Universitat de les Illes Balears

Facultat d'Economia i Empresa

Memòria del Treball de Fi de Grau

Hysteresis and change of persistence in unemployment rates, international evidence Grau d'Economia

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Grau d' Economia
Any acadèmic 2013-14

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Paraules clau del treball:
Hysteresis, Unemployment rate, Unit root, Random walk, Trend, Persistence, Non accelerating inflation rate of unemployment...

INDEX

ABSTRACT

The goal of the objective is give an empirical answer to the problem that is facing the Economic Theory in the last decades and nowadays it is a concerning issue in many European countries. It has been observed how the last recessions and important shocks have generating a necessary debate in questioning the natural rate theories. As a result, the answer we try to give is related with the hysteresis theories which argue that the actual unemployment depends on the past unemployment. The evidence will be searched through the use of unit root tests.

STRUCTURE OF THE WORK

Along this work we are going to talk about the unemployment rate hysteresis phenomenon which has been depicted in Europe during the 80s and nowadays seems to repeat the same behavior with the high persistence of unemployment. The work is structure as follows: a first part will be devoted to give an introduction about the concept of unemployment, the characteristics of the labor market that produce it and other macroeconomic concepts that will help us to understand better the development of the project. A second part would be expended in showing the different hysteresis theories and present the difference between persistence and hysteresis. The last part before the analysis will be devoted to relate the unemployment rate and hysteresis theories with econometrics. Finally it will be developed the analysis to test the unit root for a sample of five countries: Germany, Japan, United Kingdom, United States and Spain.

1. CONCEPT OF UNEMPLOYMENT IN A MACROECONOMICS WAY

A first question we should wonder is the following: why is there unemployment? Unemployment is, according to neoclassic theory, just a response of the labor market to the rigidities (regulations and policies) that avoid the market to clear. However, one may wonder why is there unemployment even when the economy is working perfectly, that is, at full employment[1]? There are two main theories[2] that explain this phenomenon in Macroeconomics: One is the natural rate of unemployment theory[3] and the other is the hysteresis hypothesis.

There is common agreement among orthodox economists that exists a rate of unemployment that doesn't accelerate the inflation rate, at which real wage rates are tending on the average to rise at a normal rate, and which causes that the unemployment rate revert to its equilibrium in the long run (even in spite of cyclical movements). In allusion to Friedman(1968):

> *"The "natural rate of unemployment," in other words, is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor avail-abilities, the costs of mobility, and so on."[Friedman (1968), p. 8]*

We have to distinguish between long-run trend and short-run (transitory) fluctuations. One important statement relating this distinction is that demand policies are able just to manage short term fluctuations, but not long run movements, at which just causes disturbances in the nominal magnitudes (inflation).

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[1] Hall, R. E. 1970 "Why is the unemployment rate so high at full employment?" *Brooking Papers on Economic Activity, Vol. 3(1973),* 369-410

[2] Camarero, M.; Carrion-i-Silvestre, J.L.; Tamarit, C. 2006. "Testing for Hysteresis in Unemployment in OECD Countries: New Evidence using Stationarity Panel Tests with Breaks*," Oxford Bulletin of Economics and Statistics, Department of Economics, University of Oxford*, vol. 68(2): 167-182 (S*ee Introduction)*

[3] From now for simplification we will refer to the Natural Rate of Unemployment or Non Accelerating Inflation Rate of Unemployment as *NRU*

2. THE CONCEPT OF HYSTERESIS. WHY IS IT SO IMPORTANT IN THIS WORK?

2.1. THEORIES OF HYSTERESIS

This concept refers to the "history matters" property and comes from natural sciences and it states:

> "*The long-run solution of such a system does not only depend on the long-run values of the exogenous variables but also on the initial condition of each state variable*[4]*"[Franz (1990), p.2]*

The definition of natural sciences is associated to an irreversible thermodynamic change, but its meaning has been spread to social sciences as Economics. There are two main areas in Economics at which this concept is applied: International trade and labor economics (the one that we want to use).

In International trade it is based on the fact that if there is temporary shock in an economy (e.g. a sufficiently high increase in the exchange rate) that induces foreign firms to start producing in that market, it will be a "permanent" choice due to the fact that those firms had to face important costs that are not recoverable (sunk costs[5]). As a result, if the shock reverts (e.g. the exchange rate falls) those firms won't have incentives to exit that market because of those not recoverable costs[6]. We won't deepen into this topic because the one that concerns us is the related with the labor market.

In Labor Economics (Samuelson 1965) the hysteresis theory states that cyclical movements have permanent effects on the level of unemployment due to labor rigidities. Therefore, the unemployment rate can be characterized as a non-stationary process or differentiated-stationary. Mitchell W.E. uses an allusion of Buiter to explain hysteresis "*Where you get to is determined by how you get there*" to show that the past has to do on the long run rate. Robert Solow stated:

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[4] Franz, W. (1990). "Hysteresis in economic relationships: An overview" *Hysteresis effects in economic models, Empirical Economics,* 1-17

[5] This model assumes that sunk costs don't have to be just fixed costs (as it is assumed in the first model of Baldwin, 1990). However, these not recoverable costs can be represented (as it is done in the second model of multiple equilibria of Baldwin) as the possibility of a firm to be sacked of the market in the presence of an exchange rate shock.

[6] Baldwin, R. (1990). "Hysteresis in Trade" *Hysteresis effects in economic models, Empirical Economics:* 127-142 (*See 127-130*)

"A natural rate that hops around from one triennium to another under the influence of unspecified forces, including past unemployment rates, is not 'natural' at all" [from Franz (1990), p. 116, who took it from Solow (1996), p. 533]

2.2. HYSTERESIS MECHANISMS IN THE LABOR MARKET

According to that there are three main deeply studied mechanisms that produce/explain hysteresis. The **first one** is based on the hypothesis that unions/membership just care of insiders, that is, as wage is down-rigid because of it is the main subsistence source, they prefer to maintain or increase their wages rather than lose purchasing power in order to allow outsiders to find a job by raising the employment demand of firms. There are two models trying to explain this phenomenon inside this theory, one at which it is assumed that outsiders don't have any pressure on wages and the other at which this assumption is relaxed.

1. When outsiders don't have any influence on wages, employment it is said that follows a random walk at which innovations are explained due to unexpected movements in aggregate demand (unexpected changes in nominal money):

$$n_t = n_{t-1} + [m_t - E(m)]$$

Thus, we observe that there is no tendency of the economy to come back to its steady state. Against a negative shock, workers still working don't want to reduce wages to increase employment, while in the case of a positive shock, outsiders now working don't desire to increase wages because it implies to overvaluate themselves and probably being fired in a near future.

2. When there is pressure on wages due to outsiders (nearer to reality), firms have the chance to hire them and force unions/membership insiders to decrease wages due to outside competition. In addition, higher unemployment implies that in case of being unemployed, there is risk of not being able to find a new job or of finding one of lower level, forcing insiders to accept lower wages. Another possible case is the one at which firms decide to renew the staff replacing high-wage-paid insiders by low-wage-paid outsiders. It is modeled as first order AR as follows:

$$n_t - \bar{n} = \frac{1}{1+b}(n_{t-1} - \bar{n}) + [m_t - E(m_t)]$$

Where b represents de degree of persistence: the higher the b, the higher the persistence and vice versa, but if b=1, employment follows a AR(1) and it is stationary. In absence of b=0 and if b is small, when there is an adverse shock unemployment follows a random walk, that is, it is a I(1).

To sum up, it is said that in the presence of a negative shock at which unemployment decreases, insiders become less with more power and they set wages so as to maintain the new, lower level of unemployment. Why is it that way? Due to two reasons: unions are more concerned about insiders than about outsiders, and outsiders cannot find jobs at lower wages than those set by unions.

The **second one,** also called unemployment duration, is related with long term unemployment. It argues that in the relationship *employee searcher-employer searcher* the variable long term unemployment is very significant, in the sense that the longer the time without a job, the higher the human capital depreciation (considering that skills are acquired not only on-the-job-training but also through changing jobs) and of course, the lower the pressure they can exert on wages. As a result, it is considered that there is a "pool" of long-term unemployment which is very difficult to recover.[7]The conclusion of this theory stands that just short term unemployment is able to have an effect on wages, and long term unemployment has a strong effect on equilibrium unemployment for some time.

Finally, the **last one** turns out the role of capital stock in the sense that if there is a shock that affects negatively the capital stock and e.g. reduces the capacity of a firm, it will generate unemployment. As the capacity of the firm cannot be restored immediately because of adjustment costs, it would be persistence in the unemployment, showing somehow hysteresis[8].

There is also a similar approach of Phelps[9] that explains two hysteresis effects which would make the natural rate of unemployment dependent upon the history of actual

[7] Blanchard, O. J. & Summers, L. H. (1987). "Hysteresis in unemployment" *European Economic Review, Vol. 31, No.1,* 288-295. (The reference is for both theories, the insider-outsider and the duration theory)

[8] Franz, W. (1990). "Hysteresis in economic relationships: An overview" *Hysteresis effects in economic models, Empirical Economics,* 1-17 *(See pages 9-11)*

[9] Cross, R. (1986), "Phelps, Hysteresis and the Natural Rate of Unemployment", *Quarterly Journal of Business and Economics, Vol. 25, No. 1, Winter,* 56-64

employment. The first effect explains the relationship between the level of employment and the level of human capital of labor force: the higher the unemployment, the less skilled the labor force. Hence, long-term unemployment tend to produce less employable people. While the second effect is related to the role of trades unions, which says that the higher the employment, the lower the power of trade unions and thus the lower the wage bargaining power.

2.3. PERSISTENCE VERSUS HYSTERESIS

After having showed the two hypotheses (NRU and hysteresis) and the major channels to which hysteresis affects the economy, it is important to turn out the difference between "persistence" and "hysteresis", because they are two concepts that are much related but very different. The persistence implies that the adjustment of the economy towards the equilibrium is slow. Even though, the effects of a shock could last a lot, that is, the effects could have long-lasting memory, we need to have in mind that this concept is a special case of the NRU, so at the end the economy will come back to the equilibrium. Which is the difference with hysteresis? The first one may have long-lasting effects but not permanent, while in the second case the shock would have permanent effects[10].

To see the difference we can take the model of Gordon (1989)[11]:

$$p_t = a \cdot p_{t-1} + \beta \cdot (U_t - \boldsymbol{U_t^*})$$

$\boldsymbol{U_t^*} = n \cdot U_{t-1} + \gamma \cdot Z_t$ rearranging U_t^* into p_t we get the equation of the model

$$p_t = a \cdot p_{t-1} + \beta \cdot (1 - n) \cdot U_t + \beta n \Delta U_t - \beta \gamma Z_t$$

Where: $p_t$is the inflation rate; U_t is the unemployment rate; U_t^* is the NRU; Z_t other explanatory variables explaining the NRU; n is the sensitiveness of NRU to past unemployment rates.

[10] Roed, K. 1996. "Unemployment hysteresis-Macro evidence from 16 OECD countries" *Empirical Economics, Vol. 21*, 589-600

[11] Gordon, R.J. (1989) "Hysteresis in History: Was there ever a Phillips curve?" *The American Economic Review, Vol. 79, No. 2,* 220-225

This model tell us that when n=1 there is full hysteresis (no long run NRU exists at all), and when n<1 there is persistence (short run NRU converges slowly towards its equilibrium level).

3. UNEMPLOYMENT RATE AND ECONOMETRICS

How can we relate these concepts of NRU, hysteresis and persistence with econometrics? What we have shown is just the theoretical framework of the unemployment rate, the empirical framework is the one related with econometrics. We will see the following relationships:

NRU is based on trend stationary processes

Hysteresis is based on difference stationary processes

3.1. STATISTICAL BACKGROUND[12][13]

First of all, we want to make sure that all the readers are aware of the concepts that are going to be used along the work. Time series can be splitted into two types: stationary or non-stationary.

Stationary series are those with transitory movements, denoted as I(0), can be stationary in strong sense or in weak sense. The first case (not usual) is the one at which mean and variance don't depend on time and correlations through time don't change. Stationarity in weak sense is the one at which mean is exogenous to time. In addition, series can also be stationary in tendency (deterministic) with temporal shocks and in differences (with permanent shocks).

On the other hand, non-stationary series are those that lack a fixed long term mean, that is, it is not going to go back to its initial point, due to it will grow/decrease along time or the effect of innovations is permanent in time. There are two main different types of non-stationary series: the trend stationary processes (TS) are those that have a deterministic function of time and a stationary stochastic process with mean zero. What it is almost a norm in economics is to transform into logs the series. In Nelson and

[12] Nelson, C.R. & Plosser, C.I. 1982 "Trends and random walks in macroeconomic time series" *Journal of Monetary Economics 10,* 139-162 (*See pages 139-146)*

[13] Mahadeva, L. & Robinson, P. 2009 "Prueba de raíz unitaria para ayudar a la construcción de un modelo" *Centro de Estudios Monetarios Latinoamericanos, Ensayo 76*

Plosser it is assumed that the deviations from trend have a representation as a stationary and invertible ARMA process. The other type of processes are the difference stationary processes (DS) or integrated processes[14] which are those that become stationary after taking one or more differences (with the first difference is usually enough) which are denoted as I(d), where d is the order of integration[15], and the differenced series in this case may follow stationary and invertible ARMA processes.

Trend Stationary: $\boldsymbol{z_t = a + \beta t + c_t}$

$where\ c_t = \frac{\theta(L)u_t}{\phi(L)}\ with\ u_t \sim NID(0, \sigma_u^2);$

$\theta(L) and\ \phi(L)\ are\ polinomials\ in\ the\ lag\ operataor\ related\ to\ the\ MA\ and\ AR\ processes$

1st difference DS: $\boldsymbol{z_t = z_0 + \beta t + \sum_{j=1}^{t} d_j}\ \ where\ d_j = \frac{\delta(L)u_t}{\lambda(L)}\ with\ u_t \sim NID(0, \sigma_u^2)$

If we take the mean and the variance of these processes, we will see that the main differences between them are: TS processes are deterministic since their mean are a constant and fixed trend and they have a finite variance, while DS processes are stochastic as they have a mean depending on the past and their variance is not finite. How can we describe it in other word? The TS processes are those at which you have certainty about what is going to happen in the future, while in DS processes you don't know what is going to happen in the future with certainty. As a result, the most usual thing in Economics is finding DS processes.

For example:

We have the following random walk (a=1): $y_t = ay_{t-1} + e_t$

$y_{t+n} = y_{t-1} + \sum_{i=0}^{n} e_{t+1}$ →*first difference* →$\Delta y_t = y_t - y_{t-1} = e_t$

After taking the first difference it becomes stationary.

What is a spurious regression and why do we have to make sure that we don't have one? A spurious regression is detected when it is assigned a causal relationship between non-stationary series and the standard errors obtained are biased. In these situations, we will have a very good adjustment, very significant t-statistics, but a low Durbin Watson.

[14] Also denoted as stochastic trend or unit root

[15] The order of Integration is the number of unit roots that have the series or the number of differences it takes to transform it into stationary.

That happens because the regression collect the deterministic trend in each variable and ascribe it to the independent one. When we identify the variables as stationary it is less likely to find spurious regressions, but not impossible. In addition, when we have stationary series very autoregressive or a short sample it is more probable to have spurious regressions.

What is a Unit Root Test and why is so important? A Unit Root Test[16] is just a method to see whether a series is or not stationary, but also to try to avoid the spurious regression problem. It is fundamental do it before using it in a regression because the inference theory is not prepared to work with series that have a integrated variable. The most used tests are the Augmented Dickey-Fuller (1979), Phillips-Perron (1988), Dickey-Fuller GLS-detrended (1996), KPSS (1992), ERS (1996) and Ng-Perron (2001). The one we are going to use is the Dickey-Fuller GLS-detrended.

3.2. HYSTERESIS IN ECONOMETRICS[17][18]:

We have seen that hysteresis is a synonym of a historical system at which the steady solution will not only depend on the long-run values of the variables, but also on the initial state value. How is it translated into econometrics? It is present when there are one or more unit roots in the equation of the process we are trying to describe.

Let's say the following process: $y_t = ay_{t-1} + z_t$ where z_t is an exogenous variable. The steady state equation is as follows: $\bar{y} = \frac{\bar{z}}{(a-1)}$ where the steady state value for y just depends on the steady state value of z, but if a=1, there will not be a unique value for y. So what we have in the steady state is the following process:

$$y_t = y_0 + \sum_{i=1}^{t} z_i$$

We see that any temporal disturbance on z will have a permanent effect on the steady state value of y.

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[16] Dickey, D. A., Bell, W. R., & Miller, R. B. (1986). "Unit roots in time series models: Tests and implications." *The American Statistician, Vol. 40 No.1,* 12-26.

[17] Neusser, K. (2012). "Difference equations for economists (preliminary and incomplete)" *University of Bern, Publications, (See pages 11-12)*

[18] Franz, W. (1990). "Hysteresis in economic relationships: An overview" *Hysteresis effects in economic models, Empirical Economics*, 1-17 *(See pages 2-4)*

We can transform the latter process into multidimensional first order difference process:

$y_{t+1} - y_t = \phi y_t + z_t \rightarrow y_t = \phi^* y_{t-1} + z_t$, where $\phi^* = 1 + \phi$ and ϕ is a stochastic matrix[19]. Hysteresis happens if $|\phi^*| < 1$, that is, the equation system is stable[20] or $\phi = 0$.

3.3. Dickey-Fuller GLS-Detrended Test

This test is just an extension and improvement of the Dickey-Fuller[21] test. The main purpose of this analysis is to discriminate the trend, that is, being able to classify the process as stationary in variance/integrated of order 0 (TS) or not/integrated of order 1 (DS).

As a summary, the difference between the DF and the DF-GLS[22] is that in the second one the time series is transformed, previously to the test, with Generalized Least Squares. The transformation is just done to remove the deterministic trend because it is usually unknown, but in the case that the trend was known is not useful remove it due to the traditional DF is as valid as the DF-GLS (in that situation is better to specify the trend, rather than remove it).

4. EMPIRICAL RESULTS

4.1. INTRODUCTION

In this part we show the different analysis and tests that we have done in order to see how unemployment behaves and study whether there is presence or not of hysteresis. We have taken a sample of five countries: Germany, Japan, United States, United Kingdom and Spain. The period of each country is different because of the statistical information is not the same for each country, but we have tried to

[19] A stochastic matrix is the one used to transform a system from one state to another according to the Markov Chain. In the case of unidimensional model it was just a scalar, but now it is a matrix of eigenes values.

[20] An equation is stable whenever the solutions of differential equations and of dynamical systems stabilize under changes in the initial values.

[21] Dickey, D. A. & Fuller, W. A. (1979). "Distribution of the Estimators for Autoregressive Time Series with a Unit Root" *Journal of the American Statistical Association, Vol.74, No.366,* 427–431

[22] Elliott, G., Rothenberg, T. J., & Stock, J. H. (1992). "Efficient tests for an autoregressive unit root." *Econometrica, Vol. 64, No. 4,* 813-836

find at least long series of time to do the tests properly. This part is structured into a first part of Unit Root Tests, where we test the model with constant (composed by a constant, lags of the log unemployment rate variable, lags of the difference of the log unemployment rate variable and the error term) and the model with constant and trend (basically the same, but now a trend is introduced).

4.2. Evidence: What did we see in data to guess that it is possible to exist hystereis?

If we have a look at the graphs, we see that after a big recession/expansion due to supply the economy tends to recover/fall but after that, it falls again into another recession/expansion.

Describing the Spanish case, it is remarkable that the country after becoming a democracy it faced a transition period of crisis and low economic growth due to the problems arising with oil, then it went through some years of high growth of the GDP rates due to the measures it were taken in the Moncloa agreement and the integration with the EU.

The first sign of hysteresis appeared in the crisis of 90s, reaching an unemployment rate similar but higher than the one in 80s. After this crisis, it took place the last expansionary period, focused on the demand side. The result of this untenable growth sustained on an economic model based on a non-competitive sector, uncontrolled rising of temporary contracts, trend to depreciate the country human capital and so on, has been another great crisis that has even overcame the unemployment rate levels of the 90s. Is this an indicator of having hysteresis in the unemployment rate or is it just mere coincidence?

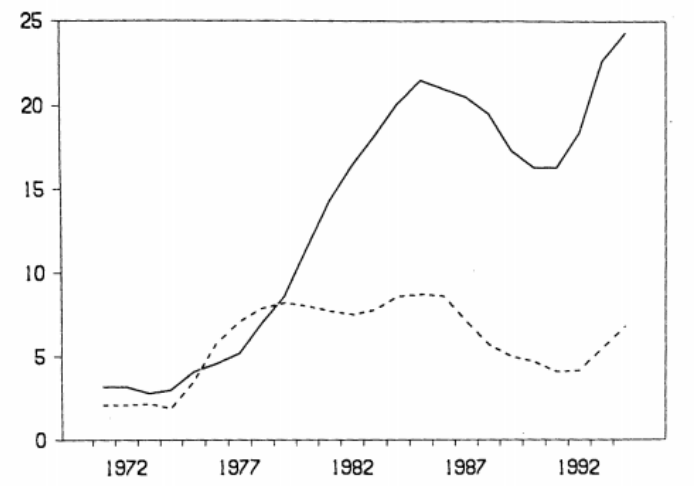


FIGURE 1. UNEMPLOYMENT RATES (PERCENTAGES) FOR SPAIN (SOLID CURVE) AND PORTUGAL (DASHED CURVE), 1971–1994

Source: Blanchard, O. & Jimeno, J.F. (1995) "Structural unemployment: Spain versus Portugal" The American Economic review, Vol.85, No.2

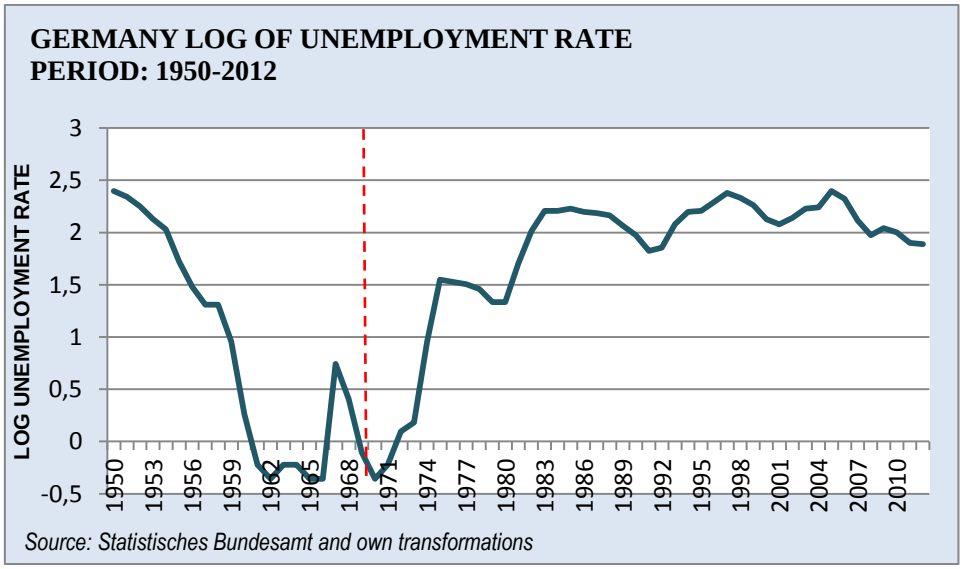
Comparing the case of Spain with Portugal in reference to the Blanchard & Jimeno (1995)[23], we see that two very similar countries had very strong disparities in unemployment rates. The evidence has shown that Spain had higher persistence in unemployment, and they argue that the unemployment benefits have something to say about that (Spain historically had more unemployment benefits than Portugal, and thus more unemployment persistence). They advert that hysteresis may have influenced the persistence in Spain due to the long-term unemployment, and also they suggest that the process of disinflation in Spain due to oil was not good because it happened while active population and wages were increasing, in contrast with Portugal.

[23] Blanchard, O. & Jimeno, J.F. (1995) "Structural unemployment: Spain versus Portugal" *The American Economic Review, Vol.85, No.2,* 212-218

4.3. UNIT ROOT TESTS RESULTS

There is a type-case of Germany to show how the procedure of rejecting or not the null hypothesis it is done and which is the best approach between constant or trend and constant. It is not showed for all the countries in that way because it would be very repetitive.

a. GERMANY



It has been considered the time period 1970-2012 because there is an structural change in that year. For that reason, it is not useful for us consider what happened before that structural change since it would bias our analysis and we would overestimate coefficient and reject with a higher probability the null hypothesis.

1) Model with constant:

$$\Delta log\_germany_{-t} = \alpha + \rho \cdot log\_germany_{-t-1} + \sum_{i=1}^{p} \gamma_i \, \Delta log\_germany_{-t-1} + u_t$$

The coefficient *log_germany_(-1)*= -0.094, so it is inside the parametric space.

The Durbin-Watson=2.190 so, as it is close to 2 we can conclude that there is almost no autocorrelation.

¿Is the error term a white noise, that is, does it has autocorrelation?

We can observe at the correlogram that it is a white noise, as it was supposed to be.

Q-Statistic provide us high values, so if we look at the p-value=0 we can reject the null hypothesis, so there is autocorrelation.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.113	-0.113	0.5902	0.442
**| . |	**| . |	2	-0.264	-0.281	3.8846	0.143
. |*. |	. | . |	3	0.135	0.072	4.7725	0.189
.*| . |	**| . |	4	-0.196	-0.268	6.6778	0.154
**| . |	**| . |	5	-0.236	-0.274	9.5171	0.090
. |*. |	.*| . |	6	0.104	-0.136	10.077	0.121
. |*. |	. | . |	7	0.160	0.044	11.449	0.120
. | . |	. | . |	8	-0.011	-0.010	11.455	0.177
. | . |	. | . |	9	0.046	-0.002	11.578	0.238
. | . |	.*| . |	10	-0.056	-0.142	11.763	0.301
. | . |	. |*. |	11	0.013	0.076	11.772	0.381
. | . |	. |*. |	12	0.053	0.105	11.946	0.450

2) Model with constant and tendency:

$$\Delta \boldsymbol{log\_germany_{-t}} = \boldsymbol{\alpha} + \boldsymbol{\beta} \cdot \boldsymbol{t} + \boldsymbol{\rho} \cdot \boldsymbol{log\_germany_{-t-1}} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{p}} \boldsymbol{\gamma_i}\, \Delta \boldsymbol{log\_germany_{-t-1}} + \boldsymbol{u_t}$$

The coefficient *log_germany_(-1)*= -0.078, so it is inside the parametric space.

The Durbin-Watson=2.185 so, as it is close to 2 we can conclude that there is almost no autocorrelation.

¿Is the error term a white noise, that is, does it has autocorrelation?

We can observe at the correlogram that it is a white noise too.

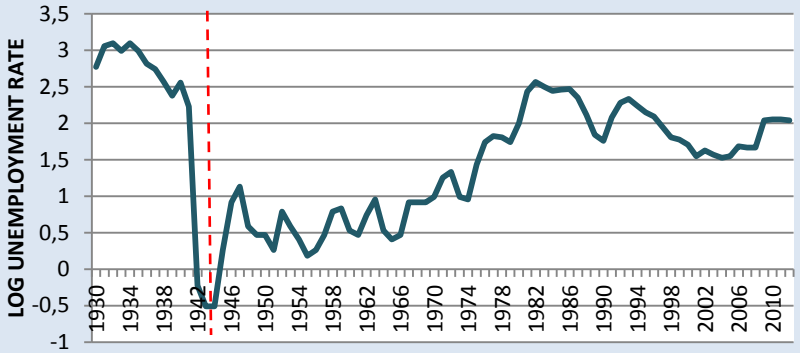
Q-Statistic provide us high values, so if we look at the p-value=0 we can reject the null hypothesis of white noise, as a result there is autocorrelation.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.108	-0.108	0.5368	0.464
**| . |	**| . |	2	-0.262	-0.277	3.7874	0.151
. |*. |	. |*. |	3	0.151	0.093	4.8965	0.180
.*| . |	**| . |	4	-0.171	-0.235	6.3389	0.175
**| . |	**| . |	5	-0.223	-0.231	8.8811	0.114
. |*. |	.*| . |	6	0.109	-0.083	9.5050	0.147
. |*. |	. |*. |	7	0.158	0.087	10.844	0.146
. | . |	. | . |	8	-0.017	0.027	10.860	0.210
. | . |	. | . |	9	0.036	0.022	10.931	0.280
. | . |	.*| . |	10	-0.061	-0.121	11.148	0.346
. | . |	. |*. |	11	0.012	0.087	11.156	0.430
. | . |	. |*. |	12	0.054	0.099	11.337	0.500

4.4. ANALYSIS OF THE RESULTS FOR ALL COUNTRIES

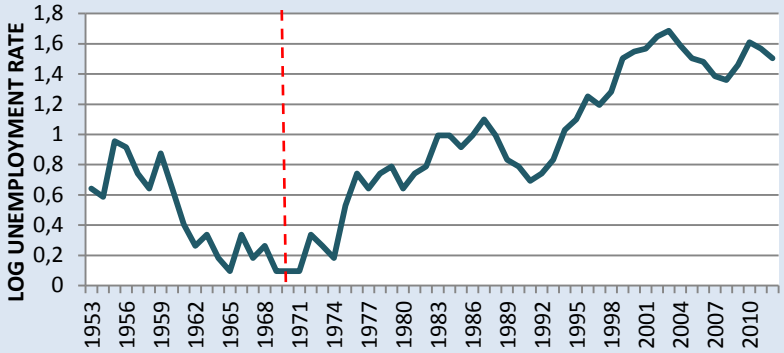
A. GRAPHS

UNITED KINGDOM LOG OF UNEMPLOYMENT RATE
PERIOD: 1930-2012



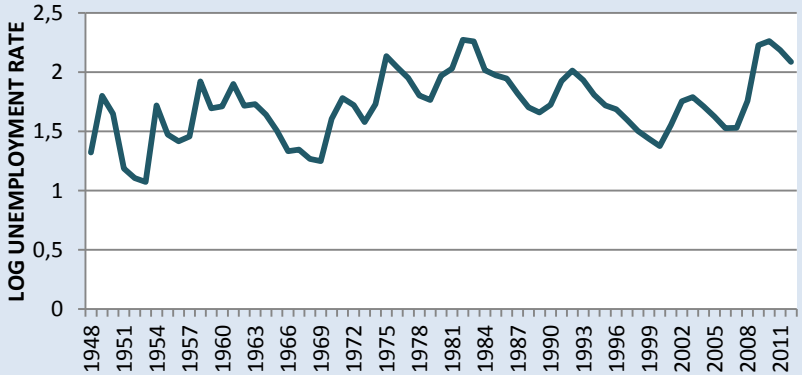
Source: UK National Statistics and own transformations

JAPAN LOG OF UNEMPLOYMENT RATE
PERIOD: 1953-2012



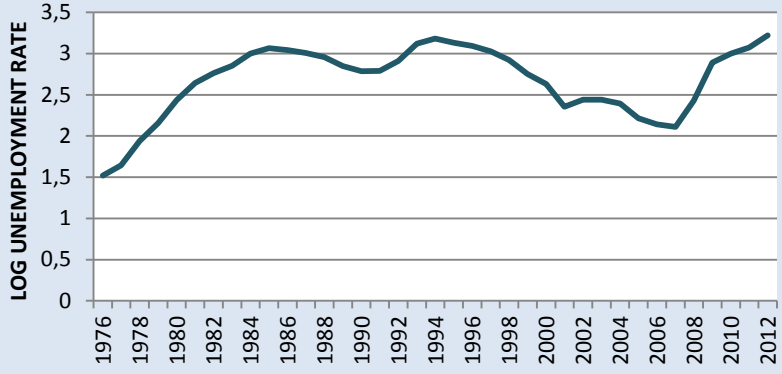
Source: Statistics Bureau of Japan (Ministry of International Affairs and Communications) and own transformations

UNITED STATES LOG OF UNEMPLOYMENT RATE
PERIOD: 1948-2012



Source: Bureau of Labor Statistics (United States department of Labor) and own

SPAIN LOG OF UNEMPLOYMENT RATE
PERIOD: 1976-2012



Source: Instituto Nacional de Estadística (INE) and own transformations

B. TABLES

SUMMARY TABLE 1:
THE DICKEY FULLER COEFFICIENT WITHOUT BREAK

	CONSTANT		CONSTANT AND TREND	
	ADF-OLS	**DF-GLS**	**ADF-OLS**	**DF-GLS**
GERMANY	-3.146**	-1.156	-2.249	-1.582
JAPAN	-1.715	-0.271	-2.539	-2.088
USA	-3.642**	-2.181**	-3.081**	-3.154**
UK	-1.528	-2.130**	-1.469	-1.957
SPAIN	-3.086**	-1.442	-3.031	-2.325

*Reject null hypothesis at: *(10%); **(5%); ***(1%)*

SUMMARY TABLE 2:
THE Q-STATISTIC

	CONSTANT	CONSTANT &TREND
	ADF-OLS	**ADF-OLS**
GERMANY	22.628***	22.996***
JAPAN	13.556*	14.821*
USA	3.406*	2.956*
UK	5.783*	6.186*
SPAIN	8.846*	8.877*

*Cannot reject null hypothesis at: *(10%); **(5%); ***(1%)*

Q-Statistic of the 11^{th} lag

SUMMARY TABLE 3:
THE DICKEY FULLER COEFFICIENT WITH BREAK

	CONSTANT		CONSTANT AND TREND	
	ADF-OLS	**DF-GLS**	**ADF-OLS**	**DF-GLS**
GERMANY	-1.493	-1.241	-2.261	-1.529
JAPAN	-0.754	-0.643	-2.225	-1.853
USA	-3.642**	-2.181**	-3.081**	-3.154**
UK	-2.096	-1.269	-2.236	-1.529
SPAIN	-3.086**	-1.442	-3.031	-2.325

*Reject null hypothesis at: *(10%); **(5%); ***(1%)*

C. COMMENTS

The procedure of the analysis has been analyzing the graphs and choose the time interval without including a structural change or break and with the break. We will see that the results considering the structural change and without considering it are different because in presence of a one time-break the unit root test results doesn't work properly[24]. To do it properly it would be necessary, as Perron suggests, introducing a change in the intercept and a change in the slope after the break.

What it is observed in the graphs is that Germany (1970-2012), Japan (1940-2012) and United Kingdom (1945-2012) are those with a break. For the United States and Spain it has been not necessary to do any change in the time series. According to the graphs it is clear that there is a positive trend in all the cases, but we have tested the unit root for both with constant and with constant and trend to discard possible disturbances.

Comparing the break case with the one without break, it is observed that in the case where the break (*Summary table 3*) it is considered the null hypothesis of unit root is not rejected, just in the cases of USA and Spain (which are those that doesn't have presence of structural change). As a result, the Perron theory it is confirmed: when there is a break in a time series, the standard unit root tests cannot reject the null hypothesis.

In the *summary table 2* it is shown the Unit Root Tests results. What we have done it is check the Augmented Dickey Fuller with least squares and then the Dickey Fuller with generalized least squares. The results are more or less the same, but in the case of Augmented Dickey Fuller with E-views we can get the correlogram of residuals while in the DF-GLS no.

In all Unit Root tests with break we have derived the same results for all countries, but not in the case of the United States. What we observe in almost all cases that we cannot reject the null hypothesis of unit root for a 10% of significance neither for the model with constant nor constant and trend.

The most accurate result is the one with Constant and Trend, at which we see that for all countries the I(1) hypothesis cannot be rejected for a 10% of significance.

The results with the United States is that we cannot reject the null hypothesis for a 1% in both cases, but for a 5% we can. As a result there is evidence that the unemployment rate in USA is a I(0).

[24] Perron, P. (1989). "The great crash, the oil price shock, and the unit root hypothesis". *Econometrica: Journal of the Econometric Society, 1361-1401*

We can add that the Durbin Watson statistic is in all cases very near to 2 indicating no autocorrelation, with the exception of Japan and USA. In addition, the Q-Statistic (which is the one corresponding to the 11^{th} lag) confirms us that the residuals follow a white noise.

As most of the countries have unit root, we are able to state that shocks affecting the unemployment rate have a permanent effect in those time series.

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