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EVALUATING THE PERSISTENCE AND STRUCTURALIST THEORIES OF UNEMPLOYMENT

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ABSTRACT

Evaluating The Persistence And Structuralist Theories Of Unemployment*

This Paper uses a threshold autoregressive (TAR) framework to assess the relative importance of structural breaks and asymmetric persistence in accounting for the post-war unemployment experience. In comparing unemployment patterns across time periods and countries, we take the US as a representative flexible labour market and Germany as an archetypal inflexible one, with the UK occupying an intermediate position. Significant breaks are detected in the UK and German series around 1980 suggesting a sharp increase in their respective natural rates. Evidence of asymmetries is also found in the dynamics of unemployment with rapid mean reversion following booms and persistence in the wake of recessions. We conclude that shifts in the natural rate explain differences over longer periods such as decades while asymmetric persistence can shed light on the short to medium run differences.

JEL Classification: C22, E30, J60
Keywords: momentum TAR process, bootstrap, asymmetries, structural breaks

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NON-TECHNICAL SUMMARY

The sustained rise of unemployment in many of the OECD countries has sparked a spiralling literature on medium-term unemployment dynamics that in recent years has been dominated by two competing schools of thought. One emphasises the role of dynamic adjustment towards the natural rate of unemployment – this is the propagation of transitory nominal and real shocks – where slow adjustment is usually referred to as persistence or hysteresis. The other is more interested in autonomous movements or shifts in the natural rate itself due to the interplay of changes in real macroeconomic variables and institutions. We call them the persistence and the structuralist schools, respectively.

This Paper evaluates empirically the ability of both schools to explain different unemployment patterns over time and across countries such as why some countries have experienced sustained high unemployment in recent decades. More specifically it uses a nonlinear framework to assess the relative importance of one-off shifts in and persistent departures from the natural rate of unemployment in accounting for the post-war unemployment experience. In comparing unemployment patterns across time periods and countries, we take the US as a representative flexible labour market and Germany as an archetypal inflexible one, with the UK occupying an intermediate position.

According to the persistence school, temporary shocks – such as cyclical movements in unemployment – often translate into medium-term unemployment. Transitory shocks can then explain differences in average unemployment across five or ten-year epochs making the exact value taken by the natural rate less important. The concept of hysteresis in unemployment, first introduced by Phelps (1972) and later used by Blanchard and Summers (1986), denotes situations where transitory shocks have permanent or very persistent effects. Informally it describes a typical pattern of upward ratcheting of unemployment post-1973 with no apparent tendency to return to previous steady-state rates. It can arise due to insider-outsider interactions (Lindbeck and Snower, 1988) or human-capital effects (Layard et al. 1991).

The structuralist school embraces those economists who see the natural rate and the associated equilibrium paths as endogenous and affected by market forces like any other economic variable. They have derived a moving-natural-rate theory of changes in actual unemployment (see Pissarides, 1990; Phelps, 1994) while downplaying, although far from ignoring, the role of slow adjustment to this equilibrium. Efficiency-wage models (Calvo, 1979; Solow, 1979; Shapiro and Stiglitz, 1984; Katz, 1986) and models of union behaviour (Layard and Nickell, 1986) are two examples. In equilibrium, a downward-sloping labour-demand or price-setting curve intersects an upward-sloping wage curve in the real-wage/employment plane. Any shift in either curve then

translates into a change in the rate of equilibrium unemployment. Differences in average unemployment across epochs and countries can be traced to differences in the movement and position of either curve.

According to the natural-rate hypothesis, the equilibrium point is independent of the adjustment path taken by unemployment and thus of all current and past monetary variables. However, the labour-demand curve can potentially shift because of changes in real interest rates (Phelps 1994; Blanchard 1999), rate of productivity growth (Pissarides, 1990), real oil prices (Oswald, 1999), and stock prices (Phelps, 1999), *inter alios*. The position of the wage curve is determined by such factors as the generosity of the unemployment–benefit welfare system, other forms of non-wage income such as rent and interest, the family network, and the (consumption) tax wedge.

The difference of opinion between the two schools of thought hinges on whether high average unemployment can be traced to a very slow speed of adjustment towards the steady state – for a given size of transitory unemployment shock – or to an autonomous movement of the steady state itself. Therefore, we can assess empirically the plausibility of the persistence school by testing whether a change from a low to a high unemployment regime – such as the one that occurred in Germany and the UK around 1980 – corresponds to a fall in the speed of adjustment. Positive results on this count would support the persistence school. By contrast, differences in average unemployment across countries and epochs may be accounted for by structural breaks in the steady-state unemployment path, which play a key role in the structuralist school. Since there is a lack of empirical work attempting to discriminate between the two approaches this Paper seeks to fill that gap. Understanding high unemployment is of great import for policy: if unemployment is high due to persistence, monetary policy can help by re-inflating the economy without any risk of inflation while, if it is due to a high natural rate, an expansionary policy will be inflationary.

At a methodological level the Paper employs a time-series approach which combines two insights previously employed to address the behaviour of unemployment in various countries. On one hand, it builds on Bianchi and Zoega (1998) and Papell, Murray and Ghiblawi (1999) who show that structural breaks can explain a large part of the apparent persistence in the unemployment rates of many European economies. On the other, it follows Acemoglu and Scott (1994), Koop and Potter (1999) and Skalin and Teräsvirta (1998) in using a non-linear framework to capture the asymmetric propagation of shocks typically observed in labour markets. Thus our approach explicitly takes account of structural breaks and employs an extension of a relatively parsimonious non-linear model introduced by Enders and Granger (1998) to represent asymmetric adjustment. In this manner our approach both complements and extends previous work on unemployment.

We employ monthly total unemployment rates, 1960–99, for the US, UK and Germany. While the German and, to a lesser extent, UK series appear to display the typical European pattern of a shift from low to high unemployment rates between the 1960s and 1980s, the US rate shows no such tendency. One significant structural break is detected in the UK and German series in 1980 and for the US in late 1973. Evidence of asymmetries are also found in the movement of unemployment around the natural rate with rapid mean reversion following booms and persistent or random walk behaviour in the wake of recessions. We can summarize our conclusions as follows:

- The structural break affecting European unemployment in 1980 was very substantial while that for the US in 1973 was comparatively minor in nature. The estimated natural rate more than trebled and doubled in the UK and Germany, respectively, offering one plausible explanation for recent high unemployment levels. The implication is that average unemployment shifts abruptly to a new and higher plateau. Since many of the presumed fundamentals of the natural rate – technical progress, real interest rates, oil prices – also shifted around the same time as the breaks, this finding provides support for the structuralist school and is consistent with the results of Bianchi and Zoega (1998) and Papell et al. (1999).

- While the finding of stationarity for all series provides *prima facie* evidence against the persistence school perspective, it may take some comfort from the speed-up and the slow-down dynamics common to both periods. Evidence of such dynamics has also been established elsewhere in the non-linear literature by Skalin and Terasvirta (1998) and Koop and Potter (1999), *inter alios*. The slow-down dynamics in particular may explain some of the protracted adjustment in Europe along the lines suggested by the persistence school. However the common dynamics across time periods imply that any sclerosis following bad shocks currently found in the German and UK labour markets was also present in the 1960s and 1970s which suggests that the size of shocks matters in recent decades. Finally, the explanation that a succession of bad shocks has sustained high unemployment post-1980 may be less credible as high unemployment enters its third decade.

- Ignoring either the structural breaks or asymmetries produces results closer to those of the standard persistence approach. Non-linear models ignoring the structural breaks suggest German and UK unemployment follows a random walk while the rate of adjustment in the US is extremely slow. Sequential unit root tests taking the structural break into account but ignoring the asymmetries, indicate hysteresis in the US and German labour markets but not the UK in the second period. Thus a substantial part of the apparent persistence of European unemployment in recent decades would appear to be an artefact of overlooking either structural breaks or asymmetries or indeed both.

Can either school of thought account for differences across epochs of high and low unemployment for each country as well as differences across countries? The structuralist school rationalizes the past two decades of high unemployment in the UK and Germany by means of an upward shift in the steady-state levels of unemployment. By contrast, the persistence school has focused on persistent or (near) unit root behaviour in the unemployment series implying a protracted recovery from bad shocks.

One stylized fact which emerges across epochs (of high and low unemployment) and countries is that it takes far longer to come out of a recession than out of a boom. This dynamic asymmetry helps to explain differences in unemployment for shorter periods of time – such as half-decades – which places the persistence school closer to the mark in this respect. However, while recessions can linger for a number of years, they cannot explain the high European unemployment over the course of two decades. The latter is more plausibly explained by autonomous increases in the natural rate.

Thus the two schools of thought may be regarded as complementary rather than rival. Shifts in the natural rate can explain differences over longer periods such as decades while asymmetric persistence can shed light on short- to medium-run differences. Finally it should be borne in mind that, while we analyse a sample of just three unemployment series, our results are robust across all economies which were chosen to exemplify the range of diversity in unemployment institutions and experiences in the OECD. Nonetheless it would be interesting to extend the analysis to other OECD economies in future.

Evaluating the Persistence and Structuralist Theories of Unemployment

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Abstract

This paper uses a threshold autoregressive (TAR) framework to assess the relative importance of structural breaks and asymmetric persistence in accounting for the post-war unemployment experience. In comparing different unemployment patterns across time periods, we take the US as a representative flexible labour market and Germany as an archetypically inflexible one, with the UK occupying an intermediate position. Significant breaks are detected in the UK and German series around 1980 suggesting a sharp increase in their respective natural rates. Evidence of dynamic asymmetries is also established with rapid mean reversion following booms and persistence in the wake of recessions. We conclude that shifts in the natural rate explain differences over longer periods such as decades while asymmetric persistence can shed light on short to medium run differences.

KEY WORDS: Momentum TAR; Bootstrap; Dynamic asymmetries; Structural breaks

The sustained rise of unemployment in many of the OECD countries has sparked a spiralling literature on unemployment dynamics (Bean 1994; Blanchard and Katz 1997) which has much enriched our understanding of the strengths and limitations of the theory of a natural rate of unemployment (Friedman 1968; Phelps 1968). This literature on medium-term unemployment dynamics has in recent years been dominated by two competing schools of thought. One (Lindbeck and Snower 1988; Layard, Nickell and Jackman 1991; Karanassou and Snower 1998) emphasises the role of dynamic adjustment towards the natural rate of unemployment or the rate consistent with correct expectations in the steady state. Thus it is concerned with the propagation of transitory nominal and real shocks, where slow adjustment is usually referred to as persistence measured by the (sum of the) coefficient(s) of lagged unemployment in an autoregressive process.

The other school (Pissarides 1990; Phelps 1994; Nickell and Layard 1998; Phelps and Zoega 1998) is more interested in autonomous movements of the natural rate itself due to the interplay of changes in real macroeconomic variables and institutions. We call them the persistence and the structuralist (Phelps 1994) schools, respectively. While the structuralist school has recently gained converts (Blanchard 1999), there is a lack of empirical work attempting to discriminate between the two approaches. This paper seeks to fill that gap by combining at a methodological level two insights previously employed to address the behaviour of unemployment in different countries in recent decades.

On one hand, it builds on Bianchi and Zoega (1998) and Papell, Murray and Ghiblawi (1999) who show that accounting for shifts in mean can explain a large part of the apparent persistence in the unemployment rates of many European economies. Both of these contributions overlook the stylised fact that unemployment displays asymmetric dynamics which is the focus of the persistence school. On the other hand, to capture the asymmetric propagation of shocks typically observed in labour markets, the paper extends the momentum threshold autoregressive (M-TAR) framework of Enders and Granger (1998) which is a special case of the continuous (C-) TAR class of models formally introduced in Chan and Tsay (1998). In this respect it follows the established tradition of using a nonlinear framework to analyse unemployment exemplified by Koop and Potter (1999), Franses and Paap (1998), Parker and Rothman (1998), Rothman (1998), Skalin and Teräsvirta (1998), Hansen (1997), and Tsay (1997) inter al. Thus our approach both complements and extends existing work on unemployment.

The focus of our paper is similar in spirit to that of Koop and Potter [hereafter KP] (1998) and Skalin and Teräsvirta [hereafter ST] (1998). While there are important differences in approach, ultimately all three papers are complementary in many respects: their methodological approaches are related, they all address both asymmetries and the possibility of long term structurtal shifts, they use transition variables based on differences (ST also use a second transition variable to capture seasonality), they reach similar conclusions on asymmetries and they all interpret their results in terms of economic theory. One difference is that while KP adopt a Bayesian TAR specification and ST use a logistic smooth transition autoregression (STAR) to analyse asymmetries, we employ a classical M-TAR specification Note however that two regime TAR models are a special case of the logistic STAR model and that we consider a larger number of models than is usual in the classical approach.

In comparing different unemployment patterns across time periods, we take the US as a representative flexible labour market and Germany as an archetypically inflexible one, with the UK occupying an intermediate position having undergone recent reforms. Understanding high unemployment is of great import for policy. If unemployment is high due to persistence, monetary policy can help by reflating the economy without any risk of inflation while, if it is due to a permanent shift to a high natural rate, an expansionary policy will be inflationary. The paper is organised as follows. Section 1 discusses the major differences between the persistence and structuralist schools and outlines our economic model. Section 2 outlines the new test procedures for threshold unit roots and asymmetries. Section 3 reports the results and a final section concludes.

1 ECONOMIC THEORY

Below we sketch the debate betweeen the two schools before proposing a simple model which encompassses the main elements of both. Many economists belonging to the persistence school claim that labour-market flexibility is the key to good unemployment performance (Scarpetta 1996; Elmeskov 1999). They argue that temporary shocks such as cyclical movements in unemployment often translate into medium-term unemployment. Transitory shocks can then explain differences in average unemployment across five or ten-year epochs making the exact value taken by the natural rate less important. The contribution of Layard, Nickell and Jackman (1991) is in this spirit. The concept of hysteresis in unemployment, first introduced by Phelps (1972) and later used by Blanchard and Summers (1986), denotes situations where transitory shocks have permanent or very persistent effects. There is a subtle difference between the definitions used by the two. While Phelps models hysteresis as the dependence of the equilibrium point on the path taken towards equilibrium, the latter take hysteresis as synonymous with the existence of a (near) unit root. Hysteresis can arise due to insider-outsider interactions (Lindbeck and Snower 1988) or human-capital effects (Layard et al. 1991). Informally it describes a typical pattern of upward ratcheting of unemployment post-1973 with no apparent tendency to return to previous steady-state rates.

Methods of characterising hysteresis include the presence of a unit root in a linear process — that is, a flat-bottomed Liapunov function for the dynamic system — or long memory in a fractionally integrated process. Alternatively, hysteresis can be viewed as a nonlinear phenomenon (Cross 1994, 1995) where fixed and sunk adjustment costs make current unemployment a function of the highs and lows of past labour demand. While the latter can be reconciled with the recent time series literature on unemployment which highlights asymmetric adjustment, this literature has not directly addressed the issue of sustained high European unemployment. This paper tackles this issue by focusing on the role of growth or dynamic asymmetry which refers to skewness in the first difference of the unemployment series. (See Açemoglou and Scott (1994), Enders and Granger (1998) and Koop and Potter (1999) on dynamic asymmetries).

The structuralist school embraces those economists who see the natural rate and the associated equilibrium paths as endogenous and affected by market forces like any other economic variable. They have derived an equilibrium theory of unemployment movements — a moving-natural-rate theory of changes in actual unemployment (Pissarides 1990; Phelps 1994) — while downplaying, although far from ignoring, the role of slow adjustment to this equilibrium. Such slow adjustment is caused for instance by the cost of hiring and training new workers or by the cost of adjusting to new capital. Labour-market equilibrium is modelled by introducing real-wage rigidity with full microfoundations. Efficiency-wage models (Calvo 1979; Solow 1979; Shapiro and Stiglitz 1984; Katz 1986) and models of union behaviour (Layard and Nickell 1986) are two examples. In equilibrium, a downward-sloping labour-demand or price-setting curve intersects an upward-sloping wage curve in the real-wage/employment plane. Any shift in either curve then translates into a change in the rate of equilibrium unemployment. Differences in average unemployment across epochs and countries can be traced to differences in the movement and position of either curve.

According to the natural-rate hypothesis, the equilibrium point is independent of the adjustment path taken by unemployment and thus of all current and past monetary variables. However, the labour-demand curve can potentially shift because of changes in real interest rates (Phelps 1994; Blanchard 1999), rate of productivity growth (Pissarides 1990), oil prices (Oswald 1999), and stock prices (Phelps 1999), inter alios. The position of the wage curve is determined by factors such as the generosity of the unemployment-benefit welfare system, other forms of nonwage income such as rent and interest, the family network, and the (consumption) tax wedge.

The difference of opinion between the two schools of thought hinges on whether high average unemployment can be traced to a slow speed of adjustment towards the steady state — for a given size of transitory unemployment shock — or to an autonomous movement of the steady state itself. Therefore, we can assess the empirical plausibility of the persistence school by testing whether a change from a low to a high unemployment regime — such as the one that occurred in Germany and the UK around 1980 — corresponds to a fall in the speed of adjustment. Positive results on this count would support the persistence school. By contrast, differences in average unemployment across countries and epochs may be accounted for by structural breaks in the steady-state path of a stochastic process which play a key role in the structuralist school.

Drawing on the recent literature on an endogenous natural rate of unemployment (Pissarides 1990; Layard et al. 1991; Phelps 1994) — the steady-state equilibrium rate of unemployment — we postulate a stable long run relationship between the natural unemployment rate u^* and a vector of variables $\tilde{x}$ — the fundamentals of the natural rate:

$$u_t^* = \tilde{\lambda}\tilde{x}_t \tag{1}$$

where $\tilde{\lambda}$ is a row vector of coefficients and $\tilde{x}$ is a vector of fundamental variables measured in logs. These include elements of the welfare system — such as the level and duration of unemployment benefits — in addition to the rate of productivity growth, the real interest rate, wealth, the level and variance of educational achievement, amongst others.

The economy can depart from its natural rate for significant periods due to nominal shocks, transitory real shocks, and changes in the fundamentals of the natural rate that only gradually affect actual employment. The following error-correction equation summarises these dynamic interactions:

$$\Delta u_t = \alpha_0 + \alpha_1 \Delta \pi_t + \rho[\tilde{\lambda}\tilde{x}_{t-1} - u_{t-1}] + v_t \tag{2}$$

where u_t denotes the rate of unemployment, π_t denotes inflation, and v_t is a random error term. Changes in the rate of unemployment can either be traced to nominal demand shocks — proxied by the change in the rate of inflation, $\Delta\pi_t$ — or to a catch-up effect when employment moves along an equilibrium path towards a (possibly changed) steady state: the new natural rate of unemployment. The speed at which unemployment approaches the natural rate is measured by the parameter ρ.

Equation (2) implies that medium-term increases in the rate of unemployment can be caused by either an adverse demand shock ($\Delta\pi_t < 0$) combined with a very small value of ρ — high persistence — or by a rise in the natural rate due to changes in some of its fundamentals. In explaining differences across countries in average unemployment over decades and half-decades, we would expect the high-unemployment economies to have a low value of ρ when compared to low-unemployment economies, assuming that they suffered similarly sized demand shocks in the past. Alternatively, they might have different values in the components of $\tilde{x}$ such as a lower rate of productivity growth. So either they are recovering very slowly from a bad demand shock or they have suffered an autonomous increase in the natural rate of unemployment. Our objective is to assess empirically the relative importance of these two possibilities.

It seems plausible that the value of ρ depends on the nature of the demand shocks. One possibility is that it takes longer to recover from a bad shock than from a good shock. This is a case of dynamic asymmetries or asymmetric persistence. Lindbeck and Snower (1987) suggest that this may be caused by asymmetric union-membership rules. Here it takes more time to gain union membership — once hired — than to lose it following an involuntary dismissal. An unexpected fall in labour demand reduces union membership almost instantaneously and the union leadership is then driven to protect the employment of the remaining members. In contrast, a positive labour-demand shock does not raise union membership as quickly, and the union leadership will only gradually seek to protect the employment and interests of the newcomers. The implication is that "a fall in current employment does more to discourage future employment than a rise in current employment does to encourage it" (Begg, Lindbeck, Martin and Snower 1989, p.560). Carruth and Oswald (1987) provide an alternative rationale for asymmetries. Here unions have kinked indifference curves in the real-wage/employment plane. When some union members lose their job, the union may respond by cutting wages while allowing employment to shrink but once labor demand recovers, the union will no longer be interested in increasing employment and demands higher wages instead. Such asymmetries can readily be captured by means of TAR models.

2 THRESHOLD UNIT ROOT AND SYMMETRY TESTS

Our empirical methodology allows for both shifts in the long run equilibrium path and asymmetries in the speed of adjustment towards this equilibrium. Granger and Teräsvirta (1999) and Granger and Hyung (1999) demonstrate that some properties similar to those of a long memory process may be an artifact of occasional structural breaks in a linear process. The failure to take account of structural breaks in labor markets may lead to correspondingly misleading evidence in unemployment. Some evidence on this issue already exists. Bianchi and Zoega (1998) employ a Hamilton Markov-switching model to identify shifts in the mean unemployment rate of 15 OECD countries 1970-96. Taking account of the shift in mean renders most of the series stationary and thus substantially reduces the apparent persistence in the unemployment series. Similarly Papell et al. (1999) conduct unit root tests in the presence of structural change for a panel of 17 OECD countries. They find that the measure of unemployment persistence falls dramatically especially in the European Union economies and they interpret this as support for the structuralist theory of the natural rate. This approach is in the same spirit as that of Perron (1989) who in analysing US real GNP identified a structural break in 1973.

Since standard linear Gaussian models cannot capture asymmetry effects, a nonlinear model is required. A variety of such models has been applied to explore unemployment. Rothman (1998) applies a variety of nonlinear models (including TAR, exponential autoregressions, exponential STAR, and bilinear models) for predicting US unemployment, Parker and Rothman (1998) apply Beaudry and Koop's (1993) current depth of recession approach, Skalin and Teräsvirta (1998) use logistic and exponential STARs and Franses and Paap (1998) introduce and apply autoregressions with censored latent effect parameters (AR-CLEP). However the most frequently adopted is the TAR class of models developed by Tong (1978) and Tong and Lim (1980), which is a special case of Priestley's (1988) general nonlinear state-dependent models. (See Tong (1990) for a detailed exposition of TAR models). TAR models have been applied to US unemployment rates by Caner and Hansen (1998), Hansen (1997), Koop and Potter (1999), Rothman (1998), and Tsay (1997), amongst others.

We employ an extension of the M-TAR models of Enders and Granger (1998) and Caner and Hansen (1998). These models split the time series into different linear regimes depending on the value of a threshold vartiable based on first and long differences, respectively. They are particularly appropriate for capturing stylised facts of unemployment dynamics such as the rapid increases and slow decreases exemplified in Figure 1.

[Figure 1 around here]

Building on this M-TAR framework, we implement bootstrap likelihood-ratio (LR) tests to explore the unit-root null against the alternative of (possibly) asymmetric mean reversion (Coakley and Fuertes, 2000). These tests extend the threshold unit-root tests introduced by Enders and Granger (1998) by generalising their transition variable. Once a single shift in the steady state is permitted, the bootstrap LR tests reject the unit-root hypothesis for US, UK and German rates. This provides a basis for testing for symmetric adjustment towards the steady state against the alternative that shocks which increase unemployment have more sustained effects than those that decrease it. Our results establish that the unemployment series in all three countries display clear evidence of dynamic asymmetries or asymmetric persistence as in Begg, Lindbeck, Martin and Snower (1989).

Consider the following error-correction equation which represents a generalisation of the Enders and Granger (1998) univariate M-TAR class of models:

$$\begin{aligned} \Delta u_t &= I_t \rho_1 (u_{t-1} - \mu) + (1 - I_t) \rho_2 (u_{t-1} - \mu) + \varepsilon_t \\ I_t &= \begin{cases} 1 & \text{if } q_t \geq 0 \\ 0 & \text{if } q_t < 0 \end{cases} \end{aligned} \qquad (3)$$

where I_t is a Heaviside indicator function, $q_t = \phi(\Delta u_{t-1}, \Delta u_{t-2}, ...\Delta u_{t-d})$ is the threshold variable which depends on past changes in unemployment, d is the delay parameter or threshhold lag and $\varepsilon_t \sim$i.i.d. $N(0, \sigma_\varepsilon^2)$. This model proxies $\tilde{\lambda}\tilde{x}$ in equation (2) by μ which is permitted to have a deterministic trend component and to change infrequently. Since this M-TAR comprises two regimes, this implies that the adjustment parameter ρ in (2) now varies by assuming the value ρ_1 in regime 1 and ρ_2 in regime 2. The error term ε_t can be regarded as the sum of the inflation shock term $(\Delta\pi)$ and the error term (v_t) in (2).

Equation (3) is a special case of the Chan and Tsay (1998) C-TAR class of models. If the stationarity condition $-2 < (\rho_1, \rho_2) < 0$ is satisfied, μ plays the role of attractor — or long run equilibrium — for the sequence $\{u_t\}$. It can also be augmented to deal with autocorrelation:

$$\Delta u_t = I_t \rho_1 (u_{t-1} - \mu) + (1 - I_t)\rho_2 (u_{t-1} - \mu) + \sum_{i=1}^{k} \beta_i \Delta u_{t-i} + \varepsilon_t \qquad (4)$$

Thus equation (4) encompasses the standard augmented Dickey-Fuller (ADF) regression. On the basis of (4) with $q_t = \Delta u_{t-1}$, Enders and Granger tabulate critical values for an F-type test of the unit-root null against the alternative of (possibly) asymmetric mean reversion. Their simulation results show that the power of this M-TAR test is enhanced relative to the ADF for a reasonable range of asymmetry.

The unit root null (ρ_1=ρ_2=0) is tested against the alternative of asymmetric mean reversion using an LR statistic based on model (4). Parametric bootstrap p-values are derived by resampling using the null model estimates and normally distributed random disturbances with variance equal to the estimated residual variance. If evidence of mean reversion is established, the null of symmetric adjustment ($\rho_1 = \rho_2$) can be tested by means of another LR statistic. Since the latter is asymptotically pivotal, the size distortion of the bootstrap test will be of at least $n^{-1/2}$ smaller than that of the corresponding asymptotic (χ^2) test. This motivates using its bootstrap p-values.

In the M-TAR class of models, the indicator function I_t determines the relevant regime according to past *changes* in the underlying variable u_t rather than its past *levels*. To extend the Enders and Granger (1998) approach, we allow for a more general threshold variable:

- First we follow Caner and Hansen (1998) in employing a long difference or cumulated lagged first differences of the underlying variable:

$q_t = \Delta u_{t-1} + \Delta u_{t-2} + ...\Delta u_{t-(d-1)} \equiv u_{t-1} - u_{t-d}$ $(d > 1)$. Since a first difference can be very noisy, a long difference has the advantage that it may better represent recent unemployment trends due to its smoothing effect. In this case, there is a regime switch depending on whether cumulated recent unemployment changes are non-decreasing or decreasing. For $d = 2$ this threshold variable nests the Enders and Granger (1998) first-differences variable. (For another application see Tsay's (1997) study of US unemployment where the threshold variable is also Δu_{t-1}). Finally, note that the above long difference and a simple average of first differences Δu_{t-i} for i=1 to $i = d - 1$, yield equivalent I_t functions.

- Second, we propose a new threshold variable consisting of convex combinations of lagged differences which extends the average transition variable of Koop and Potter (1999):

$$q_{t-d} = w_1 \Delta u_{t-1} + w_2 \Delta u_{t-2} + ...w_d \Delta u_{t-d}, \quad \sum_{i=1}^{d} w_i = 1 \qquad (5)$$

  The two new versions considered allow for exponentially decreasing weights and exponentially increasing weights. In the former case, more recent unemployment changes are assigned larger weights ($w_1 > w_2 > ..$) while the opposite holds for exponentially increasing weights. The former version is consistent with partial adjustment models while the latter may capture the supply (discouraged worker effect) and demand (possible employer discrimination) side impact of long-term unemployment. In our empirical results, this new threshold variable yields the best fit model in all but one case.

3 EMPIRICAL RESULTS

Total monthly unemployment rates are taken from *Datastream (* Although ideally we should have liked to analyse seasonally unadjusted data, only adjusted data were available at a monthly frequency). For the UK and the US the data span the 40 year period 1960:1-1999:2 giving a total of 470 observations per variable. For Germany the coverage is 1962:2-1999:6 yielding 450 observations. Although our sample embraces just three economies they were deliberately chosen to represent a range of diverse unemployment institutions and experiences. The variable analysed is the unemployment rate even though this is bounded both above and below. In this respect we follow Caner and Hansen (1998) who employ a related TAR specification for the US unemployment rate and found that their empirical results were invariant to four transformations of the dependent variable which are unbounded in one or both directions. Koop and Potter (1999) explicitly use a logistic transformation to tackle this problem which was among the four transformations considered by Caner and Hansen (1998).

The ADF test results for the whole sample confirm the conventional wisdom of apparent hysteresis in European unemployment by failing to reject the unit-root null for the UK and Germany and rejecting it for the US at the 10% level as shown in Table 1.

[Table 1 around here]

Figure 2 depicts all three series and highlights the contrast between US and European rates emphasised by Røed (1997), inter alios.

[Figure 2 around here]

While the German and, to a lesser extent, UK series appear to display the typical European pattern of an apparently inexorable movement from low to high unemployment rates between the 1960s and 1980s, the US rate clearly does not exhibit this tendency.

3.1 Shifts in the Steady State Equilibrium

The density functions in Figure 3 show that, while the US series is almost unimodal, the German and the UK series are bimodal. The implication is the presence of clear structural break in the two European series and a potential break in the US series.

[Figure 3 around here]

Since the precise timing of the structural break is not known, we employ the sequential Zivot and Andrews [ZA] (1992) test for a unit root against the alternative of stationarity with structural change at some unknown point T_B. We follow the testing-down procedure of Ng and Perron (1995) to select the augmentation lag parameter k in both the ZA and standard ADF tests. To allow for a change in both the level and growth rate of the series, the general ZA model includes intercept and slope dummies. For the US and the German series, only the level dummy is significant — there is one shift in mean unemployment. UK unemployment exhibits a significant break in both its level and slope. The estimated break dates, $\hat{T}_B$, are 1973:10 for the US, 1980:1 for the UK and 1980:9 for Germany which are very close to those found by Bianchi and Zoega (1998) for the German and UK series and by Papell et al. (1999) for all three series. (Note also that the timing of the UK break is virtually the same as that found by Haldane and Quah (1999) in their analysis of post-war UK Phillips curves).

Allowing for one structural break in implementing the ZA test, the unit root null is rejected only for the UK series at the 5% level, suggesting hysteresis in Germany and, counterintuitively, US rates. Thus structural breaks on their own do not appear adequate for explaining differences in unemployment. Next, instead of searching for multiple breaks, a nonlinear approach is employed. This is validated by the nonparametric BDS test applied to the residuals of a linear AR(k) filter with structural break dummies at the identified points. The results in Table 2 clearly indicate nonlinear dependence and conform with those of Brock and Sayers (1988). We also subjected the AR filtered sub-samples (split at $\hat{T}_B$) to the BDS test. The smaller sample sizes notwithstanding, the results were qualitatively similar and suggest that the nonlinear dependence detected is not an artifact of the structural break. (See Koop and Potter (1997) on structural breaks and nonlinearity).

[Table 2 around here]

As a further check, the results of the Randles, Flinger, Policello and Wolfe (1980) nonparametric triples test applied to the differenced series support the conjecture of dynamic asymmetries in all cases.

These results vindicate the use of M-TAR specifications for capturing asymmetries in the presence of structural breaks. Each unemployment series is split into two sub-samples at the structural break and model (4) is estimated for each by sequential OLS. To select the best fit threshold function ϕ and delay parameter d, we follow the least-squares principle to minimise the residual variance of the fitted models. For each TAR(ϕ,d) specification (allowing $1\leq d \leq 18$) a grid search is conducted to find the attractor μ that minimises the residual variance:

$$\hat{\mu} = \underset{\mu \in \Gamma}{\operatorname{argmin}} \, \hat{\sigma}_n^2(\mu) \tag{6}$$

where Γ represents the feasible set for μ. Under certain regularity conditions for u_t, including stationarity and geometric ergodicity, and i.i.d. innovations, this sequential OLS estimation yields asymptotically normal and a.s. $\sqrt{n}$-

consistent $(\hat{\mu}, \hat{\rho}, \hat{\beta})$ estimates as shown by Chan (1993) and Chan and Tsay (1993). Figure 4 illustrates the identification of (ϕ, d) for the UK 1980-99 by plotting the residual variance for the various candidates considered.

[Figure 4 around here]

The exponentially decreasing weights function with $\hat{d} = 12$ gives the best fit. Figure 4 also plots the corresponding unemployment data classified by regimes of decreasing and non-decreasing past unemployment trends. A similar procedure was applied for the other sub-sample and countries and Table 3 reports the parameter estimates.

[Table 3 around here]

The autocorrelation and partial autocorrelation functions and the Eitrheim and Teräsvirta (1996) LM misspecification tests indicate that the models have plausible statistical properties. Finally the M-TAR models clearly pass the BDS test suggesting that dynamic asymmetries account for most of the nonlinear dependence in unemployment.

The estimated attractor parameter $\hat{\mu} = \hat{\mu}_0 + \hat{\mu}_1 t$ from the best fit M-TAR for each sub-sample is taken as a proxy for the steady-state or natural rate of unemployment and is depicted in Figure 5.

[Figure 5 around here]

The attractors enable one to assess the extent of the structural break in each economy. The US natural rate is estimated to be some 5.7% for the pre-1973 period and thus considerably higher than that of its European counterparts. It increases by some 1.4 times its previous level in late 1973 and thereafter it trends back toward its former level. The UK and German natural rates start from just 0.7% in the early 1960s but exhibit a steady upward trend during the ensuing decades before sharply jumping in 1980. The structural breaks in Europe are far more dramatic in scope: both equilibrium rates more than double their prior levels, suggesting that both economies were subject to large shocks. The UK rate increases to 11.56% or by a factor of 3.3 times and exhibits a small downward trend thereafter. Post-1980, the German rate more than doubles to some 10.76% at which it remains constant. This stubbornly high German rate post-1990 may well reflect the effects of reunification rather than a lack of adjustment and thus may not be typical of other European economies in this respect.

Structuralist models are consistent with our results if we can find causal variables (fundamental variables behind the natural rate) that changed prior to these breaks. Three such causal variables are the level of real oil prices (Oswald 1999), the real rate of interest (Phelps 1994), and the rate of technical progress (Pissarides 1990; Aghion and Howitt 1992; Hoon and Phelps 1997). The increase in oil prices in 1973 and 1979 can help explain all three structural breaks. Moreover, the real rate of interest rose at the beginning of the 1980s as a result of disinflationary policies, hence preceding the structural breaks in Germany and the UK. Finally, a productivity slowdown occurred around 1973 in the US, the year in which we detected the shift to a higher steady-state and some years later in Europe. We conclude that it would be difficult to explain the major differences in average unemployment between countries and epochs without reference to the significant changes in the natural rate. In particular, the sheer scale of the structural breaks in the UK and Germany helps to shed light upon their sustained high unemployment rates in recent decades.

3.2 Asymmetric Adjustment

The parametric bootstrap p-values from the LR statistic for the unit root null against possible asymmetric mean reversion are given in Table 4. They suggest that, by contrast with the ADF results, the null is rejected at the 2% level or better for both sub-samples for all three economies.

[Table 4 around here]

Having established clear evidence of mean reversion, the symmetric adjustment ($\rho_1 = \rho_2$) null is tested by means of another LR statistic. Its bootstrap p-values are also reported in Table 4, which suggest asymmetry at better than the 5% level in all but one case: the UK pre-1980 where the null is nonetheless rejected at the 10% level. As a check for robustness, the Hodrick-Prescott (HP) detrended series are split at the identified structural break and the M-TAR asymmetry tests are applied. Despite the smoothing effects of the HP filter resulting in a decrease in asymmetry (Psaradakis and Sola 1997), the bootstrap p-values still indicate significant dynamic asymmetries.

The interpretation and comparison of the unemployment dynamics suggested by the M-TAR parameter estimates is not straightforward. For the regime of nonnegative unemployment growth, the series are mean reverting in all cases while they behave like a random walk for negative growth, with the possible exception of Germany pre-1980. However, the insignificant rate of adjustment in the random walk, high unemployment regime makes comparisons difficult. What is required to assess differences in persistence is some overall index of adjustment $\tilde{\rho}$. The latter can be defined as $\tilde{\rho} = (n_1/n)\rho_1$, the adjustment parameter (ρ_1) of the positive growth regime weighted by the relative frequency of the observations in this regime. This yields the following weighted rates of adjustment $\tilde{\rho}$ for the second period (first period rates in parentheses) for the US, UK and Germany, respectively: -0.016 (-0.027), -0.011 (-0.014), and -0.018 (-0.014). From the persistence school perspective, it is puzzling that the values of $\tilde{\rho}$ for the US and Germany are similar in recent decades despite markedly different underlying rates of unemployment. In addition, for the UK the value $\tilde{\rho}$ is considerably smaller than for its German counterpart which is difficult to reconcile with the apparently more sclerotic labour market conditions in the latter.

Overall, the M-TAR results confirm the fast-up, slow-down dynamics typically found in the nonlinear literature (Açemoglou and Scott 1994; Caner and Hansen 1998, Hansen 1997; Koop and Potter 1999; Skalin and Teräsvirta 1998). This behaviour is consistent with the persistence school to the extent that it suggests hysteresis for negative unemployment growth or when the economy is recovering from a recession. However, it may have difficulty in reconciling the finding that the asymmetric persistence pattern is *common* to both sub-periods with the stubbornly high levels of European unemployment observed in the second period only.

Finally, we compare these results with those allowing for asymmetries but ignoring the structural breaks. Table 5 gives the results and diagnostics for the M-TAR model estimated over the entire sample period.

[Table 5 around here]

By contrast with the earlier results for the separate sub-samples, the threshold unit root test now rejects the null at the 5% level for the US only. However, the US weighted rate of adjustment $\tilde{\rho}$ is but a mere -0.008 or a fraction of its estimates for the separate sub-samples. Perhaps unsurprisingly, German unemployment dynamics is insignificantly different from a pure random walk. The UK series yields a negligible $\tilde{\rho} = -0.002$ which probably explains why the unit root null cannot be rejected at the 5% level. We conclude that ignoring structural breaks produces an exaggerated picture of apparent persistence.

4 CONCLUSIONS

Our conclusions can be summarized as follows:

- The structural break affecting European unemployment in 1980 was very substantial while that for the US in 1973 was comparatively minor. The estimated natural rate more than trebled and doubled in the UK and Germany, respectively, offering one plausible explanation for their recent high unemployment levels. The implication is that average unemployment shifted abruptly to a new and higher plateau. Since many of the presumed fundamentals of the natural rate — technical progress, real interest rates, oil prices — also shifted around the same time as the identified breaks, this finding provides support for the structuralist school and is consistent with the results of Bianchi and Zoega (1998) and Papell et al. (1999).

- While the finding of stationarity for all series provides *prima facie* evidence against the persistence school view, it may take some comfort from the fast-up and the slow-down dynamics common to both periods. Evidence of such dynamics has also been established elsewhere in the applied nonlinear literature by Koop and Potter (1999), Skalin and Teräsvirta (1998), Hansen (1997), and Tsay (1997) inter al. The slow-down dynamics in particular may explain some of the protracted adjustment in Europe. However the fact that such dynamic patterns are common across time periods implies that any sclerosis following bad shocks currently found in the German and UK labor markets was also present in the 1960s and 1970s, suggesting a major role for the size of shocks. Finally, the explanation that a succession of bad shocks has sustained high unemployment post-1980 may be less credible as high unemployment enters its third decade and the economic models explaining persistence (human capital and insider-outsiders) do not describe mechanisms that operate over such intervals.

- Ignoring either the structural breaks or asymmetries gives an exaggerated impression of hysteresis and thus produces results more in line with the persistence school. TAR models ignoring the structural break suggest that German and UK unemployment rates follow a random walk while the rate of adjustment in the US is very slow. Sequential unit root tests allowing for structural breaks but ignoring asymmetries, indicate hysteresis in the US and German but not UK labour markets. Thus a substantial part of the apparent persistence characterizing European unemployment in recent decades would appear to be an artifact of overlooking either structural breaks or asymmetries or indeed both.

We now turn to the question posed at the beginning of the paper. Can either school of thought account for differences across epochs of high and low unemployment for each country as well as differences across countries? The structuralist school rationalizes the move to two decades of higher unemployment in the UK and Germany by means of an upward shift in the steady-state levels of unemployment. By contrast the persistence school has focussed on (near) unit root behavior in unemployment implying a protracted recovery from bad shocks. (The models of Cross (1994, 1995) are an exception by emphasizing the difference between the long term effects of small and large shocks).One stylized fact which emerges across epochs — of high and low unemployment — and countries is that it takes far longer to come out of a recession than out of a boom. This dynamic asymmetry helps to explain differences in unemployment for shorter periods of time — such as half-decades — which places the persistence school closer to the mark in this respect. However, while recessions can linger for a number of years, they cannot explain the high European unemployment over the course of two decades. The latter is more plausibly explained by autonomous increases in the natural rate.

Thus the two schools of thought may be regarded as complementary rather than rival. Shifts in the natural rate can explain differences over longer periods such as decades while asymmetric persistence can shed light on the short to medium run differences. Finally it should be borne in mind that, while we analyse a sample of just three unemployment series, our results are robust across all economies which were chosen to exemplify the range of diversity in unemployment intsitutions and experiences in the OECD. Nonetheles it would be interesting to extend the analysis to other OECD economies in future.

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Appendix

Table 1. ADF Unit Root Test Results

I. Standard ADF Tests

Country	Sample	Observations (T)	Lag (k)	ADF statistics	
				t_μ	$t\tau$
US	1960:1-99:2	470	4	-2.700^{**}	-2.642
UK	1960:1-99:2	470	5	-2.199	-2.620
Germany	1962:1-99:6	450	4	-0.678	-2.802

NOTE: t_μ is the ADF statistic for the model with a constant term but not a time trend, t_τ for the model with a constant term and a time trend. ** denotes significant at the 10% level.

II. Sequential ADF Tests of Zivot and Andrews (1992)

Country	Dummy variable t-ratio		$\hat{T}_B$	k	ADF statistic
	DU_t	DT_t			
US	2.965	-0.723	1973:10	4	-4.239
US	3.443	–	1973:10	4	-4.223
UK	4.525	-3.663	1980:1	5	-5.421^{*}
Germany	2.085	-0.594	1980:9	4	-3.387
Germany	2.106	–	1980:9	4	-3.439

NOTE: DU_t and DT_t denote level and slope dummies, respectively. $DU_t = 1$ if $t > T_B$ and zero otherwise. $DT_t = t - T_B$ if $t > T_B$ and zero otherwise. All models were estimated including a constant and time trend and with the break point T_B ranging from $t = 20$ to $t = T - 20$. * Denotes significant at the 5% level using the Zivot and Andrews (1992) critical values.

Table 3. Best Fit M-TAR Model Parameter Estimates

Country	Sample	k	Threshold variable q_t Type	Delay d	Regime 1: $q_t \geq 0$ ρ_1 (t-ratio)	% obs.	Regime 2: $q_t < 0$ ρ_2 (t-ratio)	% obs.
US	1960:1-73:10	4	*ExpI*	15	$-.0788$	34	$-.0788$	66
					(-3.595)		(-1.037)	
	1973:11-99:2	4	*ExpI*	16	$-.0421$	39	$-.0058$	61
					(-3.112)		$(-.0462)$	
UK	1960:1-80:1	5	*LD*	13	$-.0336$	43	$-.0180$	57
					(-2.825)		(-1.376)	
	1980:2-99:2	3	*ExpD*	12	$(-.0216)$	50	$(-.0033)$	50
					(-3.716)		$(-.952)$	
Germany	1960:1-80:9	3	*ExpD*	14	$(-.0194)$	30	$(-.0114)$	70
					(-2.487)		(-1.759)	
	1980:10-99:6	3	*ExpI*	8	$(-.0328)$	56	(0.0091)	44
					(-3.743)		(1.042)	

NOTE: The threshold variable is selected by minimising the residual variance of the fitted models. *LD* denotes long difference and *ExpI (D)* exponentially increasing (decreasing) weights.

Figure 1. A steep or growth asymmetric time series

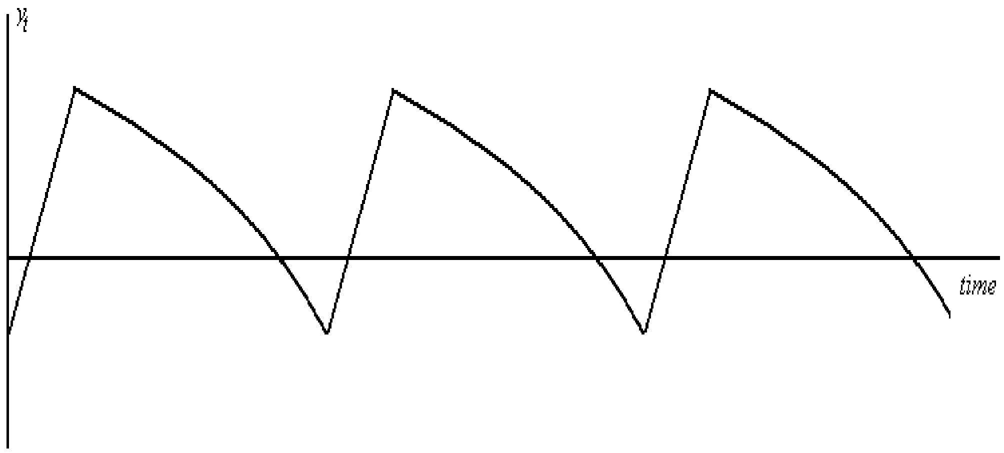


Figure 2. Total Unemployment Rates (%)

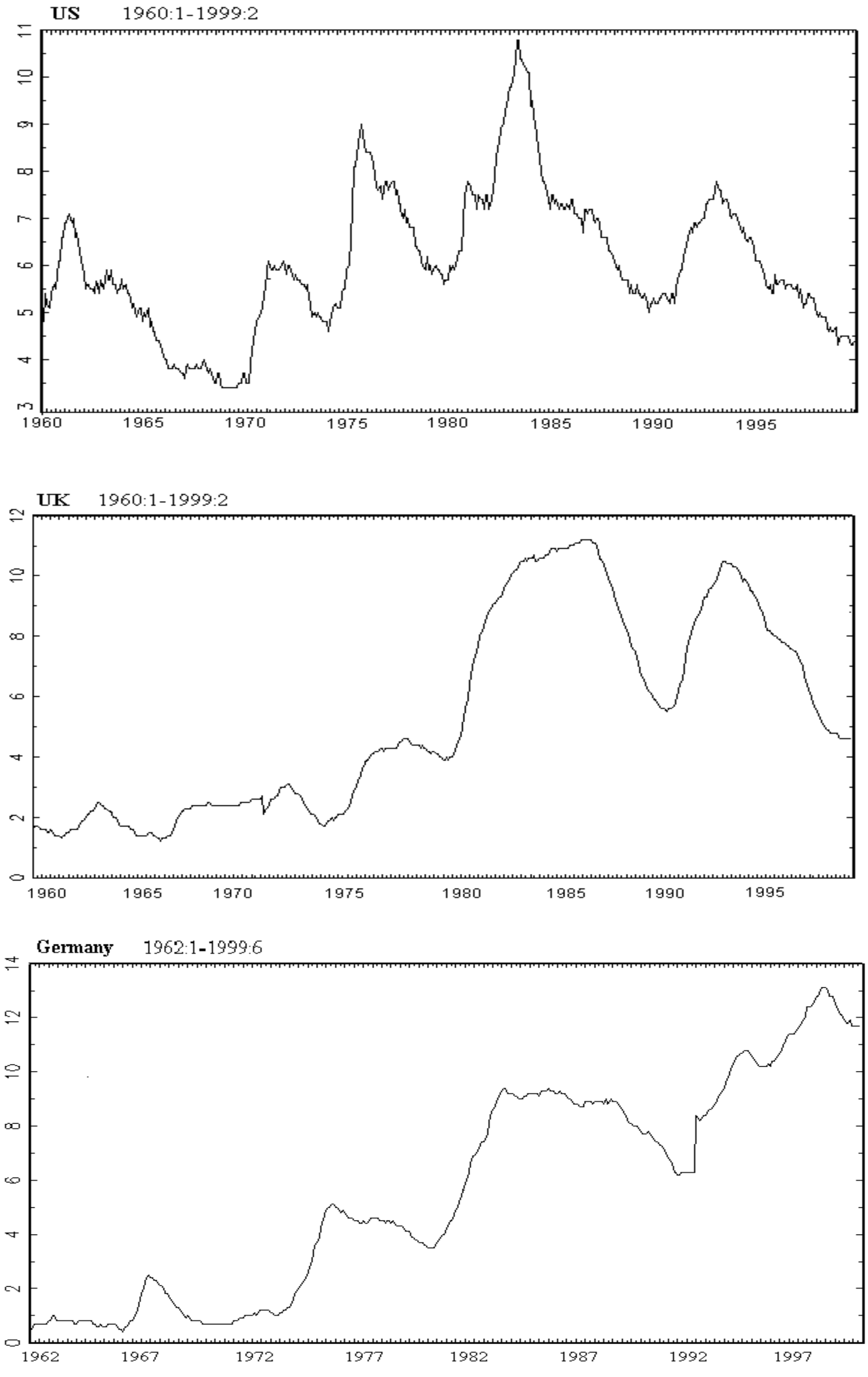
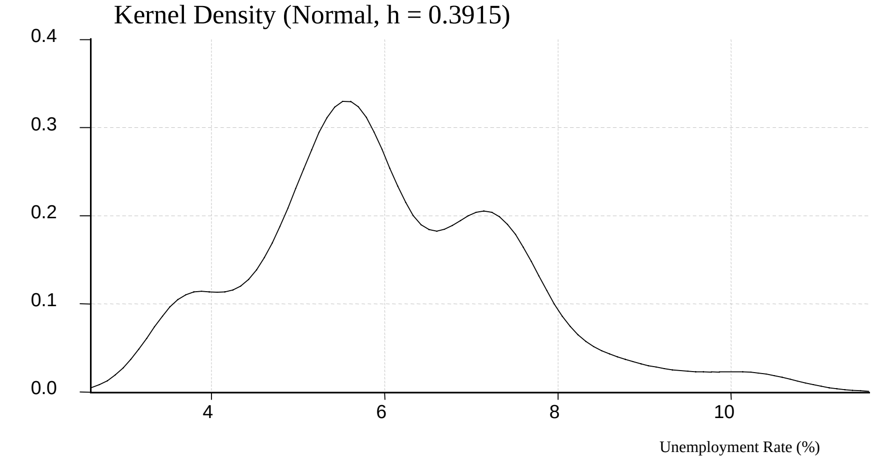


Figure 3. Unemployment Density Functions

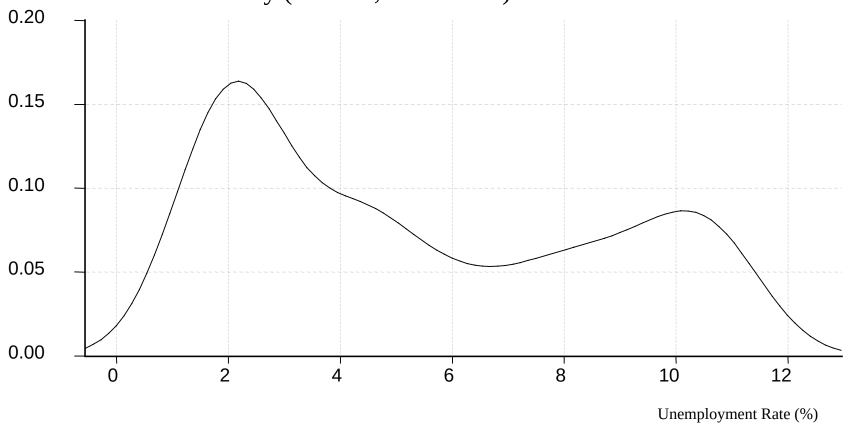
US

Kernel Density (Normal, h = 0.3915)



UK

Kernel Density (Normal, h = 0.8713)



Germany

Kernel Density (Normal, h = 1.0465)

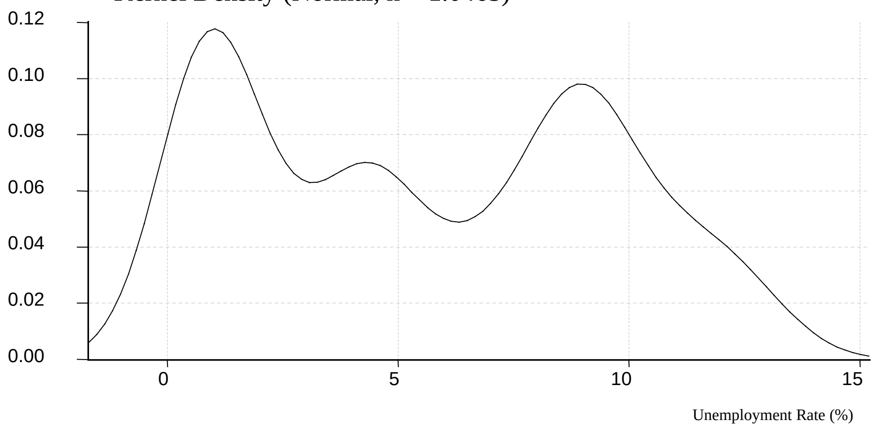
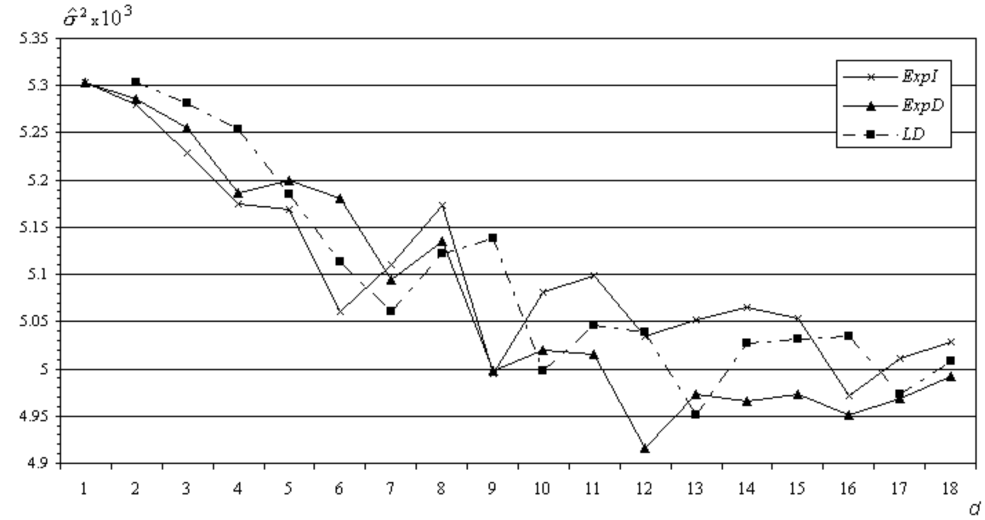


Figure 4. Estimated Residual Variance and Observations Classified by Regime
(UK 1980:2-1999:2)



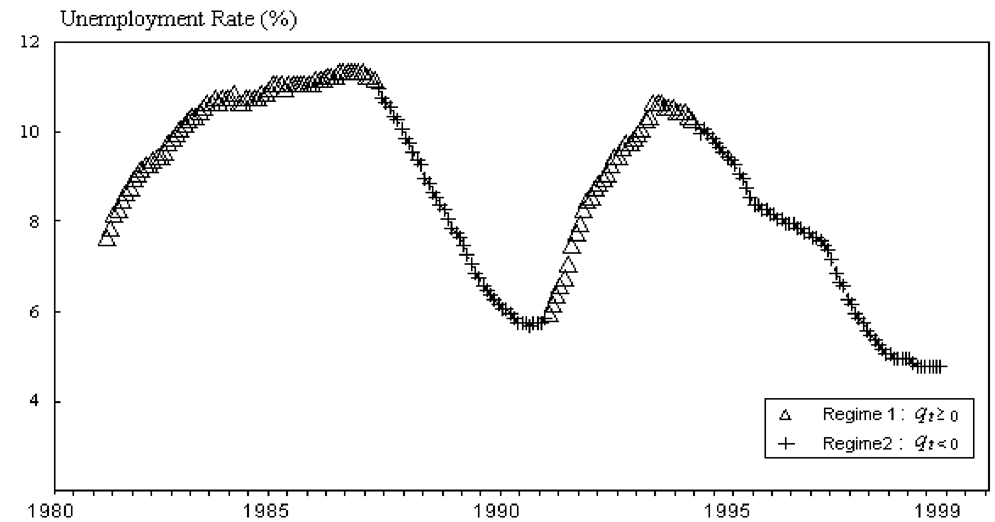


Figure 5. Structural Breaks and Estimated Attractors

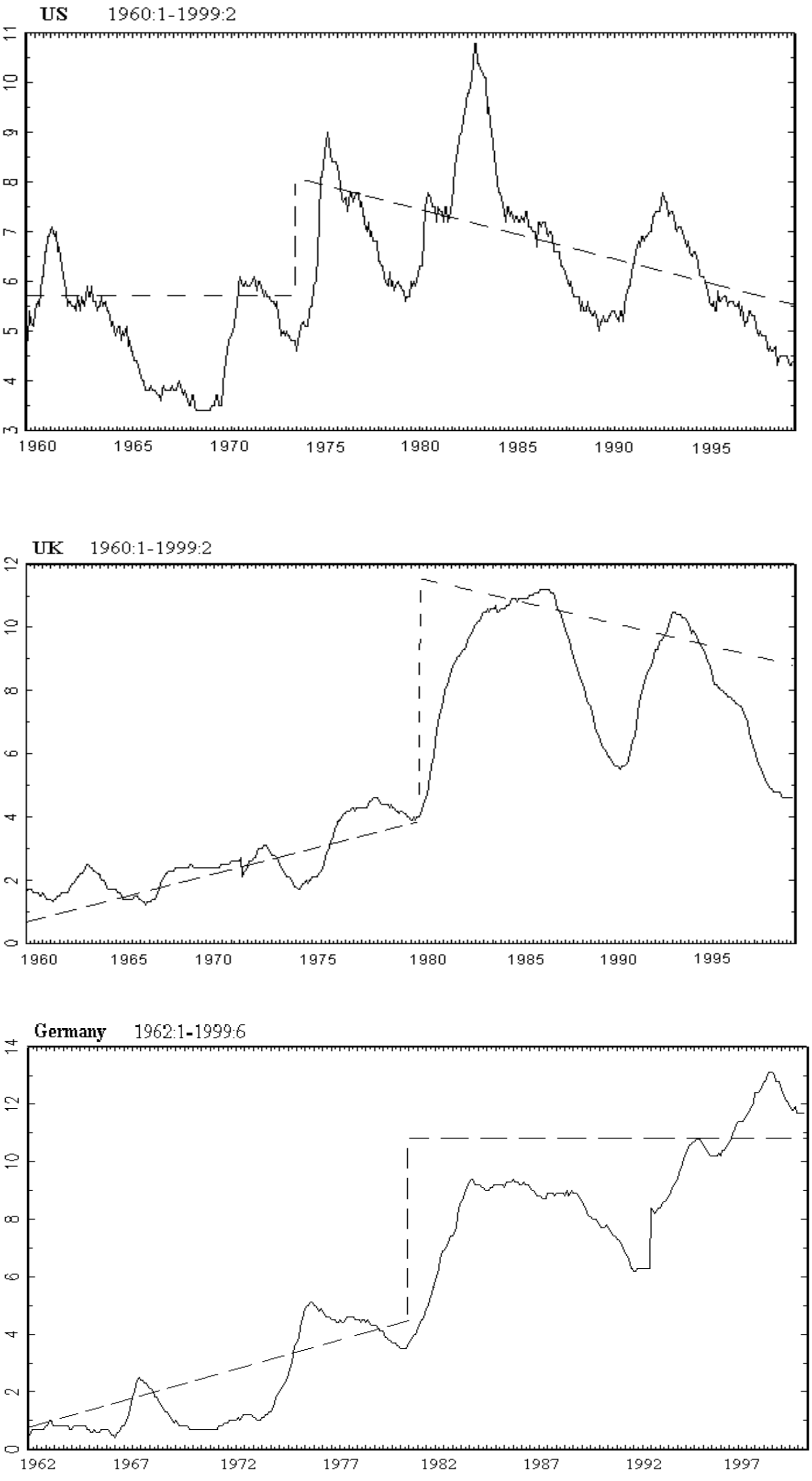


Table 5. Best Fit M-TAR Model and Unit Root Test: No Structural Break

Country	Sample	k	Threshold variable q_t Type	Delay d	Regime 1: $q_t \geq 0$ ρ_1 (t-ratio)	% obs	Regime 2: $q_t < 0$ ρ_2 (t-ratio)	% obs	Threshold Unit root test
US	1960:1-99:2	4	*ExpI*	11	−.02207	35	−.00834	65	.014
					(−2.835)		(−1.282)		
UK	1960:1-99:2	5	*ExpI*	13	−.00048	55	−.00523	45	.078
					(−0.366)		(−3.611)		
Germany	1962:1-99:6	4	*ExpI*	7	−.00274	55	−.00106	45	.853
					(−1.290)		(−0.465)		

NOTE: The threshold variable is selected by minimising the residual variance of the fitted models. *ExpI* denotes exponentially increasing weights.

Table 2. Nonparametric Tests for Nonlinear Dependence and Steepness

Country	BDS test					Triples test
	ε/σ	Embedding Dimension (m)				
		2	3	4	5	
US	.75	1.285	2.039	2.304	$2,343$	1.661
	1	1.620	2.135	2.196	1.981	
	1.25	2.160	2.403	2.565	2.440	
UK	.75	2.105	2.378	2.644	2.251	3.039
	1	4.369	4.817	4.822	4.302	
	1.25	2.973	3.581	3.526	3.096	
Germany	.75	4.435	4.668	4426	4.096	4.817
	1	5.043	5.187	4.823	4.464	
	1.25	4.999	4.893	4.412	3.891	

NOTE: The BDS test is carried out on the residuals of a linear AR model with structural break dummies. The distance ε is selected as .75, 1 and 1.25 standard deviations (σ) of the residuals. H_0 is iid-ness and H_1 is stochastic nonlinear dependence or deterministic chaos. For the triples test H_0 is symmetry and H_1 is asymmetry (steepness). Both the BDS and the triples test are two-sided tests based on asymptotically standard normal distributed statistics.

Table 4. Bootstrap LR Threshold Unit Root and Symmetry Tests

			Symmetry tests	
Country	Sample	Unit root	u_t	HP-detrended u_t
US	1960:1-73:10	34.84(0.000)	32.99(0.000)	24.27(0.018)
	1973:11-99:2	52.97(0.000)	41.70(0.000)	43.38(0.000)
UK	1960:1-80:1	24.85(0.020)	16.74(0.058)	13.75(0.115)
	1980:2-99:2	37.56(0.000)	26.20(0.001)	29.29(0.008)
Germany	1960:1-80:9	31.76(0.012)	20.27(0.019)	27.00(0.013)
	1980:10-99:6	24.47(0.018)	15.83(0.023)	8.19(0.218)

NOTE: For the unit root test, H_0 is a unit root and H_1 is stationarity with possible M-TAR asymmetry while H_0 is linear symmetric AR adjustment and H_1 is M-TAR adjustment for the symmetry test. Empirical p-values obtained from a parametric bootstrap simulation with 999 replications are given in parentheses.