Unemployment Hysteresis and Structural Change in Europe

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Abstract

We examine the unemployment hysteresis hypothesis for 31 European countries, US and Japan, using linear and nonlinear unit root tests. Two types of smooth transition models - Exponential Smooth Transition Autoregressive (ESTAR) and Asymmetric Exponential Smooth Transition Autoregressive (AESTAR) - are employed to account for the 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 are moderately better than the random walk model in the longer term. 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.

Two important factors that would determine whether a shock would be temporary or long-lived are the labour market conditions before the shock and the source of the shock (i.e. demand or supply shocks)[2]. A recent European Commission (2013) report documents significant heterogeneity in both of these factors across the European region. First, pre-crisis labour market conditions were different among union countries. Second, demand shocks have also been revealed in alternative strengths across 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 before "*cyclical unemployment becomes structural*".

This fear of a cyclical variation turning into a persistent change in unemployment is somewhat reminiscent of 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[3]. That assessment of a *path-dependent* long-run unemployment, or hysteresis

[2] 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.

[3] 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.

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*". This line of reasoning is also adopted in a recent speech of Draghi (2014), on combatting with current European unemployment problem:

"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."[4]

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 positive answer to this question would provide a partial support for the application of policies to boost aggregate demand in the short-run, as argued above. 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.

This paper tests unemployment hysteresis hypothesis for 31 European countries (as well as US and Japan for comparison purposes) using linear and nonlinear unit root tests. We also conduct multiple structural break tests for the series and present the results of an out-of sample forecasting exercise using these models. In particular, we employ two types of smooth transition models- 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. 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.

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

[4] 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."*

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 are moderately better than the random walk model in the longer term. We discuss the policy implications of our results regarding the role of demand or supply side policies for combatting the European unemployment problem.

Second section provides a review of hysteresis concept and the literature. Third section describes the data and the econometric methodology; presents the results of structural break tests, linear and nonlinear unit root tests, model estimation and the out-of-sample forecasting exercise. The fourth 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) paper brings 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[5]. 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[6].

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

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

[6] 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).

(1994) assumes 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. Layard et al. (1991) explores 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) proposes 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.

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) suggest 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[7]. 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*.

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) underlies the different behaviour of the natural rate of unemployment at deep recessions compared to shallow ones. They argue that the surge in UK 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[8]. One appealing explanation is the asymmetries in adjustment costs of labour faced by the firms. Costs of hiring or firing could be

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

[8] Davis and Haltiwanger (1991) shows 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.

asymmetric due to factors such as search costs, training costs or severance pay (Hamermesh and Pfann, 1996; Bentolila and Bertola, 1990)[9]. 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) shows 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. Caner and Hansen (2001) proposes a joint test for nonlinearity and nonstationarity using a similar framework where they describe US unemployment rate as a stationary nonlinear process[10].

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) recommends this type of a smooth adjustment for a number of OECD countries using a logistic STAR framework,

[9] 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).

[10]Koop and Potter (1999) corroborates 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).

including a lagged level term which would induce local nonstationarity in a globally stationary model. Lanzafame (2010) examine 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[11].

Our paper focuses on the aforementioned nonlinear dynamics in the unemployment while taking into account possible structural breaks in the unemployment series. In a general manner, we follow the strand of literature that employs unit root tests to explore hysteresis. In particular, in addition to linear unit root tests, we conduct two nonlinear unit root tests, ESTAR (Kapetanios, Shin and Snell, 2003) and AESTAR (Sollis, 2009) tests in order to account for aforementioned asymmetries in the unemployment dynamics. Our interest lies in assessing the time-series properties of unemployment rates in European countries from a statistical viewpoint, rather than a focus on the structural factors that would determine the path of unemployment.

Our analysis further includes an out-of-sample forecasting analysis to measure the predictive power of our proposed smooth transition models. To this end, we follow 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 next section, we conduct joint tests of linearity and unit root for two smooth transition models, ESTAR and AESTAR for 33 countries in our sample. In addition to these test, we also conduct Bai-Perron (2003) multiple structural break test to explore possible mean-shifts in the unemployment series. Later on, we carry on to the model estimation and forecasting exercises with 13 countries for which the tests suggest signs of nonlinear behaviour.

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

[11] Caporale and Gil-Alana (2007) uses fractional integration along with nonlinear techniques to test for hysteresis. Pérez-Alonso and Di Sanzo (2011) proposes a nonlinear unobserved component model to test for hysteresis. Recently, Cuestas and Ordóñez (2011) explores the nonlinearities in unemployment rates of Central and Eastern European countries with ESTAR and LSTAR models. Gustavsson and Österholm (2006) also employs ESTAR model for testing the unemployment hysteresis for five developed countries.

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 next subsection.

a. Structural break test

We employ Bai and Perron (2003) methodology to test for the structural breaks for 33 countries in our sample. The first column of Table 2 provides the equal weighted version of the double maximum test statistics with null hypothesis of no structural break against an unknown number of breaks. All countries except Austria, France, Latvia, Netherlands, Portugal, United Kingdom and United States suffer from structural break problem according to this double maximum test.

Subsequent to establishing the presence of breaks, we further conduct F(i/0) tests, with the null of no structural break against (i=1,…5) number of breaks, as documented in columns two to six[12]. The number of breaks is determined with the BIC criteria as suggested by Bai and Perron (2003). The last column of the Table 2 documents these break dates. It is worthwhile to note that the global financial crisis indicates a structural break for 60 percent of the countries (19 countries) while 2010 Eurozone crisis marks a break for around a quarter of the countries (9 countries).

The presence of structural breaks can cause distortions in both linearity tests and estimation; hence, in turn, result in lower forecasting power. As regards the first problem; Carrasco (2002) argues that under the presence of a nonlinear data generating process, tests with a threshold alternative provide a better alternative against parameter instability problem compared to the structural change tests[13]. Therefore, the tests including threshold models that will be demonstrated in the next subsection could be another alternative to identify parameter instability regardless of its nature, in addition to the structural break tests.

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. In our analysis, we conducted unit root tests with both whole series and post-break series, provided that the post-break series has at least 30 observations[14]. However, as discussed above, for most of the series the global crisis in 2008 and Eurozone crisis in 2010 marks a structural break. Since this left us with a few observations, we opt out to conduct a post-break analysis with these series which would lead to

[12] We select the trimming value as 0.15 similar to Bai and Perron (2003).
[13] In particular, the latter type of tests assumes a permanent break while the former approach imposes a more cyclical adjustment behavior.
[14] In Table 3, for Belgium (2004Q4), Finland (2005Q3) and Norway (2006Q3) are the post break series in this sense.

significantly higher variances. 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.

b. Linear and 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[15]

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: θ=0 against the alternative H_1: θ>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:

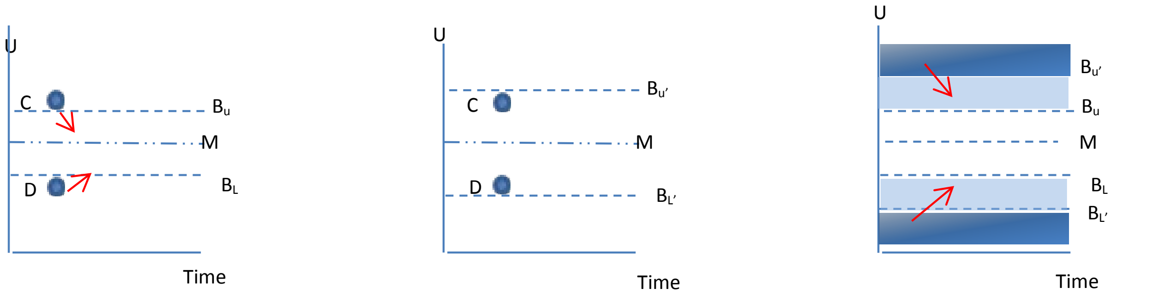
[15] This correction behaviour could also be motivated as a reflection of the business cycles. A long-run mean reversion would imply that recessions will be followed by a recovery which could be the result of an improvement in expectations, corresponding to a positive demand shock in Bentolila and Bertola (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[16]. 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:

[16] 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.

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

where

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

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

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:

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

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:

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

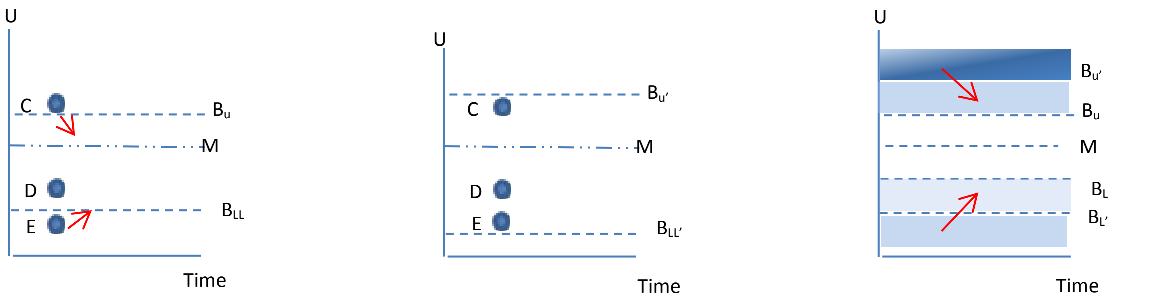
with $\phi_1 = a_2\theta_1$ and $\phi_2 = c(a_2^* - a_1^*)\,\theta_1\,\theta_2$ where c=0.25, a_1^* and a_2^* are functions of a_1 and a_2 as defined in Sollis (2009). The joint null hypothesis of linearity and unit root of this auxiliary model is H_0: $\phi_1 = \phi_2 = 0$. The asymptotic distribution 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



The results of the linear and nonlinear unit root tests are documented in Table 3. For Belgium, Finland and Norway, tests are conducted with post-break series in addition to the whole sample. 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. Last two columns of the table document the ESTAR test statistics (t_{nl}) and the AESTAR test statistics ($F_{AE,\mu}$).

A first look at the results suggests no sign of stationarity, providing support for the hysteresis hypothesis for 14 countries out of 33: Bulgaria, France, Germany, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Portugal, Slovenia, Sweden and United Kingdom.

For the rest of the countries 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 19 countries.

At first, for 5 countries out of 19 (Austria, Croatia, 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 5 countries as well as the 14 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 14 countries. For eleven of these countries both linear and nonlinear unit root tests reject the null of unit root: Belgium, Czech Republic, Estonia, Finland, Greece, Latvia, Netherlands, Norway (post-break series), Romania, Turkey and United States. For three of these countries only nonlinear tests reject the null of a unit root: AESTAR test for Cyprus; ESTAR test for Denmark and Slovakia. For these countries unemployment could be described as a stationary process which is subject to regime changes as discussed above. While this process might be explained within a business cycle perspective or heterogeneities in firing or hiring costs, 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 as discussed in the previous section. That being said, as discussed above, threshold type tests are proved to be more powerful to detect parameter instability regardless of its nature and provide us a useful framework to forecast the future behaviour of these variables. In line of this view, we examine the forecasting power of these nonlinear models in the next section.

c. Model Estimation and Out-of-Sample Forecasting Analysis

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[17]. 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. Akdogan (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[18].

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 $H_0 = a_1 - a_2 = 0$. This test statistics is very low for Greece but significant for Cyprus. The sign of the (a_1-a_2) difference would give us an idea about the asymmetry in adjustment. 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).

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[17] 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.

[18] The estimation returns the smallest value to fulfil with the restrictions for some parameters. Standard errors are very close to zero for these cases.

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 the naïve random walk 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 a naïve random walk model using the relative root mean square errors (RRMSE) for each forecast horizon.

The results of this exercise for ESTAR and AESTAR cases are reported in Table 5 below. The columns represent forecast horizons in the table. A first look at the results 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, Latvia, Netherlands or Finland in 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. This result corroborates with Akdoğan (2014) which suggests that the predictive power of both ESTAR and AESTAR models to forecast inflation are better than that of random walk in the longer horizon for some countries.

Previous literature also includes some studies that 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 documents higher predictive power for alternative nonlinear models in exchange rate determination. However, the literature still provides mixed results on the forecasting power of nonlinear models. For a review of this literature and examples see Terasvirta et al. (2005) and Ferrara et al. (2013).

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

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). 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.

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.

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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: Multiple Structural Break Test (Bai-Perron, 2003)

	Udmax		F(1/0)		F(2/0)		F(3/0)		F(4/0)		F(5/0)		Break Dates
Austria	3.87		1.17		3.39		3.87		3.28		1.52		
Belgium	24.41	***	0.34		4.51		24.41	***	18.33	***	14.55	***	1988Q3, 1993Q1, 1999Q2, 2003Q4
Bulgaria	33.64	***	1.84		0.79		33.64	***	18.51	***	16.59	***	2002Q4, 2004Q4, 2006Q4, 2009Q4, 2011Q4
Croatia	76.62	***	1.46		3.85		32.79	***	59.90	***	76.62	***	2002Q3, 2004Q3, 2006Q3, 2010Q1, 2012Q2
Cyprus	20.64	***	6.51		20.64	***	15.53	***	13.41	***	11.15	***	2009Q3, 2012Q1
Czech Rep.	12.82	***	3.31		12.82		9.17	***	9.67	***	3.66	*	1998Q2, 2006Q2, 2009Q2
Denmark	14.49	***	0.20		9.02		7.67		14.49	***	8.67	***	1990Q3, 1996Q2, 2004Q4, 2009Q2
Estonia	13.27	***	0.27		0.96		1.79		13.27	***	5.00		2001Q4, 2005Q2, 2008Q4, 2011Q2
Finland	9.11	**	0.37		6.80		9.11	***	7.93	***	7.57	***	1991Q4, 1997Q1, 2000Q4, 2005Q2
France	4.41		0.90		2.21		4.20		3.53		4.41		
Germany	9.44	**	4.78		0.22		0.39		9.44	***	7.83	***	1994Q2, 1999Q2, 2002Q4, 2007Q1, 2010Q4
Greece	45.50	***	24.12	***	37.42	***	45.50	***	35.53	***	29.95	***	2005Q4, 2009Q3, 2011Q4
Hungary	17.82	***	0.06		0.13		2.29		16.75	***	17.82	***	1998Q4, 2001Q3, 2005Q1
Iceland	240.37	***	16.50	***	96.57	***	143.27	***	240.37	***	209.98	***	2004Q3, 2008Q4, 2011Q1, 2012Q3
Ireland	70.39	***	0.09		23.31	***	12.52	***	12.93	***	70.39	***	1989Q1, 1994Q2, 1998Q4, 2008Q4
Italy	14.79	***	0.26		1.51		3.65		14.79	***	9.26	***	1987Q2, 1993Q3, 2000Q3, 2005Q1, 2009Q4
Japan	32.13	***	1.51		4.03		17.58	***	32.13	***	29.52	***	1988Q3, 1993Q3, 1998Q1, 2004Q3, 2009Q1
Latvia	7.48		0.03		1.53		7.48		2.38		4.48		
Lithuania	10.88	***	0.15		2.07		10.88	***	2.65		2.18		2002Q2, 2005Q2, 2008Q4
Luxembourg	20.35	***	2.50		6.05		3.35		20.35	***	17.33	***	1987Q3, 1993Q1, 1998Q2, 2003Q1, 2008Q2
Malta	31.97	***	9.23	***	7.44	***	13.09	***	19.33	***	31.97	***	2004Q2, 2007Q1, 2009Q1, 2011Q2
Netherlands	1.35		0.31		0.11		0.31		0.37		1.35		
Norway	13.97	***	4.17		6.92	*	4.19	*	4.50		13.97	***	1996Q3, 2002Q3, 2006Q2
Poland	85.31	***	0.61		1.23		13.66	***	14.77	***	85.31	***	1999Q2, 2001Q4, 2004Q2, 2006Q4, 2009Q4
Portugal	7.09		0.27		2.70		3.68		5.36		7.09		
Romania	34.96	***	17.50	***	34.96	***	25.32	***	23.32	***	20.21	***	1999Q2, 2001Q4, 2006Q4, 2009Q2
Slovakia	91.55	***	2.51		0.79		2.95		20.01	***	91.55	***	2000Q1, 2004Q2, 2006Q3, 2009Q2
Slovenia	11.39	**	4.87		2.50		10.13	***	11.39	***	9.56	***	2000Q3, 2006Q1, 2008Q4, 2011Q3
Spain	7.75	*	0.48		0.08		0.41		6.74	***	7.75	***	1992Q4, 1998Q3, 2004Q3, 2008Q4
Sweden	16.10	***	1.22		6.93	*	6.85	**	12.38	***	16.10	***	1992Q2, 1998Q3, 2003Q2, 2009Q1
Turkey	27.87	***	0.53		3.64		18.49	***	24.26	***	27.87	***	2008Q3, 2010Q1, 2011Q2
United Kingdom	5.67		0.51		2.01		5.67	*	5.13	*	3.58	*	
United States	3.39		2.37		0.93		0.93		3.39		2.49		

Table 3: Linear and Nonlinear Unit Root Tests

	ADF		ERS		PP		t_{nl}		$F_{AE,\mu}$	
Austria	-2.62	*	3.35	*	-2.31		-2.48		2.15	
Belgium	-3.35	**	4.81		-2.40		-3.10	**	2.50	
(2003Q4 onwards)	-1.97		4.26		-2.04		-2.44		7.72	***
Bulgaria	-1.89		9.05		-1.26		-2.10		2.78	
Croatia	-2.24		2.63	**	-0.98		-2.51		1.19	
Cyprus	-0.31		16.16		0.82		-2.32		8.61	***
Czech Rep.	-2.89	*	3.23	*	-1.90		-3.19	**	2.07	
Denmark	-2.37		5.15		-2.19		-3.01	**	1.29	
Estonia	-2.61	*	3.37	*	-1.87		-4.06	***	0.93	
Finland	-2.92	**	4.68		-1.91		-3.36	**	4.08	
(2005Q3 onwards)	-2.41		1.62	***	-1.69		2.21		2.91	
France	-2.48		4.85		-2.05		-2.40		0.84	
Germany	-1.92		5.82		-1.36		-1.51		0.39	
Greece	-2.16		0.37	***	0.83		-2.76	*	10.07	***
Hungary	-1.54		9.92		-1.47		-1.26		1.20	
Iceland	-1.11		11.90		-1.25		-1.99		2.07	
Ireland	-1.90		4.34		-1.26		-1.90		1.12	
Italy	-1.67		8.85		-1.34		-2.08		0.05	
Japan	-1.23		18.17		-1.35		-2.03		2.45	
Latvia	-3.32	**	0.78	***	-1.85		-3.39	**	0.48	
Lithuania	-2.04		2.46	**	-1.69		-2.21		1.12	
Luxembourg	-0.37		11.48		-0.12		-0.89		0.26	
Malta	-1.16		6.35		-1.62		-0.99		2.18	
Netherlands	-2.95	**	9.46		-2.10		-3.08	**	0.41	
Norway	-1.38		10.38		-1.24		-1.40		2.67	
(2006Q3 onwards)	-1.12		10.05		-1.52		-3.60	***	6.37	**
Poland	-1.67		3.58	*	-1.11		-1.79		2.19	
Portugal	-1.22		6.71		-0.25		-2.20		2.34	
Romania	-2.95	**	9.68		-2.51		-2.80	**	2.18	
Slovakia	-2.10		4.35		-1.65		-3.06	**	2.16	
Slovenia	0.19		17.16		-0.27		-0.83		0.15	
Spain	-2.21		3.15	*	-1.14		2.18		0.09	
Sweden	-2.01		5.62		-1.55		-1.92		2.69	
Turkey	-2.34		2.01	**	-1.65		-3.07	**	0.98	
United Kingdom	-2.20		12.29		1.75		-2.27		2.36	
United States	-2.96	**	9.94		-2.93	**	-2.95	**	0.55	

Note: Number of lags selected by Akaike Information Criteria., ** and *** stand for significance levels at 10%,5% and 1%, 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*

Table 4
AESTAR Model Estimation

	θ1	θ2	a1	a2	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)

Table 5: Out-of-Sample Forecasting

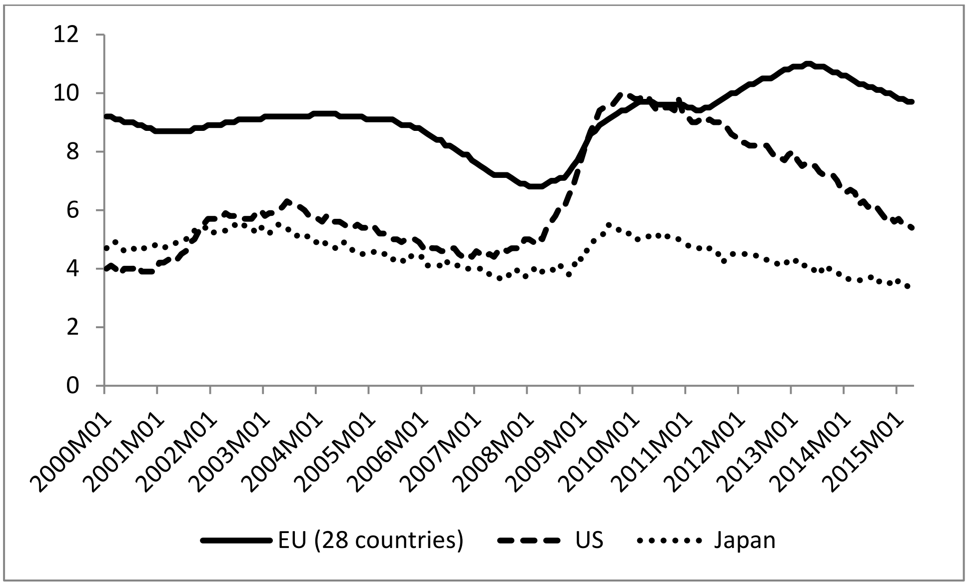
a) RRMSE's of the Out-of-Sample Exercise (ESTAR)

	h=1	h=2	h=3	h=4
Belgium	0.97	0.95	0.94	0.60
Czech Rep.	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
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
Finland	0.99	1.01	1.00	0.37
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) RRMSE's of the Out-of-Sample Exercise (AESTAR)

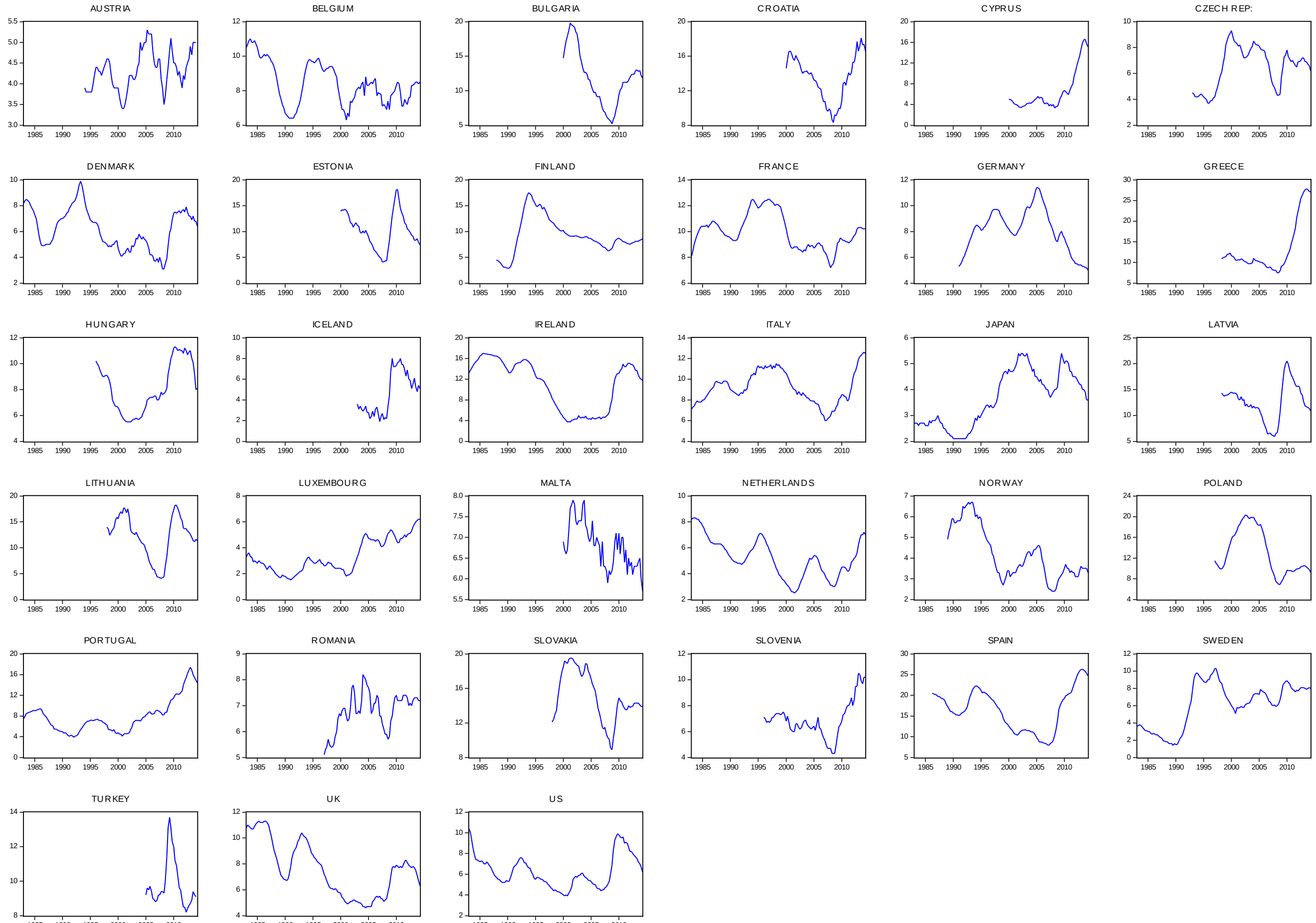
	h=1	h=2	h=3	h=4
Greece	1.00	0.97	0.93	0.29
Cyprus	1.00	1.01	1.01	0.33
average	**1.00**	**0.99**	**0.97**	**0.31**

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



Source: Eurostat

Figure 2: Unemployment Rates
(quarterly, seasonally adjusted)



Source: Eurostat