold indicate the mean values of the powers. The Model C of Leybourne *et al.* (1998) clearly has considerable power to reject the (false) unit root hypothesis. On the other hand, other conventional unit root tests have no ability to distinguish the actual generating process from one with a unit root. Results from both Models A and B are similar to those found here, not reported here to save space but are available upon request. Normal sizes are 0.10 and 0.05.

5. SUMMARY AND CONCLUSION

In this empirical note we employ the Lebyourne *et al.* (1998) nonlinear (logistic) unit root tests to investigate the hysteresis in unemployment for ten European countries for the period 1961-2003. The results from five conventional unit tests provide strong evidence in support of the hysteresis hypothesis given the European countries' unemployment data. The hypothesis is also confirmed for all the European countries except for Belgium and the UK when Leybourne *et al.*'s (2001) nonlinear (logistic) unit root test is conducted. As far as major policies are concerned, our study implies that a fiscal stabilization policy and/or monetary policy would possibly have permanent effects on the unemployment rates of these European countries.

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