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HYSTERESIS IN WEST GERMAN UNEMPLOYMENT RECONSIDERED

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Abstract

The view that high unemployment in West Germany and other European countries is caused by a path dependence effect – or “hysteresis“ effect – is quite popular among economists. However, because of an identification problem, much of the empirical evidence for this hypothesis is not fully convincing. This paper suggests a testing procedure that overcomes this problem. It is argued that in a cointegration framework it is reasonable to define hysteresis as the absence of weak exogeneity of the explanatory variables. Building on a cointegration model of the employment rate in West Germany, I find only weak evidence for hysteresis.

Keywords: Cointegration, hysteresis, trade unions, unemployment

JEL Classification: E24, J51, J64

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1 Introduction

In the labour economics literature the notion of hysteresis became popular through a paper by Blanchard and Summers (1986)[1]. While generally what is meant by hysteresis is clear enough in a particular article, different articles use different definitions of the term. Loosely speaking, the term refers to models that display shock persistence, i.e. deviations from the long run equilibrium can have permanent feedback effects on the equilibrium itself. In figure 1, the unemployment rates in the United States u_{US} and West Germany[2] u_G are plotted for the period from 1959 to 1996. The graph shows that both economies were hit by similar shocks that induced cycles in the unemployment series. However, while in the US the unemployment rate reverted to its pre-shock level, this was not the case in West Germany.

A major reason for the popularity of the hysteresis approach is the alleged failure of the variables in standard labour market models to account for the dramatic rise in European unemployment rates[3]. As noted by Blanchard and Summers (1988), "we believe that understanding unemployment in Europe will require economists to dispense with the natural rate hypothesis that underlies much of both Keynesian and Classical macroeconomics. Theories of fragile equilibria are necessary to come to grip with events in Europe"(p.186). Deviations from the natural rate are not temporary phenomena in such a theory and the natural rate no longer constitutes a long run labour market equilibrium in a meaningful way. It should be noted, however, that in the literature on hysteresis it is generally not the deviation from the natural rate that is itself causal for a further deviation in later periods. There is always an intermediate variable that is invoked to justify this behaviour of the unemployment rate. Shocks to unemployment are assumed to influence variables like union membership, capital scrapping by firms, or skills (see e.g. Hargreaves, 1980;

[1] The idea as such can be found in a number of earlier contributions. See Røed (1997) for an overview.

[2] To assure comparability, the series for Germany is not the official unemployment rate, but an approximation of the US concept published by the US Bureau of Labor Statistics.

[3] This view is held by many economists. For a summary of the arguments see the papers collected in Cross (1995b) and the survey by Manning (1995).

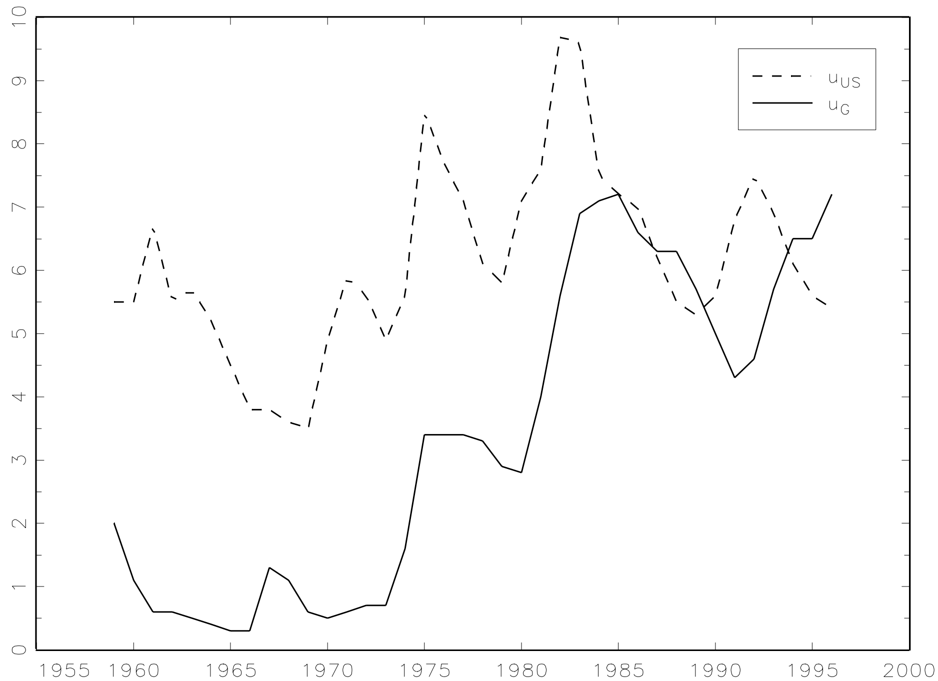

Figure 1: Unemployment rates for the US and West Germany in %

Carlin and Soskice, 1990), and these variables are assumed to be important determinants of unemployment in the following periods.

In this paper I argue that it is necessary to include these variables in a complete model of the long run determinants of unemployment before a convincing hysteresis test is feasible. To have shock persistence, a necessary condition is that unemployment has a stochastic trend. In this case, a model of long run labour market equilibrium should state a cointegration relation between unemployment and a set of explanatory variables. Hysteresis tests that focus on univariate properties of unemployment can only verify the presence of a stochastic trend in the time series. Such a trend does not imply that shocks to unemployment affect the explanatory variables, however. This identification problem is exemplified with the model of Blanchard and Summers (1986). An important message of this paper is that even if there are feedback effects from unemployment shocks to the explanatory variables this does not necessarily imply hysteresis. Only if these shocks lead to a *permanent* change in the long run equilibrium the system has the hysteresis property. It turns out that a test of this hypothesis is equivalent to a test for weak exogeneity of the explanatory variables.

The suggested hysteresis test is applied to an existing model of long run employment determination in West Germany. The variable that is most likely to induce a feedback mechanism in this model is the wedge between labour costs and the net wage. Part of this wedge are the contributions to social insurance. Rising unemployment puts the social insurance system under strain, especially unemployment insurance, and is likely to lead to a rise in contribution rates which in turn affects wage bargaining and thereby unemployment in future periods. However, the results indicate that all the explanatory variables in this model are weakly exogenous, at least in the preferred specification. This does not mean that the rise in unemployment did not have any effects on contribution rates. The message is that short run deviations from the long run equilibrium do not have significant feedback effects on these rates. Changes in the long run equilibrium itself, by contrast, might well have repercussions on the variables that determine it. This is not what is generally meant by hysteresis, however.

The remainder of the paper is organized as follows. The meaning of hysteresis in this paper is defined in the next section. Section 3 discusses the identification problem that arises in univariate tests. In Section 4 the implication of hysteresis for cointegrated systems is analyzed and a simple hysteresis test follows. Section 5 evaluates the evidence for hysteresis in West German unemployment. The last section concludes.

2 Hysteresis Models

It is useful to discuss the different meanings of hysteresis as special properties of a prototypical model. A model generally describes a variable Y_t through a mathematical relation like $Y_t = f(\mathbf{x}_t)$, where $\mathbf{x}_t \in \mathbf{X} \subset \mathbb{R}^N$ is a vector of N explanatory variables and $f(.)$ is a possibly multivalued function that associates each point in $\mathbf{X}$ with a set of points Y_t. Let's call $\mathbf{x}_t$ the structure and Y_t the equilibrium of the model at time t. The fact that $f(.)$ is multivalued does not mean that the realization y_t of the endogenous variable itself is multivalued. The realization is assumed to be singlevalued, but it cannot be predicted by the structure of the model.

It is now possible to identify different frameworks for the path dependence effect just mentioned. In the first framework, discussed e.g. in Amable et al. (1993), $f(.)$ is multivalued. The model is derived from the origin of the term hysteresis in physics and the mathematical treatment in Krasnosel'skii and Pokrovskii (1989) and Mayergoyz (1991). Here, the realization at time t is determined by the history of the structure of the model. The concept distinguishes weak hysteresis that is observed on a micro level in so called "elementary hysteretic operators", e.g. firms, and strong hysteresis that relates to the behaviour of aggregates of these micro units. The intuition behind weak hysteresis is the following. Assume that the structure is altered at time t such that the range of possible equilibria narrows to a single point $y_t = Y_t \in Y_{t-1}$ that is different from the realization in the period before y_{t-1}. This is called a "loading". In period $t+1$ the structure may revert to its former level in $t-1$, called "unloading", but there is no reason why the equilibrium should switch to its former level. In the examples given for this behaviour there is generally a kind of inertia involved that boils down to the assumption $y_t \in Y_{t+1} \Rightarrow y_{t+1} = y_t$. For an application of this model to trade see Baldwin and Krugman (1989). In this paper I want to concentrate on the other possible framework for hysteresis.

Hysteresis is also an issue in linear models with unit roots (or zero roots in continuous time)[1]. Consider the following univariate example

$$y_t = y_{t-1} + \boldsymbol{\beta}'\mathbf{x}_t + \epsilon_t \tag{1}$$

where ϵ_t is a stationary stochastic process. In the deterministic model with $\epsilon_t = 0\ \forall t$, the focus is on long run equilibria of the type $\bar{Y} = f(\bar{\mathbf{x}})$, where $\bar{\mathbf{x}} = \lim\limits_{t\to\infty} \mathbf{x}_t$ and $\bar{Y} = \lim\limits_{t\to\infty} y_t$. Existence requires $\boldsymbol{\beta}'\bar{\mathbf{x}} = 0$. As Giavazzi and Wyplosz (1985) show for continuous time

[1]The difference from the mechanism described above is emphasized by Amable et al. (1993). They suggest that the use of the term hysteresis for the properties of linear models with unit roots is improper. I follow a large part of the literature here by also using the term for this class of models.

models, the steady state of y_t may be unique, but it depends on the starting conditions and the parameters of the adjustment process. A brief discussion of the discrete case is given by Franz (1990). This behaviour is different to models with all roots inside the unit circle and the reason for the use of the term hysteresis model here. If y_t is not predetermined, i.e. if a starting value is not specified, the steady state is not unique. In the empirical hysteresis literature it is generally the stochastic model that is used, where y_t is a first order integrated process if $\boldsymbol{\beta}'\mathbf{x}_t$ is a stationary process. The difference is that even if the deterministic model has a steady state solution, y_t has a stochastic trend in this model.

The focus of this paper is on the idea that this type of model is the result of neglecting factors that are part of the "true" structure, but which are not considered in the model, e.g. because they are unobservable. The hysteretic behaviour of the dependent variable could then be the result of permanent changes in these variables. If these changes are caused by past shocks to the dependent variable this is called "endogenous structural change" in the survey by Røed (1997). It is *this* property of a statistical model that is called hysteresis in the following.

Røed emphasizes the importance of discriminating between exogenous and endogenous structural changes in this respect. This paper suggests a multivariate test that does exactly this. In the next section it is shown that it is not possible to discriminate between the two types in a univariate setting.

3 The Identification Problem

The paper by Blanchard and Summers (1986)—called BS in the following discussion—analyzes a specific source of hysteresis, namely wage setting by insiders represented by a trade union. When the unemployed loose their status as trade union members, then the number of trade union members at time t depends on employment in $t-1$. BS assume that the trade union sets wages so as to reach a certain employment level that depends on the number of trade union members. This leads to the following equilibrium relation for employment:

$$l_t = (1 - a)l^* + al_{t-1} + \eta_t \tag{2}$$

where l_t is the natural logarithm of employment in period t and l^* is a (constant) target level of employment and η_t is an expectation error. The parameter a determines how much weight the union places on past employment, because of membership effects. This parameter is estimated by BS to determine the degree of persistence in employment. They estimate the parameter from a modified wage equation. For Germany, the results suggest that a is close to one, indicating hysteresis.

It is not clear, however, whether this is really the result of *endogenous* structural change, as suggested by the membership interpretation of BS. Consider e.g. a variation in the assumptions about l^*. While BS relax the assumption of a constant l^* to a deterministic linear time trend[1] to proxy for changes in l^*, they do not treat the case where l^* has a stochastic trend. Assume that $l^* = x_t$ and, for simplicity, $x_t = x_{t-1} + v_t$, where v_t is a stationary stochastic process. Further assume that $a = 0$. In this case the reduced form of the employment equation takes exactly the same form[2] as with the BS assumption and $a = 1$:

$$l_t = l^* + \eta_t = x_t + \eta_t = x_{t-1} + v_t + \eta_t = l_{t-1} + v_t + \eta_t - \eta_{t-1} \tag{3}$$

What seems to be the crucial question is generally not whether employment has a stochastic trend. This can be decided by a simple unit root test. The important thing is the nature of the shocks. Hysteresis means that shocks to employment have persistent effects on future employment. This, however, is not the case when v_t is uncorrelated with the employment shocks η_t and η_{t-1}.

[1]This is extended to a deterministic quadratic time trend in Alogoskoufis and Manning (1988). They show that even this mild variation has profound implications for the results.

[2]It is easy to show that in this case BS would estimate a value of $a = 1$ in their wage equation irrespective of the true value of a in equation 2 (see Reutter, 1999, p.145ff.).

The interpretation of the unit root given by BS boils down to $x_t = l_{t-1}$. The target in each period is employment in the period before, because this is equivalent to union membership in this period. In this case are v_t and η_{t-1} perfectly correlated and we have $l_t = l_{t-1} + \eta_t$ and therefore hysteresis.

Without the important variable x_t it is not possible to discriminate between these possibilities. For an answer to this question we therefore need a complete model of the long run equilibrium as discussed in the next section.

4 Hysteresis and Cointegration

Consider a model where $f(.)$ is a singlevalued function and y_t is predictable by $\mathbf{x}_t$ at every point in time. Endogenous structural change is created by the fact that at least one of the $\mathbf{x}_t$ variables depends on past deviations from the equilibrium. In a linear model this can be written as

$$\begin{aligned} y_t &= \boldsymbol{\beta}'\mathbf{x}_t + u_{1,t} & (4) \\ \boldsymbol{\Phi}(L)\mathbf{x}_t &= \mathbf{v}_t & (5) \end{aligned}$$

where $\boldsymbol{\Phi}(L)$ is a matrix polynomial in the lag operator L of unspecified order and $(u_{1,t}, \mathbf{v}_t')$ is a stationary vector stochastic process with

$$\mathrm{E}(\mathbf{v}_t | u_{1,t-1}, u_{1,t-2}, \ldots) \neq \mathrm{E}(\mathbf{v}_t) \qquad (6)$$

Only if this change in the structure is permanent we have hysteresis. A necessary condition for this to hold is that the marginal process of the $\mathbf{x}_t$ variables producing the hysteresis effect is nonstationary, e.g. a first order integrated process. For simplicity, I assume in the following discussion that all explanatory variables fulfill this condition. Under this assumption, and excluding the possibility of cointegration among these variables, the hysteresis model represents a cointegrated system with a single cointegration vector given by equation (4).

To illustrate the implications of hysteresis in a cointegration framework, it is useful to start with the triangular representation of a cointegrated system used by Phillips (1991):

$$y_t = \boldsymbol{\beta}'\mathbf{x}_t + u_{1,t} \tag{7}$$

$$\Delta\mathbf{x}_t = \mathbf{u}_{2,t} \tag{8}$$

It is assumed that $\mathbf{u}_t' = (u_{1,t}, \mathbf{u}_{2,t}')$ follows an n-dimensional stationary linear process

$$\mathbf{B}(L)\mathbf{u}_t = \boldsymbol{\epsilon}_t \qquad \mathbf{B}(L) = \sum_{j=0}^{\infty} \mathbf{B}_j L^j, \quad \mathbf{B}_0 = \mathbf{I}_n \tag{9}$$

where $\boldsymbol{\epsilon}_t$ is i.i.d. with zero mean and covariance matrix $\boldsymbol{\Sigma}$. The only difference here is that all the autocorrelation in the second equation is moved to the error term and only the unit root is left on the left hand side.

An important point to note is that the model does not necessarily imply hysteresis even if the right hand side variables are nonstationary *and* depend on past equilibrium errors. To show this in more detail, it is necessary to take a look at the structure of the error process. The following decomposition of a matrix lag polynomial will be useful

$$\begin{aligned}\mathbf{C}(L) &= \sum_{i=0}^{n} \mathbf{C}_i L^i \\ &= \sum_{i=0}^{n} \mathbf{C}_i L + (1-L)\mathbf{C}_0 + (1-L)\sum_{i=2}^{n}\left(\sum_{j=i}^{n} -\mathbf{C}_j\right) L^{i-1}\end{aligned}$$

which can be written as

$$\mathbf{C}(L) = \mathbf{C}(1)L + (1-L)\mathbf{C}_0 + (1-L)\mathbf{C}^{+}(L) \tag{10}$$

where $\mathbf{C}_i^{+} = -\sum_{j=i+1}^{n} \mathbf{C}_j$ for $i = 1, \ldots, n-1$. This decomposition is now applied to the polynomial of the error process. First, rewrite (9) to

$$\mathbf{B}_1(L)u_{1,t} + \mathbf{B}_2(L)\mathbf{u}_{2,t} = \begin{pmatrix} \epsilon_{1,t} \\ \boldsymbol{\epsilon}_{2,t} \end{pmatrix} \tag{11}$$

where

$$\mathbf{B}_1(L) = \begin{pmatrix} b_{11}(L) \\ \mathbf{b}_{12}(L) \end{pmatrix} = \begin{pmatrix} 1 \\ \mathbf{0} \end{pmatrix} + \begin{pmatrix} b_{11,1} \\ \mathbf{b}_{12,1} \end{pmatrix} L + \dots \tag{12}$$

$$\mathbf{B}_2(L) = \begin{pmatrix} \mathbf{b}_{21}(L) \\ \mathbf{B}_{22}(L) \end{pmatrix} = \begin{pmatrix} \mathbf{0}' \\ \mathbf{I} \end{pmatrix} + \begin{pmatrix} \mathbf{b}_{21,1} \\ \mathbf{B}_{22,1} \end{pmatrix} L + \dots \tag{13}$$

Using the introduced decomposition leads to

$$\mathbf{B}_1(1)u_{1,t-1} + \begin{pmatrix} 1 \\ \mathbf{0} \end{pmatrix} \Delta u_{1,t} + \mathbf{B}_1^+(L)\Delta u_{1,t} + \mathbf{B}_2(L)\mathbf{u}_{2,t} = \begin{pmatrix} \epsilon_{1,t} \\ \boldsymbol{\epsilon}_{2,t} \end{pmatrix} \tag{14}$$

Solving the last $n-1$ equations for $\mathbf{u}_{2,t}$ leads to

$$\Delta \mathbf{x}_t = -\mathbf{b}_{12}(1)u_{1,t-1} - \mathbf{b}_{12}^+(L)\Delta u_{1,t} - \mathbf{B}_{22}^*(L)\mathbf{u}_{2,t} + \boldsymbol{\epsilon}_{2,t} \tag{15}$$

where $\mathbf{B}_{22}^*(L) = \mathbf{B}_{22}(L) - \mathbf{I}$. It is easily seen that a necessary and sufficient condition to have hysteresis in such a model is $-\mathbf{b}_{12}(1) \neq \mathbf{0}$. Only if this condition is satisfied does a shock in the cointegration relation have a long run impact on the level of the right hand side variables. Substitution from equations (7) and (8) and rearranging leads to:

$$\begin{aligned} \Delta y_t = {} & -b_{11}(1)(y_{t-1} - \boldsymbol{\beta}'\mathbf{x}_{t-1}) + \beta'\Delta\mathbf{x}_t - b_{11}^+(L)\Delta y_t \\ & + b_{11}^+(L)\boldsymbol{\beta}'\Delta\mathbf{x}_t - \mathbf{b}_{21}(L)\Delta\mathbf{x}_t + \epsilon_{1,t} \end{aligned} \tag{16}$$

$$\begin{aligned} \Delta \mathbf{x}_t = {} & -\mathbf{b}_{12}(1)(y_{t-1} - \boldsymbol{\beta}'\mathbf{x}_{t-1}) - \mathbf{b}_{12}^+(L)\Delta y_t \\ & + \mathbf{b}_{12}^+(L)\boldsymbol{\beta}'\Delta\mathbf{x}_t - \mathbf{B}_{22}^*(L)\Delta\mathbf{x}_t + \boldsymbol{\epsilon}_{2,t} \end{aligned} \tag{17}$$

As is well known (Boswijk, 1992; Urbain, 1993; Johansen, 1992), testing for weak exogeneity of a variable in this framework amounts to a test of the significance of the error correction term in the respective reduced form equation. For the $\mathbf{x}_t$ variables this is equivalent to the null hypothesis $-\mathbf{b}_{12}(1) = \mathbf{0}$. As a result, even if the endogenous variable has a unit root and there is feedback from the equilibrium error to the right hand side variables, this does not necessarily imply hysteresis. The key for getting stronger evidence of the presence of hysteresis is the error correction representation of the cointegration model.

Although the analysis so far concentrated on permanent effects of $u_{1,t}$, a definition of hysteresis based on permanent effects of $\epsilon_{1,t}$ would obviously lead to the same condition on the parameters. Since the model allows for contemporary correlation between $\epsilon_{1,t}$ and $\boldsymbol{\epsilon}_{2,t}$, the problem of identification of shocks that is pervasive in the literature on VAR models arises here as well (see Hamilton, 1994, p.318ff, for a discussion). The stationary VAR that is of interest here is given by equation (9). One could argue that the partial impact of $\epsilon_{1,t}$ is not relevant, because the realization of $\epsilon_{1,t}$ contains information on the other error terms. However, I think that in the special framework discussed in this paper it is adequate to define hysteresis with regard to the partial effect of $\epsilon_{1,t}$. If a structural shock were identified by an ordering of the variables, then it might be a reasonable assumption in many conceivable models of a long run equilibrium that the variables determining the equilibrium do only react with delay to disequilibrium errors, because these are generally variables that describe structural features of the economy. This would suggest the following structural form of the VAR

$$\mathbf{\Gamma}(L)\mathbf{u}_t = \tilde{\boldsymbol{\epsilon}}_t \qquad \mathbf{\Gamma}(L) = \sum_{j=0}^{\infty} \mathbf{\Gamma}_j L^j \tag{18}$$

where the structural residuals $\tilde{\boldsymbol{\epsilon}}_t$ are i.i.d. with zero mean and diagonal covariance matrix $\tilde{\mathbf{\Sigma}}$ and

$$\mathbf{\Gamma}_0 = \begin{pmatrix} \gamma_{11} & \boldsymbol{\gamma}'_{21} \\ \mathbf{0} & \mathbf{\Gamma}_{22} \end{pmatrix} \tag{19}$$

If hysteresis were defined by the existence of a permanent impact of the structural residual $\tilde{\epsilon}_{1,t}$, again the same condition for hysteresis would result. Second, from the viewpoint of economic policy, the interesting question generally is whether a temporary change in the employment rate *without* changing the structural variables would induce a permanent reduction in the natural rate. Even if in the past the error terms were correlated, this does not preclude that economic policy can affect employment without changing the structure. And often it is argued that in the political process it is easier to achieve employment effects with demand side policies than through structural reforms. Therefore, hysteresis as defined above seems to be the interesting case.

5 Hysteresis in German Unemployment

In this section I apply the testing procedure to an existing cointegration model of the employment rate in West Germany (see Reutter, 1998, for details). In a nutshell, the model can be written as follows. Consider a right-to-manage model of wage bargaining along the lines of Nickell and Andrews (1983), where the bargain is about the wage only. The capital stock is assumed to be quasi-fixed. The firm is on its labour demand curve $L_t(w_{rt}, \mathbf{q}_t)$, where w_{rt} is real labour costs and $\mathbf{q}_t$ is a vector of other variables influencing labour demand, the so called "productivity variables" (Manning, 1993), like technology, the capital stock and other factor prices. Union utility U_t depends on w_{rt}, the price wedge pw_t—given by the ratio of producer and consumer prices, the tax wedge tw_t—given by the ratio of labour costs and the net wage, the replacement ratio ρ_t, labour demand L_t and labour supply N_t. The utility of the firm U_{ft} is assumed to depend on real capital income $\pi_{rt} = \pi_{rt}(w_{rt}, \mathbf{q}_t)$ and the average tax on capital income t_{pt}. Using the proportional solution of Kalai (1977), the wage is determined by

$$\frac{U_t(w_{rt}, pw_t, tw_t, \rho_t, L_t(w_{rt}, \mathbf{q}_t), N_t)}{U_{ft}((1 - t_{pt}), \pi_{rt}(w_{rt}, \mathbf{q}_t))} = c \qquad (20)$$

where c is a constant—given by the respective weights of the utilities in the solution. The system given by this wage equation and the labour demand relation can be solved for the equilibrium reduced form employment rate equation. As Reutter (1998) shows, the employment rate e_t does not depend on the productivity variables with certain Cobb-Douglas type utilities. This is a reasonable property when modeling the long run behaviour of wages and employment. The important variables in the model are given by $e_t = e_t(pw_t, tw_t, \rho_t, N_t, 1 - t_{pt})$. The replacement ratio is assumed constant in the paper and it is shown that the logarithms of all other variables have a unit root at the zero frequency. Labour supply $\ln N_t$ is not significant in the cointegration relation and the following long run model of the employment rate emerges

$$\ln e_t = \beta_0 + \beta_1 \ln pw_t + \beta_2 \ln tw_t + \beta_3 \ln(1 - t_{pt}) + u_t \tag{21}$$

where u_t is a stationary error term. In this model, hysteresis could only play a role if one of the right hand side variables depended on past equilibrium errors in the way described above. If there were hysteresis because of some other unobserved variable, the absence of cointegration between the variables in the model would be implied. Because this is not the case, the results sharply reduce the number of possible variables that produce a hysteresis effect.

Only the observed variables are candidates in this case. The usual factors that are mentioned in the literature do not play a role here. The variable that is included in the model, and is most likely to depend on past unemployment, is the tax wedge that includes the social insurance contributions. The story behind this effect is quite simple: if a shock leads to a negative deviation of the employment rate from the long run equilibrium, the contribution rates, especially for unemployment insurance, of the workers still employed could increase and this will be important in the wage negotiations where the union will manage to push wages up, and this stabilizes the lower employment rate.

As I use quarterly seasonally unadjusted data, the natural starting point is a seasonal ECM for the series that can be seen as a reduced form of the model in equations (16) and (17), possibly with additional seasonal unit roots[1]:

$$\begin{aligned}\Delta_4 \mathbf{z}_t &= \mathbf{\Pi}_1 \mathbf{w}_{1,t-1} + \mathbf{\Pi}_2 \mathbf{w}_{2,t-1} + \mathbf{\Pi}_3 \mathbf{w}_{3,t-1} + \mathbf{\Pi}_4 \mathbf{w}_{3,t} \\ &\quad + \mathbf{A}_1 \Delta_4 \mathbf{z}_{t-1} + \cdots + \mathbf{A}_p \Delta_4 \mathbf{z}_{t-p} + \bar{\boldsymbol{\epsilon}}_t \end{aligned} \tag{22}$$

where

$$\mathbf{w}_{1,t} = (1 + L + L^2 + L^3)\mathbf{z}_t \tag{23}$$

$$\mathbf{w}_{2,t} = (1 - L + L^2 - L^3)\mathbf{z}_t \tag{24}$$

$$\mathbf{w}_{3,t} = (L - L^3)\mathbf{z}_t \tag{25}$$

and the $\bar{\boldsymbol{\epsilon}}_t$ are n.i.i.d. with mean zero and covariance matrix $\bar{\mathbf{\Sigma}}$. The vector $\mathbf{z}_t$ is given by

$$\mathbf{z}_t = (\ln e_t, \ln pw_t, \ln tw_t, \ln(1 - t_{pt}))' \tag{26}$$

The data are taken from the quarterly national accounts of the DIW and the monthly reports of the German Bundesbank. A more detailed description is given in Reutter (1998). The sample is from 1960:1 to 1993:4 for the unadjusted series. The results of the HEGY test (Hylleberg et al., 1990) and the CH test (Canova and Hansen, 1995) in Reutter (1998) indicated the absence of a seasonal unit root for $\ln e_t$ at frequency $\omega = \pi/2$ and for $\ln(1 - t_{pt})$ at frequency $\omega = \pi$. The tests gave a conflicting result for $\ln pw_t$ at frequency $\omega = \pi/2$. I therefore collected the variables that are likely to have a seasonal unit root at a certain frequency in a separate model and conducted trace tests for seasonal cointegration according to Lee (1992). I consider the hypothesis of cointegration at the frequency π and of contemporaneous cointegration at the frequency $\pi/2$. In the ECM these hypothesis correspond to ranks $r > 0$ of the matrices $\mathbf{\Pi}_2$ and $\mathbf{\Pi}_3$ respectively. The results are given

[1] Seasonal unit roots are a simple way to allow for a changing seasonal pattern. They can be modeled by factors $1 + L$ and $1 + L^2$ in the autoregressive polynomial of the univariate representation of a series. The seasonal unit roots lead to peaks in the spectrum of the process at the frequencies π and $\pi/2$ respectively. For a more detailed discussion see Franses (1996).

Table 1: Trace tests

H_0	$\mathbf{\Pi}_2$	$\mathbf{\Pi}_3$
$(\ln e_t, \ln pw_t, \ln tw_t)$		
r=0	25.71	46.60**
r=1	10.10	17.87
$(\ln pw_t, \ln tw_t, \ln(1-t_{pt}))$		
r=0	19.93	57.41**
r=1	9.76	27.00**

Note: The tests included a constant and seasonal dummies. The critical values for the case $r = 0$ have been simulated using the GAUSS random number generator with 30000 replications of the process $\Delta_4 \mathbf{x}_t = \boldsymbol{\epsilon}_t$ with $\boldsymbol{\epsilon}_t$ i.i.d. $N(0, \mathbf{I})$ and 130 observations. For the case $r = 1$ the critical values are taken from Lee and Siklos (1995). * 10% sig., ** 5% sig.

in table 1.

The tests for cointegration at the seasonal frequencies led to results that were not always in line with the results of the univariate tests. For the first vector considered $(\ln e_t, \ln pw_t, \ln tw_t)'$ the null hypothesis of no seasonal cointegration was not rejected for the frequency $\omega = \pi$. The result at the other frequency is easily explained by the fact that $\ln e_t$ does not have a unit root at this frequency according to the univariate tests. I therefore included $(1-L^2)\ln e_{t-1}$ and $(1-L^2)\ln e_{t-2}$ as regressors in the ECM. The tests moreover indicate the existence of two cointegration vectors for $(\ln pw_t, \ln tw_t, \ln(1-t_{pt}))$ at the frequency $\omega = \pi/2$. However, despite the fact that $\ln(1-t_{pt})$ does not have a unit root at this frequency in the univariate test, the tests did not reject the null hypothesis at the frequency $\omega = \pi$. I decided to follow the univariate results and included $(1-L)(1+L^2)\ln(1-t_{pt-1})$ in the model. Regarding the conflicting results for $\ln pw_t$ in the univariate tests, the existence of seasonal cointegration could partially be due to the fact that $\ln pw_t$ has almost a unit root. Therefore, I simply put $(1-L^2)\ln pw_{t-1}$ and $(1-L^2)\ln pw_{t-2}$ in the regression. This restriction of the cointegration space was confirmed by a separate trace test for the last two variables which have the cointegration vector $\boldsymbol{\gamma}_1 = (-71.01, 15.76)'$ leading to the inclusion of $\boldsymbol{\gamma}_1'(1-L^2)\mathbf{z}_{1t-2} = \boldsymbol{\gamma}_1'(1-L^2)(\ln tw_{t-2}, \ln(1-t_{pt-2}))'$. All the series were adjusted

Table 2: Cointegration vectors

	1 lag	2 lags	3 lags
$(1+L+L^2+L^3)\ln e_t$	1.000	1.000	1.000
$(1+L+L^2+L^3)\ln pw_t$	-0.525^{**}	-0.551^{**}	-0.544^{**}
$(1+L+L^2+L^3)\ln tw_t$	0.443^{**}	0.456^{**}	0.437^{**}
$(1+L+L^2+L^3)\ln(1-t_{pt})$	0.132^{**}	0.115^{**}	0.158^{**}

Note: Maximum likelihood estimation including a constant. * 10% sig., ** 5% sig.

for remaining deterministic seasonality. I want to emphasize that the results presented below are not very sensitive to the exclusion of one or several of these terms and the main conclusions are very robust.

The cointegration vector at the zero frequency γ is estimated by maximum likelihood and the ECM is estimated by OLS. Both estimations included an intercept that is not reported. Considering a maximum length of eight, the SIC criterion suggests using one lag in the estimation. Lag lengths of two and three have the second and third best values respectively. The estimated cointegration vectors are given in table 2. The estimates of the cointegration vector are quite close to the results in Reutter (1998) using the fully modified procedure of Phillips and Hansen (1990). The results for the ECM using one lag are given in table 3. As can be seen, all right hand side variables are weakly exogenous. The results in the model with two and three lags differ only for the price wedge, for which the disequilibrium error is positively significant. With more than three lags the result vanishes again. Taken together, I conclude from the results that the null hypothesis of no hysteresis is not rejected by this model for the tax wedge and the capital income tax. The evidence for hysteresis effects through the price wedge is very weak. This indicates that feedback effects of deviations from the long run equilibrium to the equilibrium itself through contribution rates for unemployment insurance do not exist.

A possible explanation for this result lies in the nature of adjustments to this variable. The contribution rates for unemployment insurance are not changed immediately if the

Table 3: ECM with one lag

	Dependent variable			
	$\Delta_4 \ln e_t$	$\Delta_4 \ln pw_t$	$\Delta_4 \ln tw_t$	$\Delta_4 \ln(1-t_{pt})$
$\boldsymbol{\gamma}'\mathbf{w}_{t-1}$	-0.051^{**}	0.042	-0.018	-0.006
$\Delta_4 \ln e_{t-1}$	0.657^{**}	0.051	-0.080	-1.18^{**}
$\Delta_4 \ln pw_{t-1}$	-0.029	0.474^{**}	-0.080	0.299
$\Delta_4 \ln tw_{t-1}$	0.017	0.016	0.587^{**}	-0.250^{*}
$\Delta_4 \ln(1-t_{pt-1})$	0.000	-0.029	0.134^{**}	0.255^{**}
$(1-L^2)\ln e_{t-1}$	0.217^{**}	0.316^{**}	0.124	0.279
$(1-L^2)\ln e_{t-2}$	0.073	-0.243^{*}	0.030	0.337
$\Delta(1+L^2)\ln(1-t_{pt-1})$	0.003	0.007	-0.018	0.100^{**}
$(1-L^2)\ln pw_{t-1}$	-0.017	0.089^{*}	-0.162^{**}	0.121
$(1-L^2)\ln pw_{t-2}$	0.030^{**}	0.250^{**}	-0.015	0.023
$\boldsymbol{\gamma}_1'(1-L^2)\mathbf{z}_{1t-2}$	0.000	0.000	-0.003^{**}	0.003^{**}

Note: OLS estimation including a constant. * 10% sig., ** 5% sig.

employment rate deviates from the long run level. Cyclical swings in the amount of paid unemployment benefits can be accommodated by the Federal Labour Office by financial support from the government. The federal government in Germany is obliged by law—article 120 of the constitution—to defray any deficits in the budget of the Federal Labour Office. These government contributions have a strong cyclical component and made up a large part of the increase in spending on unemployment insurance after the two oil price shocks (Dornbusch, 1991). It should not be concluded, however, that contribution rates are independent of the employment rate. After all, contribution rates for unemployment insurance have increased from 2% in 1960 to 6.5% in 1993 in Germany and this is clearly related to the trend in the unemployment rate. This indicates that the contribution rate is increased if there are signs of a permanent change in the employment rate which necessitates an increase in average contributions.

6 Conclusions

The model presented here tells quite a different story of German unemployment than a large part of the literature does. The main finding is that the West German unemployment rate in figure 1 fluctuates around an increasing trend. The shocks are temporary and do not feed back to the long run level of the unemployment rate; the trend is caused by exogenous factors that have led to an increase in the long run equilibrium. Because this trend has a stochastic component, the reduced form model for the employment rate has a unit root. The long run equilibrium in this model has the kind of autonomy that is generally seen as a salient feature the natural rate (see Cross, 1995a, for a discussion).

In their discussion of natural rate theory and unemployment in the OECD Phelps and Zoega (1998) question the relevance of hysteresis theories and ask for a proper definition of conditions for hysteresis to arise. The general framework for hysteresis in linear stochastic models presented here suggests to start with a cointegration model for the variable under consideration and then move on to an exogeneity test to test for hysteresis effects. This procedure has the advantage that the possibility of an incorrect hysteresis result due to a missing integrated variable is excluded. Of course this requires that all variables in the cointegration relation are observable which is not always the case. At the very least more caution should be applied when interpreting standard hysteresis tests that are often only necessary conditions and not sufficient ones.

The important message from this paper for economic policy is that any measures that have only a temporary direct effect on unemployment, e.g. because of nominal rigidities, do not lead to a permanent reduction in unemployment through structural changes which shift the natural rate. As a result, Keynesian type demand side policies are unlikely to be appropriate for curing unemployment problems in Germany. Although this seems to be the perception of many economists anyhow (see Profit and Tschernig, 1998), the evidence presented here gives further support for this view as it makes one of the most reasonable arguments in favour of such policies questionable.

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