TESTING FOR HYSTERESIS IN UNEMPLOYMENT

AN UNOBSERVED COMPONENTS APPROACH[1]

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Abstract

We suggest a new test for hysteresis in unemployment based on an unobserved components model. Observed unemployment rates are decomposed into a natural rate component and a cyclical component. The impact of lagged cyclical shocks on the current natural component is the measure of hysteresis. To identify the two components of unemployment, we assume that the cyclical component is correlated with capacity utilization. The model is applied to U.S. and German data. We find no evidence of hysteresis in U.S. data. German unemployment rates exhibit substantial hysteresis. A shock of 1.0 percent to the current cyclical component permanently increases future German natural rates by about 0.5 percent. For both countries, natural rate shocks turn out to be an important impulse mechanism to explain movements in observed unemployment rates.

Zusammenfassung

Wir entwickeln in dieser Arbeit einen neuen Test auf Hysteresis in der Arbeitslosenrate. Die beobachtbare Arbeitslosenrate wird in eine strukturelle Komponente und eine zyklische Komponente zerlegt. Der Effekt von verzögerten zyklischen Schocks auf die gegenwärtige strukturelle Arbeitslosenkomponente definiert ein Maß für Hysteresis. Um die beiden Komponenten identifizieren zu können, wird angenommen, daß die zyklische Arbeitslosen-komponente mit der Kapazitätsauslastung korreliert ist. Das Modell wird für deutsche und amerikanische Daten geschätzt. Wir finden keine Evidenz für Hysteresis in amerikanischen Daten. Die deutsche Arbeitslosenrate weist dagegen starke Hysteresis auf. Ein zyklischer Schock von 1.0 Prozent erhöht die strukturelle Arbeitslosenrate um 0.5 Prozent. In beiden Ländern erklären direkte strukturelle Schocks einen bedeutenden Teil der Variationen in der beobachteten Arbeitslosenrate.

Contents

1 Introduction

Over the last 15 years, high and persistent unemployment has surfaced as the major macroeconomic problem in many European economies (in particular in Germany, France, Italy and the United Kingdom) as well as in Australia and Canada. In contrast, the U.S. has experienced large swings in its unemployment rate with an apparent tendency of observed unemployment to move back toward some relatively stable underlying rate. By way of further contrast, Japan and some European economies, notably Austria, Norway, Sweden, and Switzerland, have enjoyed basically stable unemployment rates over the same time period. Explaining this diversity of experience has put macroeconomic theory to a severe test, and several commentators have already expressed doubt that it has met this challenge adequately (see Blinder 1988).

As a matter of taxonomy, standard theories of unemployment suggest that high observed unemployment can be the result of structural factors that have changed the natural rate of unemployment or of cyclical factors that have temporarily driven unemployment above the natural rate. The relatively low and stable inflation rates of the 1980s are widely interpreted as casting doubt on the possibility that cyclical factors are responsible for high unemployment rates. The pressing question then is: Why have natural rates moved up so sharply in many countries over the last 15 years?

According to one influential view, unemployment increased because the structural determinants of the natural rate changed. Bruno and Sachs (1985) argue that increased "wage gaps" led to upward pressure on the natural rate in many countries during the 1970s. Layard and Nickell (1986) report that part of the increase in British unemployment can be traced to changes in structural factors including unemployment benefits, employment protection laws, and union militancy. Lindbeck (1985) attributes the increase in natural rates to the debilitating effects of increased government intervention. Coe (1989) investigates the Lindbeck-hypothesis for Canada and concludes that the increased generosity of the unemployment insurance system was a major cause for the rise in the natural rate during the 1970s.

The main alternative hypothesis to the structural view is based on the concept of hysteresis in the natural rate. First applied in unambiguous terms to the labor market by Hargreaves Heap (1980), this hypothesis postulates that the natural rate depends on the previous history of unemployment. Three major mechanisms for this history-dependence have been suggested - the erosion of human capital due to unemployment, a shortage of physical capital, and so called "insider-outsider" mechanisms associated with wage determination. Blanchard and Summers (1986) and Gordon (1988) find that the hysteresis hypothesis is well supported for several European countries by empirical evidence from wage-price systems. Some supporting evidence is also reported by Franz (1987) for Germany and Gregory (1986) for Australia. Coe (1987) reports mixed results in a study of wage equations for 12 OECD countries.

In this paper we adopt an unobserved components (UC) approach to test for hysteresis in unemployment. Unobserved components models have been suggested by Watson and Engle (1983) and Harvey and Todd (1983) as flexible instruments for extracting information from observed variables (e.g. the unemployment rate) regarding the properties of unobservable variables (e.g. the natural unemployment rate). Our application of UC models to labor markets is closely related to work by Clark (1989). The basic idea in statistical terms is to disentangle the nonstationary natural rate component and the stationary cyclical component of unemployment by using the information contained in a variable that is correlated with the cyclical component of unemployment. Preferably, the variable used to achieve the decomposition should be stationary to obviate the need to decompose this variable itself into a stationary and nonstationary part. For this reason, we use capacity utilization to identify the decomposition. Other variables such as Gross National

Product could be used for the decomposition. The difficulty with GNP, however, is that it is itself nonstationary and has first to be decomposed into a stationary and nonstationary component. Regardless of the variable used to achieve the decomposition of unemployment into its natural and cyclical components, the measure of hysteresis defined in this paper is given by the impact on the current natural rate of lagged cyclical shocks.

We use the UC approach to provide information on the importance of hysteresis effects relative to structural factors for explaining persistently high unemployment. The UC approach is not a substitute for work that tries to pin down the economic forces behind the movements in the natural rate, but it can provide a clue on where the search for these forces is most likely to be successful.

In the empirical section of the paper we apply the UC model to seasonally adjusted quarterly postwar time series on unemployment rates and capacity utilization from the U.S. and Germany. Our results indicate no evidence in favor of hysteresis for U.S. data. For Germany, the results show that shocks to the cyclical component of unemployment have a substantial long term effect on the natural rate. A shock of 1.0 percent to the current cyclical component permanently increases future German natural rates by about 0.5 percent. For both countries, current shocks to the natural rate turn out to be an important impulse mechanism to explain movements in observed unemployment rates.

Section 2 outlines an operational definition of hysteresis in terms of unobserved components of unemployment. Section 3 discusses the estimation of the UC model. In section 4, we offer a critical appraisal of alternative approaches to testing hysteresis from the viewpoint of the UC approach. Empirical results are presented in section 5, and section 6 concludes.

2 Measuring Hysteresis

Assume unemployment to be the sum of a cyclical ("transitory" or "stationary") component, U_t^C, and a natural ("permanent" or "nonstationary") component, U_t^N,

$$U_t = U_t^N + U_t^C. \tag{1}$$

The cyclical component is assumed to be generated by a stationary process and to follow an autoregressive process of order two with the suitable stationarity conditions imposed on the coefficients ϕ_1 and ϕ_2

$$U_t^C = \phi_1 U_{t-1}^C + \phi_2 U_{t-1}^C + \epsilon_t^C. \tag{2}$$

The assumption of a second order autoregressive representation for the cyclical component can easily be relaxed, but we find that second order processes typically fit well for the unemployment data used in this paper.

The natural rate component is assumed to evolve as

$$U_t^N = U_{t-1}^N + \epsilon_t^N + \theta\epsilon_{t-1}^C, \tag{3}$$

i.e. as a random walk plus the effect of lagged shocks to the cyclical component of unemployment. The coefficient θ

measures in percentage points by how much the natural rate increases in all future periods if the economy experiences a 1.0 percent cyclical shock in unemployment. Our measure of hysteresis is analogous to measures of persistence in GNP (see Campbell and Mankiw 1987).

Permanent and cyclical shocks are assumed to be uncorrelated at all leads and lags. The presence of the cyclical shock lagged once in (3) captures the notion that hysteresis occurs if the natural rate is dependent on the history of cyclical shocks. As a special case, the natural rate component may be constant (variance(ϵ_t^N)=0 and θ=0). By ruling out a drift term in (3), we a priori exclude the possibility that unemployment follows a deterministic trend. A further restriction imposed by (3) is that permanent shocks, ϵ_t^N, increase the current and all future natural rates by exactly the amount of the current shock. It should be kept in mind that these assumptions will give one possible decomposition of unemployment in its permanent and transitory component. Other researchers might prefer different decompositions on an a priori basis (see Quah 1988).

Measuring hysteresis by the effect of once-lagged cyclical shocks on the current natural rate may not capture physical and human capital channels causing hysteresis adequately if there are long time lags involved before human or physical capital decays. In principle, the model could be generalized by including higher lags of the cyclical shock in (3) and by imposing a distributed lag structure on the generalized model (e.g. a Koyck lag structure). The model as adopted in this paper should be able to capture hysteresis effects working through insider-outsider mechanisms in wage bargaining (see Lindbeck and Snower 1986). The insider-outsider hypothesis asserts in its most simplified form that wages are set by bargaining between firms and their employees (the insiders) without regard for the unemployed (the outsiders). The employed wish to ensure to remain employed but have no interest in ensuring the employment of the outsiders. The major implication of the insider-outsider hypothesis is that in response to an adverse shock which reduces employment some of the previous insiders become outsiders and the new, smaller, group of insiders sets the wage to ensure the new lower level of employment. Hence any given cyclical shock to unemployment will at least be partially permanent, raising next period's natural rate.

3 Estimation of the Unobserved Components Model

The discussion of identification of UC models in Watson (1986) shows that the system (1) to (3) is not identified because the cyclical and the permanent component are neither perfectly correlated nor uncorrelated. Additional identifying information bearing either on the cyclical or the permanent component of unemployment has to be brought into the model. We use capacity utilization (CU_t) to pick up the movements in the cyclical component of unemployment. Capacity utilization is assumed to be stationary, an assumption that will be tested below, and to be correlated with the cyclical component in unemployment.

To estimate the model, we write it in state space form. The transition equations are set up as

$$\begin{bmatrix} U_t^N \\ U_t^C \\ U_{t-1}^C \\ F_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 1 & U_{t-1}^N \\ 0 & \phi_1 & \phi_2 & 0 & U_{t-1}^C \\ 0 & 1 & 0 & 0 & U_{t-2}^C \\ 0 & 0 & 0 & 0 & F_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_t^N \\ \epsilon_t^C \\ 0 \\ \theta\epsilon_t^C \end{bmatrix} \qquad (4)$$

Writing out the transition equations (4) in equation form and substitution shows that (4) is equivalent to equations (2) and (3). The measurement equations are given by

$$\begin{bmatrix} U_t \\ CU_t \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & a_0 & a_1 & 0 \end{bmatrix} \begin{bmatrix} U_t^N \\ U_t^C \\ U_{t-1}^C \\ F_t \end{bmatrix} + \begin{bmatrix} 0 \\ v_t \end{bmatrix} \qquad (5)$$

The shock v_t denotes a measurement error in the equation linking capacity utilization and cyclical unemployment. The variance-covariance matrix (Σ) of the three shocks is given by

$$\Sigma = \begin{bmatrix} \sigma_N^2 & 0 & 0 \\ 0 & \sigma_C^2 & 0 \\ 0 & 0 & \sigma_v^2 \end{bmatrix} \qquad (6)$$

We could allow for contemporaneous correlation between the shocks to the natural and the cyclical component but found this type of correlation to be insignificant in our empirical work with U.S. and German data. All shocks are assumed to be uncorrelated over time and normally distributed.

The parameters to be estimated are ϕ_1, ϕ_2, θ, a_0, a_1, σ_N^2 , σ_C^2, and σ_v^2. We use the Kalman filter to calculate the likelihood for observing a sample of observations on unemployment and capacity utilization given a fixed parameter vector. Harvey (1981, chapter 4) is a straightforward guide for setting up the prediction and updating equations of the Kalman filter. The likelihood is maximized by the method of scoring with modified step size suggested in Berndt et. al. (1974). The program used for estimation is written in GAUSS.

4 Alternative Approaches for Testing Hysteresis

The UC approach provides a useful perspective for a critical appraisal of other approaches for testing hysteresis. The UC approach suggests that all tests of hysteresis must at least implicitly disentangle the cyclical and natural component in unemployment by using information in variables that move either with the natural or the cyclical component. From this point of view it follows immediately that the univariate properties of the observed unemployment series, e.g. the persistence of unemployment, can provide no information on the existence of hysteresis effects. High persistence of unemployment can be due either to natural rate shocks or hysteresis effects or both.

Most authors have taken the following stylized approach for testing hysteresis (see the discussion of Franz 1987 by Wyplosz 1987). A Phillips curve is postulated

$$\pi_t = \pi_t^e + \beta(U_t^N - U_t), \qquad (7)$$

where π_t and π_t^e are the actual and expected rates of inflation. Other variables may be included without affecting the argument. The natural rate is assumed to be determined by

$$U_t^N = cU_{t-1} + bZ_t. \tag{8}$$

The vector Z_t contains variables explaining shifts in the natural rate due to "structural factors". The vector of structural factors, Z, may include changes in the composition of the labour force by demographic and skill category (what is commonly referred to as "mismatch") and causes of distortions in the labour market such as unemployment replacement ratios, minimum wages, labour taxes, employment security legislation, and social obstacles to labour mobility. Inserting (8) into (7) gives

$$\pi_t = \pi_t^e - \beta U_t + \beta c U_{t-1} + \beta b Z_t. \tag{9}$$

The hypothesis c=1 is taken to represent the case of a "hysteresis economy". To discuss the properties of this test it is useful to rewrite (9) with the unemployment rate as the dependent variable

$$U_t = cU_{t-1} + bZ_t + (1/\beta)(\pi_t - \pi_t^e). \tag{10}$$

We note the following properties of this alternative test for hysteresis:

First, the hysteresis hypothesis is a point hypothesis. It corresponds to the extreme hypothesis $\theta=1$ in the UC approach. Past shocks to cyclical unemployment are assumed to be fully reflected in the natural rate.

Second, from equation (10) we see that the test c=1 is basically a unit root test. The test does not supply a measure of the economic significance of hysteresis. From the literature on unit roots in GNP we know that the finding of a unit root gives no indication of the economic significance of permanent shocks to GNP (see Campbell and Mankiw 1987).

Third, the statistical distributions of the estimates from the Phillips curve approach are presumably nonstandard. If we assume the unemployment rate to have a unit root and b=0, the test is biased against finding hysteresis since under the null of c=1 the critical values for the resulting test statistic must be taken from Fuller (1976) and not, as is usual practice, from the standard Student-t distribution. Furthermore, if the natural rate is in fact shifted by a vector of presumably nonstationary variables Z_t, i.e. b is different from zero, the relevant distributions of the test statistics of the coefficients c and b might also be nonstandard.

Fourth, the Phillips curve approach works by using "information variables", Z_t, correlated with the natural rate. Failure to specify Z_t correctly, or not at all as in Blanchard and Summers (1986), will lead to finding hysteresis by default if unemployment has a unit root. If Z_t is correctly specified, however, the Phillips curve approach could in principle provide the relevant information for economic policy on what actually moved the natural rate.

5 Empirical Results

The empirical analysis uses seasonally adjusted, quarterly data for the U.S. and Germany. The sample period for the U.S. data is 1954.1 to 1989.1. Data for the unemployment rate are from various issues of the Bureau of Labor Statistics Bulletin. Data on capacity utilization are taken from various issues of the Federal Reserve Bulletin. Figure 1a plots the U.S. unemployment rate and the mean adjusted capacity utilization rate. The unemployment and capacity utilization series for Germany run from 1962.1 to 1989.1. These data are taken from OECD Main Economic Indicators. Because the German capacity utilization series is seasonally unadjusted we have adjusted the series by Census X-11. The German series are plotted in figure 1b. The capacity utilization series refer to the manufacturing sector, and figures 1a and 1b suggest a close inverse relationship between these series and the unemployment rates for both countries.

As a first step, we test two important assumptions concerning the stationarity properties of the variables in the UC model. Unemployment should have a unit root in levels while capacity utilization should be stationary in levels. We test for unit roots using augmented Dickey-Fuller tests.

Starting with regressions including 6 lagged autoregressive terms, lags insignificant at the 5 percent level were eliminated in a stepwise regression procedure starting with the highest lag. Table 1 reports the results with only the significant lags included. The null of a unit root can not be rejected for the unemployment rates even at the 10 percent significance level. Capacity utilization measures are judged stationary at the conventional 5 percent significance level.

We excluded a time trend from the Dickey-Fuller regressions on the assumption that neither unemployment nor capacity utilization is deterministically growing or falling over time. This point is important since other researchers appear to assume the unemployment rate to have a deterministic trend (see e.g. Blanchard and Quah 1988 and Clark 1989). We find the assumption of a deterministic upward or downward trend in unemployment unattractive on an a priori basis.

Table 2 reports estimates of the parameters and test statistics for the UC model. We first discuss the U.S. results.

The point estimate of the hysteresis coefficient θ for the U.S. is 0.11. A likelihood ratio test of the hypothesis that θ=0.0 cannot reject the null even at the 10 percent level. This finding suggests that hysteresis effects in the U.S. unemployment rate are neither economically important nor statistically significant. These results are consistent with conventional wisdom in the sense that they suggest a U.S. natural unemployment rate that is shifted over time by structural factors with large but independent movements of the actual unemployment rate around the natural rate. In figure 2a, we plot the natural rate component of U.S. unemployment derived from smoothed Kalman filter estimates along with the actual unemployment rate. As an aside, we note from figure 2a that by the time the Kennedy-Johnson tax cuts were implemented as a countercyclical measure in February 1964, the actual rate of unemployment was already below the natural rate. By contrast, the Reagan Economic Recovery Tax Act of 1981 introduced tax cuts which took effect in 1982, a time when the actual unemployment rate exceeded the natural rate by more than two percentage points.

The results for Germany suggest a different interpretation. The hysteresis coefficient θ is estimated to be about 0.50, implying that a positive 1 percent shock in cyclical unemployment will increase future natural rates by about 0.50 percent. A likelihood ratio test of $\theta=0.0$ rejects the null at the 5 percent significance level but not at a 1 percent level. We conclude from these results that the evidence in a formal statistical sense is not overwhelming but accepting the point estimate of θ would indicate substantial hysteresis in the German unemployment rate. It is important to note, however, that hysteresis is only a partial explanation for the increase in the German natural rate given the substantial variance of the shocks to the natural rate. Figure 2 plots the natural and actual unemployment rate for Germany.

In both countries, a 1 percent change in cyclical unemployment is associated with a steady state change in capacity utilization of some 4 percent. Judging from the standard deviation of measurement error in the equation linking capacity utilization and cyclical unemployment (σ_v), movements in the U.S. cyclical component appear to be much more closely related to capacity utilization than in the German case.

6 Conclusion

We suggested in this paper a new test for hysteresis in unemployment. The observed unemployment rate is decomposed into a natural rate component and a cyclical component. The impact of lagged cyclical shocks on the current natural component supplies a measure of hysteresis. The empirical results for U.S. and German data provide no evidence for hysteresis in the U.S. unemployment rate but an economically significant hysteresis effect for the German unemployment rate. A shock of 1.0 percent to the current cyclical component permanently increases future German natural rates by about 0.5 percent. For both countries, current shocks to the natural rate turn out to be an important impulse mechanism to explain movements in observed unemployment rates.

Table 1. Augmented Dickey-Fuller (ADF) Tests for Unit Roots[a]

A.) U.S. Data: 1954.1-1989.1

Unemployment Rate

$$\Delta U_t = \underset{(.11)}{.24} - \underset{(.02)}{.04}U_{t-1} + \underset{(.08)}{.78}\Delta U_{t-1} - \underset{(.09)}{.22}\Delta U_{t-2}$$

$R^2 = .46$ ADF = -2.43

Capacity Utilization

$$\Delta CU_t = \underset{(2.89)}{9.22} - \underset{(.04)}{.11}CU_{t-1} + \underset{(.08)}{.59}\Delta CU_{t-1} - \underset{(.10)}{.27}\Delta CU_{t-2} + \underset{(.09)}{.26}\Delta CU_{t-3} - \underset{(.09)}{.17}\Delta CU_{t-4}$$

$R^2 = .34$ ADF = -3.21

B. German Data: 1962.1-1989.1

Unemployment Rate

$$\Delta U_t = \underset{(.03)}{.04} - \underset{(.005)}{.008}U_{t-1} + \underset{(.06)}{.82}\Delta U_{t-1}$$

$R^2 = .64$ ADF = -1.02

Capacity Utilization

$$\Delta CU_t = \underset{(2.86)}{8.75} - \underset{(.03)}{.11}CU_{t-1} + \underset{(.09)}{.19}\Delta CU_{t-1} + \underset{(.09)}{.32}\Delta CU_{t-2}$$

$R^2 = .18$ ADF = -3.07

[a] Standard errors in parentheses below coefficient estimates. Critical values for Augmented Dickey-Fuller test statistic (ADF) from Fuller (1976, p. 373) are -3.51 (1%), -2.89 (5%), and -2.58 (10%).

Table 2. Estimates for Unobserved Components Models[a]

U.S.A. 1954.1 - 1989.1

Log Likelihood 76.32

Parameters	ϕ_1	1.63	(.05)
	ϕ_2	-.72	(.06)
	θ	.11	(.09)
	a_0	-.79	(.06)
	a_1	.36	(.05)
	$\sigma_N = .18$		
	$\sigma_C = .23$		
	$\sigma_v = .004$		

Likelihood Ratio Test (Null: $\theta = 0$) 2.34[b]

Germany 1962.1 - 1989.1

Log Likelihood 82.97

Parameters	ϕ_1	1.78	(.08)
	ϕ_2	-.83	(.07)
	θ	.50	(.30)
	a_0	-1.38	(.26)
	a_1	.93	(.28)
	$\sigma_P = .18$		
	$\sigma_C = .09$		
	$\sigma_v = .03$		

Likelihood Ratio Test (Null $\theta = 0$) 4.29[b]

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a Capacity utilization has been scaled by a factor of 10. Asymptotic standard errors in parentheses.

b Distributed as Chi-Square with 1 degree of freedom under the null. Critical values are 6.63 (1%), 3.84 (5%), and 2.71 (10%).

FIGURE 1a: U.S. UNEMPLOYMENT AND CAPACITY UTILIZATION. 1954.1 - 1989.1

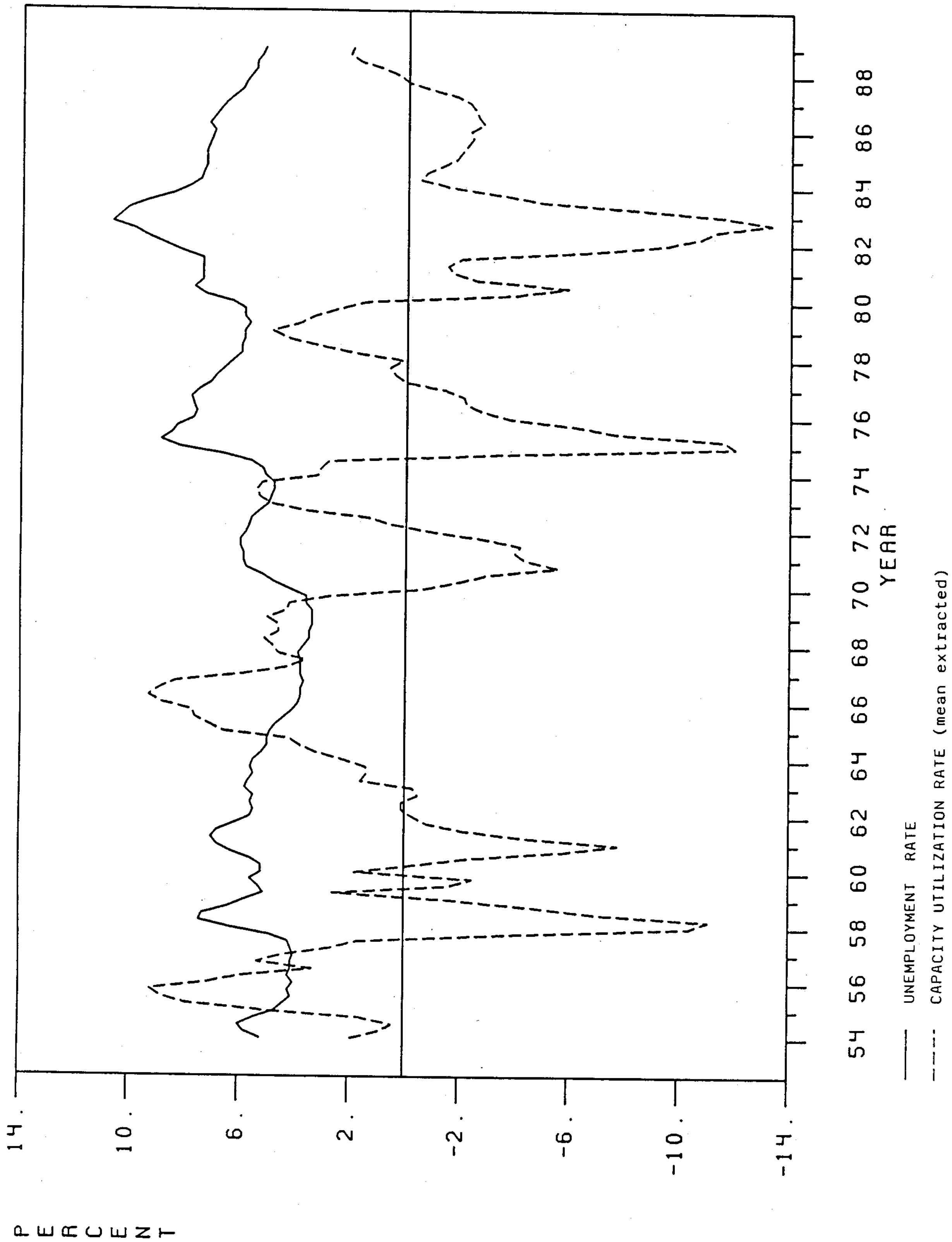


FIGURE 1b: GERMAN UNEMPLOYMENT AND CAPACITY UTILIZATION. 1962.1 - 1981.1

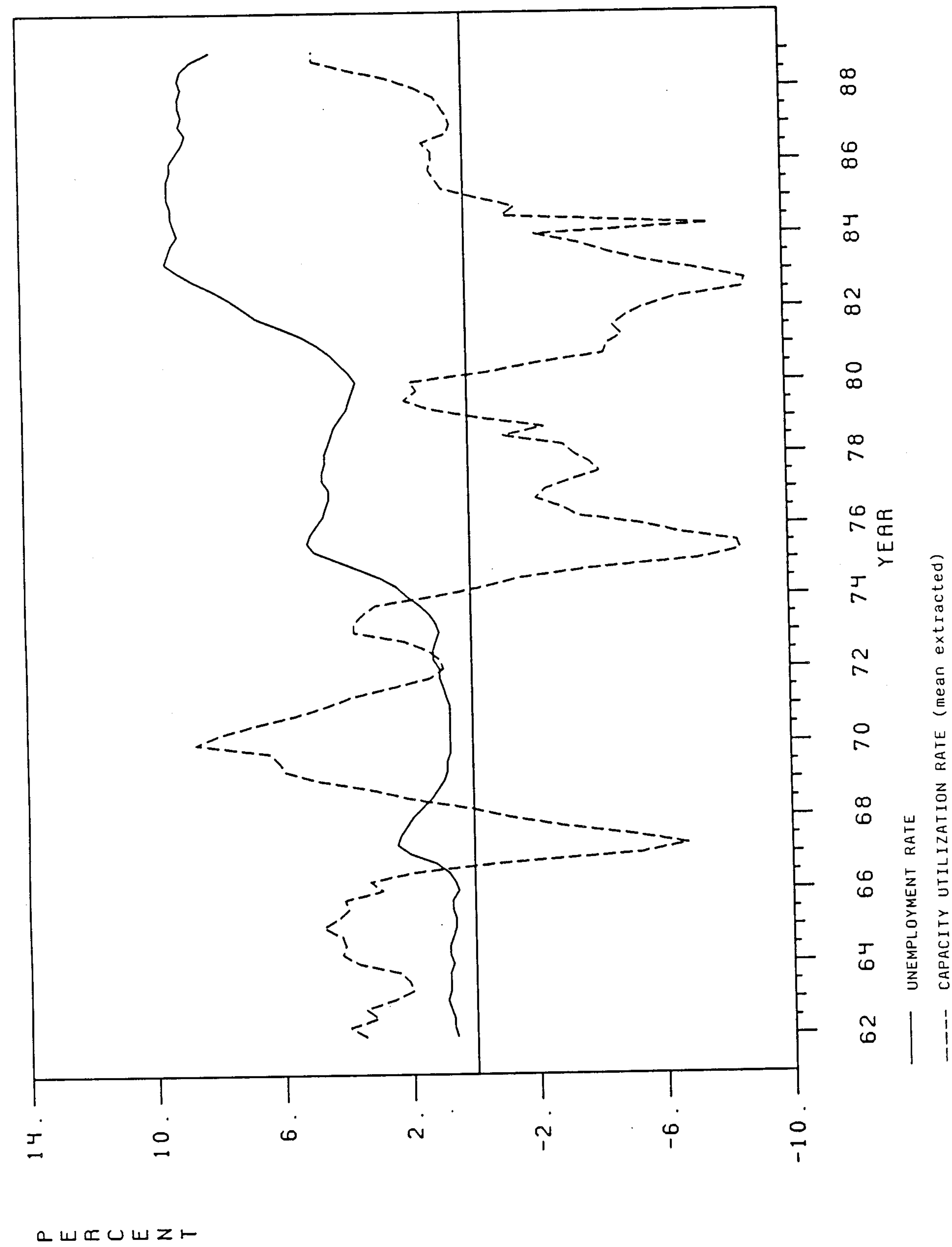


FIGURE 2a: U.S. ACTUAL AND NATURAL UNEMPLOYMENT RATE. 1954.1 - 1989.1

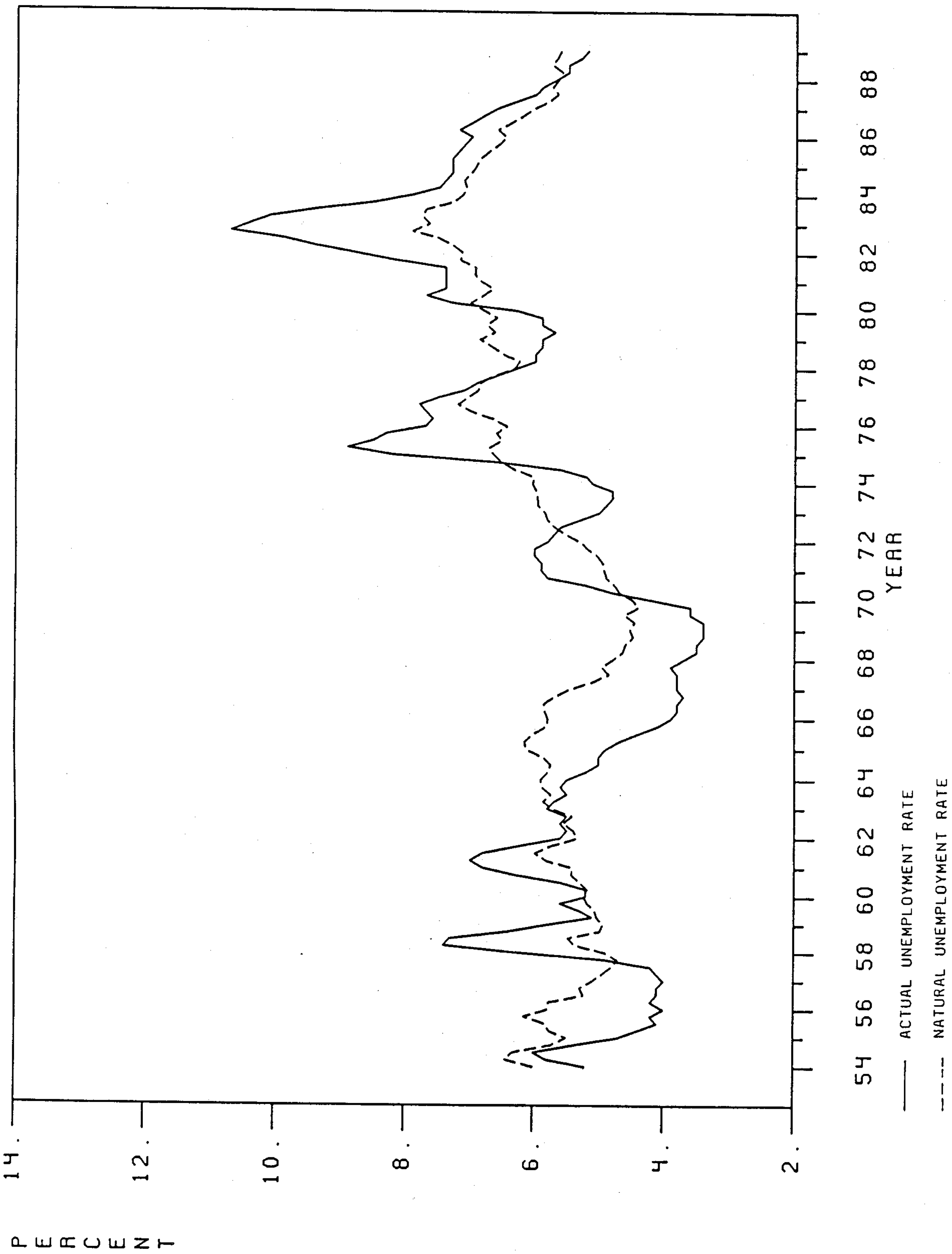
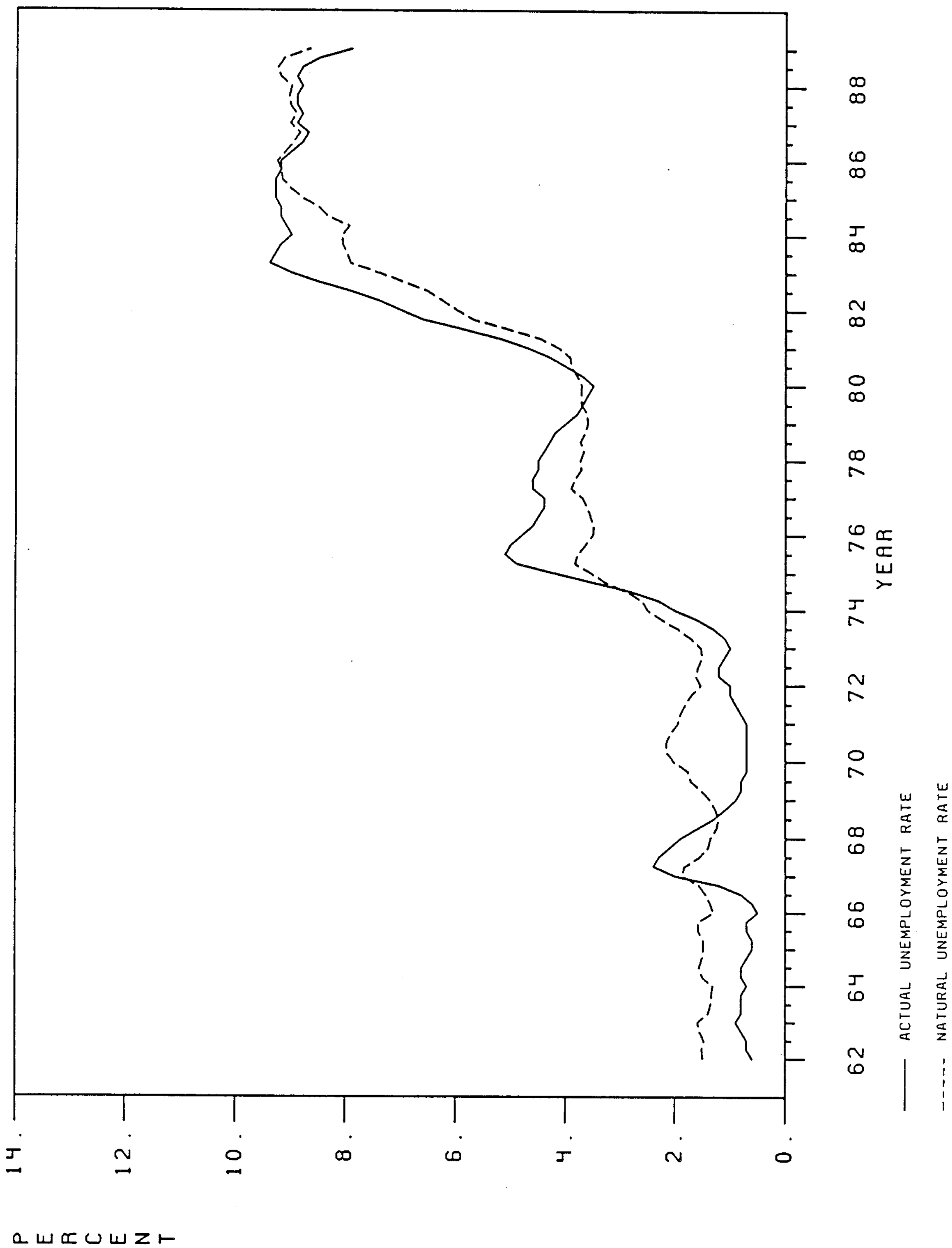


FIGURE 2b: GERMAN ACTUAL AND NATURAL UNEMPLOYMENT RATE. 1962.1 - 1989.1



References

Berndt EK, Hall RE, Hall BH, Hausman J (1974) Estimation and inference in nonlinear structural models. Annals of Economic and Social Measurement 3: 653-66

Blanchard OJ, Quah D (1988) The dynamic effects of aggregate demand and supply disturbances. NBER Working Paper No. 2737

Blanchard OJ, Summers LH (1986) Hysteresis and the European unemployment problem. NBER Macroeconomics Annual 1986, MIT Press

Blinder AS (1988) The challenge of high unemployment. American Economic Review 78:1-15

Bruno M, Sachs JD (1985) Economics of Worldwide Stagflation. Harvard University Press

Campbell JY, Mankiw NG (1987) Are output fluctuations transitory? Quarterly Journal of Economics 102:857-880

Clark PK (1989) Trend reversion in real output and unemployment. Journal of Econometrics, 40:15-32

Coe DT (1988) Hysteresis Effects in Aggregate Wage Equations. In: R Cross (ed.) Unemployment, Hysteresis and the Natural Rate Hypothesis, Basil Blackwell

Coe DT (1989) Structural determinants of the natural rate of unemployment in Canada. IMF Working Paper.

Franz W (1987) Hysteresis, persistence, and the NAIRU: An empirical analysis for the Republic of Germany In: R Layard, L Calmfors (eds.) The Fight Against Unemployment, Centre for European Policy Studies, MIT Press

Fuller WA (1976) Introduction to Statistical Time Series. John Wiley & Sons

Gordon RJ (1988) Back to the future: European unemployment today viewed from America in 1939. Brookings Papers on Economic Activity 19:1271-312

Gregory RG (1986) Wage policy and unemployment in Australia. Economica (Supplement):53-74

Hargreaves Heap SP (1980) Choosing the wrong natural rate, accelerating inflation or decelerating unemployment and growth? Economic Journal 90:611-20

Harvey AC (1981) Time Series Models. Philip Allan

Harvey AC, Todd PHJ (1983) Forecasting economic time series with structural and Box-Jenkins models: A case study. Journal of Business and Economic Statistics, 1:299-315

Layard R, Nickell SJ (1986) Unemployment in Britain. Economica 53 (Supplement):121-170

Lindbeck A (1985) What is wrong with the West European economies? World Economy 8:153-70

Lindbeck A, Snower DJ (1986) Wage setting, unemployment and insider-outsider relations. American Economic Review 76/2: 235-39

Quah D (1988) The relative importance of permanent and transitory components: identification and some theoretical bounds. mimeo, MIT.

Watson MW (1986) Univariate detrending methods with stochastic trends. Journal of Monetary Economics 18:49-76

Watson MW, Engle RE (1983) Alternative algorithms for the estimation of dynamic factor MIMIC, and varying coefficient regression models. Journal of Econometrics, 23: 485-500

Wyplosz C (1987) Comments. In: R Layard, L Calmfors (eds.) The Fight Against Unemployment, Centre for European Policy Studies, MIT Press