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Abstract

We examine the unemployment hysteresis hypothesis for 31 European countries, US and Japan, using alternative linear and nonlinear unit root tests, taking into account possible structural breaks. Two types of smooth transition models - Exponential Smooth Transition Autoregressive (ESTAR) and Asymmetric Exponential Smooth Transition Autoregressive (AESTAR) - are employed to account for the nonlinear mean-reverting behaviour in unemployment due to heterogeneity in hiring and firing costs across firms. Four main results emerge: First, the hysteresis hypothesis is rejected for 60 percent of the countries in our sample. Second, nonlinear models capture the asymmetries in unemployment dynamics over the business cycle for some countries. Third, many of the series display multiple structural breaks which might point out shifts in mean level of unemployment. Fourth, forecasting powers of our nonlinear models display poor performance against the linear AR specification. The results have policy implications for the debate on the benefits of demand or supply side policies for tackling the current unemployment problem in Europe.

Keywords: *unemployment hysteresis, nonlinear adjustment, structural breaks, forecasting*

JEL Codes: *E24, C22, E27*

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"…at present the situation is different. The risks of "doing too little" – i.e. that cyclical unemployment becomes structural – outweigh those of "doing too much" – that is, excessive upward wage and price pressures."

Mario Draghi (2014), President of the ECB, Jackson Hole Speech

I. Introduction

High and increasing unemployment is a pervasive problem across Europe in the post-crisis era (Figures 1 and 2). An optimal policy response design to tackle this issue calls for a true assessment of the dynamic properties of unemployment. If the unemployment problem is *structural*, then more often than not, suggested policies aim towards a change in the structure of the labour market. If the problem is rather *cyclical*, then demand management policies could be of use to deal with a temporary deviation from a long-run equilibrium level. Nevertheless, this distinction is far from being clear-cut. At times, cyclical variations could lead to a persistent change in equilibrium unemployment as emphasized by the above quotation for the current European unemployment problem.

The fear of cyclical unemployment turning into a structural problem is far from being new and, in fact, somewhat reminiscent of the 1980s Europe, which is distinguished with unemployment *hysteresis* problem. In their seminal paper, Blanchard and Summers (1986) analyse the protracted effects of unemployment shocks in Europe after 1970s. They argue that the theories which advocate the existence of a *natural* unemployment rate which is compatible with a steady, or, non-accelerating inflation rate (NAIRU) fails to identify the endogenous impact of a surge in unemployment on the long-run natural rate. As the argument goes, temporary shocks in unemployment could have a permanent impact due to labour market rigidities.[2] That assessment of a *path-dependent* long-run unemployment, or hysteresis problem, has important policy implications. In particular, the authors argue that the European hysteresis problem of 1980s underlies the role for demand management policies to cut down unemployment "*regardless of the source of the shocks that caused it."*

Analysing hysteresis for Europe in the light of the current economic crisis is important for a couple of reasons. First, an evidence of hysteresis would provide a partial support for the application of policies to boost aggregate demand in the short-run, as argued above. A crucial factor that would determine whether a shock would be temporary or long-lived is the source of the shock (i.e. demand or

[2] Blanchard and Summers (1986) point out asymmetries in wage setting process between insiders and outsiders as the main driver of a propagation mechanism in unemployment. They argue that negative shocks contracting number of workers could increase the bargaining power of insiders due to their increasing marginal product. This would lead to a new equilibrium wage rate. This line of reasoning is later critisized in Lindbeck and Snower (2001) which argues that the remaining insiders are not necessarily more secure because in case of negative shocks i) firms might decide to contract capital and labour services simultaneously provided that they have excess capacity ii) the relation between the wage negotiation and employment is not unambigous due to changes in reservation wage.

supply shocks).[3] On the one hand, labour market distortions due to aggregate demand shocks could largely be offset by monetary or fiscal policies. If the unemployment shocks are rather temporary, then demand-management policies would suffice for the policymakers to stabilize the labour market around a long-run equilibrium level.[4] On the other hand, the increase in equilibrium unemployment could well be the result of aggregate supply shocks. This type of a deviation calls for the short-term demand management policies to be augmented with structural and supply-side reforms. A recent European Commission (2013) report documents significant heterogeneity in both the source of shocks and the labour market conditions before the recent crisis across the European region. Demand shocks have been revealed in alternative strengths across the union countries. Also, pre-crisis labour market conditions were different among them. As a result of this heterogeneity, Draghi (2014) argues that the structural reforms in the labour markets at both union and national levels should be augmented by demand side policies:

"Demand side policies are not only justified by the significant cyclical component in unemployment. They are also relevant because, given prevailing uncertainty; they help insure against the risk that a weak economy is contributing to hysteresis effects."[5]

Third, as will be discussed further in the paper, absence of hysteresis, which might lead to a mean-reverting behaviour in unemployment, would help the researchers to forecast the level of unemployment. We propose alternative testing frameworks for hysteresis and present the forecasting performance of our proposed models in the third chapter.

Two central questions emerge for the researchers from what has been presented so far. First, is the unemployment hysteresis problem still valid for Europe? A second issue of concern is exploring the presence of heterogeneity in hysteresis across Europe which would justify policies that would be conducted at a national level, in addition to a union perspective. Pursuing these lines of investigation, the unemployment hysteresis hypothesis is tested for 31 European countries (as well as US and Japan for comparison purposes). In a general manner, we follow the strand of literature that employs unit root tests to explore hysteresis, with an emphasis on the nonlinear dynamics and possible mean-shifts in the series. We further estimate the proposed models and conduct an out-of-sample forecasting exercise.

[3] In general, short-term *demand shocks* are considered to have cyclical impacts on unemployment while *supply shocks* might lead to long-term changes in labour market conditions.
[4] Obviously, as Bean (1997) argues, a "fine tuning" is almost impossible due to high level of uncertainty regarding the economy. However, offsetting policy actions would lead to a "coarse tune" of the economy by means of smoothing the economic activity.
[5] In a similar manner, Yellen (2012) motivates a loose monetary policy stance with FED's concerns over hysteresis: *"To date, I have not seen evidence that hysteresis is occurring to any substantial degree… Nonetheless, the risk that continued high unemployment could eventually lead to more-persistent structural problems underscores the case for maintaining a highly accommodative stance of monetary policy."*

Regarding the nonlinear dynamics in unemployment, we employ two types of smooth transition models: The Exponential Smooth Transition Autoregressive (ESTAR) and the recently introduced Asymmetric Exponential Smooth Transition Autoregressive (AESTAR) models, both implying alternative nonlinear mean reversion processes for unemployment, as will be detailed in the third chapter. The former, ESTAR, model assumes *smooth adjustment* of unemployment towards its mean with a *symmetric* band of inaction around the long-run value. The mean-reverting behaviour could be an implication of business cycles while the inaction band is a consequence of hiring and firing costs. Moreover, the smoothness of the transition is motivated with *heterogeneity* in hiring and firing costs *across* firms. The latter model, AESTAR, suggests similar smooth adjustment behaviour, this time with an *asymmetric* band of inaction around the mean. This further asymmetry is motivated with heterogeneity across hiring and firing costs *for all firms* such as an increase in severance payments. Our analysis follows the steps described below.

We first determine the possible structural break dates using Lee and Strazicich (2003 and 2004) studies, in the first part of the following section. Both studies propose Lagrange-Multiplier unit root tests allowing for endogenous break(s) both under the null and alternative hypothesis (the first one assuming two-breaks whereas the latter one allows for a single break). The break dates derived from these exercises help us to form new series that would be used further in the forecasting exercises.

The rest of the exercise follows the steps of nonlinear model building as portrayed in Teräsvirta (2006). Nonlinear models nest a linear regression model that could be unidentified under a linear data generating process. Hence, an important pre-requisite of nonlinear model building is conducting linearity tests. Consequently, in the second part of the next section, we conduct three types of tests that would take into account the possible nonlinear mean reversion in unemployment series for 33 countries in our sample, in addition to the standard linear unit root tests. Two of these tests, ESTAR test of Kapetanios et al. (2003) and AESTAR test of Sollis (2009) are joint tests of linearity and unit root; and are motivated through the hiring and firing dynamics as discussed above. The third test, Christopoulos and Leon-Ledesma (2010) is employed for taking cognisance of a simultaneous presence of structural breaks and nonlinear dynamics in the unemployment. Later on, we carry on to the model estimation an out-of-sample forecasting exercise with the countries for which the tests suggest signs of nonlinear behaviour.

We obtain four major results from this exercise: First, we can reject the hysteresis hypothesis for 60 percent of the countries in our sample. Second, nonlinear models could be useful to describe the unemployment dynamics over the business cycles. Third, a significant number of the series in our sample suffer from multiple structural breaks which could indicate shifts in the mean level of unemployment. Fourth, the predictive powers of our nonlinear models depend on the choice of the benchmark. In particular, the forecasts are moderately better than the random walk model in the longer term, yet worse than a linear AR benchmark. We further discuss the policy implications of our results regarding the role of demand or supply side policies for combatting the European unemployment problem.

The rest of the paper is organized as follows. Second section provides a review of hysteresis concept and a review of the previous literature. Third section describes the data and the econometric methodology; presents the results of linear and nonlinear unit root tests, model estimation and the out-of-sample forecasting exercise. The fourth, and the last, section presents a discussion of possible policy implications and concludes.

II. Literature Review

The literature poses two alternative sets of descriptions for unemployment dynamics. First one rests on the notion of a *natural rate of unemployment* that would reflect the supply side determinants - or fundamentals- in the economy such as labour market institutions or educational attainment (Phelps 1967, 1968). The economy could depart from this equilibrium in the short-run as a result of nominal shocks, whereas these deviations are supposed to disappear eventually, implying a convergence towards the natural rate.

The aforementioned mean-reverting behaviour provided an appealing explanation for the European and US unemployment of 1950s or 1960s. However, the high degree of unemployment persistence in 1970s gave rise to a second type of exposition for unemployment dynamics. Blanchard and Summers (1986) bring the hysteresis approach to the forefront of the labour market theory, suggesting that the high and persistent unemployment is a result of the protracted effects of temporary shocks due to imperfections in the labour market, as discussed in the introductory section.[6] Propagation of nominal or real shocks would result in exogenous shifts in unemployment and hence inhibit a reversion to the original level. Accordingly, they define hysteresis as the case where current unemployment depends on a combination of its past values with coefficients summing to one i.e. a *unit root* process.[7]

Permanent changes in the unemployment rate are interpreted differently in alternative strands of the literature. Firstly, there are numerous studies that focus on the persistence issue and explore the *dynamic adjustment* between different equilibrium rates of unemployment. Jaeger and Parkinson (1994) assume a stationary cyclical and a nonstationary natural rate component for unemployment; and define hysteresis as the impact of the lagged values of the former component on the latter one.

[6] Another reason for unemployment persistence could be the stigmatization of unemployed workers (Blanchard and Diamond, 1994).

[7] Blanchard and Summers (1986) also favor a looser form of the definiton where coefficients does not add up to one but very close to one (a near unit root process). These two cases are also referred later in the literature as *pure hysteresis* or *partial hysteresis* (See Layard et al. 1991; León-Ledesma and McAdam 2004). In this study, the hysteresis term is used to refer to the case where the autoregressive parameter is unity (i.e. a unit root process or pure hysteresis).

Layard et al. (1991) explore the role of labour market institutions (benefits, employer protection measures etc.) on the impact of the temporary shocks on natural rate. Recently, Karanassou et al. (2010) propose a method that would further include the spillover effects in the labour market as well as differentiate the cyclical and permanent shocks.

A second line of the literature explores the changes in unemployment rate within the framework of *multiple equilibrium* models. Multiple equilibria in unemployment could exist in case of a downward sloping wage curve or an upward sloping labour demand (Mortensen, 1989). Among studies that employ Markov Switching regressions, Bianchi and Zoega (1998) suggest that a significant part of the unemployment persistence in fifteen OECD countries is due to infrequent large shifts in unemployment rather than impact of frequent small shocks; León-Ledesma and McAdam (2004) shows that the unemployment in European transition economies displays a multiple equilibrium pattern. Raurich et al. (2006) suggest fiscal policy as an explanation for European hysteresis where multiple equilibria arise due to endogenous tax rates. Mathews et al. (2008) suggest that political reactions from public against large swings in economic activity might result in distortionary supply-side policies which, in turn, lead to a shift in equilibrium rate of unemployment.

In a third group of models, the interest lies in the *structural factors* of the economy (such as preferences, technology, institutions or asset prices) as the main determinants of the unemployment dynamics. Phelps (1994) suggests that oil price hikes were the main determinants of the equilibrium path of the unemployment rate in 1970s whereas high levels of world public debt and real interest rates were responsible for soaring unemployment in1980s.[8] As the argument goes, the persistence in those driving forces might lead to long-lived shifts in unemployment level. Hence, unemployment dynamics is characterized by a stationary process with occasional *mean-shifts*. These structural explanations of the natural rate of unemployment would also underscore the need to explicitly take into account the possible structural breaks when testing for hysteresis. The recent literature includes numerous studies test for the hysteresis hypothesis using unit root tests that considers endogenous structural breaks and provides support for the structuralist hypothesis, documenting evidence favouring mean-reversion of unemployment [Ayala and Gil-Alana (2012), Lee and Chang (2008), Lee et al. (2009), Fosten and Ghoshray (2011)]. Our study also covers analyses that follow this strand of literature, as will be presented in the next section.

An important critique of the structuralist school is the incapability of hysteresis framework to capture the *nonlinear* path dependence of unemployment due to the omission of relevant structural determinants. Phelps and Zoega (1998) underlie the different behaviour of the natural rate of unemployment at deep recessions compared to shallow ones. They argue that the surge in UK

[8] Phelps and Zoega (1998) point out other structural factors behind unemployment such as technological change, labour productivity or educational composition of the labour force.

unemployment in 1970s and early 1980s displays persistence while the drop in unemployment in late 1990s is relatively short-lived.

The nonlinear feature of the unemployment dynamics is explored by a fourth group of studies with a focus on the business cycle asymmetries. Empirical studies show that the fall in unemployment levels during booms is slower than the rise during recessions.[9] One appealing explanation is the asymmetries in adjustment costs of labour faced by the firms. Costs of hiring or firing could be asymmetric due to factors such as search costs, training costs or severance pay (Hamermesh and Pfann, 1996; Bentolila and Bertola, 1990).[10] Once the cost of positive adjustments (hiring) is higher than negative ones (firing) at the macro level, troughs could be deeper compared to peaks. Another explanation is the *cleansing* effect of recessions as put forth by Caballero and Hammour (1991). In a Schumpeterian manner, they suggest that during recessions outdated technologies would be cleansed from the production lines, resulting in higher job destruction in smaller or less productive plants compared to the mass-production units. A third exposition is suggested within the insider-outsider framework by Lindbeck and Snower (2001). Strong bargaining power of incumbents during upswings leads to higher insider wages which could hamper employment opportunities. Downswings, on the other hand, would be characterized by relatively stable insider wages with higher layoffs. Finally, a fourth explanation is the impact of deterioration in capital stock during recessions on employment (Bean and Mayer, 1989; Arestis and Mariscal, 1998).

The literature includes numerous studies that examine possible asymmetries in unemployment series. A rough categorization of nonlinear models could be centred on the postulated regime switching behaviour of the series. If the presumed regime change is governed by an unobservable variable, then Markov-switching models provide a convenient framework to capture the transition dynamics. Among the studies using this approach, Neftçi (1984) argues that the unemployment display faster upswings and slower downswings; Bianchi and Zoega (1998) show that relatively larger shocks are responsible for the persistence in unemployment as opposed to frequent smaller shocks in a multiple-equilibrium setting.

An alternative to the Markov-Switching models are the threshold models that portray a process where the regime change is determined by an observable variable. Self-exciting threshold models are particular cases where the shift from one regime to another is controlled by the past observations of the series itself. The threshold autoregressive (TAR) model (Tong, 1990) implies a sharp transition in between regimes. Hansen (1997) employs TAR model to show that the autoregressive structure of unemployment is different in expansions or contractions in the economy.

[9] Davis and Haltiwanger (1991) show that job destruction and job creation by US firms displays hetereogenity for both cross-sectional and time dimensions for US firms. They argue that job destruction is relatively more volatile over the business cycle and job reallocation displays a countercyclical movement.
[10] Moreover, these causes could be a result of government policies such as compulsory advance notice of layoffs or changes in the financing structure of unemployment compensation dynamics (Hamermesh and Pfann, 1996).

Caner and Hansen (2001) propose a joint test for nonlinearity and nonstationarity using a similar framework where they describe US unemployment rate as a stationary nonlinear process.[11]

Smooth transition autoregressive (STAR) models (Granger and Teräsvirta, 1993) represent another form of self-exciting threshold models, assuming a gradual adjustment towards the long-run mean, as opposed to immediate transition in TAR models. Skalin and Teräsvirta (2002) recommend this type of a smooth adjustment for a number of OECD countries using a logistic STAR framework, including a lagged level term which would induce local nonstationarity in a globally stationary model. Lanzafame (2010) examines the hysteresis hypothesis for regional unemployment in Italy using nonlinear dynamic panel unit root tests with the alternative of a globally stationary ESTAR process and documents the regional Italian unemployment as a stationary but non-linear process that is subject to multiple equilibria.[12]

III. Data, Econometric Methodology, Estimation and Out-of-Sample Forecasting Analysis

Our empirical analysis covers structural break, unit root and linearity tests as well as AESTAR model estimation and an out-of-sample forecasting exercise for 31 European countries, Japan and US. The summary statistics for the quarterly and seasonally adjusted unemployment series taken from Eurostat database are documented in Table 1, and the series are depicted in Figure 2. The initial data point for each country is given in the first column. All series end in the second quarter of 2014. The longest series has 126; the shortest one has 37 data points. Table 1 reports that 10 countries out of 33 have an average unemployment rate above 10 percent. The standard deviation of some countries such as Greece, Spain or Ireland is larger than the others. Also, a first look at Figure 2 suggests that for many countries, unemployment rates fall until the 2008 crisis and rise thereafter. This observation would call for a test of structural breaks as will be covered in the following subsection.

a. Unit roots and structural breaks

A well-established problem of the unit root tests are their sensitivity to the presence of the structural breaks. In his seminal paper, Perron (1989) argued that the presence of a break in the deterministic trend could lead to a bias against rejecting the null of unit root. He proposes a modified Dickey-Fuller test, assuming an exogenous, or known, break date. Subsequent literature provided tests

[11] Koop and Potter (1999) corroborate with these result using TAR model with Bayesian methods. Coakley et al. (2001) also detect nonlinear behaviour in US, UK and Germany unemployment series using Momentum-TAR framework introduced by Enders and Granger (1998).

[12] Recently, Cheng et al. (2014) employs flexible Fourier unit root test; Caporale and Gil-Alana (2007) and Cuestas et al. (2011) use fractional integration along with nonlinear techniques; Pérez-Alonso and Di Sanzo (2011) propose a nonlinear unobserved component model to test for hysteresis. Cuestas and Ordóñez (2011) explore the nonlinearities in unemployment rates of Central and Eastern European countries with ESTAR and LSTAR models. Gustavsson and Österholm (2006) also employ ESTAR model for testing the unemployment hysteresis for five developed countries. Bolat et al. (2014) applies nonlinear panel unit root tests for the Eurozone area.

with unknown breaks that are endogenously determined from the data. In a popular example, Zivot and Andrews (1992) estimates a single breakpoint which minimizes the Dickey Fuller t-statistics for testing the null of a unit root.[13] One key difference between these methodologies is on the subject of the specification of the breaks. While Perron (1989) test allows for breaks both under the null and the alternative hypothesis, the latter test allow for breaks only under the alternative specification, but not under the null of unit root. Kim and Perron (2009) argue that not allowing breaks under the null leads to low power of these tests since they are not invariant to the parameters of the trend function. Lee and Strazicich (2003) tell that neglected structural breaks under the null could lead to a spurious rejection of the unit root null, under the presence of unit root with breaks. They propose an endogenous two-break Lagrange Multiplier tests that allow for breaks both under the null and alternative hypothesis, where rejecting the null would unambiguously imply trend stationarity.

In our study we take into account the structural breaks in a three-step exercise. First, we would like to determine the source of the parameter instability in linear estimations using the Lee and Strazicich (2003) test with the null of a unit root with structural breaks. Second, as described in Starzicich et al. (2004) we repeat the exercise with the one-break test of Lee and Strazicich (2004), for the countries for which the two-break test suggest only one significant break. Third, we extend our quest of exploring the parameter instability towards processes that would allow nonlinear dynamics. To this end, we employ Christopoulos and Leon-Ledesma (2010) test. This test allow for simultaneous presence of structural breaks and nonlinear mean reversion. In particular they consider a modified version of ESTAR test that also considers the possibility of structural breaks. Later on, we compare these results with those of ESTAR test of Kapetanios et al. (2003) and AETAR tests of Sollis (2009), neither of which considers structural break during the testing procedure.

The first six columns of the Table 2 document the results of the Lee and Strazicich (2003) test. The first column reports the optimal lag length *k* which is determined with a general-to-specific procedure as described in Lee and Strazicich (2003). LM test statistics is given in the subsequent columns under LM_{T2}, subscript denoting the number of breaks considered. A first look at the results of the reveals that 16 countries out of 33 reject the unit root null at least at 10 percent significance level. Structural breaks that are significant (at least in 10 percent) are given in T_{B2} column. The results suggest that two structural breaks are significant for 21 countries and one-structural break is significant for 9 countries whereas no significant breaks are suggested for Japan, Sweden or UK.

We follow Strazicich et al. (2004) which suggest repeating the test with the one-break alternative (Lee and Strazicich, 2004) for the 9 countries for which the two-break test suggest only one significant break. The results are documented between columns 7 to 11. The test results suggest that including two-breaks instead of one lowers the power to reject the unit root null for Slovakia. For

[13] Later on, Lumsdaine and Papell (1997) extend this methodology with two structural breakpoints alternative, emphasizing that the unit-root test results are sensitive to the number of breaks in the alternative hypothesis.

Austria and Norway, the results did not change. Estonia and Latvia does not reject the unit root null in this case while they reject it in the two-break test. The power of the test to reject the unit root null goes down in Lithuania. For Hungary, Luxembourg and Portugal, only the breaks date change.

Combining the results from these two tests, we can conclude that the unit root could be rejected for 17 countries out of 33. It is worthwhile to note that the global financial crisis and the following Eurozone crisis indicate a structural break for Croatia, Cyprus, Denmark, Germany, Estonia, Latvia, Lithuania, Hungary, Ireland, Italy, Malta, Poland, Romania, Slovenia and Turkey, with reasonable lags. Also, Eurozone crisis which deepened in 2010 marks a break for Bulgaria, France, Greece, Iceland, Turkey and US, again with reasonable delays.

Lee and Chang (2008) also employ these tests to examine the hysteresis in 14 OECD countries using annual data spanning over a century, ending at 2004. While the data coverage is different in both papers, our results corroborate for some of the countries such as France, Germany, Netherlands, Sweden and United Kingdom, in both papers favouring the hysteresis hypothesis. However, results differ in the sense that they do not reject the unit root hypothesis for Belgium, Denmark, Italy, Japan and Norway, while we do. These differences might come from the last ten years' data included in our data set.

The impact of structural break on estimation and in turn the robustness of the forecasts could be analysed by means of a bias-variance trade-off (Teräsvirta, 2006; Pesaran and Timmermann, 1999). Disregarding the break and using whole series in estimation would lead to biased forecasts since forecasting exercise would utilize the most recent observations instead of average ones. Alternatively, using a model with post-break series to produce unbiased forecasts might lead to a greater variance compared to the forecasts of the model covering pre-break data with lower mean square errors. However, as discussed above, for most of the series the recent crises mark structural breaks. Since this left us with a few observations, we opt out to conduct a post-break analysis with these series which would lead to significantly higher variances. Yet, we conducted unit root tests with post-break series, provided that it has at least 30 observations: Czech Rep (2005q1 onwards), Estonia (2006q2 onw). , Finland (1998q1 onw.), Latvia (2006q1 onw.), Lithuania (2006q2 onw.), Netherlands (1998q2 onw.) In none of these series, we could not reject the null of unit root in nonlinear tests. Hence, we do not report these results for the sake of space limitations but they are available upon request. Future research could conduct the analysis with post-break series and compare it with the one with whole series once more data points are available in the post-break period.

As discussed at the beginning of this subsection, we also consider nonlinear dynamics and structural break simultaneously, using the unit root test of Christopoulos and Leon-Ledesma (2010) which develops a modified version of Kapetanios et al. (2003) ESTAR unit root test. To this end, we first demonstrate this latter ESTAR model in the next subsection and further describe the Kapetanios et al. (2003) test. Later on we discuss Christopoulos and Leon-Ledesma (2010) test which takes into account structural break and nonlinear mean reversion simultaneously and present the results of both tests in a comparative manner.

b. Non-linear unit root tests

It is widely documented that under the presence of nonlinearities, conventional unit root tests have low power in assessing the stationarity of the series (see, for example, Enders and Granger, 1998). Hence, in order to explore the presence of hysteresis in unemployment, we employ nonlinear unit root tests that proved to perform well when the underlying data generation process is subject to nonlinearities, in addition to linear tests. After detecting nonlinearities in some of these series, we continue with estimating the nonlinear models to evaluate their predictive power.

Our first model, ESTAR, suggest a *gradual* adjustment towards a long-run attractor around a *symmetric* threshold band. Once this band is exceeded, either in positive or negative direction, the series would display mean-reverting behaviour. Hence, the series might be governed by a unit-root process inside the band while it might exhibit a stationary behaviour below or above the band. This *inaction band* around the long-run level of unemployment could be motivated using hiring and firing costs in a similar manner with Bentolila and Bertola (1990). As the argument goes, in case of an (expected) increase in demand, firms do not hire immediately due to the presence of adjustment costs because the (expected) marginal revenue product of labour could be higher than the discounted wage cost plus the hiring cost, up to a certain threshold. Similarly, firms do not fire immediately against a demand slump if the expected marginal revenue product of labour is higher than the firing cost minus saving from firing a worker (discounted wage cost saved). Discussing the role of demand management policies on combatting European unemployment problem, Bean (1997) states that this type threshold behaviour could further explain the sluggish recovery of unemployment after recessions:

"hiring and firing costs create a "zone of inaction" within which the firm is neither hiring nor firing…[F]irms …will not immediately start taking labour back on as soon as demand starts expanding or labour costs begin to fall, but wait until the recovery has proceeded beyond a threshold level that among other things depends upon the degree of uncertainty."

Accordingly, small shocks in demand would lead to transitory effects which would keep unemployment inside the band, while large shocks might have relatively stronger effects that would move the unemployment level outside the band *for a certain period of time*. ESTAR model assumes that this kind of a jump outside the band would be corrected *gradually*, over time through hiring or firing behaviour.

One reason for this gradual or *smooth* adjustment of unemployment towards its mean could be heterogeneity of hiring and firing costs *across* firms. To understand the impact of this asymmetry on unemployment let us examine the hypothetical graphs below. In part (a), we assume that the hiring and firing costs are the same for all firms in the market, i.e. there is only one type of firm. ESTAR model assumes that small shocks would keep unemployment inside the band [B_L,B_U] where unemployment level does not have a tendency to revert back to the mean level (M), i.e. unit root case. However, once the series cross this band, e.g. points C or D, the series has a tendency to move towards the mean level as indicated by the arrows.[14]

In Part (b) we picture the case where the market consists of another type of firm with a higher hiring or firing cost, hence a wider band [$B_{L'}$,$B_{U'}$] compared to case (a). This time points C or D in the previous graph would be inside the transaction band and reaching these levels would not lead to correction behaviour. Hence, when both type of firms in the market are aggregated as in Part (c), we have a pale region around the band where only one type of firm displays adjustment behaviour, and a dark region where both type of firms react. Assuming *n* different types of firms, the ESTAR process indicates stronger correction behaviour when the series gets far away from the mean.

After this graphical exposition, ESTAR model in Kapetanios et al. (2003) is demonstrated as:

$$\Delta u_t = a_1 u_{t-1} + a_2 u_{t-1}\left[1-\exp(-\theta(u_{t-d}-\lambda)^2)\right] + \varepsilon_t \qquad (1)$$

where u stands for the unemployment rate. The transition function is inside the brackets with θ determining the speed of adjustment. We impose two simplifying assumptions in Kapetanios et al. (2003) study. First, we impose a mean-zero stochastic process by choosing $\lambda=0$. Second we take $a_1=0$ so that the series would follow a unit root process when it is close to its long-run equilibrium value, while it reverts to its mean when it is far away from it. The delay parameter is chosen as $d=1$ in line with several studies in literature (see for example Teräsvirta, 1994). Then, equation (1) turns into:

$$\Delta u_t = a_2 u_{t-1}\left[1-\exp(-\theta u^2_{t-1})\right] + \varepsilon_t \qquad (2)$$

Kapetanios et al. (2003) suggest a test with the joint null hypothesis of linearity and unit root as H_0: $\theta=0$ against the alternative H_1: $\theta>0$. To address the identification problem under the null for the parameter (a_2), they suggest a first order Taylor series approximation and obtain an auxiliary equation. Including serially correlated errors, the model reads:

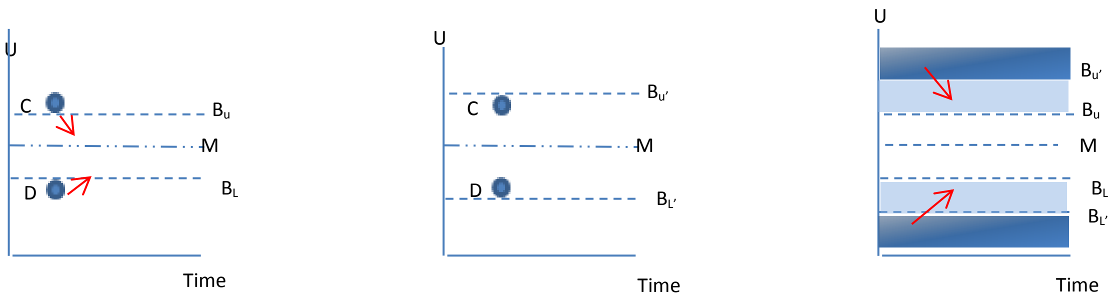
[14] This correction behaviour could also be motivated as a reflection of the business cycles. A long-run mean reversion would imply that recessions will be followed by a recovery which could be the result of an improvement in expectations, corresponding to a positive demand shock in Bentolila and Bertola (1990). An ESTAR type adjustment imposes that these *countercyclical* movements that would move the unemployment level back to equilibrium are not that strong when the series is close to its mean but gets stronger when it gets far away from it. Also, note that employment is a nonstationary process in Bentolila and Bertola (1990) since they conduct their analysis for a given level of demand in order to examine the comparative dynamics. Instead, our study focuses on long-term time series characteristics of unemployment, i.e. considering alternative phases of the cycle, testing the presence of a long-run mean-reversion

$$\Delta u_t = \sum_{j=1}^{p} p_j \Delta u_{t-j} + \gamma u_{t-1}{}^{3} + \varepsilon_t \qquad (3)$$

The asymptotic critical values for the t-statistics from the OLS estimation of $\gamma(\hat{\gamma})$ are tabulated in Kapetanios et.al (2003).

ESTAR Case

a) Type 1 Firm b) Type 2 Firm c) Aggregate Case



AESTAR model is an extension of ESTAR model where the speed of adjustment could be different below or above the threshold band (Sollis, 2009). The model suggests a further asymmetry relative to the ESTAR case as pictured below. Assume that, as discussed in the previous section, the cost of firing becomes higher relative to the cost of hiring *for all firms*, due to an increase in severance pay introduced by government. This would change the symmetric band around the mean that is imposed by the ESTAR model. First, similar to the ESTAR case above, small shocks are contained in the band inside which unemployment reveals a unit root behaviour, yet large shocks are corrected towards a mean level. However, this time, once the unemployment is below the band (the economy is in a boom) the expected increase in unemployment (due to business cycle impacts) would be much slower due to higher severance pay scheme; hence both regions below the band is much paler compared to ESTAR case. This is because the speed of transition towards the mean is slower below the band, compared to the ESTAR case above.[15] Similarly, the model allows for portraying the opposite case: The hiring costs (such as search or screening costs) could be relatively higher compared to firing costs and hence the adjustment towards equilibrium would be slower above the band which would flip dark and pale regions in part (c). This would mean that the expected recovery in employment after the recessions would be slower compared to the expected increase in unemployment following the expansionary part of the business cycle.

The model is extended to capture this asymmetry with the help of an additional transition function:

[15] The B_L level could also move depending on the magnitude of the impact of the change in severance payments on the threshold levels B_{LL} or $B_{LL'}$ in the lower regions.

$$\Delta u_t = G(\theta_1, u_{t-1})[S(\theta_2, u_{t-1})a_1 + \{1 - S(\theta_2, u_{t-1})\}a_2]u_{t-1} + \varepsilon_t \qquad (4)$$

where

$$G(\theta_1, u_{t-d}) = 1 - \exp(-\theta_1 u^2{}_{t-1}),\ \ \theta_1 > 0 \qquad (5)$$

$$S(\theta_2, u_{t-d}) = [1 + \exp(-\theta_2 u_{t-1})]^{-1},\ \theta_2 > 0 \qquad (6)$$

Without loss of generality, assuming $\theta_1 > 0$ and $\theta_2 \rightarrow \infty$; if u_{t-1} moves from 0 to $-\infty$ then $S(\theta_2, u_{t-d}) \rightarrow 0$; therefore an ESTAR type transition is in place between the central regime model $\Delta u_t = \varepsilon_t$ and the outer regime model $\Delta u_t = a_2 u_{t-1} + \varepsilon_t$. Similarly, if u_{t-1} moves from 0 to ∞ then we have the transition function $S(\theta_2, u_{t-d}) \rightarrow 1$ and the ESTAR type transition is observed between the central regime model $\Delta u_t = \varepsilon_t$ and the outer regime model $\Delta u_t = a_1 u_{t-1} + \varepsilon_t$. The speed of transition is controlled by θ_1 in both cases. The asymmetric adjustment requires $a_1 \neq a_2$. The general model with serially controlled errors is:

$$\Delta u_t = G(\theta_1, u_{t-1})[S(\theta_2, u_{t-1})a_1 + \{1 - S(\theta_2, u_{t-1})\}a_2]u_{t-1} + \sum_{i=1}^{k} \kappa_i \Delta u_{t-i} + \varepsilon_t \qquad (7)$$

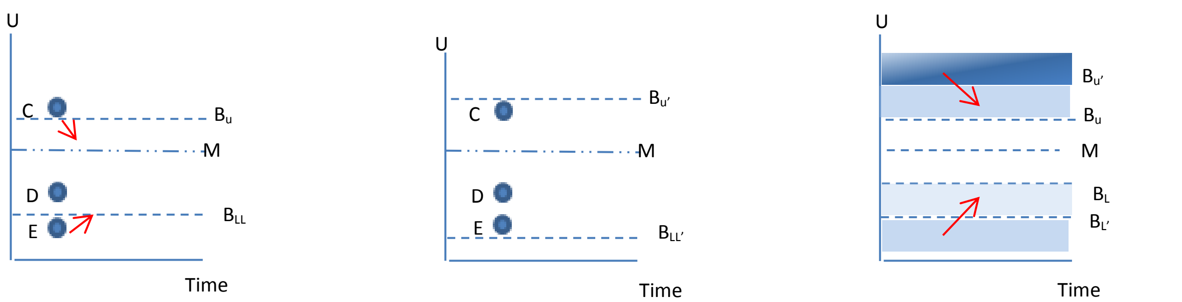
To address the identification problem in the unit root test similar to the ESTAR case above, Sollis (2009) employs a two-step Taylor series expansion (around θ_1 and θ_2 respectively) and the model boils down to:

$$\Delta u_t = \phi_1 (u_{t-1})^3 + \phi_2 (u_{t-1})^4 + \sum_{i=1}^{k} \kappa_i \Delta u_{t-i} + \mu_t \qquad (8)$$

with $\phi_1 = a_2\theta_1$ and $\phi_2 = c(a_2^* - a_1^*)\ \theta_1\ \theta_2$ where c=0.25, a_1^* and a_2^* are functions of a_1 and a_2 as defined in Sollis (2009). The joint null hypothesis of linearity and unit root of this auxiliary model is H_0: $\phi_1 = \phi_2 = 0$. The asymptotic distribution of an F-test is derived and the critical values for zero mean, non-zero mean and deterministic trend cases are tabulated in Sollis (2009).

AESTAR Case

a) Type 1 Firm b) Type 2 Firm c) Aggregate Case



As discussed above, the last test we consider is the Christoupuolos and Leon-Ledesma (2010) test which jointly considers structural breaks and nonlinear dynamics. This test allows for an unemployment process where temporary breaks are compatible with long-run mean reversion. A modified version of the Kapetanios et al. (2003) ESTAR test that would consider structural breaks would describe a process where i) unemployment is mean-reverting around an infrequently smooth-breaking mean and ii) the further from the equilibrium, the stronger is the mean-reversion in unemployment.[16]

The results of the linear and nonlinear unit root tests are documented in Table 3. The results of the three linear tests, Augmented Dickey Fuller (ADF), Elliot-Rottenberg-Stock (ERS) and Phillips-Perron, are reported in columns one to three respectively. The fourth and fifth columns, presents the results of the Christopoulos and Leon-Ledesma (2010) test, where $k_{,cl}$ is the optimal lag and $t_{nl,cl}$ is the t-statistics. Last two columns of the table document the Kapetanios et al. (2003) ESTAR test statistics ($t_{nl,kss}$) and the Sollis (2009) AESTAR test statistics ($F_{AE,\mu}$).

A first look at the results suggests no sign of stationarity, providing support for the hysteresis hypothesis for 13 countries out of 33: Bulgaria, France, Germany, Iceland, Italy, Japan, Luxembourg, Malta, Norway, Portugal, Slovenia, Sweden and United Kingdom. It is worth to note that this list mostly include the advanced economies of the region. Lee and Chang (2008, pg 314) tabulates the previous literature on testing hysteresis, emphasizing evidence favouring the hysteresis hypothesis for most advanced European economies, yet mixed results for US. Hence, our results largely corroborates with the majority of the studies in literature that cannot reject the null of unit root for most advanced European countries.

For US, most of the linear and nonlinear tests reject the null of unit root, as opposed to many major European countries. This difference in the persistence of shocks between US and Europe was also emphasized in many studies during 1980s. Roed (1997) investigates the alternative sources of hysteresis for European unemployment providing comparisons with US for this period.[17]

For the rest of the countries in our sample the hysteresis hypothesis is rejected by either linear or unit root tests, or both of them. Below, we provide a more detailed look at the result for these 20 countries.

[16] We follow the three-step testing procedure that is described in detail at page 1082 of Christopoulos and Leon-Ledesma (2010), using equation (7) as our base model. The footnotes of the Table (3) also provide details of the estimation.
[17] For the current period, the source of the differences requires an in-depth analysis for the individual countries, which is beyond the scope of this exercise and stands as a good research question for the future.

At first, for 4 countries out of 20 (Austria, Lithuania, Poland, Spain) only linear tests suggest stationarity. These countries display a mean reverting behaviour over the long run but this process does not involve a nonlinear characteristics. Hence, we exclude these 4 countries as well as the 13 countries which shows no signs of stationarity from our forecasting exercise with nonlinear models that we present in the next subsection. As discussed in the previous section, fitting a nonlinear model to a linear series might result in inconsistent parameter estimates which would lead to non-robust forecasts (Teräsvirta, 2006).

The result of the nonlinear tests provides support for rejection of the hysteresis hypothesis for 16 countries. For 11 of these countries both linear and nonlinear unit root tests reject the null of unit root: Belgium, Croatia, Czech Republic, Estonia, Finland, Greece, Latvia, Netherlands, Romania, Turkey and United States. The results corroborate with Bolat et al. (2014) employing panel unit root tests (for Belgium, Estonia, Finland, Greece for 2000-2013 period); with Gustavsson and Österholm (2006) which also employs Kapetanios et al. (2003) test (for Finland for 1964-2001 period).

For five of these countries only nonlinear tests reject the null of a unit root: AESTAR test for Cyprus; both Kapetanios et al. (2003) and Christopoulos and Leon-Ledesma (2010) tests for Denmark and Slovakia; and only Christopoulos and Leon-Ledesma (2010) test for Hungary and Ireland. For these countries unemployment could be described as a stationary process which is subject to regime changes. Cuestas and Ordines (2011) also apply Kapetanios et al. (2003) test for Central and Easter European Countries and reports evidence of mean reversion for Slovakia for 1998-2007 period.

While the results of ESTAR and AESTAR unit root tests might be explained within a business cycle perspective or heterogeneities in firing or hiring costs as discussed before; the presence of structural breaks does not allow us to disregard the possibility of describing the process as a stationary process around an occasionally changing mean. To this end, the results of Kapetanios et al. (2003) and Christopoulos and Leon-Ledesma (2010) unit root tests both of which considers ESTAR type of nonlinearity (the latter considering structural break as well) is examined in a comparative manner. For 9 countries (Denmark, Estonia, Finland, Latvia, Netherlands, Romania, Slovakia, Turkey and US), both tests reject the null of unit root. On the other hand only the latter test including the possibility of structural breaks would reject the unit root null for Croatia, Hungary and Ireland. For these countries, not allowing for structural breaks would lower the power of the nonlinear unit root test to reject the null of unit root. In particular, for Hungary and Ireland this test is the only one that would reject the null of a unit root among all linear and nonlinear tests in Tables 2 and 3. Hence, the unemployment process for these countries is compatible with temporary, smooth breaks and non-linear mean reversion.

c. AESTAR Model Estimation

We estimate the ESTAR model for 12 countries and the AESTAR model for 2 countries. As discussed above and documented in Table 3, these are the countries for which the linearity tests suggest the presence of nonlinearity. For the rest of the countries for which there is no indication of nonlinearity we do not estimate a nonlinear model since forecast taken from these models would be biased.

The literature that studies the forecasting power of AESTAR model is very limited.[18] McMillan and Wohar (2010) documents that the predictive power of AESTAR model for the dividend–price ratio for stock returns is relatively better than that of the linear models as well as ESTAR model. Akdoğan (2014) reports superior forecasting performance of both ESTAR and AESTAR models for inflation over random walk in the longer horizon for some countries.

AESTAR model is estimated in its raw form in Equation 4 for Cyprus and Greece with restrictions $\theta_1, \theta_2 > 0$ and $a_1, a_2 < 0$. Table 4 presents the set of $\{\theta_1, \theta_2, a_1, a_2\}$ values. The figures in parentheses are standard errors.[19]

The asymmetry is sustained when $a_1 \neq a_2$ otherwise the system would collapse to an ESTAR model. The difference (a_1-a_2) and the coefficient θ_1 controls for the degree of asymmetry and transition speed, respectively. Consequently, in addition to the AESTAR test, we also develop and conduct a Wald test with the null hypothesis $H_0 = a_1 - a_2 = 0$. The test statistics is derived as

$$F = (R\hat{\beta} - r)'[\hat{\sigma}^2 R\{\textstyle\sum_t x_t x_t'\}^{-1} R']^{-1}(R\hat{\beta} - r)/m \qquad (9)$$

where R is a 2 x 2 identity matrix, $\hat{\beta} = [\hat{a}_1 - \hat{a}_2]'$ with $\hat{a}_1$ and $\hat{a}_2$ being the least square estimates of a_1 and a_2 respectively. $r=[0,0]'$ and $\hat{\sigma}^2$is the least square estimate of σ^2. $x_t = [u_{t-1}^3, u_{t-1}^4]'$ as in equation 8 and m=2. This test statistics is very low for Greece but significant for Cyprus. Hence, while Sollis (2009) unit root test would suggest AESTAR type nonlinearity for Cyprus and Greece, the Wald test that we present would suggest that the estimated model is not adequate for Greece.

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[18] Hence, we only present the estimation results for AESTAR model in this section. The ESTAR estimation results are not presented due to space considerations but are available upon request.
[19] The nonlinear problem is solved by the sequential quadratic programming method of Gauss 14. The estimation returns the smallest value to fulfil with the restrictions for some parameters. Standard errors are very close to zero for these cases.

The sign of the (a_1-a_2) difference would give us an idea about the asymmetry in adjustment. In Table 2, for Cyprus, when unemployment is below the mean, the combined function:

$$G\left(0.01, u^{*}_{t-1}\right)\left[S\left(0.48, u^{*}_{t-1}\right)(-0.01) + \left\{1 - S\left(0.2, u^{*}_{t-1}\right)\right\}(-0.52)\right]u^{*}_{t-1}$$

changes between -0.52 and 0. Alternatively, when the unemployment is above its attractor, the combined function changes between -0.01 and 0. Therefore, when the (a_1-a_2) difference is positive, the mean-reversion is stronger when unemployment is below the band (i.e. the expected increase in unemployment after booms due to business cycles), compared to the case when unemployment is above the band (the expected recovery after recessions).

d. Out-of-Sample Forecasting Analysis

After estimating the nonlinear ESTAR and AESTAR models, we continue with an out-of-sample forecast analysis to compare the predictive power of these models with respect to two benchmark models: a naïve random walk model and a linear AR model. First, the sample is divided into two parts. A training sample which starts from the initial point of the series and ends at 2009Q4; and a forecasting sample (2010Q1:2014Q2). Then, one to four quarters-ahead forecasts are derived from the estimation. This exercise is repeated with extending the estimation period one at a time until the end of the pseudo out-of-sample period. The reported forecasts are compared with that of the benchmark models using the relative root mean square errors (RRMSE) for each forecast horizon.

Table 5 reports the RRMSE's for ESTAR and AESTAR models, against the random walk benchmark (part a and part b) and linear AR model benchmark (part c and part d). In each table, the columns represent forecast horizons. A first comparison of two models (parts a & b vs. c & d) suggest that while the nonlinear models shows slight improvements in forecasting compared to that of a naïve random walk benchmark, their forecasting power is poor against the linear AR specification. A detailed look at the results in part a and part b of the table suggest that for the first two forecast horizons, 1 and 2, nonlinear models does not suggest an improvement over the benchmark random walk model. However, for 3 and 4 quarter ahead forecasts, there are improvements for some countries such as for Estonia, Finland, Latvia or Netherlands in the ESTAR case; both Greece and Cyprus in AESTAR case. Hence, forecasting performance of our nonlinear models are relatively better in longer-horizons compared to short term, when we use a naïve random walk as benchmark. However, once we use a linear AR specification as a benchmark model, our nonlinear models does not show any improvement in forecasting in any of the horizons, as documented in Table 5 (part c and part d).

Similar to our mixed results, there is no consensus in the previous literature on the predictive power of nonlinear models.[20] On the one hand, some studies corroborate with our result that suggests higher predictive power for nonlinear models in the long-run. Killian and Taylor (2003) shows that the forecasting power of ESTAR model for exchange rates is stronger in long-term. Altavilla and De Grauwe (2010) also document higher predictive power for alternative nonlinear models in exchange rate determination. Akdoğan (2014) suggests that the predictive powers of both ESTAR and AESTAR models to forecast inflation are better than that of random walk in the longer horizon for some countries. On the other hand, Teräsvirta and Anderson (1992) findings does not suggest improvements in predictive power of STAR type models over their linear alternatives. Similarly, Clements and Smith (2001) shows that the forecasting performance of nonlinear models strongly depend on the estimation and forecasting period. In a more general statement, Ferrara et al. (2013) tells that the predictive power of nonlinear models is not robust to the choice of model and macroeconomic variables, forecasting horizon as well as estimation and forecasting periods. Our results suggest that specification of the benchmark is also important in determining the forecasting power of nonlinear models.

The next section presents a discussion of the policy implications of our findings for the debate on alternative policies to tackle the persistent European unemployment problem.

IV. Policy Implications and Conclusion

This paper examines hysteresis hypothesis for Europe, US and Japan with the help of linear and nonlinear unit root tests, taking into account the possible structural breaks. In particular, ESTAR and AESTAR models are proposed to capture the mean-reverting behaviour in unemployment due to heterogeneities in hiring and firing costs across firms. Our results point out significant heterogeneity in unemployment dynamics over European countries as well as some improvements in unemployment forecasts in the longer run with the use of nonlinear models. In this final section we further draw and discuss policy implications of our findings.

The introductory section highlights the recent ECB approach including a blend of supply and demand management policies at both euro area and national level to combat with European unemployment problem. However, Draghi (2014) further points out important limitations for the implementation of monetary or fiscal policies. Below, we discuss these policies and limitations along with our findings.

[20] For a review of this literature and examples see Terasvirta et al. (2005) and Ferrara et al. (2013).

Regarding the monetary side; the first and most important feature of a monetary union is that asymmetric shocks would result in cyclical unemployment as a result of the incapability of individual countries to use domestic monetary policies (Calmfors, 2001). Moreover, unification would intrinsically change the character of the structural reform process in labour market. Beetsma and Giuliodori (2010) emphasizes that the incentive to conduct structural reforms is higher before entering into a union since markets are relatively more flexible. However, with a monetary union there are counteracting effects depending on the degree of the correlation of shocks across countries. A monetary union would be less capable of stabilizing output shocks once the correlations of the shock between countries are weak. As Sibert and Sutherland (2000) argue, a more flexible labour market would suggest a partial remedy for this problem. On the other hand, highly correlated shocks would call for more autonomy in terms of monetary policy making in order to generate policies that would protect the individual countries from other countries' beggar-thy-neighbour policies.[21] Hence, it is rational to expect differences in the impact of alternative policies across the region, in addition to the heterogeneities in initial conditions. Our findings point out significant heterogeneity across countries in terms of the pace of correction towards equilibrium, taking into account asymmetries over the cycle.[22]

Second, there is uncertainty about the prevailing equilibrium rate of unemployment which would further complicate measuring the appropriate growth rate of demand that would be compatible with the inflation target. Moreover, Bean (1997) points out that the view that a fall in unemployment could have a stronger positive impact on inflation than the negative impact of an equivalent rise in unemployment. This nonlinear response of inflation could also be a determinant of the asymmetric mean reversion across the cycle that is suggested for some countries in our study. That being said, we opt to avoid a further discussion of a nonlinear Phillips curve relation that would be beyond the scope of this study.

Third, as put forward by Blanchard (2006), once the initial adverse shocks on unemployment in 1970s amplified ending up having longer-term impacts during 1980s; the focus of research shifted towards the differences in labour market institutions. As the argument goes, the alternative paths of evolution of these institutions across Europe could provide a rationale for the heterogeneity in unemployment, across the countries and over time, as explored in this paper. Accordingly, design of structural reforms requires taking cognisance of not only the current level of unemployment but also significant asymmetries in the dynamics of adjustment over the cycle.

[21]For time-inconsistency and resulting free-rider problems in a monetary union that would negatively affect the structural reform incentives, see Chari and Kehoe (2008).
[22] For the impacts of economic governance of Europe on European labour markets see Ioannou and Stracca (2014).

References

Akdoğan, K. (2014). Asymmetric Behaviour of Inflation around the Target in Inflation-Targeting Countries. *Forthcoming in Scottish Journal of Political Economy*.

Altavilla, C., & De Grauwe, P. (2010). Forecasting and combining competing models of exchange rate determination. *Applied economics*, *42*(27), 3455-3480.

Arestis, P., & Mariscal, I. B. F. (1998). Capital shortages and asymmetries in UK unemployment. *Structural Change and Economic Dynamics*, 9(2), 189-204

Ayala, A., Cuñado, J., & Gil-Alana, L. A. (2012). Unemployment hysteresis: empirical evidence for Latin America. *Journal of Applied Economics*, 15(2), 213-233.

Bean, C. (1997). The role of demand-management policies in reducing unemployment. *Unemployment policy: Government options for the labour market*, 83-111.

Bean, C. and Mayer, C., (1989). Capital shortages and persistent unemployment. *Economic Policy*, 4(8), 11-53.

Beetsma, R., & Giuliodori, M. (2010). The macroeconomic costs and benefits of the EMU and other monetary unions: an overview of recent research. *Journal of Economic literature*, 603-641.

Bentolila, S., & Bertola, G. (1990). Firing costs and labour demand: how bad is eurosclerosis? *Review of Economic Studies*, 57(3), 381-402.

Bianchi, M., & Zoega, G. (1998). Unemployment Persistence: Does the size of the shock matter? *Journal of Applied Econometrics*, 13(3), 283-304.

Blanchard, O. (2006). European unemployment: the evolution of facts and ideas. *Economic Policy*, 21(45), 6-59.

Blanchard, O. J., & Diamond, P. (1994). Ranking, unemployment duration, and wages. *Review of Economic Studies*, 61(3), 417-434.

Blanchard, O. J., & Summers, L. H. (1986). Hysteresis and the European unemployment problem. In *NBER Macroeconomics Annual 1986*, (1) 15-90. MIT Press.

Bolat, S., Tiwari, A.K., Erdayi, A.U. (2014). Unemployment hysteresis in the Eurozone area: evidences from nonlinear heterogenous panel unit root tests. *Applied Economics Letters*, 21(8), 536-540.

Caballero, R. J., & Hammour, M. L. (1991). The cleansing effect of recessions. National Bureau of Economic Research. w3922.

Calmfors, L. (2001). Unemployment, labour market reform, and monetary union. *Journal of Labor Economics*, *19*(2), 265-289.

Caner, M., & Hansen, B. E. (2001). Threshold autoregression with a unit root. *Econometrica*, 69(6), 1555-1596.

Caporale, G. M., & Gil-Alana, L. A. (2007). Nonlinearities and Fractional Integration in the US Unemployment Rate. *Oxford Bulletin of Economics and Statistics*, 69(4), 521-544.

Chari, V. V., & Kehoe, P. J. (2008). Time Inconsistency and Free-Riding in a Monetary Union. *Journal of Money, Credit and Banking*, 40(7), 1329-1356.

Cheng, S. C., Wu, T. P., Lee, K. C., & Chang, T. (2014). Flexible Fourier unit root test of unemployment for PIIGS countries. *Economic Modelling*, 36, 142-148.

Christopoulos, D. K., & León-Ledesma, M. A. (2010). Smooth breaks and non-linear mean reversion: Post-Bretton Woods real exchange rates. *Journal of International Money and Finance*, 29(6), 1076-1093.

Clements, M. P., & Smith, J. (2001). Evaluating forecasts from SETAR models of exchange rates. *Journal of International Money and Finance*, 20(1), 133-148.

Coakley, J., Fuertes, A. M., & Zoega, G. (2001). Evaluating the persistence and structuralist theories of unemployment from a nonlinear perspective. *Studies in Nonlinear Dynamics & Econometrics*, 5(3).

Cuestas, J. C., Gil-Alana, L. A., & Staehr, K. (2011). A further investigation of unemployment persistence in European transition economies. *Journal of Comparative Economics*, 39(4), 514-532.

Cuestas, J. C., & Ordóñez, J. (2011). Unemployment and common smooth transition trends in Central and Eastern European Countries. *Economic Issues*, 16(2), 39.

Davis, S. J., & Haltiwanger, J. (1991). Gross job creation, gross job destruction and employment reallocation. National Bureau of Economic Research. w3728.

Draghi, M. (2014). Unemployment in the euro area. Speech in Annual central bank symposium in Jackson Hole, 22 August 2014. (available at www.ecb.eu)

Enders, W., & Granger, C. W. J. (1998). Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. *Journal of Business & Economic Statistics*, 16(3), 304-311.

European Commission (2013). Labour Market Developments in Europe. European Economy, 6/2013.

Ferrara, L., Marcellino, M., & Mogliani, M. (2013). Macroeconomic forecasting during the Great Recession: The return of non-linearity?. *Centre for Economic Policy Research*.

Fosten, J., & Ghoshray, A. (2011). Dynamic persistence in the unemployment rate of OECD countries. *Economic Modelling*, 28(3), 948-954.

Granger, C.W.J. and Teräsvirta, T., (1993), *Modelling Nonlinear Economic Relationships,* Oxford University Press, Oxford.

Gustavsson, M., & Österholm, P. (2006). Hysteresis and non-linearities in unemployment rates. *Applied Economics Letters*, 13(9), 545-548.

Hamermesh, D. S., & Pfann, G. A. (1996). Adjustment costs in factor demand. *Journal of Economic Literature*, 1264-1292.

Hansen, B. E. (1997). Inference in TAR models. *Studies in nonlinear dynamics & econometrics*, 2(1).

Ioannou, D., & Stracca, L. (2014). Have the euro area and EU governance worked? Just the facts. *European Journal of Political Economy*, 34, 1-17.

Jaeger, A., & Parkinson, M. (1994). Some evidence on hysteresis in unemployment rates. *European Economic Review*, 38(2), 329-342.

Kapetanios, G., Shin, Y., & Snell, A. (2003). Testing for a unit root in the nonlinear STAR framework. *Journal of Econometrics*, 112(2), 359-379.

Karanassou, M., Sala, H., & Snower, D. J. (2010). Phillips curves and unemployment dynamics: a critique and a holistic perspective. *Journal of Economic Surveys*, 24(1), 1-51.

Kilian, L., & Taylor, M. P. (2003). Why is it so difficult to beat the random walk forecast of exchange rates?. *Journal of International Economics*, 60(1), 85-107.

Kim, D., & Perron, P. (2009). Unit root tests allowing for a break in the trend function at an unknown time under both the null and alternative hypotheses. *Journal of Econometrics*, 148(1), 1-13.

Koop, G., & Potter, S. M. (1999). Dynamic asymmetries in US unemployment. *Journal of Business & Economic Statistics*, 17(3), 298-312.

Lanzafame, M. (2010). The nature of regional unemployment in Italy. *Empirical Economics*, 39(3), 877-895.

Layard, R., Nickell, S.J. & Jackman, R. (1991*) Unemployment: Macroeconomic Performance and the Labour Market*. Oxford: Oxford University Press.

Lee, C. C., & Chang, C. P. (2008). Unemployment hysteresis in OECD countries: Centurial time series evidence with structural breaks. *Economic Modelling*, 25(2), 312-325.

Lee, J. D., Lee, C. C., & Chang, C. P. (2009). Hysteresis in unemployment revisited: evidence from panel LM unit root tests with heterogeneous structural breaks. *Bulletin of Economic Research*, 61(4), 325-334.

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *Review of Economics and Statistics*, 85(4), 1082-1089.

Lee, J., & Strazicich, M. C. (2004). Minimum LM unit root test with one structural break. Manuscript, Department of Economics, Appalachian State University, 1-16.

León-Ledesma, M. A., & McAdam, P. (2004). Unemployment, hysteresis and transition. *Scottish Journal of Political Economy*, 51(3), 377-401.

Lindbeck, A., & Snower, D. J. (2001). Insiders versus outsiders. *Journal of Economic Perspectives*, 165-188.

Lumsdaine, R. L., & Papell, D. H. (1997). Multiple trend breaks and the unit-root hypothesis. *Review of Economics and Statistics*, 79(2), 212-218.

Matthews, K., Minford, P., & Naraidoo, R. (2008). Vicious and virtuous circles—The political economy of unemployment in interwar UK and USA. *European Journal of Political Economy*, 24(3), 605-614.

McMillan, D. G., & Wohar, M. E. (2010). Stock return predictability and dividend-price ratio: a nonlinear approach. *International Journal of Finance & Economics*, 15(4), 351-365.

Mortensen, D. T. (1989). The persistence and indeterminacy of unemployment in search equilibrium. *Scandinavian Journal of Economics*, 347-370.

Neftci, S. N. (1984). Are economic time series asymmetric over the business cycle?. *Journal of Political Economy*, 307-328.

Pérez-Alonso, A., & Di Sanzo, S. (2011). Unemployment and hysteresis: a nonlinear unobserved components approach. *Studies in Nonlinear Dynamics & Econometrics*, 15(1).

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

Pesaran, H., & Timmermann, A. (1999). *Model instability and choice of observation window*. Department of Economics, UCSD.

Phelps, E. S. (1967). Phillips curves, expectations of inflation and optimal unemployment over time, *Economica*, 34, 254–81.

Phelps, E. S. (1968). Money–wage dynamics and labour market equilibrium. *Journal of Political Economy*, 76, 678–711.

Phelps, E. S. (1994). *Structural Slumps: The Modern Equilibrium Theory of Unemployment, Interests and Assets*. Harvard University Press, Cambridge, MA.

Phelps, E. S., & Zoega, G. (1998). Natural-rate Theory and OECD Unemployment. *Economic Journal*, 108(448), 782-801.

Raurich, X., Sala, H., & Sorolla, V. (2006). Unemployment, growth, and fiscal policy: new insights on the hysteresis hypothesis. *Macroeconomic Dynamics*, 10(03), 285-316.

Røed, K. (1997). Hysteresis in unemployment. *Journal of Economic Surveys*, 11(4), 389-418.

Sibert, A., & Sutherland, A. (2000). Monetary union and labour market reform. *Journal of International Economics*, 51(2), 421-435.

Skalin, J., & Teräsvirta, T. (2002). Modeling asymmetries and moving equilibria in unemployment rates. *Macroeconomic Dynamics*, 6(02), 202-241.

Sollis, R. (2009). A simple unit root test against asymmetric STAR nonlinearity with an application to real exchange rates in Nordic countries. *Economic Modelling*, 26(1), 118-125.

Strazicich, M. C., Lee, J., & Day, E. (2004). Are incomes converging among OECD countries? Time series evidence with two structural breaks. *Journal of Macroeconomics*, 26(1), 131-145.

Teräsvirta, T. (1994). Specification, estimation, and evaluation of smooth transition autoregressive models. *Journal of the American Statistical Association*, 89(425), 208-218.

Teräsvirta, T., & Anderson, H. M. (1992). Characterizing nonlinearities in business cycles using smooth transition autoregressive models. *Journal of Applied Econometrics*, 7(S1), S119-S136.

Teräsvirta, T., Van Dijk, D., & Medeiros, M. C. (2005). Linear models, smooth transition autoregressions, and neural networks for forecasting macroeconomic time series: A re-examination. *International Journal of Forecasting*, 21(4), 755-774.

Teräsvirta, T. (2006). Forecasting economic variables with nonlinear models. *Handbook of economic forecasting*, 413-457.

Tong, H., (1990), *Nonlinear Time Series: A Dynamical System Approach*, Clarendon Press, Oxford.

Yellen, J., (2012), The Economic Outlook and Monetary Policy. Speech. At the Money Marketeers of New York University, New York, April 11, 2012 (available at www.federalreserve.gov)

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of business & economic statistics*, 20(1), 25-44.

Table 1: Data Summary Statistics
Unemployment, Quarterly, Seasonally Adjusted

	initial data point	number of obs.	average	min	max	standard deviation
Austria	1994Q1	81	4.3	3.4	5.3	0.5
Belgium	1983Q1	126	8.4	6.3	11.0	1.2
Bulgaria	2000Q1	58	11.8	5.2	19.8	4.0
Croatia	2000Q1	58	13.5	8.3	18.1	2.6
Cyprus	2000Q1	58	6.4	3.3	16.6	3.9
Czech Republic	1993Q1	86	6.5	3.7	9.3	1.6
Denmark	1983Q1	126	6.2	3.1	9.9	1.6
Estonia	2000Q1	58	10.2	4.1	18.1	3.5
Finland	1988Q1	106	9.2	2.9	17.5	3.5
France	1983Q1	126	10.0	7.2	12.5	1.3
Germany	1991Q1	94	8.1	5.0	11.4	1.7
Greece	1998Q2	65	13.2	7.5	27.8	6.1
Hungary	1996Q1	74	8.2	5.5	11.3	1.9
Iceland	2003Q1	46	4.6	1.9	8.0	2.0
Ireland	1983Q1	126	11.0	3.7	17.0	4.7
Italy	1983Q1	126	9.2	6.0	12.6	1.6
Japan	1983Q1	126	3.7	2.1	5.4	1.1
Latvia	1998Q2	65	12.6	5.9	20.5	3.6
Lithuania	1998Q1	66	12.2	4.1	18.2	4.1
Luxembourg	1983Q1	126	3.3	1.5	6.2	1.3
Malta	2000Q1	58	6.8	5.7	7.9	0.5
Netherlands	1983Q1	126	5.2	2.5	8.3	1.5
Norway	1989Q1	102	4.2	2.4	6.7	1.2
Poland	1997Q1	70	13.1	6.9	20.3	4.4
Portugal	1983Q1	126	7.9	3.9	17.4	3.2
Romania	1997Q1	70	6.8	5.1	8.2	0.7
Slovakia	1998Q1	66	15.1	8.9	19.5	2.9
Slovenia	1996Q1	74	6.9	4.3	10.5	1.4
Spain	1986Q2	113	16.5	8.0	26.3	5.1
Sweden	1983Q1	126	6.1	1.4	10.3	2.6
Turkey	2005Q1	37	9.8	8.2	13.7	1.4
United Kingdom	1983Q1	126	7.6	4.6	11.3	2.1
United States	1983Q1	126	6.3	3.9	10.4	1.6

Source: Eurostat

Table 2: Minimum LM Unit Root Test with Structural Breaks (Lee and Strazicich, 2003 & 2004)

	Two-breaks test						One break test				
Country	k	LM_{T2}		T_{B2}	λ_1	λ_2	k	LM_{T1}		T_{B1}	λ
Austria	4	-3.78		2007q1	0.6		4	-2.53		2007q1	0.6
Belgium	4	-4.66		1992q1, 1999q1	0.3	0.5					
Bulgaria	4	-5.12	*	2006q3, 2011q1	0.4	0.8					
Croatia	3	-3.84		2006q1, 2009q3	0.4	0.7					
Cyprus	4	-5.01	*	2004q2, 2008q3	0.3	0.6					
Czech Rep.	0	-4.76		2003q2, 2005q1	0.5	0.6					
Denmark	3	-4.56		1990q1, 2008q3	0.2	0.8					
Estonia	3	-7.44	***	2006q2	0.4		3	-3.95		2008q3	0.6
Finland	3	-6.40	***	1992q1, 1998q1	0.2	0.4					
France	2	-4.68		1998q4, 2010q2	0.5	0.9					
Germany	4	-5.16	*	2002q2, 2009q2	0.5	0.8					
Greece	4	-5.72	**	2006q4, 2011q1	0.5	0.8					
Hungary	1	-4.62		2009q2	0.7		1	-2.51		2003q4	0.4
Iceland	4	5.68	**	2008q1, 2010q3	0.4	0.7					
Ireland	4	-4.16		1998q3, 2009q4	0.5	0.8					
Italy	3	-4.59		200q1, 2008q3	0.5	0.8					
Japan	3	-4.21									
Latvia	3	-6.69	***	2006q1	0.5		2	-4.19		2008q1	0.6
Lithuania	3	-5.52	**	2006q2	0.5		3	-4.35	*	2008q1	0.6
Luxembourg	2	-3.92		2005q1	0.7		2	-3.36		1992q4	0.3
Malta	3	-6.39	***	2003q1, 2008q4	0.2	0.6					
Netherlands	2	-5.39	**	1993q1, 1998q2	0.3	0.5					
Norway	4	-4.07		1996q3	0.3		4	-3.71		1996q3	0.3
Poland	3	-5.35	**	2002q2, 2009q2	0.3	0.7					
Portugal	4	-4.08		1992q3	0.3		3	-3.44		2004q1	0.7
Romania	1	-5.26	*	2004q4, 2009q1	0.4	0.7					
Slovakia	3	-4.64		2002q4	0.3		1	-7.41	*		
Slovenia	3	-5.41	**	2006q4, 2009q4	0.6	0.7					
Spain	0	-4.00		1995q1, 1998q4	0.3	0.4					
Sweden	3	-5.12	*								
Turkey	3	-6.43	***	2008q3, 2011q1	0.4	0.6					
UK	2	-4.63									
US	3	-4.36		2002q2, 2011q1	0.6	0.9					

Notes: LM_{T2} and LM_{T1} are the test statistics for the two-break minimum LM unit root test [Lee and Strazicich, 2003)] and one-break mimimum LM unit root test [Lee and Strazicich, 2004)], respectively. k stands for the optimal number of lagged first-differenced terms to correct for serial correlation for the corresponding test. λ_1 and λ_2 are the locations of structural breaks in two-break minimum LM unit root test; whereas λ is the location of structural break in the one-break test. The critical values depend on the location of the structural breaks where (λ_i=TB_i/T), with T being the number of observations as documented in Table 1. Critical values for LM_{T2} are tabulated in Table 2 (Model C) of Lee and Strazicich (2003). Critical values for LM_{T1} are tabulated in Table 1 (Model C) of Lee and Strazicich (2004). *, **, *** denote the significance at the 10%, 5% and 1%, respectively.

Table 3: Linear and Nonlinear Unit Root Tests

	ADF		ERS		PP		k_{cl}	$t_{nl, cl}$		$t_{nl, kss}$		$F_{AE,\mu}$	
Austria	-2.62	*	3.35	*	-2.31		3	-2.51		-2.48		2.15	
Belgium	-3.35	**	4.81		-2.40		3	-2.53		-3.10	**	2.50	
Bulgaria	-1.89		9.05		-1.26		1	0.57		-2.10		2.78	
Croatia	-2.24		2.63	**	-0.98		1	-3.28	*	-2.51		1.19	
Cyprus	-0.31		16.16		0.82		1	-2.61		-2.32		8.61	***
Czech Rep.	-2.89	*	3.23	*	-1.90		2	-2.47		-3.19	**	2.07	
Denmark	-2.37		5.15		-2.19		1	-3.93	**	-3.01	**	1.29	
Estonia	-2.61	*	3.37	*	-1.87		2	-3.46	**	-4.06	***	0.93	
Finland	-2.92	**	4.68		-1.91		1	-5.51	***	-3.36	**	4.08	
France	-2.48		4.85		-2.05		1	-2.18		-2.40		0.84	
Germany	-1.92		5.82		-1.36		1	-2.89		-1.51		0.39	
Greece	-2.16		0.37	***	0.83		1	-2.03		-2.76	*	10.07	***
Hungary	-1.54		9.92		-1.47		1	-3.27	*	-1.26		1.20	
Iceland	-1.11		11.90		-1.25		1	-2.31		-1.99		2.07	
Ireland	-1.90		4.34		-1.26		1	-4.16	***	-1.90		1.12	
Italy	-1.67		8.85		-1.34		2	-3.21		-2.08		0.05	
Japan	-1.23		18.17		-1.35		1	-2.38		-2.03		2.45	
Latvia	-3.32	**	0.78	***	-1.85		2	-3.85	***	-3.39	**	0.48	
Lithuania	-2.04		2.46	**	-1.69		1	-2.60		-2.21		1.12	
Luxembourg	-0.37		11.48		-0.12		1	-1.13		-0.89		0.26	
Malta	-1.16		6.35		-1.62		1	-1.06		-0.99		2.18	
Netherlands	-2.95	**	9.46		-2.10		1	-4.18	***	-3.08	**	0.41	
Norway	-1.38		10.38		-1.24		1	-2.27		-1.40		2.67	
Poland	-1.67		3.58	*	-1.11		1	-2.63		-1.79		2.19	
Portugal	-1.22		6.71		-0.25		1	-2.88		-2.20		2.34	
Romania	-2.95	**	9.68		-2.51		2	-3.29	**	-2.80	**	2.18	
Slovakia	-2.10		4.35		-1.65		1	-3.83	**	-3.06	**	2.16	
Slovenia	0.19		17.16		-0.27		1	-1.44		-0.83		0.15	
Spain	-2.21		3.15	*	-1.14		1	-2.56		2.18		0.09	
Sweden	-2.01		5.62		-1.55		2	-1.84		-1.92		2.69	
Turkey	-2.34		2.01	**	-1.65		1	-3.65	**	-3.07	**	0.98	
United Kingdom	-2.20		12.29		1.75		1	-2.76		-2.27		2.36	
United States	-2.96	**	9.94		-2.93	**	1	-4.09	**	-2.95	**	0.55	

Note: First three columns report the ADF, Elliot-Rottemberg abd Phillips-Perron test statistics. k_{cl} denote the optimal number of lags selected in Christopoulos and Leon-Ledesma (2010) test. $t_{nl,cl}$, $t_{nl,kss}$ and $F_{AE,\mu}$ stand for the t-statstics in Christopoulos and Leon Ledesma (2010) test, ESTAR t-statistics in Kapetanios et al. (2003) test and AESTAR F-statistics in Sollis (2009), respectively. Critical values for 10%,5% and 1% are -2.66, -2.93 and -3.48 for ESTAR test; 4.16, 4.95 and 6.89 for AESTAR test, respectively. For the Christopoulos and Leon-Ledesma (2010) test, critical values depend on the optimal value of k_{cl} and are tabulated in Table 3 (page 1084) of that article.

Table 4
AESTAR Model Estimation

	θ_1	θ_2	a_1	a_2	W_{a1-a2}
Cyprus	0.01	0.48	-0.01	-0.52	0.51
	(0.00)	(4.94)	(0.48)	(0.00)	(9.65)
Greece	0.01	0.20	-0.01	-0.10	0.09
	(0.00)	(3.07)	(1.13)	(0.85)	(0.63)

Note: The parameters θ_1,θ_2,a_1 and a_2 are defined in equation 4. The figures in parentheses are standard errors. The last column gives the Wald test statistics in equation 9.

Table 5: Out-of-Sample Forecasting

RRMSE's of the Out-of-Sample Exercise
(h's denote the forecast horizons)

a) Random walk benchmark, ESTAR model

	h=1	h=2	h=3	h=4
Belgium	0.97	0.95	0.94	0.60
Czech Republic	0.98	0.97	0.93	0.88
Denmark	0.97	0.96	0.91	1.59
Estonia	1.02	0.86	0.68	0.29
Finland	0.99	1.01	1.00	0.37
Greece	1.05	1.03	1.00	0.64
Latvia	0.96	0.85	0.75	0.24
Netherlands	0.99	1.06	1.10	0.52
Romania	1.01	1.02	1.01	3.62
Slovakia	0.98	0.97	0.97	0.79
Turkey	1.05	1.00	0.95	0.86
United States	0.96	0.93	0.89	0.94
average	**0.99**	**0.97**	**0.93**	**0.94**

b) Random walk benchmark, AESTAR model

	h=1	h=2	h=3	h=4
Greece	1.00	0.97	0.93	0.29
Cyprus	1.00	1.01	1.01	0.33
average	**1.00**	**0.99**	**0.97**	**0.31**

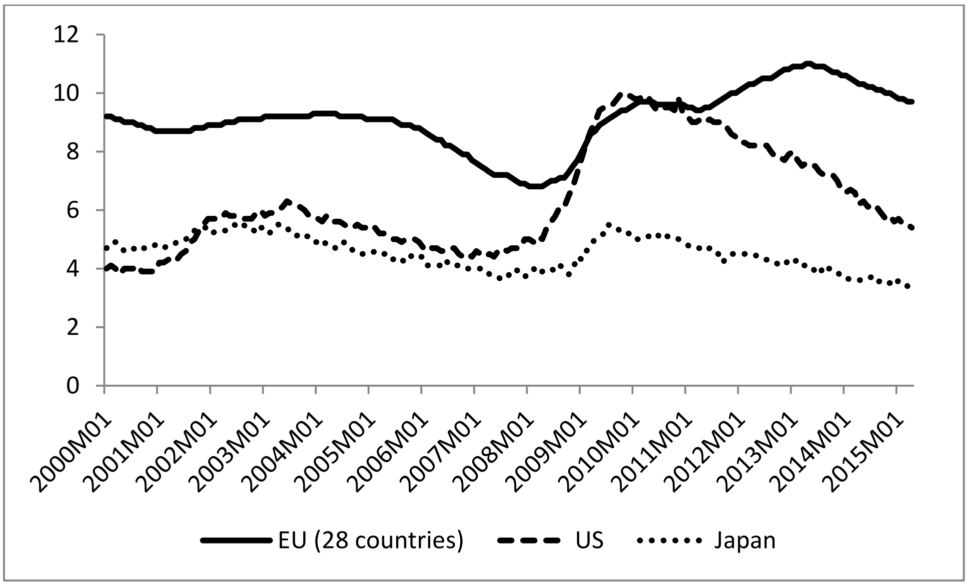
c) Linear AR benchmark, ESTAR model

	h=1	h=2	h=3	h=4
Belgium	0.98	0.97	0.97	1.19
Czech Rep.	0.98	0.98	0.98	2.23
Denmark	0.97	0.97	0.96	2.22
Estonia	1.03	1.01	0.95	1.07
Finland	0.99	0.98	0.98	1.13
Greece	1.02	1.03	1.03	2.79
Latvia	0.96	0.96	0.96	0.70
Netherlands	1.00	0.99	0.99	1.14
Romania	1.01	0.99	0.97	6.10
Slovakia	0.98	0.97	0.98	1.88
Turkey	0.96	1.02	0.99	2.85
United States	0.96	0.96	0.96	2.66
average	**0.99**	**0.99**	**0.98**	**2.16**

d) Linear AR benchmark, AESTAR model

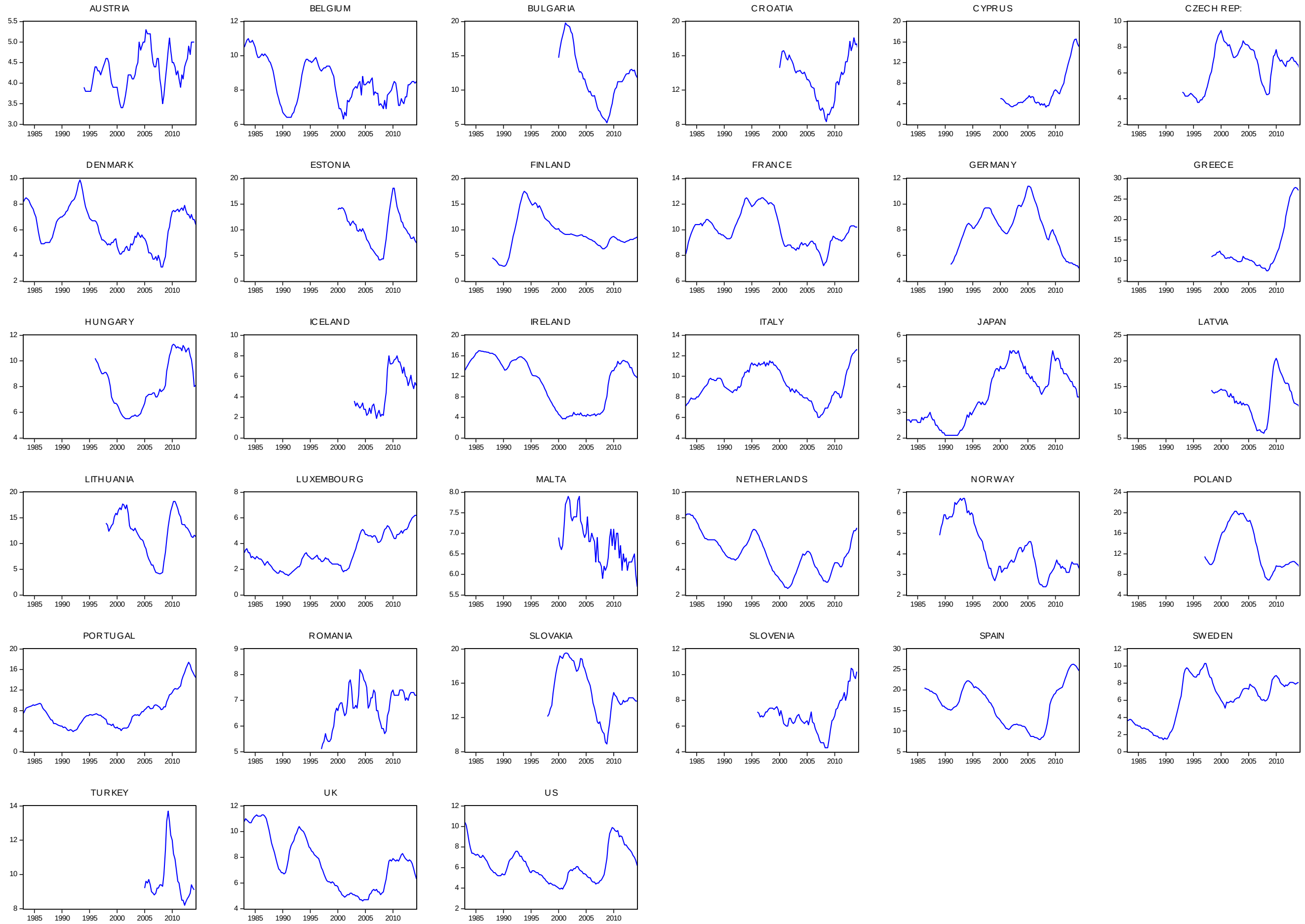
	h=1	h=2	h=3	h=4
Cyprus	0.96	0.96	0.96	1.24
Greece	0.97	0.97	0.97	1.28
average	**0.97**	**0.97**	**0.97**	**1.28**

Figure 1: European Unemployment
(monthly average, seasonally adjusted, percent)



Source: Eurostat

Figure 2: Unemployment Rates
(quarterly, seasonally adjusted, percent)



Source: Eurostat

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