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Hysteresis in unemployment: an empirical research for three member states of the European Union

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Abstract. *This empirical paper investigates the hysteresis in unemployment in the case of three European countries namely Greece, Ireland and Portugal for the period 1984-2010. This study uses three classical unit-root tests, and a number of panel unit root tests, which are known to overcome specification problems, to check the existence of hysteresis in unemployment data from three European Union countries. The empirical results do not reject a unit root in the unemployment rates. This suggests that the unemployment hysteresis hypothesis exists in all three countries.*

Keywords: hysteresis; unemployment rate; panel unit root test.

JEL Codes: C22, C23.
REL Code: 8G.

Introduction

The issue of unemployment has clearly become the most pressing problem for the governments of the majority of countries over the past but also the current decade. In the case of European countries, the average unemployment rate has increased from less than 4% in the 1960s to over 9% in the 1990s as well as over 10% in the 2000s. The European countries with the highest unemployment rate are those which recently joined the International Monetary Fund (IMF) supervision (ie Greece, Ireland, Portugal). The dominant feature of unemployment is its high persistence even in times of relative booms. Hysteresis refers to the influence of current market shocks on future market equilibrium conditions. Confirming the validity of the hypothesis of hysteresis in unemployment is critical both for empirical researchers and policymakers. According to Phelps (1972), unemployment hysteresis describes *a sustained unemployment after a transitory shock*. In essence, the shock effect is being built into the natural rate of unemployment resulting *in a change of long run equilibrium.*

There are two theoretical justifications for the existence of hysteresis in unemployment. The first justification is based on market rigidities. In their model, Lindbeck and Snower (1988a) support the view that the existence of hysteresis is due to the power of labour unions that keep the equilibrium wage high, and therefore increase unemployment. The second justification for hysteresis is based on the anticipation of inflation in a Phillips Curve approach, whereby downward pressures on inflation lead to sustained high unemployment (Hall, 1979).

When considering the relationship between hysteresis hypothesis with unemployment, we identify the following cases: 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 unemployment dynamics as a mean reversion process (Chang et al., 2007).

The question of whether unemployment rates should be treated as stationary or non-stationary processes has received a great deal of attention ever since the publication of the paper by Nelson and Plosser (1982). Indeed, classifying unemployment rates as one or the other has a number of important statistical and economic implications. From a statistical point of view, stationary series have a finite (non-zero) variance and exhibit temporary memory in the sense that the effect of a perturbation disappears as time passes. In contrast, non-stationary series have an unbounded variance and exhibit a permanent memory. From an economic perspective, a stationary unemployment rate has been commonly associated with the natural rate of unemployment hypothesis (NAIRU), for it may be viewed as a mean reverting process that fluctuates around its long-run equilibrium value, while non-stationarity has been associated with the hysteresis hypothesis, whereby long lasting unemployment effects arise from cyclical fluctuations (Blanchard, Summers, 1986).

Because hysteresis is associated with non-stationary unemployment rates, unit root tests have been widely used to investigate its validity. This study contributes to this line of research by determining whether hysteresis in unemployment is characteristic of the three European countries. In the current paper we test the hysteresis hypothesis in unemployment for three European country data sets using the traditional tests by Dickey-Fuller (ADF) (1979), Phillips and Perron (PP) (1988) and Kwiatkowski, Phillips, Schmidt, and Shin test (KPSS) (1992), as well as the panel-based unit root tests by Levin, Lin, and Chu (LLC) (2002), Breitung (2000), Hadri (2000) Im, Pesaran and Shin (IPS) (2003), Maddala and Wu (1999) and Choi (2001).

The remainder of this empirical note is organized as follows. Section two presents the data used, and in section three different unit root tests are carried out to test for the presence of hysteresis. Section four reports the empirical results, and section five presents some concluding remarks.

Data

This study employs the unemployment rates for three European countries, Greece, Ireland and Portugal. All data that we use derive from IMF (International Monetary Fund) over the period 1984 - 2010. Summary statistics are given in Table 1. Unemployment data indicate that Ireland has the highest average unemployment rates. Jarque-Bera (1987) test results indicate that unemployment data sets for the three countries follow normal distribution. Figure 1, Figure 2 and Figure 3 plot the actual and forecast values of the unemployment rates for Greece, Ireland and Portugal respectively.

Table 1

Summary atatistics of unemployment data sets

Country	Mean	Std	Max	Min	Skewness	Kurtosis	J-B
Greece	9.274	1.615	12.50	7.00	0.195	1.972	1.360
Ireland	11.351	5.905	19.00	3.90	-0.084	1.304	3.266
Portugal	6.544	1.829	10.80	3.90	0.270	2.383	0.756

Note: J-B denotes the Jarque-Bera test [1987] for normality.

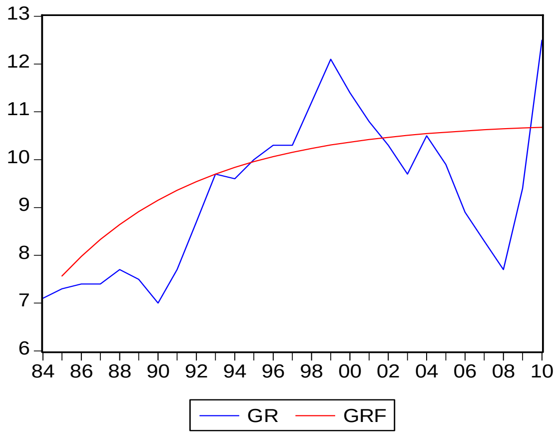

Figure 1. *Actual and forecast values of the unemployment rates for Greece*

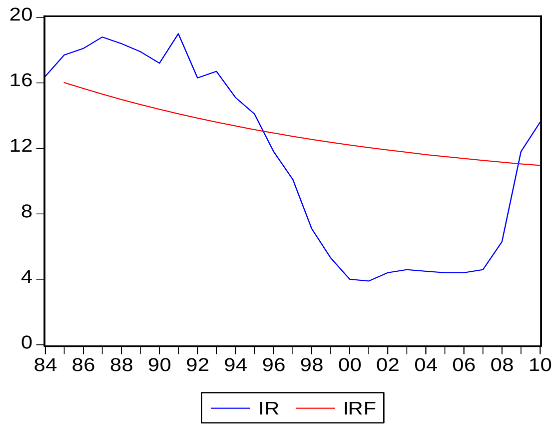

Figure 2. *Actual and forecast values of the unemployment rates for Ireland*

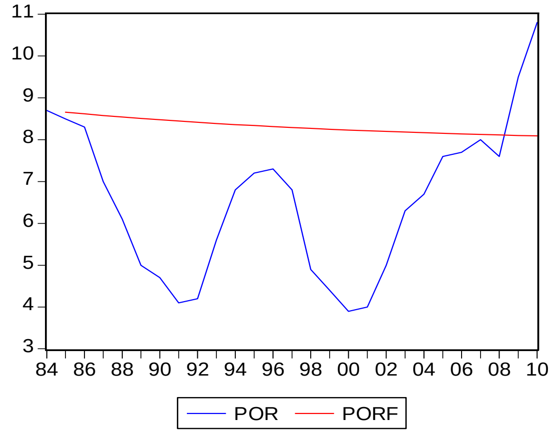

Figure 3. *Actual and forecast values of the unemployment rates for Portugal*

Testing for hysteresis

Time series unit root tests

For the presence of hysteresis in unemployment rate of three countries European Union we use time series unit root tests and panel unit root tests. The first test which is applied is the augmented Dickey-Fuller test (ADF) (1979). For time series, an AR (1) model can be written as follows:

$$y_t = \alpha + \gamma t + \rho y_{t-1} + \varepsilon_t \quad (1)$$

where y_t is unemployment rate, α, γ and ρ are parameters, ε_t is the error term and t = 1,...,T. The series y_t has a unit root if ρ = 1. Rewriting equation (1) gives:

$$\Delta y_t = \alpha + \gamma t + \delta y_{t-1} + \varepsilon_t \quad (2)$$

where $\delta = \rho - 1$. Under the null hypothesis the series y_t is a random walk, and thus non-stationary if $\delta = 0$. The AR (1) scheme is then replaced by a AR(p) scheme. The appropriate lag length is chosen by using information criteria such as the Akaike information criterion (1973).

The second unit root test which is applied is the Phillips-Perron test (PP) (1988) based on the ADF-test. Phillips and Perron start from the original DF-test equation (2), but they change in a semi-parametric way the DF-statistic such that serial correlation does not affect the asymptotic distribution of it.

The ADF test and the Phillips-Perron test are widely used methods of investigating the presence of a unit root in single time series. Unfortunately, in finite samples these tests suffer from limited power against near unit root alternatives (Maddala, Kim, 1998).

The third unit root test which is applied is the Kwiatkowski, Phillips, Schmidt, and Shin test (KPSS) (1992). Kwiatkowski et al. present a test where the null hypothesis is referred to a stationary time series. KPSS test implements the ADF test considering that the power for both tests can be determined from the comparison of the significance of statistical criteria on both tests. A stationary time series has statistical significant criteria for ADF test and non statistical significant criteria on KPSS test.

Panel unit root tests

In order to address the aforementioned power problem further (Maddala, Kim 1998), the unemployment series are checked for the presence of unit root by applying some panel unit root tests. According to recent literature, panel-based unit root tests are more powerful than those based on individual time series. In this article, we apply six recently developed unit root tests to a panel of unemployment rate. The panel unit root tests applied in this article are those developed by Levin, Lin and Chu (LLC) (2002), Breitung (2000), Hadri (2000), Im, Pesaran and Shin (IPS) (2003), Maddala and Wu (1999) and Choi (2001). For panel data, an AR (1) model can be written as follows:

$$y_{it} = \rho_i y_{it-1} + x_{it}\delta_i + \varepsilon_{it} \tag{3}$$

where y_{it} is the unemployment rate in region, x_{it} is the exogenous variable including any fixed effects or individual trends, ρ_i is the autoregressive coefficient, ε_{it} is assumed to be mutually independent idiosyncratic error, i = 1, 2,…, N cross-sections, and t = 1, 2,…,T_i time periods. If $|\rho_i| <1$, y_{it} is trend-stationary or weakly stationary, and if $|\rho_i| = 1$ y_{it} contains a unit root.

In a test for a unit root, normally, there are two assumptions regarding ρ_i. According to ρ_i same (different) quality of the different assumptions, all tests can be divided into two categories. First, we can assume that one is the assumption that all units of the panel include a common unit root ($\rho_i = \rho$ for all cross-sections), such as LLC test (2002), Breitung test (2000), and Hadri test (2000). Second, we can assume that ρ_i vary freely across cross-sections (test relaxes the assumption of homogeneity), such as IPS test, Fisher-ADF, Fisher-PP test and Choi test.

Tests with common unit root processes

Levin, Lin and Chu (LLC) (2002) test use a version of the basic ADF equation:

$$\Delta y_{it} = \alpha_{0i} + \alpha_i y_{it-1} + \gamma t + + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + x_{it}\delta + \varepsilon_{it} \tag{4}$$

where Δ is the first difference operator, y_{it} is the unemployment rate, and i = 1, 2…N indexes across cross section regions, ε_{it} is assumed to be independently distributed across individuals. In this model the deterministic components are an important source of heterogeneity and the coefficient of the lagged dependent variable is restricted to be homogeneous across all units in the panel. LLC tested the null hypothesis of $H_0 : \alpha_1 = \alpha_2 = ...\alpha_N = \alpha = 0$ against the alternative of $H_1 : \alpha_1 = \alpha_2 = ...\alpha_N = \alpha < 0$. The test is based on the test statistic $t_{\alpha_i} = \dfrac{\widehat{\alpha}_i}{se(\widehat{\alpha}_i)}$ (where $\widehat{\alpha}_i$ is the OLS estimate of α_i in equation (4) and $se(\widehat{\alpha}_i)$ is its standard error).

LLC obtain the following modified *t*-statistic for the estimated α which is normally distributed:

$$t_\alpha^* = \frac{t_a - (N\widetilde{T})\widehat{S}_{NT}\widehat{\sigma}_\varepsilon^{-2} se(\widehat{\alpha})\mu_{mT*}^*}{\sigma_{mT*}^*} \rightarrow N(0,1) \tag{5}$$

where t_a is the standard t-statistic for $\hat{\alpha}=0$, $se(\hat{\alpha})$ is the standard error of $\hat{\alpha}$, μ^*_{mT*} and σ^*_{mT*} the mean and the standard deviation adjustment terms which are obtained from Monte Carlo simulation and tabulated in Levin and Lin's paper (1992). $\hat{S}_{NT}=\frac{1}{N}\sum_{i=1}^{N}\frac{\hat{\sigma}_{yi}}{\hat{\sigma}_{\varepsilon i}}$, where $\hat{\sigma}_{yi}$ denotes a kernel estimator of the long-run variance for the individual i.

The Breitung (2000) unit root test differs from the Levin, Lin and Chu (LLC) (2002) method in two ways. First, as opposed to the LLC method, it removes only the auto-regressive component in constructing proxies for Δy_{it} and y_{it}. Second, the proxies for Δy_{it} and y_{it} are transformed and de-trended. Then the persistence parameter, α, is estimated from the following pooled proxy equation (Wickremasinghe, Kim (2008).

$$\Delta y^*_{it}=\alpha y^*_{it-1}+e_{it} \tag{6}$$

where e_{it} is the white noise error term.

The Hadri LM Test (2000) differs from the other tests in that its null hypothesis is that all series in the panel are stationary. The test statistic is distributed as standard normal under the null hypothesis. As in the univariate KPSS test, the series may be stationary around a deterministic level or around a unit–specific deterministic trend. The error process may be assumed to be homoskedastic across the panel, or heteroskedastic across units. Serial dependence in the disturbances may also be taken into account using a Newey–West (1994) estimator of the long–run variance. (Baum, 2003) Using the residuals from OLS regressions for individual series in the panel, we can compute the LM statistic as follows:

$$LM_1=\frac{1}{\bar{f}_0}\frac{1}{NT^2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}S_{it}^2\right) \tag{7}$$

where S_{it}^2 are the cumulative sum of residuals and $\bar{f}_o$ is the average of individual estimators of the residual spectrum at frequency zero. Hadri (2000) also provides an alternative Lagrange Multiplier (LM) statistic that allows for hereroskedasticity across cross-sections:

$$LM_2=\frac{1}{\bar{f}_{0,i}}\frac{1}{NT^2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}S_{it}^2\right) \tag{8}$$

Hadri [12] proves that under mild assumptions:

$$Z_\mu=\frac{\sqrt{N}(LM-\xi_\mu)}{\zeta_\mu}\rightarrow N(0,1) \tag{9}$$

where $\xi_{\mu} = \frac{1}{6}$ and $\zeta_{\mu} = \frac{1}{45}$ when only constants are included in the model, and

$$Z_{T} = \frac{\sqrt{N}(LM - \xi_{T})}{\zeta_{T}} \rightarrow N(0,1) \qquad (10)$$

where $\xi_{T} = \frac{1}{15}$ and $\zeta_{T} = \frac{11}{6300}$ if both a constant and a time trend are included in the model.

Tests with individual unit root processes

The Im, Pesaran and Shin (IPS) (2003) test extends the Levin, Lin and Chu (LLC) (2002) framework to allow for heterogeneity in the value of under the alternative hypothesis. Given the equation (4), the null and alternative hypotheses are defined as:

$H_0 : \alpha_i = 0$ for all i

$$H_1 : \begin{cases} \alpha_i < 0 & for \quad i = 1,...,N_1 \\ a_i = 0 & for \quad i = N_1 + 1,...N \end{cases} \quad \text{with } 0 < N_1 < N$$

that allows for some (but not all) of individual series to have unit roots.

Im, Pesaran and Shin (IPS) (2003) compute separate unit root tests for the N cross-section units and define their t-bar statistic as a simple average of the individual ADF statistics $\bar{t}_{NT}$. Im, Pesaran and Shin (IPS) provide simulated critical values for different numbers of cross-sections and series lengths when the lag order of the ADF equations is zero. When the lag order for some cross-sections in the panel is non-zero, Im, Pesaran and Shin (IPS) shows that a properly standardised $\bar{t}_{NT}$ follows an asymptotic standard normal distribution. The new test statistic denoted by $W_{\bar{t}_{NT}}$ is computed as follows:

$$W_{\bar{t}_{NT}} = \frac{\sqrt{N}\left(\bar{t}_{NT} - N^{-1}\sum_{i=1}^{N} E(\bar{t}_{iT})(P_i)\right)}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(\bar{t}_{iT})(P_i)}} \qquad (11)$$

where $E(\bar{t}_{iT})$ and $Var(\bar{t}_{iT})$ are expressions for the mean and variance of the ADF regression t-statistics.

Maddala and Wu (1999) and Choi (2001) suggest a non-parametric approach that Fisher (1932) used which is based on a combination of the p-values of the test-statistics for a unit root in each cross-sectional unit. If the test statistics are continuous, the significance levels p_i (i = 1, 2,…,N) are independent uniform variables and p_i has a X2 distribution with two degrees of freedom. If π_i is the p-value for any individual unit root test for cross-section i we get:

$$\lambda = -2\sum_{i=1}^{N}\log(\pi_i) \rightarrow x_{2N}^2 \tag{12}$$

Choi proves that:

$$Z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\Phi^{-1}(\pi_i) \rightarrow N(0,1) \tag{13}$$

where Φ^{-1} is the inverse of the standard normal cumulative distribution function.

Empirical results

For the presence of hysteresis, we first apply several conventional unit root tests to examine the null of a unit root in the unemployment rate of each country. The results in Table 2 indicate that the tests ADF (of Dickey, Fuller, 1979), and PP (of Phillips, Perron, 1988) fail to reject the null hypothesis of non-stationary unemployment for the three countries. Also, the KPSS (of Kwiatkowski, Phillips, Schmidt, and Shin, 1992) test yields the same results.

Table 2

Univariate unit root tests

Country	ADF		PP		KPSS	
	Const.	Const. Trend	Const.	Const. Trend	Const.	Const. Trend
Greece	-1.62(1)	-3.115(6)	-1.063[0]	-1.839[1]	0.430[3]*	0.144[3]*
Ireland	-2.14(2)	0.667(0)	-1.179[3]	-0.364[3]	0.563[3]**	0.132[3]*
Portugal	-1.72(1)	1.530(5)	-1.243[2]	-1.204[2]	0.481[3]*	0.148[3]*

Notes:

1. ***, **, * denotes rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively.
2. The numbers within parentheses for the ADF statistics represents the lag length of the dependent variable used to obtain white noise residuals.
3. The lag lengths for ADF equation were selected using Akaike Information Criterion (AIC) (1973).
4. The numbers within brackets for the PP and KPSS statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel.

The results in Table 2 clearly indicate that all tests fail to reject the null of nonstationarity unemployment for three countries. Since the single equation ADF test has low power with short time spans (Shiller, Perron, 1985), here we have annual observations spanning a 27-years period) we apply the tests of Breitung, Levin, Lin and Chu (LLC), Im, Perasan and Shin W-test (IPS), ADF-Fisher Chi-square test (ADF-Fisher), PP Fisher Chi-Square test (PP-Fisher) (Maddala and Wu), Choi and Hadri based on panel data unit root tests and examine the stationarity of unemployment, avoiding the weakness of the single equation ADF test.

Table 3 shows that the panel based unit root test results are also indicative of the nonstationary unemployment rates. It seems reasonable to conclude that the hysteresis hypothesis for the unemployment rates for the three European countries studied cannot be rejected.

Table 3

Panel unit root tests

Method	Statistics	
	Individual effects	Individual effects and individual linear trends
Null Hypothesis: Unit root (assumes common unit root process)		
LLC (t* - statistics)	-0.947 (0.171)	4.494 (1.000)
Breitung (t – statistics)		5.232 (1.000)
Hadri (Z - statistics)	4.265 (0.000)***	2.886 (0.001)***
Null Hypothesis: Unit root (assumes individual unit root process)		
IPS (W - statistics)	-0.627 (0.265)	3.507 (0.999)
ADF (Fisher X2)	6.286 (0.391)	3.043 (0.803)
PP (Fisher X2)	2.376 (0.882)	1.112 (0.981)

Notes

(1) Panel data include all countries.

(2) The numbers in parentheses denote p-values.

(3) ***, **, * denotes rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively.

(4) The null hypothesis of these tests is that the panel series has a unit root (nonstationary series) except with the Hadri test which has no unit root in panel series.

(5) Probabilities for Fisher tests are computed using an asymptotic X2 distribution. All other tests assume asymptotic normality.

(6) Selection of lags based on SIC. Newey-West bandwidth selection using Bartlett kernel.

Conclusions

Due to current economic crisis, the number of unemployed people increases in many countries. Blanchard and Summers (1986) defined hysteresis as the tendency of cyclical unemployment and pointed out the possible danger of permanent effects that recessions can have on unemployment. The hysteresis is statistically described as the presence of a unit root. Hence, unit root tests are obvious candidate to test for the presence of hysteresis.

In this study, we adopt not only the traditional but also a number of panel unit root tests to investigate the hysteresis in unemployment for three European countries which currently went into surveillance in the IMF for the period 1984-2010. The results from all unit root tests provide strong evidence in support of the hysteresis hypothesis given the three European countries' unemployment data.

Our proposal based on the results of the paper is that governments of the three examined countries should apply a fiscal stabilization policy in order to stop the rise of unemployment rate and also to try and reduce this rate in the average levels of unemployment of other European countries by gradually decreasing taxation.

References

Akaike, H. (1973). "Information theory and an extension of the maximum likelihood principle", in: Petrov, B. and Csake, F. (eds.) 2nd *International Symposium on Information Theory*, Budapest: Akademiai Kiado

Baum (2003). *Time Series Econometrics,* Spring 2003 EC821

Blanchard, O., Summers, L. (1986). "Hysteresis and the European unemployment problem", in S. Fischer (Ed.), *NBER Macroeconomics Annual 1986*, Cambridge MA: MIT Press, pp. 15-78

Breitung, J. (2000). *The Local Power of Some Unit Root Tests for Panel Data*, in B. Baltagi (ed.), *Advances in Econometrics*, Vol. 15: *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, Amsterdam: Jai Press, pp. 161-178

Chang, T., Yuan, H.H., Chung, J.H. (2007). "Revisiting Hysteresis in Unemployment for Ten European Countries: An Empirical Note on a More Powerful Nonlinear (Logistic) Unit Root", *Journal of Economic Development*, 49(32), pp. 49-57

Choi, I. (2001). "Unit Root Tests for Panel Data", *Journal of International Money and Finance*, 20(2), pp. 249-272

Dickey, D.A., Fuller W.A. (1979). "Distributions of the Estimators for Autore-gressive Time Series With a Unit Root", *Journal of American Statistical Association*, 74, pp. 427-431

Fisher, R.A. (1932). *Statistical Methods for Research Workers* (4th Edition). Edinburgh: Oliver and Boyd

Hadri, K., (2000). "Testing for stationarity in heterogeneous panel data", *Econometrics Journal*, 3, pp. 148-161

Hall, R.E. (1979). "A Theory of the Natural Unemployment Rate and the Duration of Unemployment", *Journal of Monetary Economics*, 5, pp. 153-70

Im, K., Pesaran, M., Shin Y. (2003). "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*, 115, pp. 53-74

Jarque, C.M., Bera, A.K. (1987). "A Test for Normality of Observations and Regression Residuals", *International Statistical Review*, Vol. 55(2), pp. 163-172

Kwiatkowski, D., Phillips, P. Schmidt, P., Shin, Y. (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root", *Journal of Econometrics,* 54, pp. 159-178

Levin, A, Lin, C, Chu J. (2002). "Unit root test in panel data: Asymptotic and finite-sample properties", *Journal of Econometrics*, 108, pp. 1-24

Levin, A., Lin, C.-F. (1992). "Unit root tests in panel data: asymptotic and finite-sample properties", *Discussion Paper* 92-93, University of California, San Diego

Lindbeck, A., Snower, D. (1988a). "Cooperation, Harassment, and Involuntary Unemployment: An Insider-Outsider Approach", *American Economic Review*, 78(1), pp. 167-187

Maddala, G., Kim, I-M. (1998). *Unit Roots, Cointegration and Structural Change*, Cambridge University Press

Maddala, G.S., Wu, S. (1999). "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test", *Oxford Bulletin of Economics and Statistics*, 61(4), pp. 631-652

Nelson, C.R., Plosser, C.I. (1982). "Trends and random walks in macroeconomic time series: Some evidence and implications", *Journal of Monetary Economics*, 10, pp. 139-162

Newey, W.K., West, K.D. (1994). "Automatic lag selection in covariance matrix estimation", *Review of Economic Studies*, 61, pp. 631-653

Phelps, E.S. (1972). *Inflation, Policy and Unemployment Theory. The Cost-Benefit Approach to Monetary Planning,* Macmillan

Phillips, P.C., Perron, P. (1988). "Testing for a Unit Root in Time Series Regression", *Biometrika, 75*, pp. 335-346

Shiller, R.J., Perron, P. (1985). "Testing the random walk hypothesis: power versus frequency of observation", *Economic Letters,* 18, pp. 381-386

Wickremasinghe, G.B., Kim, H.J. (2008). "Weak-Form Efficiency of Foreign Exchange Markets of Developing Economies: Some Sri Lankan Evidence", *Journal of Emerging Market Finance*, 7(2), pp. 169-196