The political economy of unemployment and threshold effects. A nonlinear time series approach.

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Abstract

This paper develops a political economy model of multiple unemployment equilibria to provide a theory of an endogenous natural rate of unemployment using a nonlinear threshold model for a number of OECD countries. The theory here sees the natural rate and the associated path of unemployment as a reaction to shocks (mainly demand in nature) and the institutional structure of the economy. The channel through which these two forces feed on each other is a political economy process whereby voters with limited information on the natural rate react to shocks by demanding more or less social protection. The empirical results obtained confirm the existence of multiple and "moving" equilibria ("vicious" and "virtuous" circles). The conclusion is that macroeconomics and supply side policies feed on each other via the political economy.

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1. Introduction

The idea of the paper is that shocks causing sharp cyclical demand swings and other persistent influences on unemployment generate political reactions from public opinion and vested interests, these in turn produce not merely fiscal and monetary (demand policy) responses but also changes in supply-side policy, i.e., policy affecting the equilibrium values of real variables or "natural rates". Specifically, bad demand shocks tend to produce supply policies that distorts the market because these shocks generate demands for protection; these distortions in turn produce a worse equilibrium with a higher natural rate of unemployment which in turn can reinforce the demands for yet more protection, until matters are bad enough to create a political equilibrium where the bad effects cause enough opposition to yet more distortions.

Vice versa, a good run of demand shocks produces more liberal supply-side policies as people are less nervous about potential misfortune. This again is self-reinforcing so that the economy moves in a virtuous circle to a low-unemployment high-output equilibrium. The path and dynamics of unemployment move between a lower regime (low equilibria) and an upper regime (high equilibria) following shocks to the economy.

The model of political economy of supply-side policies in this paper is similar to Wright (1986). In Wright (1986), workers have different unemployment risks, and unemployment benefits play the sole role of an insurance against adverse shocks. The median voter will optimally determine unemployment benefits by weighing their benefits (in terms of better insurance) against their costs (in terms of higher taxes). Thus, the more exposed to unemployment is the median voter, the higher the political support for unemployment benefits, much as in Meltzer and Richard (1981) the median voter's support for redistributive taxation varies with the state of the economy. However as noted by St-Paul (1996), this prediction neglects other effects of unemployment benefits to the extent that higher wages lower job creation and harm the unemployed. Therefore, a higher exposure of the employed to unemployment will tend to moderate the desire of the median voter for a high benefit level. St-Paul also analyses how labour market institutions can affect the median voter's choice.

The political economy model of institutions in this paper extends the analysis of Meltzer and Richard (1981), Wright (1986) and St-Paul (1996). Long-lasting shocks to the economy lead to demand for social protection (identified with the benefit/wage -or replacement- ratio). However, we also take into account the feedback distortionary effect of benefits on unemployment which progressively raises the chances of unemployment for the median voter. We therefore address the missing channel of Wright (1986) of how labour market institutions can affect the welfare of the decisive voter, as suggested by St-Paul (1996).

This paper joins a large literature on the creation and evolution of the institutions that favour or inhibit capitalist growth (see, for example, Persson and Tabellini, 1994; Alesina and Roderick, 1993; Perotti, 1993; Stokey and Rebelo, 1993, and Krusell et al, 1994). There is in particular a large literature of 'hysteresis' (see Layard *et al.* (1991)) which has noted the tendency for unemployment to react with high persistence to temporary demand and supply shocks. Indeed, Layard *et al.* (1991) following Burda (1988) find that long-duration unemployment is closely linked to long-duration benefits as originally posited by Minford (1983). Therefore it also joins a set of other studies explaining the rise in unemployment since the 1970s in terms of macroeconomic shocks interacting with institutional patterns (see the recent literature, for instance, Blanchard and Wolfers, 2000, Fitoussi et al., 2000; Bertola et al., 200; Minford and Naraidoo, 2006; Nickell et al., 2005). Multiple equilibria also have a long history in the macroeconomics of unemployment (for an early example see Diamond, 1982). Our contribution here is to view these interactions as the product of a political economy process using nonlinear estimation techniques.

The structure of the paper is as follows. In section 2, we present the theoretical framework of the threshold model. Section 3 discusses the econometric methods that will be used to estimate parameters and test hypotheses. Section 4 reports and discusses our results and section 6 concludes.

2. The political economy of unemployment

This section sketches the theoretical framework that produces vicious and virtuous circles in unemployment. The theory consists of two components: a model of the natural rate and a model of the political economy of supply-side policy (particularly towards the central labour market). We discuss each in turn.

As outlined by Siebert (1997), starting from a simple notion of an equilibrium in a classically clearing labour market, institutional arrangements can influence the clearing function of the labour market in basically three ways: by weakening the demand for labour, making it less attractive to hire a worker by explicitly pushing up wage costs or by introducing a negative shadow price for labour; by distorting labour supply; and by impairing the equilibrating function of the market mechanism (for instance, by influencing bargaining behaviour). To these interventions may be added those of trade unions (see Blanchard and Katz, 1997).

Our set-up for the labour market follows that of Minford (1983). He took the classical labour supply set-up and added the idea of a permanent unemployment benefit, payable without check on work availability. The result was to tilt the labour supply curve so that the real wage offer never fell below the benefit level, as shown in Fig. 1. Should the benefit level rise relative to productivity, unemployment will increase. That is, people will voluntarily refuse to take available wage offers because benefits are preferable; they are 'unemployed' in the sense that they are not working but are 'available for work'.

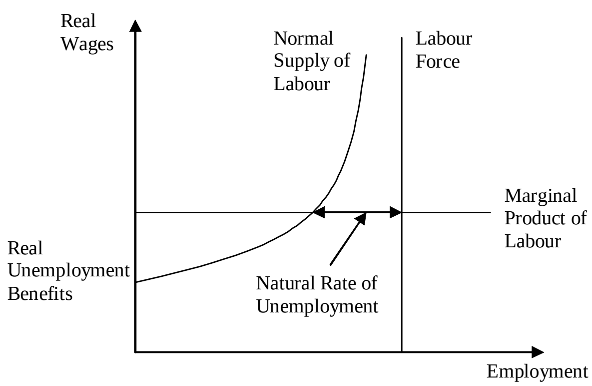

Figure 1: The Natural Rate of Unemployment

These ideas can be summarised in the following model of structural unemployment[1]. In our analysis we focus purely on benefits, because this will

[1]Later versions have proliferated; in the UK, Layard and Nickell (1986) estimated a similar model, and Bean *et al.* (1986) attempted to extend it to other European countries which began to experience rising unemployment UK-style during the late 1980s and 1990s. It turns out that in each country there are substantial idiosyncracies in the social support mechanisms, complicating effective modelling of the natural unemployment rate.

In more recent empirical works, Nickell(1997), Nickell and Layard(1998) and OECD (1999) suggest that structural unemployment in major OECD economies is associated with the following labour market features: (a) generous unemployment benefits that are allowed to run on indefinitely, combined with little or no pressure on the unemployed to obtain work, (b) high unionisation with wages bargained collectively and no coordination between either unions or employers in wage bargaining and (c) high overall taxes impinging on labour or a combination of high minimum wages for young people associated with high be the choice variable for voters under our political economy model below; such things as taxation and public expenditure, union power, and minimum wages are also potential choice variables but for simplicity we leave them out of the explicit model,

$$lnU_t = u_0 + \delta ln(\frac{B_t}{\overline{W_t}}) + u_{1t} + u_t^c \tag{1}$$

where u_0 is a constant, B_t is the real benefit rate , $\overline{W_t}$ is real wages (set it is assumed by productivity), u_t^c is cyclical unemployment, and u_{1t} represents other persistent influences on unemployment, an error process assumed therefore to display high serial correlation. Examples of such influences would be demographic shifts (such as a rise in working age population), and sectoral shifts like a decline in manufacturing. These influences will have no long-run effect on unemployment but their effect is assumed to be long drawn out.

This effect provokes a political economy response. In our model, the median voter holds some non-human capital but nevertheless relies heavily on income from human capital. If this voter experiences unemployment spells, unemployment benefits yield a much needed replacement of wage income. The higher level of unemployment means that agents are more exposed to the risk of being unemployed which therefore increases their desired benefit/wage ratio. However, we also take into account the feedback distortionary effect of benefit on unemployment which increases the probability of unemployment for the median voter. Hence, as unemployment rises, the median voter's demands for benefits rise but at a diminishing rate, as these higher benefits progressively raise the chances of unemployment.

We expound this model in the first place under the assumption of rational expectations with full information up to time t-1 on the relevant data and full knowledge of all model parameters. Let the (risk-neutral) median voter's utility be given purely by a linear function of income so that the mth such voter maximises at t:

$$V_t^m = E_t \sum_{i=0}^{\infty} \beta^i \left(N_{t+i}^m s B_{t+i} + [1 - N_{t+i}^m s] W_{t+i} + rK - T \right) \tag{2}$$

where $\beta =$ the voter's time-preference rate, N_{t+i}^m is the number of spells the mth voter spends unemployed in year t+i, $s =$fraction of a year that each spell lasts; r is the rate of return on non-human capital, K, and $T =$ general per capita taxation (treated as lump sum). In addition this voter faces two

payroll taxes.

constraints. First, the expected duration of unemployment in t+i (that is s times the expected number of spells) is π_{t+i} which we write as:

$$\pi_{t+i} = \pi_0 + \pi U_{t+i} \qquad\qquad 0 \leq \pi_{t+i} \leq 1 \tag{3}$$

Note that U (the rate of unemployment) $= s.(N/POP)$ where N/POP is the average number of spells per head of working population, that is the 'turnover rate' (fraction of jobs lost per annum) and s is the length of such spell. Therefore if the median voter is typical; $\pi_{t+i} = U_{t+i}$ so that $U = \frac{\pi_0}{1-\pi}$. We expect π_0 to be small and positive, on the grounds that the chances of becoming unemployed never go to zero however low unemployment may go; and π to be positive and less than unity, if we assume (as we do) that the median voter's chances of unemployment are approximately the same as the population's.

The second constraint comes from the economic model of unemployment of Eq. (1):

$$U_{t+i} = \exp(u_0 + v_{t+i}).[B_{t+i}/W_{t+i}]^{\delta} \tag{4}$$

Eq. (2) can be rewritten, once expectations are taken, as:

$$V_t^m = \sum_{i=0}^{\infty} \beta^i \left(\pi_{t+i} E_t B_{t+i} + [1 - \pi_{t+i}] E_t W_{t+i} + rK - T\right) \tag{5}$$

Now we will treat W (wages, i.e. productivity) as a random walk. We expect productivity to be non-stationary (an I(1) process) because productivity growth is by its nature an innovation. If in addition to this random shock, productivity growth was related to past shocks making it an ARIMA process integrated of order 1 then future wages would be related to current wages by a linear function of the autocorrelation and moving average parameters; however for simplicity here we assume it is a simple random walk so that $E_t W_{t+i} = W_t$. We also assume that the voters can only demand at any point of time a single, constant, benefit level (because political debate enforces simplicity), and thus they must decide on a single B_t at each date t; this will not prevent them at a later date demanding a different one but at t they cannot demand a level that is planned to change. From these arguments we may further rewrite (5) as:

$$V_t^m = \frac{1}{1-\beta}(W_t + rK - T) + \left(\pi_0 + \pi \overline{U}_t\right)(B_t - W_t) \tag{6}$$

where

$$\overline{U}_t = \exp(u_0). \left(E_t \sum_{i=0}^{\infty} \beta^i \exp v_{t+i}\right) [B_t/W_t]^{\delta} \tag{7}$$

The first order condition for benefits from maximising (6) is then:

$$B_t = W_t \frac{\pi\delta\overline{U}_t}{\pi_0 + (1+\delta)\pi\overline{U}_t} \tag{8}$$

Inspection of (8) reveals that median voters will demand a higher benefit-wage ratio as $\overline{U}_t$ rises but at a diminishing rate.

For greater tractability we loglinearise (8) around $\overline{U}_0$ as:[2]

$$\ln B_t = \eta(\overline{U}_0)\ln\overline{U}_t + \ln W_t + constant \tag{9}$$

where $\eta(\overline{U}_0) = \left(\frac{\pi_0}{\pi_0+(1+\delta)\pi\overline{U}_0}\right)$. By making $\overline{U}_0$ as close as possible to $\overline{U}_t$ the degree of approximation is minimised; thus we set $\overline{U}_0 = \overline{U}_{t-1}$, so that now we have $\eta(\overline{U}_{t-1}) = \left(\frac{\pi_0}{\pi_0+(1+\delta)\pi\overline{U}_{t-1}}\right)$.

We also have from equation (4):

$$\ln\overline{U}_t = u_0 + \delta(\ln B_t - \ln W_t) + \overline{v}_t^e \tag{10}$$

where $\overline{v}_t^e = \left(E_t \sum_{i=0}^{\infty}\beta^i \exp v_{t+i}\right)$. We can then compactly write the solution for the median voter's desired benefits in loglinear terms as:

$$(\ln B_t - \ln W_t) = \frac{\eta}{1-\delta\eta}\overline{v}_t^e + constant \tag{11}$$

The interpretation of (11) is that voters are altering their benefit demands (which in turn control changes in the natural rate) in response to that part of unemployment, the persistent cyclical and other movements, that they cannot control.

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[2] log first differences of (8)

$$d\ln B_t = d\ln W_t + d\ln\left(\frac{\pi\delta\overline{U}_t}{\pi_0+(1+\delta)\pi\overline{U}_t}\right) = d\ln W_t + d\ln\overline{U}_t - d\ln\left(\pi_0 + (1+\delta)\pi\overline{U}_t\right)$$

Using the approximation that

$$d\ln(x+z) \simeq \frac{x_0}{x_0+z_0}d\ln x + \frac{z_0}{x_0+z_0}d\ln z$$

the last term can be rewritten as $\left(\frac{(1+\delta)\pi\overline{U}_0}{\pi_0+(1+\delta)\pi\overline{U}_0}\right)d\ln\overline{U}_t$. Substituting this in yields (A8). The constant of integration is found as

$$\ln\pi\delta + (1-\eta)\ln\overline{U}_0 - \ln\left(\pi_0 + (1+\delta)\pi\overline{U}_0\right)$$

Note that it does not change with $\overline{U}_0$ and that $\eta(\overline{U}_0)\ln\overline{U}_t$ has the required property that it rises with unemployment at a diminishing rate.

At this point we introduce an important information limitation; we have assumed rational expectations conditional on their information set. However, it is clear that within this model if voters know the correct value of v_t and of the natural rate, U_t^*, then their demands for benefits would be self-limiting. What would occur would be that faced with a persistent v shock to unemployment they would demand higher benefits which would raise unemployment temporarily, until the shock had disappeared. This would produce an extended cycle in the natural rate and in the benefit-wage ratio around a single steady state equilibrium; but it would not produce the very large and apparently self-propagating movements in the natural rate of unemployment during the interwar period that we observed quite widely. However, it is worth bearing such a model of full information in mind as it is possible that in some countries' episodes information is sufficiently full to avoid this phenomenon and hence produce a single unemployment equilibrium.

Instead we assume that the voters' general situation is one of limited information about the natural rate and hence about the other v shocks disturbing unemployment. (By implication they also have limited information about the parameters.) This limitation is motivated by the sheer difficulty and indeed controversy that has surrounded the estimation of natural rates for different economies. Indeed as recently as the 1970s it was commonplace among economists influential in policy to deny the existence of a natural rate. Hence we would argue that it is quite reasonable to assume that voters faced a signal extraction problem. They observed U_{t-1} but could not decompose it into v_{t-1} and the natural rate. To solve this in a standard way, we assume that they used past experience (prior to the sample) on the ratio, ξ, of the variance of v_t to the total variance of the unemployment rate. In the model here they apply this ratio to the rise in unemployment since some initial rate,z. Thus their estimate of v_t is:

$E_{t-1}v_t = \xi(U_{t-1} - z)$ and of the natural rate $E_{t-1}U_t^* = (1-\xi)(U_{t-1} - z)$. Hence the permanent value $\overline{v}_t^e = \theta E_{t-1}v_t$ where θ is determined by the coefficients of the v autocorrelation function and the discount rate. $E_{t-1}U_t^*$ is treated as a constant, as it depends on B_t/W_t which is expected to be constant by virtue of the voter's optimising choice. We recall that $\frac{\eta}{1-\delta\eta}$ is a declining function of $\overline{U}_{t-1}$; under our limited information assumption this parameter becomes an estimated one, $\widehat{\frac{\eta}{1-\delta\eta}}$, to be updated on the basis of the latest estimates of the v shock and the natural rate, in conjunction with other information about the model. The best estimate of $\overline{U}_{t-1}$ is $E_{t-1}\overline{U}_{t-1} = \overline{v}_t^e + E_{t-1}U_t^* = [1 - \xi(1-\theta)](U_{t-1} - z)$. We represent the function here linearly as:

$$\frac{\widehat{\eta}}{1-\delta\eta} = \psi_1 - \psi_2(U_{t-1} - z) \tag{12}$$

We can now write:

$$(\ln B_t - \ln \overline{W}_t) = [\psi_1 - \psi_2(U_{t-1} - z)][\theta\xi(U_{t-1} - z)] + constant + \epsilon_t \tag{13}$$

where we have added an error term, ϵ_t, to capture the influence of other factors and pieces of information on the choice of optimal benefits- because these elements may well be persistent, this error term may well too be autocorrelated.. Hence finally we obtain a reduced form equation for benefits as:

$$\ln(B_t/\overline{W_t}) = B_0 + \varphi(U_{t-1} - z) - \beta(U_{t-1} - z)^2 + \epsilon_t \tag{14}$$

which is Eq. (2) in the main text.

Initially a rise in unemployment above some normal rate, z, would trigger demands for higher benefits, but as unemployment rises, the rising chances of unemployment become an increasingly restraining factor. In Eq (14), B_0 is a minimum benefit/wage ratio set in normal circumstances and φ and β are constants.

Extension to threshold model:

We note in the theoretical derivation above that $\eta = \left(\frac{\pi_0}{\pi_0+(1+\delta)\pi\overline{U}_{t-1}}\right)$ hence ψ_1 and -ψ_2 reflect respectively the constant value of η when $\overline{U}_{t-1}$ is low and the effect of it rising from this value. Thus

$\psi_1 = (\frac{\eta}{1-\delta\eta})$ for low values of $\overline{U}_{t-1}$

$(-\psi_2) = \frac{\partial(\frac{\eta}{1-\delta\eta})}{\partial\overline{U}_{t-1}} = \frac{\partial(\frac{\eta}{1-\delta\eta})}{\partial\eta}\frac{\partial\eta}{\partial\overline{U}_{t-1}} = (1-\delta\eta)^{-2}\left(\frac{-\pi_0(1+\delta)\pi}{[\pi_0+(1+\delta)\pi\overline{U}_{t-1}]^2}\right) \prec 0$

We can differentiate both parameters with respect to $\overline{U}_{t-1}$ and we find that as either of them rise, ψ_1 rises and $(-\psi_2)$ falls (i.e. becomes more negative). Thus in effect the function becomes steeper and also more curved as $\overline{U}_{t-1}$ rises.

We might expect this relationship to be non-linear. It could well be that for 'low' values of $\overline{U}_{t-1}$ (i.e., below the threshold c) the function mean reverts quickly, yielding a stable equilibrium at a low level of unemployment; while for 'high' values (i.e., when unemployment lies above the threshold c) the function is highly quadratic yielding two stable equilibria at high and low unemployment. In this paper we test for this possibility by allowing for a threshold level of unemployment at which the function switches in this way. This would lead us to posit the following:

$$(\ln B_t - \ln \overline{W}_t) = B_0 + \varphi'(U_{t-1} - z) - \beta^{'}(U_{t-1} - z)^2 + \epsilon_t \qquad \text{if } U_{t-1} \leq c \tag{15a}$$

$$(\ln B_t - \ln \overline{W}_t) = B_0 + \varphi''(U_{t-1} - z^{'}) - \beta''(U_{t-1} - z)^2 + \epsilon_t \qquad \text{if } U_{t-1} > c \tag{15b}$$

The main intuition is that when unemployment is below some threshold, c, i.e., lower regime, we could assume that at very low rates of unemployment (good performance) the floating voters are predominantly capitalists, with little concern for unemployment because prosperity has enhanced holdings of non-human capital and reduced the risk to human capital. In that state, the political economy is relatively stable as represented by Eq. (15a). However, a rise in unemployment above the critical rate, c, would disturb the political equilibrium triggering demands for higher benefits and other supply-side policies, but since unemployment rises, the general good element becomes more of a restraining factor until reform is demanded. This idea is captured in Eq. (15b).

Combining Eqs. (15a) and (15b) into (1) leads to the following threshold log-linear autoregression[3] (TAR) model.

$$\begin{aligned} \ln u_t &= a_0 + a_1 u_{t-1} + a_2 u_{t-1}^2 + \xi_t \quad \text{if } \; u_{t-d} \leq c \\ \ln u_t &= b_0 + b_1 u_{t-1} + b_2 u_{t-1}^2 + \xi_t \quad \text{if } \; u_{t-d} > c \end{aligned} \tag{16}$$

where ξ_t represents a composite error term $(u_{1t} + u_t^c + \delta\epsilon_t)$. We therefore reformulate the model into a two-regime threshold autoregressive one, positing that unemployment follows different dynamics and moving equilibria given that past unemployment was "low" or "high" distinguishing between a lower and an upper regime.

In our empirical study we use this extended version to a nonlinear threshold model that allows richer dynamic and economic behavior. Statistical methods by Hansen (1997) are employed in the estimation and specification of the threshold model. The dominance of linear models is undoubtedly due to the convenience of their mathematical forms despite the fact that theoretical arguments for linearity rarely exist. Early work by Neftci (1984) found asymmetries in unemployment although Rothman (1991) modified

[3] The idea of approximating a general nonlinear autoregressive structure by a threshold autoregression with a small number of regimes is due to Tong (1983, 1990).

Neftci's tests to find marginally significant asymmetries. Brock and Sayers (1988) document considerable evidence of nonlinearity in unemployment using the nonparametric BDS test. More recently, Koop and Potter (1999) find strong evidence of economically interesting dynamic asymmetries in unemployment. Skalin and Terasvirta (1999) employ smooth transition models to model asymmetry and moving equilibria in many OECD countries (see also Peel and Speight, 1998). Parker and Rothman (1997), Rothman (1998), and Montgomery, Zarnowitz, Tsay and Tiao (1998) consider nonlinear forecasting of U.S unemployment. The latter authors compare the forecasting performance for a variety of linear and nonlinear models and find evidence of superiority of the nonlinear model at least during recessions. Venetis, Paya and Peel (2007) have attempted to model unemployment series in ESTAR models that allow for multiple equilibria.

3. Econometric Methods

Model (16) is a parametric model that can capture a variety of nonlinear dynamic behavior patterns in unemployment. The integer d is called the delay lag and typically it is unknown, so it must be estimated. The least-squares principle allows d to be estimated along with the other parameters. Parameter c is the "threshold" that distinguishes two regimes i) unemployment is below c (lower regime) ii) unemployment is above c (upper regime). Then, parameter vectors $\boldsymbol{\alpha} = (a_0, a_1, a_2)'$ and $\mathbf{b} = (b_0, b_1, b_2)'$ determine the dynamics of u_t and the mean reversion speed at the lower (upper) regime. We would expect, a priori, unemployment to display quick mean reversion in the lower regime when the economy is at a low-unemployment high output equilibrium and significant persistence in the upper regime coming from the political response to unemployment, leading to a high unemployment equilibrium.

In our statistical application we will assume that the unemployment rate is a stationary process. Although in a recent survey Roed (1997) reports that the unit root hypothesis (pure hysteresis) has rarely been rejected in the relevant theory, our assumption may not be unrealistic. Pippenger and Goering (1993) showed that the power of unit root tests falls dramatically under threshold processes. Loosely speaking, this means that the researcher is likely to "accept" the null of a unit root even if the true process is a threshold process and therefore cautious interpretation is necessary. Caner and Hansen (2001) develop an asymptotic theory of inference for an unrestricted two-regime TAR model with an autoregressive unit root. They illustrate their methods with an application to the U.S monthly unemployment rate and they find significant threshold effects and strong evidence that the unemployment rate is not a unit root process. Second and more importantly, the unit root hypothesis is hard to reconcile with economic intuition and "stylized" facts. Hysteresis will denote a situation in which transitory shocks have permanent effects and any unemployment rate can be considered as an equilibrium. The fact that the variance of a unit root process grows indefinitely over time rules out the possibility of a bounded variable. Furthermore, large unemployment fluctuations are expected to induce policy switches capable of altering the unemployment path. Thus, "global" unit root behavior of the unemployment rate is a rather stringent assumption although "local" random walk behavior could not be ruled out.

If the threshold value, c, were known, then to test for threshold behavior all one needs is to test the hypothesis $H_0 : \boldsymbol{\alpha} = \mathbf{b}$. Unfortunately, the threshold value is typically unknown and, under the null hypothesis, parameter c is not identified[4]. The second difficult statistical issue associated with TAR models is the sampling distribution of the threshold estimate. Our model specification and inference will closely follow Hansen (1997) who a) provides a bootstrap procedure to test H_0, b) develops an approximation to the sampling distribution of the threshold estimator free of nuisance parameters and c) develops a statistical technique that allows confidence interval construction for c.

4. Econometric Results

We begin our empirical work by estimating equation (16) for our dozen OECD countries over the post-war period.[5] The table below summarizes the minimum and maximum values of each series. The table also gives the delay lag d estimate following the searching procedure mentioned in the previous section.

[4] Nothing can be learned about c from the data when the null hypothesis is true.

[5] France (1967.4-2005.2, 151 obs), Germany (1962.1-2005.2, 174 obs), Ireland (1960.1-2005.2, 182 obs), Italy (1960.1-2005.2, 182 obs), U.K (1960.1-2005.2, 182 obs), U.S (1960.1-2005.2, 182 obs), Spain (1964.2-2005.2, 165 obs), Denmark (1970.1-2005.2, 142 obs), Finland (1960.1-2005.2, 182 obs), Sweden (1970.1-2005.2, 142 obs), Norway (1972.1-2005.2, 134 obs) and the Netherlands (1975.1-2005.2, 122 obs).

	Countries						
	France	Germany	Ireland	Italy	U.K	U.S	Spain
$\min_t u_t$	2.1	0.5	5.5	3.5	1.3	3.4	0.9
$\max_t u_t$	12.5	11.7	18.1	12.2	11.2	10.7	24.6
d	5	7	4	9	2	2	2
	Denmark	Finland	Sweden	Norway	Netherlands		
$\min_t u_t$	0.9	1.1	1.4	1.1	2		
$\max_t u_t$	12.4	17.8	8.6	6.1	9.9		
d	4	2	8	7	3		

The results from estimating the TAR model are given in tables 1 and 2 which report the parameter estimates $\hat{a}, \hat{b}$ of the TAR model for the different countries considered, the estimated thresholds $\hat{c}$, the number of observations lying in the lower regime ($obs \leq \hat{c}$), the standard error of regression (se), the F statistic for the null of no threshold effects, $H_0 : a = b$, and the corresponding p-value and the estimated asymptotic 95% confidence intervals LR^c for the threshold estimates.[6]

Noticeable parameter shifts between the two regimes occur and the statistical significance of the threshold model is verified from the F test results. The F test of the null hypothesis that a single log-linear autoregression is appropriate against the TAR alternative strongly rejects the linear model in all cases. The parameters of interest, i.e., a_0, a_1, a_2 and b_0, b_1, b_2 are in almost all cases statistically significant. In the lower regime (low unemployment equilibrium case), the constants a_0 are negative in many cases as opposed to the upper regime (high unemployment equilibrium case) and the a_2 coefficients are much sizeable in the lower regime with the right negative sign. The implication is that unemployment will mean revert much quicker in the lower regime as suggested by the theory and will be more persistent in the upper regime where the coefficients b_0 and b_2 are positive and smaller respectively.

Taking the natural exponential function of equation (16), we end up with equation (17) and setting $e^{\xi_t} = 1$, i.e., turning off the supply and demand shocks as represented by ξ_t, we focus on the deterministic path of unemployment and obtain the following non-linear relationship:

[6] Also, we include any of the first four significant lags of the error process ξ_t in the regression (higher lags prove to be irrelevant) on account of the theory which predicts that u_t^c (cyclical influences) and u_{1t} (other structural influences), and hence ξ_t will be persistent. The coefficients on the lag error terms turn out to be highly significant, with the implied roots in these processes all less than unity.

$$U_t = \exp(a_0 + a_1 U_{t-1} + a_2 U_{t-1}^2) \quad (17)$$
$$U_t = \exp(b_0 + b_1 U_{t-1} + b_2 U_{t-1}^2)$$

We solve $u_t - e^{a_0 + a_1 u_{t-1} + a_2 u_{t-1}^2} = 0$ and numerically calculate the unemployment equilibria in both lower and upper regimes and we tabulate them below. Figures 2 to 4 include plots of the estimated functions in the lower and upper regimes as well as a plot of the adjusted likelihood ratio[7] LR^c (the values of $\hat{c}$ where the likelihood ratio lies beneath the flat line given by 7.35 yield the confidence region). We can read from these graphs that the thresholds estimates are quite precise, and the confidence interval is statistically reasonable. Only for Denmark the confidence region is wide, $(1.906, 5.212)$, whereas for Sweden we obtain a discontinuous interval[8]. On an average, the thresholds lie within 5 percent unemployment rate band, except in the case of Ireland where the threshold is 9.3 percent. This seems to reflect a practical importance given that prior to the mid 1970s, most countries had low unemployment rates.

The smallest number of available observations in the lower regime is 17 in the case of Sweden which has a threshold value of 1.675%. However the asymptotic 95% confidence interval is not particularly wide with $LR^c = (1.670, 2.370)$. The low equilibria can be seen in the upper diagram of figures 2 to 4 when unemployment lies below the threshold. Above the threshold, the middle diagram becomes the relevant one as unemployment changes its deterministic path and gravitates to a high unemployment equilibrium.

Lower regime							
	France	Germany	Ireland	Italy	U.K	U.S	Spain
$\bar{u}$	4.91	4.96	13.60	5.23	2.36	3.02	4.67
	Denmark	Finland	Sweden	Norway	Netherlands		
$\bar{u}$	5.30	2.86	2.27	1.87	2.04		
Upper regime							
	France	Germany	Ireland	Italy	U.K	U.S	Spain
$\bar{u}$	11.19	9.78	15.19	11.23	9.78	7.78	20.37
	Denmark	Finland	Sweden	Norway	Netherlands		
$\bar{u}$	9.10	13.92	7.09	4.75	8.73		

There are basically three groups:

[7] The plots of the 95% confidence intervals highlight some of the statistical aspects of our estimations since the Hansen (1997) method is relatively new and not widely applied.

[8] The discontinouity is "at the limit" since the second interval is near the 7.35 line.

A those which move between a lower regime (a low natural rate of unemployment) and an upper regime (a high unemployment equilibrium rate) as suggested generally by our theory (Denmark, Finland, France, Germany, Italy, the Netherlands, Spain and the UK).

B The US and Nordic countries like Norway and Sweden which have relatively low equilibrium rates.

C Ireland, where the model does not seem to give valuable information.

The general idea is that unemployment moves closely above the 45-degree line below the threshold (upper diagram) but mean reverts quickly, yielding a low equilibrium unemployment rate. Once pushed in the upper regime by shocks, unemployment follows more persistent dynamics but mean reverts globally, implying a high unemployment equilibrium rate. The equilibrium values are given in the table above and seem to have a practical echo in the countries' unemployment history. All calculated equilibria fall within the data range.

A-type countries give the appearance of economies being stuck for long periods at high unemployment levels. The UK which carried out a determined reform program in 1979, has succeeded in bringing the natural rate unemployment towards its best equilibrium. Smaller countries, like the Netherlands, have reformed perhaps because it is easier to get a consensus in favor of rational action. Nordic countries, like Denmark, that have rebounded from their great employment losses give credit to their pro-employment culture policies. However, Finland, France, Germany, Italy and Spain seem caught in a high-level unemployment equilibrium, maybe due to their lack of political will to undertake reforms. It should be noted that Finland and Spain have carried out some reforms, though much need to be done. Therefore, the results show that few countries have managed to undertake drastic reforms to direct their economies towards the best natural rate.

B-type countries such as Norway and Sweden have low equilibrium rates in both regimes giving credit to their active labor market policies. Although unemployment was rising quite steadily in the 1990s, there have always been pressures to keep it down. In the US, voters' social demands appear to be fairly insensitive to shocks. It would appear that (perhaps after its interwar experiment with the New Deal) US voter opinion is hostile to labour market intervention in line with its general espousal of free markets. What our theory suggests is that such a country's unemployment is dominated by purely cyclical movement and that this in turn induces voters to assume that there is no movement in 'permanent' unemployment to be protected against. Plainly such cycle-dominance can only occur in labour markets which are either highly flexible or where active government policy substitutes for this flexibility (possibly at high budgetary cost)..

In C-type countries, in our case only Ireland, the model does not pin down a realistic low natural rate. However, a look at Ireland's unemployment series reveals some peculiar facts (min at: 5.5%, max at: 18.1% and a high threshold of 9.3%), with unemployment being exceedingly high in most of the periods and falling sharply only recently.

5. Conclusions

In this paper, we model equilibrium unemployment using a nonlinear threshold model for a number of countries. For the purposes of this study we a priori confine the number of regimes to two, one corresponding to low past unemployment levels and one corresponding to high past unemployment levels. In each regime multiple equilibria (stable and/or unstable) are allowed and given the nature of the model, moving equilibria are implied. Our results strongly confirmed the existence of moving equilibria (and the presence of the particular type of nonlinearity) as suggested by the theory. The almost general case in the European countries is that unemployment moves between a low and a high natural rate of unemployment, supporting the model implication that bad demand shocks tend to produce supply policy that distorts the market because these shocks generate demands for protection; these distortions in turn produce a worse equilibrium with a higher natural rate of unemployment. But the model also points out to the phenomenon of drastic reform which can cut into a vicious circle (for example, the UK in 1979).

The paper has a number of policy implications. One is that good macroeconomic management has a role in supporting good supply-side policy. Another is that the education of public opinion in the nature of the economy and the shocks hitting it can avoid counter-productive demands for social protection. Yet another is that reform programmes or demand shocks which overall jolt the economy away from the high unemployment equilibrium can be beneficial.

	Countries						
	France	Germany	Ireland	Italy	U.K	U.S	Spain
$\hat{a}_0$	-0.326*	-1.059*	0.316*	0.854*	-0.528*	0.671*	-0.776*
	0.105	0.059	0.118	0.243	0.141	0.176	0.049
$\hat{a}_1$	0.619*	1.158*	0.305*	0.194*	0.780*	0.144**	0.897*
	0.059	0.062	0.030	0.090	0.134	0.075	0.047
$\hat{a}_2$	-0.046*	-0.125*	-0.010*	-0.008	-0.081*	0.008	-0.085*
	0.007	0.010	0.001	0.008	0.031	0.007	0.008
$\hat{a}_3$	0.055*	-0.013	0.012	0.147*	0.094*	0.016**	0.254*
	0.022	0.037	0.008	0.020	0.029	0.009	0.048
$\hat{b}_0$	0.706*	0.434*	0.516*	0.404*	0.412*	0.291	1.019*
	0.072	0.110	0.136	0.053	0.078	0.195	0.058
$\hat{b}_1$	0.226*	0.282*	0.233*	0.294*	0.288*	0.324*	0.162*
	0.016	0.032	0.021	0.013	0.023	0.049	0.009
$\hat{b}_2$	-0.006*	-0.009*	-0.005*	-0.010*	-0.009*	-0.012*	0.003*
	0.000	0.002	0.000	0.000	0.001	0.003	0.000
$\hat{b}_3$	0.022*	0.039*	0.010*	0.054*	0.006	0.027*	0.028*
	0.009	0.018	0.005	0.008	0.009	0.010	0.009
$\hat{c}$	5.005	2.800	9.320	5.300	3.218	5.985	4.525
$obs \leq \hat{c}$	39	52	71	23	62	90	50
se	0.035	0.113	0.048	0.037	0.066	0.045	0.069
R^2	0.996	0.985	0.986	0.988	0.990	0.968	0.996
F	101.20	212.08	39.15	58.212	95.605	32.057	848.33
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LR^c	(4.495	(2.525	(9.310	(5.290	(2.976	(5.718	(4.520
	6.152)	3.350)	10.870)	5.618)	4.188)	6.162)	4.877)

Table 1. Least squares results for model (16). Below each parameter estimate we report its standard error.

One asterisk denotes statistical significance at (at least) the 10% level.

$\hat{c}$ is the estimated threshold parameter. $obs \leq \hat{c}$ denotes the number of observations below or equal to the threshold and se is the standard error of regression. The F statistic tests the null $H_0 : \boldsymbol{\alpha} = \mathbf{b}$ (no threshold effects) using the bootstrap procedure of Hansen (1997). Squared brackets enclose The F statistic p-values.

LR^c denotes the 95% asymptotic confidence interval for c calculated as in Hansen (1997).

	Countries				
	Denmark	Finland	Sweden	Norway	Netherlands
$\hat{a}_0$	-0.482*	-0.476*	-0.249	-0.645	-0.045
	0.138	0.063	0.189	0.747	0.072
$\hat{a}_1$	0.755*	0.660*	0.540*	1.158	0.400*
	0.109	0.049	0.135	0.800	0.035
$\hat{a}_2$	-0.065*	-0.044*	-0.024	-0.255	-0.014*
	0.014	0.008	0.022	0.210	0.004
$\hat{a}_3$	0.095*	-0.011	-0.102*	0.363*	-0.010
	0.037	0.011	0.026	0.084	0.015
$\hat{b}_0$	0.621*	0.547*	-0.224*	-0.111	-0.277
	0.195	0.086	0.029	0.084	0.276
$\hat{b}_1$	0.239*	0.244*	0.513*	0.493*	0.463*
	0.046	0.019	0.015	0.049	0.070
$\hat{b}_2$	-0.007*	-0.006*	-0.029*	-0.030*	-0.021*
	0.002	0.000	0.001	0.006	0.004
$\hat{b}_3$	0.018	0.033*	0.086*	0.113*	0.047*
	0.016	0.012	0.012	0.026	0.012
$\hat{c}$	4.493	4.648	1.675	1.740	6.332
$obs \leq \hat{c}$	20	81	17	21	53
se	0.105	0.101	0.062	0.109	0.042
R^2	0.975	0.984	0.988	0.947	0.987
F	44.52	188.16	86.45	22.751	52.24
	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]
LR^c	(1.906	(3.187	(1.670	(1.500	(5.602
	5.212)	5.692)	2.375)	1.860)	6.515)

Table 2. Least squares results for model (16). Below each parameter estimate we report its standard error.

One asterisk denotes statistical significance at (at least) the 10% level.

$\hat{c}$ is the estimated threshold parameter. $obs \leq \hat{c}$ denotes the number of observations below or equal to the threshold and se is the standard error of regression. The F statistic tests the null $H_0 : \boldsymbol{\alpha} = \mathbf{b}$ (no threshold effects) using the bootstrap procedure of Hansen (1997). Squared brackets enclose The F statistic p-values.

LR^c denotes the 95% asymptotic confidence interval for c calculated as in Hansen (1997).

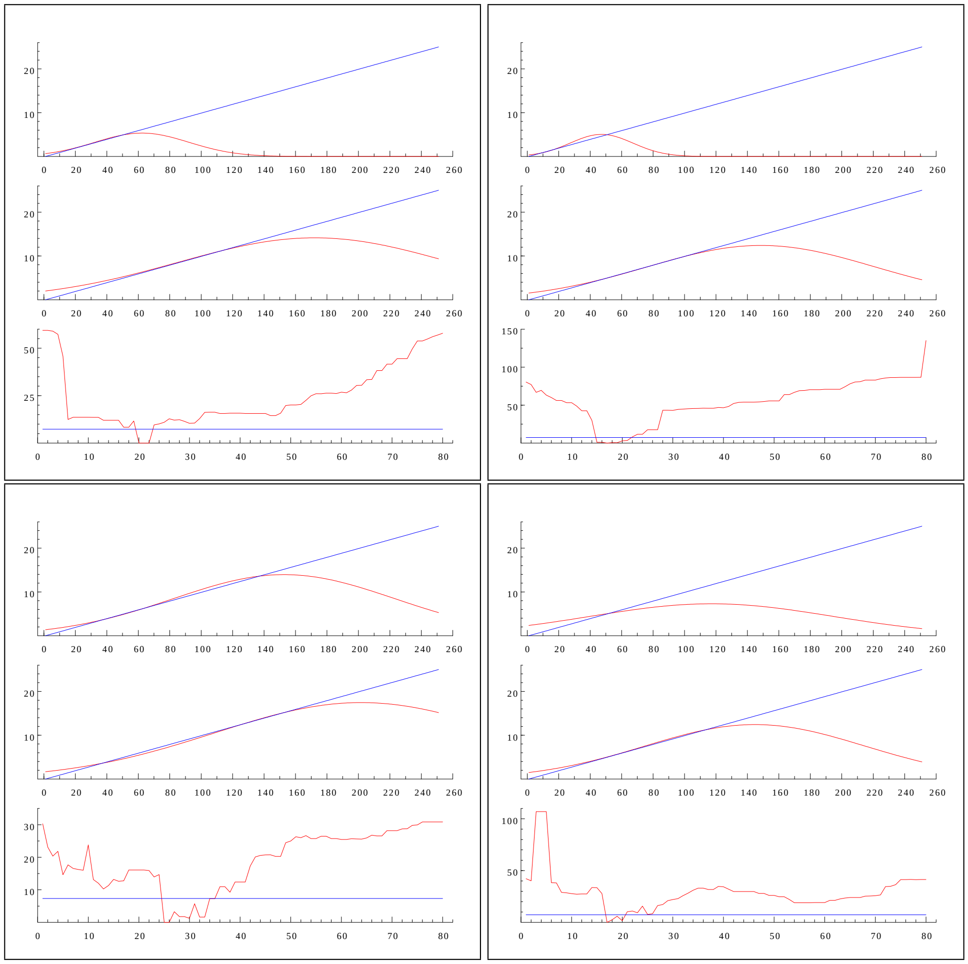

Figure 5. Top left: France. Top right: Germany. Bottom left: Ireland. Bottom right: Italy. The upper diagram depicts $u_t = e^{a_0+a_1 u_{t-1}+a_2 u_{t-1}^2}$ against $u_t = u_{t-1}$, the middle diagram depicts $u_t = e^{b_0+b_1 u_{t-1}+b_2 u_{t-1}^2}$ against $u_t = u_{t-1}$. In both diagrams we set $u_{t-1} \in [0, 25]$ and the x-axis corresponds to the interval $[0, 25]$ divided into 250 points. The lower diagram depicts $LR(c)$ for $c \in C$ against the asymptotic 5% critical line given by 7.35. The points $LR(c) = 7.35$ produce the interval LR^c as reported in table 2. The x-axis corresponds to the interval C divided into 80 points.

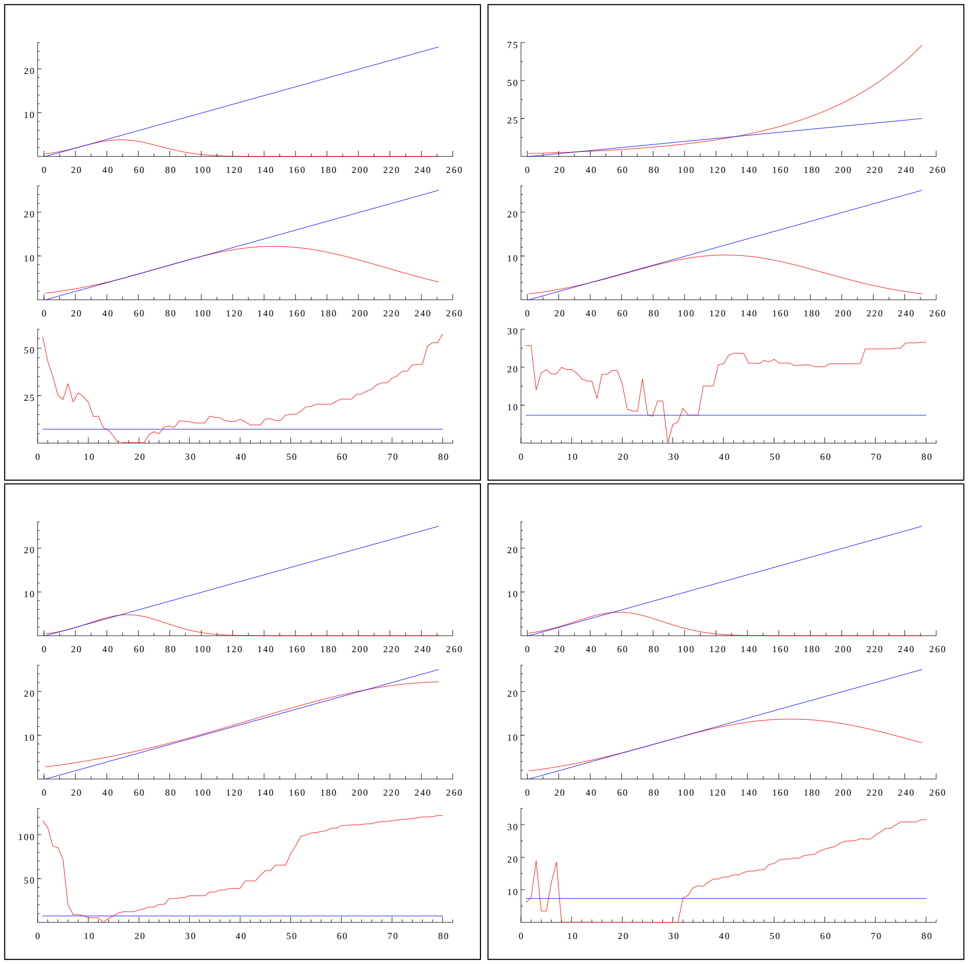

Figure 6. Top left: U.K. Top right: U.S. Bottom left: Spain. Bottom right: Denmark. The upper diagram depicts $u_t = e^{a_0+a_1u_{t-1}+a_2u_{t-1}^2}$ against $u_t = u_{t-1}$, the middle diagram depicts $u_t = e^{b_0+b_1u_{t-1}+b_2u_{t-1}^2}$ against $u_t = u_{t-1}$. In both diagrams we set $u_{t-1} \in [0, 25]$ and the x-axis corresponds to the interval $[0, 25]$ divided into 250 points. The lower diagram depicts $LR(c)$ for $c \in C$ against the asymptotic 5% critical line given by 7.35. The points $LR(c) = 7.35$ produce the interval LR^c as reported in table 2. The x-axis corresponds to the interval C divided into 80 points.

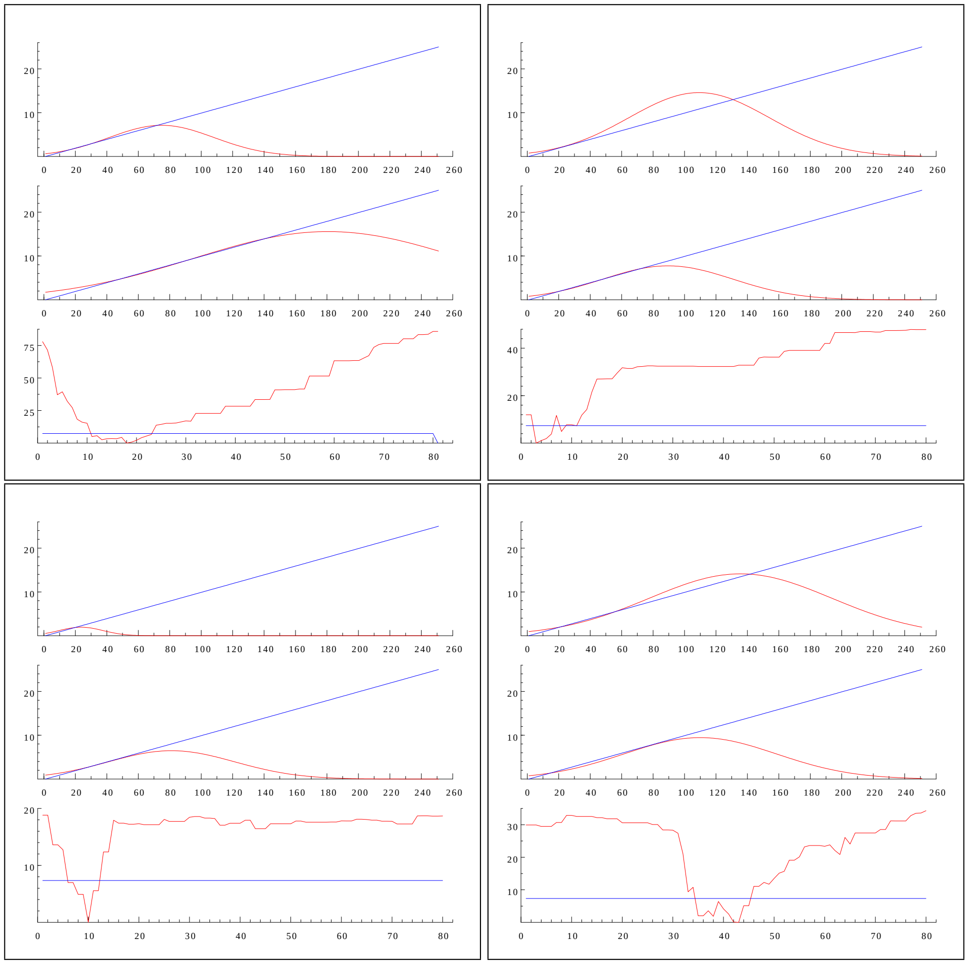

Figure 7. Top left: Finland. Top right: Sweden. Bottom left: Norway. Bottom right: Netherlands. The upper diagram depicts $u_t = e^{a_0 + a_1 u_{t-1} + a_2 u_{t-1}^2}$ against $u_t = u_{t-1}$, the middle diagram depicts $u_t = e^{b_0 + b_1 u_{t-1} + b_2 u_{t-1}^2}$ against $u_t = u_{t-1}$. In both diagrams we set $u_{t-1} \in [0, 25]$ and the x-axis corresponds to the interval $[0, 25]$ divided into 250 points. The lower diagram depicts $LR(c)$ for $c \in C$ against the asymptotic 5% critical line given by 7.35. The points $LR(c) = 7.35$ produce the interval LR^c as reported in table 2. The x-axis corresponds to the interval C divided into 80 points.

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