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NOMINAL WAGES, THE NAIRU AND WAGE FLEXIBILITY

David T. Coe

CONTENTS

Before joining the Balance of Payments Division, the author was a member of the General Economics Division in the OECD Economics and Statistics Department. The author gratefully acknowledges the help of Francesco Gagliardi, who did most of the econometric work as a Consultant/Trainee in the General Economics Division during 1983 and 1984; Rich Lyons and Marie-Christine Bonnefous also provided expert research assistance. Many helpful and insightful discussions with Gerald Holtham, Head of the General Economics Division, are also acknowledged, as are comments from David Grubb, Peter Jarrett, John Martin and Ulrich Stiehler.

I. INTRODUCTION

The importance of wages in the analysis and forecasting of macroeconomic developments needs no emphasis. Nominal wage inflation is a crucial component of price inflation, while real wages importantly influence the demand for labour and for other factors of production. More generally, the way in which nominal wages are set is an important determinant of whether or not there is any short- or long-run trade-off between inflation and employment. Because labour markets are sensitive in the short run to economic policies which accommodate or do not accommodate inflation, the Phillips curve plays a central role in the dynamic transformation of an economy from an inflationary to a less-inflationary regime, and *vice versa*. In the current situation, where inflation has declined and unemployment remains high, the behaviour of nominal wages will be critical in determining whether there are pressures which might contribute to a resurgence of inflation. This paper analyses the historical determinants of nominal wages in eleven OECD economies and considers the implications for future wage, and hence inflation, developments. This includes the calculation of unemployment rates consistent with stable inflation and the derivation of specific measures of wage flexibility.

Given the importance of nominal wages, there remain a large number of questions about how best to characterise the wage determination process at the macroeconomic level. Section II sets the stage for the analysis which follows by presenting an overview of the estimation results. Section III investigates a number of specification issues: the linearity or non-linearity of the short-run Phillips curve; the temporal dependence of the natural rate of unemployment on the actual rate; the indexation of wages to inflation and the specification of inflation expectations; the existence of "speed limits" to growth; and the role in aggregate wage formation of incomes policies, labour productivity, changes in the terms of trade, taxes, profits and previous shortfalls in real wages below trend. Section III also tests the stability of the preferred equations, thereby addressing the question of possible structural changes which might suggest future wage moderation. Section IV discusses the implications of the preferred equations for short-term inflation prospects and presents calculations of the non-accelerating inflation rate of unemployment – the NAIRU. The concluding Section V summarises cross-country differences in a discussion of specific measures of real and nominal wage flexibility.

II. AN OVERVIEW OF ESTIMATION RESULTS

The Phillips curve is often presented in the literature as a dynamic adjustment process of nominal wages to equilibrium and disequilibrium phenomena [cf. Tobin (1982), Laidler and Parkin (1975) and Santomero and Seater (1978)]. Labour market equilibrium is generally considered to be at the "natural rate of unemployment" which, according to Friedman (1968), is "the level that would be ground out by the Walrasian system of general equilibrium equations ...". Typically, the labour market is not in equilibrium and nominal wage changes will reflect this disequilibrium as well as equilibrium elements such as the steady-state growth of trend productivity and past or expected rates of inflation. In the long run, it is generally assumed that the labour market, like other markets, tends to equilibrium.

The actual process underlying the Phillips curve whereby wages react to the disequilibrium and equilibrium elements is generally not specified. Nominal wages may be determined through atomistic trading in unorganised or dispersed labour markets, some of which might be characterised by implicit contracts; or through a more or less centralised bargaining process between the representatives of labour and employers, and, perhaps, government. In either case, the settlements typically specify the nominal wage but not the real wage and very seldom the level of employment. Resulting changes in unemployment then strengthen or weaken the negotiating position of employers and workers, or their representatives, in subsequent rounds of bargaining.

A general formulation of the short-run Phillips curve, applicable to a variety of institutional arrangements, relates the rate of change of wages *(w)* to a measure of past or expected consumer price inflation *(pe)*, the unemployment rate *(U)* and a vector of other relevant variables *(X)*:

$$w_t = a0 + a1.pe_t - a2.U_t + a3.X_t. \quad [1]$$

The disequilibrium component of equation [1] is represented by the unemployment rate or, in the case of Switzerland, a measure of the employment rate, which serves as a proxy for excess demand in the labour market; the equilibrium component is the constant, which might represent, in part, trend productivity, and the inflation term. Relevant variables included in *X* might be derived from alternative theories of wage determination or represent country-specific influences on nominal wage growth.

Estimates of this basic equation, or a non-linear version of it, are given in Table 1[1]. The dependent variable is the growth of a relatively broadly defined measure of wages and salaries per employee (an appendix gives information on data definitions and sources). The particular specifications of the activity variable and the inflation term anticipate results discussed below. The basic equations, with the exception of Australia, perform well based on the standard criteria, i.e. coefficient

Table 1. **The basic augmented Phillips curve**[a]

	Constant	Unemployment rate			Inflation term[b]	Other[c]	*SEE*	*DW*	$\bar{R}^2$	Estimation period
		U	*log U*	*1/U*						
United States	2.58	−0.33			1.01	0.02	0.24	1.74	0.90	65I-83I
	(0.21)	(0.06)			(0.09)	(0.01)				
Japan	−3.34			9.57	0.93		1.11	1.97	0.90	68I-83I
	(0.75)			(1.23)	(0.11)					
Germany	2.82		−0.96		0.59		1.07	2.02	0.59	64I-83I
	(0.50)		(0.21)		(0.23)					
	0.88		−0.68		0.88	0.68	0.93	2.43	0.69	64I-83I
	(0.77)		(0.20)		(0.23)	(0.21)				
France	2.36	−0.31			0.94	0.11	0.69	1.93	0.85	64II-83I
	(0.29)	(0.08)			(0.14)	(0.04)				
United Kingdom	2.13	−0.17			0.99		1.46	1.72	0.77	65I-83I
	(0.59)	(0.09)			(0.11)					
Italy	5.84	−0.65			0.96		1.99	2.10	0.72	62II-83I
	(1.14)	(0.23)			(0.14)					
Canada	5.29	−0.57			0.92		0.95	2.10	0.77	61I-83I
	(0.80)	(0.10)			(0.10)					
Australia	4.78	−0.48			0.66		2.46	1.88	0.44	69II-83I
	(1.76)	(0.25)			(0.43)					
Austria	2.52		−2.27		0.97		1.13	1.95	0.67	70II-83I
	(1.21)		(0.64)		(0.33)					
Netherlands	4.92		−2.24		0.94		1.17	2.03	0.63	69I-82II
	(1.15)		(0.40)		(0.27)					
Switzerland[d]	−33.07	0.34			0.99	−0.49	0.99	2.05	0.66	65II-83I
	(11.64)	(0.12)			(0.14)	(0.15)				
	−29.10	0.30			1.04	0.23 −0.51	0.92	2.17	0.71	65II-83I
	(10.88)	(0.11)			(0.14)	(0.09) (0.14)				

a) The dependent variable is the growth of the wage rate as defined in the data appendix. All equations are estimated by two-stage least squares on seasonally-adjusted semi-annual data, per cent changes refer to semi-annual changes. The standard error of the estimate *(SEE)*, the Durbin-Watson statistic *(DW)* and the adjusted proportion of explained variation ($\bar{R}^2$) are calculated using the actual values of the independent variables; $\bar{R}^2$ is based on the error sum of squares. Standard errors appear in parentheses below the coefficient estimates. Except for the Netherlands, all equations include dummy variables which are reported in Table 7.

b) Specified as current inflation (based on the personal consumption deflator) for Japan and Italy; a two-semester moving average for Germany, France, Austria, Australia, the Netherlands and Switzerland; a three-semester moving average for the United Kingdom and Canada; separate two- and eight-semester moving averages [respective coefficients of 0.26 (standard error of 0.08) and 0.75 (0.15)] for the United States.

c) The equations for the U.S. and France include the growth of the minimum wage. The second equation for Germany includes a two-semester moving average of the rate of growth of productivity. Both equations for Switzerland include the difference between the growth of the private consumption deflator and the growth of the GDP deflator; the second equation for Switzerland also includes the growth of productivity.

d) As discussed in the text, the activity variable for Switzerland is a measure of the employment rate defined as total employment divided by a lagged two-period moving average of the labour force, multiplied by 100.

estimates are well determined, correctly signed and explain a large part of the variance in wage inflation. The estimates are based on semi-annual observations, usually from about the mid-1960s to the early 1980s. Given the simultaneous determination of wages and prices, all equations are estimated by two-stage least squares with a lagged value of the inflation term, the current and lagged growth of the money stock and all other independent variables used as instruments.

With regard to equation selection criteria, the most important is that it include explicitly an activity variable and an inflation variable and be consistent, insofar as possible, with known institutional aspects of the relevant country. For most of the hypotheses tested, theory provides little, if any, *a priori* guidance beyond the expected direction of causality. In these cases, consistency with the data as revealed by the standard tests for significance becomes an important additional criteria. Where the data do not provide strong evidence to either support or reject a hypothesis, Occam's razor is appealed to and the simplest and most straightforward hypothesis is accepted. Given the number of alternative specifications and the fact that they are neither independent nor mutually exclusive, a nested hypothesis approach to testing, proceeding from the most general to the particular, is not feasible.

III. THE DETERMINANTS OF NOMINAL WAGE GROWTH

A. The activity variable

For most countries, the unemployment rate is likely to be an appropriate proxy for excess demand in the labour market[2]. Switzerland is unusual in this respect because a large part of the flows into and out of employment are across the national frontier. That is, changes in the labour force, due to changes in net immigration, tend to reflect changes in employment, leaving the unemployment rate relatively constant at a very low level. For this reason, the activity variable which has been used in the Swiss wage equation is the ratio of total employment to a lagged two-period moving average of the labour force, multiplied by 100[3]. The estimated coefficient on this measure of the employment rate, but with the opposite sign, is directly analogous to the estimated coefficients on the unemployment rate in the other equations reported in Table 1.

1. *The linearity or non-linearity of the Phillips curve*

Labour demand is, by definition, employment plus vacancies and labour supply is employment plus unemployment. Thus proportional excess demand in the labour market is measured by the vacancy rate minus the unemployment rate. Vacancy data exist for only a few countries but it has been shown that the vacancy and unemployment rates are related in a hyperbolic fashion, i.e. the vacancy rate *(V)* can be expressed as a function of the inverse of the unemployment rate (i.e. $V = a22/U$) [cf. Santomero and Seater (1978), pp. 505-6].

On this interpretation, the activity term in equation [1] $(-a2.U)$ would be modified to include both the level and the inverse of the unemployment rate $(-a21.U + a22/U)$. In terms of the shape of the Phillips curve, the inverse term would dominate at low rates of unemployment (*w* going to infinity as *U* goes to zero), whereas the level term would dominate at high rates of unemployment (the slope going to $-a21$ as *U* gets large). The estimation results, however, always failed to support such a combined specification.

Most empirical estimates of the Phillips curve prior to the 1980s specified only the inverse of the unemployment rate, suggesting decreasing returns to unemployment as an instrument of anti-inflation policy. In a survey of empirical studies in 1978, Santomero and Seater (p. 506) report "that the weight of the evidence lies with a significant non-linear relation [between wage inflation and the unemployment rate]". But this evidence was based on estimation periods during which the unemployment rate was relatively stable so the difference between a level and an inverse specification was not great. Since 1980, however, unemployment rates have risen to post-war highs in many countries and wage inflation has fallen sharply. At a minimum, these developments appear to cast doubt on any *a priori* presumption of a non-linear Phillips curve.

At high rates of unemployment, the implications for wage developments are very different on the flat, far right part of a non-linear Phillips curve compared to a linear Phillips curve. This is shown in Table 2 where the change in wage inflation given by a 1 percentage point increase in the unemployment rate is computed, assuming average coefficients (from Table 3), under each of three alternative linearity specifications: *i)* a linear specification as in equation [1], implying that a given change in *U* has the same impact regardless of the level of *U*; *ii)* a non-linear

Table 2. **Implications of alternative linearity specifications**

	Linear	*Non-linear*	
U	*w = −0.5 U + ...* *dw/dU = −0.5* *dw/dU*	*w = −2 log U + ...* *dw/dU = −2/U* *dw/dU*	*w = 7/U + ...* $dw/dU = -7/U^2$ *dw/dU*
15	−0.5	−0.13	−0.03
10	−0.5	−0.20	−0.07
7	−0.5	−0.29	−0.14
4	−0.5	−0.50	−0.40
2	−0.5	−1.00	−1.75
1	−0.5	−2.00	−7.00

specification of the inverse of U; and *iii)* a non-linear specification intermediate between *i)* and *ii)* of the log of the unemployment rate implying that a given percentage increase (not percentage point increase) has the same impact regardless of the level of U. At unemployment rates around 10 per cent, not uncommon by recent standards, the reciprocal specification shows almost no reduction in wage inflation resulting from a 1 percentage point increase in the unemployment rate. Thus this specification, and to a lesser extent the logarithmic specification, has strong implications for wage inflation when unemployment rates move beyond the range experienced in the estimation period.

Table 3 presents equations comparable to those in Table 1 but estimated with the alternative specifications of the unemployment rate. Also reported in Table 3 are the equation errors from 1980I, a period when the unemployment rate increased to levels outside the pre-1980 range. For the United States, France, Canada and especially the United Kingdom, the linear specification dominates when judged on the standard criteria as well as equation performance since 1980. For Italy and Australia there is little to choose between the alternatives. The logarithm of the unemployment rate works better for Germany. A non-linear specification is also preferred for Japan, Austria and the Netherlands. Given the historical stability of unemployment rates in Japan, the reciprocal specification has been chosen, although not clearly superior on statistical grounds. For the same reason, the alternative non-linear specifications of the employment rate in the Swiss equation, which are not reported, gave virtually identical results to the linear specification[4].

2. *Dynamic specification of the unemployment rate*

The early literature often reported counter-clockwise loops around estimated Phillips curves [cf. Santomero and Seater (1978), pp. 503-4, 508]. This can be allowed for by including the change in the unemployment rate as an additional argument in the basic equation. The expected coefficient would be negative implying that a decline in the unemployment rate would result in an overshoot of wages and hence counter-clockwise loops. This might represent a type of "speed limit" on changes in the unemployment rate. A specification with the change in the unemployment rate as the only activity variable would mean that there is no link between wage inflation and the level of excess demand in the labour market. When changes in the unemployment rate were entered as an additional argument in the basic equation (both linear and non-linear versions), however, they were never significantly different from zero in any country, and were often incorrectly signed.

Given the existence in some countries of long-term contracts, either explicit or implicit, past values of the activity variable should, in principle, have an impact on current wage developments. The unemployment rate, however, is generally

Table 3. **Linear and non-linear Phillips curves**[a]

	Speci-fication[b]	Estimated coefficient	Standard error	DW	$\bar{R}^2$	Equation error (actual minus predicted) 80I	80II	81I	81II	82I	82II	83I	Ave-rage	RMSE
United States	*U*	−0.33	0.06	1.74	0.90	−0.06	0.32	0.04	−0.26	−0.15	−0.05	−0.37	−0.08	0.22
	Log U	−1.95	0.41	1.48	0.89	−0.04	0.32	0.04	−0.25	−0.25	−0.29	−0.48	−0.14	0.28
	1/U	8.28	2.12	1.22	0.86	−0.02	0.30	0.07	−0.19	−0.31	−0.49	−0.61	−0.18	0.35
Japan	*U*	−3.88	0.49	1.84	0.90	−2.05	−0.93	−0.70	−0.04	−0.03	1.72	1.37	−0.09	1.22
	Log U	−6.24	0.76	1.94	0.90	−1.92	−0.92	−0.77	−0.04	−0.15	1.48	1.26	−0.15	1.13
	1/U	9.57	1.23	1.97	0.89	−1.83	−0.95	−0.86	−0.07	−0.26	1.28	1.16	−0.22	1.07
Germany[c]	*U*	−0.28	0.08	2.44	0.68	0.06	0.41	−0.84	0.09	−1.07	0.24	0.76	−0.05	0.62
	Log U	−0.68	0.20	2.43	0.69	0.23	0.50	−0.83	0.01	−1.30	−0.17	0.24	−0.19	0.63
	1/U	0.92	0.29	1.93	0.68	0.28	0.54	−0.86	−0.18	−1.56	−0.54	−0.17	−0.35	0.75
	Log(U/U)*	−1.14	0.36	2.31	0.66	−0.52	0.07	−1.17	−0.52	−1.75	−0.59	−0.33	−0.69	0.88
France	*U*	−0.31	0.08	1.93	0.85	−0.10	−0.10	−0.02	0.00	0.17	−1.58	1.12	−0.08	0.74
	Log U	−1.12	0.40	1.71	0.82	−0.10	−0.13	−0.16	−0.32	−0.17	−1.94	0.71	−0.30	0.80
	1/U	1.43	1.43	1.42	0.78	0.00	−0.01	−0.27	−0.62	−0.42	−2.53	0.06	−0.54	0.99
United Kingdom	*U*	−0.17	0.09	1.72	0.77	−0.01	−1.59	−3.53	0.54	−0.37	−1.19	1.65	−0.64	1.67
	Log U	−0.46	0.46	1.61	0.75	0.06	−1.68	−3.83	−0.07	−0.91	−1.83	0.95	−1.02	1.80
	1/U	−0.22	1.10	1.52	0.74	0.09	−1.78	−4.18	−0.41	−1.46	−2.50	0.21	−1.43	2.04
	*U-U**	−0.42	0.18	1.82	0.79	−0.45	−1.59	−3.23	0.95	−0.09	−0.98	1.59	−0.54	1.58
Italy	*U*	−0.65	0.23	2.10	0.72	0.77	−2.75	−0.15	5.35	1.32	−2.47	−0.33	0.25	2.53
	Log U	−3.28	1.08	2.13	0.73	0.85	−2.72	−0.22	5.08	0.93	−2.79	−0.96	0.02	2.49
	1/U	13.18	4.29	2.13	0.73	0.91	−2.74	−0.29	4.79	0.55	−3.11	−1.47	−0.20	2.49
Canada	*U*	−0.57	0.10	2.11	0.77	−1.03	−1.10	−0.12	0.68	1.00	−1.05	−0.16	−0.25	0.83
	Log U	−3.49	0.73	1.88	0.73	−0.89	−0.90	0.12	0.85	0.86	−1.92	−1.12	−0.43	1.07
	1/U	15.81	4.60	1.67	0.67	−0.85	−0.76	0.30	0.92	0.59	−2.74	−2.04	−0.65	1.42
Australia	*U*	−0.48	0.25	1.88	0.44	−0.37	1.53	1.80	0.53	4.49	2.98	−2.48	1.21	2.43
	Log U	−1.81	1.06	1.90	0.43	−0.34	1.59	1.95	0.62	4.47	2.61	−3.39	1.07	2.54
	1/U	5.29	3.78	1.90	0.41	−0.41	1.53	1.94	0.57	4.35	2.28	−4.00	0.89	2.59
	*U-U**	−1.78	0.49	2.16	0.59	−2.02	−0.49	−0.94	−1.81	2.68	2.82	−0.16	0.01	1.84

Austria	*U*	–0.95	0.32	1.74	0.62	–1.01	–0.83	0.27	–1.74	–0.62	0.22	1.51	–0.31	1.03
	Log U	–2.27	0.64	1.95	0.67	–0.89	–0.66	0.47	–1.57	–0.51	0.14	1.29	–0.25	0.91
	1/U	4.38	1.15	2.05	0.68	–0.73	–0.50	0.59	–1.53	–0.57	–0.13	0.91	–0.28	0.81
Netherlands	*U*	–0.41	0.09	1.66	0.55	–1.20	–2.31	–2.60	2.22	0.87	1.40		–0.27	1.88
	Log U	–2.24	0.40	2.03	0.63	–0.84	–2.04	–2.43	2.12	0.45	0.81		–0.32	1.64
	1/U	8.17	1.49	2.04	0.61	–0.66	–2.07	–2.62	1.68	–0.19	0.11		–0.63	1.55
Switzerland[d]	*EA*	0.30	0.11	2.17	0.71	–0.67	–0.45	–0.48	–0.90	0.14	–0.17	0.12	–0.34	0.50

a) Except for the Netherlands, all equations include dummy variables as reported in Table 7. The specification of the unreported inflation term is given in Table 1, note *b*.

b) As discussed below, U^* is a proxy for the natural rate of unemployment and is defined as a four-year moving average of the unemployment rate (see Table 4).

c) All equations include a two-semester moving average of the growth of productivity.

d) *EA* is the adjusted employment rate defined in Table 1, note d; the alternative linearity specifications gave virtually identical results and are not reported. The equation includes the growth of productivity and the difference between the growth of consumer prices and domestic output prices.

considered to be a lagging indicator of labour market conditions due to the hiring and firing practises of firms as reflected in the pro-cyclical movement of productivity. Thus the most common specification involves only contemporaneous values of the unemployment rate. When short (less than two year) lag distributions of the unemployment rate were included in the basic equation, the results were inferior to a specification of just the contemporaneous level of the unemployment rate. Testing for a more long-lived impact of unemployment on wages is discussed below in the context of testing the hypothesis of hysteresis in the natural rate. It should be noted that Phillips curves estimated with a lagged dependent variable impose the identical lag distribution on the unemployment rate as on the inflation term. This constraint may be inappropriate for countries such as the United States, where institutional features such as overlapping three-year contracts in the unionised sector suggest long lags on the inflation term.

3. *Hysteresis in the natural rate*

As noted in the introduction, the labour market is in equilibrium at the natural rate of unemployment. If estimates of the natural rate (denoted U^*) are available, they can be explicitly incorporated into the Phillips curve by estimating,

$$w_t = a0 + a1.pe_t - a21(U - U^*)_t + a3.X_t, \qquad [2]$$

or the comparable non-linear version [cf. Robertson and McDougall (1980)]. If U^* is constant over the estimation period, estimating the above equation will be econometrically equivalent to estimating equation [1] where just the level of U appears since the estimated constant will incorporate the impact from the natural rate ($a21.U^*$). The constant thus plays an important role in equations with only the actual rate of unemployment.

But estimates of the natural rate, which will not in general be constant, are rarely available. Most estimates of the non-accelerating inflation rate of unemployment (the NAIRU) reported in the literature, and those reported in Table 8, tend to follow developments in actual unemployment rates. As noted in Section IV.B, this may be a consequence of the calculation methods. Another possibility is a causal relationship running from actual and past unemployment rates to the natural rate. One hypothesis is that unemployment destroys human capital, undermines the work ethic and, if accompanied by low investment, reduces the stock of capital. If this hypothesis were true, the natural rate would have the property of hysteresis, i.e. the equilibrium natural rate would not be invariant to the adjustment path towards equilibrium [cf. Heap (1980) and Buiter and Gersovitz (1981)].

This hypothesis of hysteresis in the natural rate is inconsistent with the accelerationist implication of the conventional natural rate hypothesis, and has quite radical implications. The policy implication for unemployment is straightforward: one way to reduce the natural rate is to reduce unemployment [cf. Heap (1980) and

Solow (1985)]. The implication for anti-inflation policy is that, if the other structural factors affecting the natural rate are unchanged, then the disinflationary (inflationary) impact of a given gap between the actual and the natural rate of unemployment will disappear over time as the natural rate catches up with the actual rate. This possibility would appear to be consistent with European experience since the late 1970s and projections to the late 1980s: the sharp rise in unemployment between 1980 and 1984 to rates far higher than most estimates of the natural rate was accompanied by an impressive deceleration of inflation; yet although unemployment rates are generally projected to level off or increase somewhat more over the period 1985 to 1988, inflation is expected to remain relatively stable implying little difference between the actual and the natural rates. There are few recent changes in structural factors that would explain such a dramatic rise in the natural rate.

The simplest test of the hysteresis hypothesis is to define U^* as a distributed lag on past values of U in the estimation of equation [2]. This also tests for a long-lived impact of unemployment rates on wage inflation if the constraint in equation [2] that U and U^* have the same but opposite-signed coefficient is dropped. The estimated equation in linear form is:

$$w_t = a0 + a1.pe_t - a22.U_t \mp a23.U^*_t + a3.X_t. \quad [3]$$

A significant positive estimated coefficient on U^* of roughly the same size as $a22$ would be evidence of hysteresis in the natural rate[5]; whereas a significant negative estimated coefficient on U^* would be evidence of lagged responses to the unemployment rate. Estimates of equation [3], using either a four- or an eight-year moving average of the unemployment rate, indicate that there is some evidence of a long-lived impact of unemployment in the United States, Japan and Canada where the estimated coefficient on U^* was negative but never statistically different from zero. For North America these very weak results would be consistent with the relatively long-term contracts compared to the other countries. For France, Italy, Austria, the Netherlands and Switzerland, both of the estimated coefficients $a22$ and $a23$ in equation [3] were either insignificantly different from zero and/or perversely signed, suggesting multi-collinearity between U and U^*. Estimates of equation [3] for Germany, the United Kingdom and Australia gave the following coefficient estimates (standard errors in parentheses):

	$a22$	$a23$
Germany	– 1.41 (0.39)	0.61 (0.44)
United Kingdom	– 0.52 (0.26)	0.63 (0.45)
Australia	– 1.76 (0.49)	1.61 (0.58)

Table 4. **The Phillips curve with the natural rate** *(U^*)* **specified as a moving average**[a]

	Constant	Unemployment rate[b]			Inflation term	*SEE*	*DW*	$\bar{R}^2$	Estimation period
		*U-U**	*Log (U/U*)*	*1/U-1/U**					
Japan	2.25 (0.69)			10.56 (3.03)	1.28 (0.16)	1.77	1.19	0.72	68I-83I
Germany[c]	0.44 (4.40)		−1.14 (0.36)		1.03 (0.23)	0.95	2.31	0.66	64I-83I
United Kingdom	1.80 (0.53)	−0.42 (0.18)			1.00 (0.10)	1.42	1.82	0.79	65I-83I
Canada	2.42 (0.69)	−0.50 (0.15)			0.71 (0.16)	1.14	1.50	0.67	61I-83I
Australia	2.94 (1.55)	−1.78 (0.49)			0.90 (0.35)	2.09	2.16	0.59	69II-83I
Austria[d]	1.52 (1.11)		−4.08 (2.30)		1.09 (0.34)	1.14	1.83	0.66	71I-83I

a) See notes *a* and *b* to Table 1.
b) U^* is defined as a four-year moving average of lagged unemployment rates, except for Japan which is an eight-year moving average.
c) Includes a two-semester moving average of the growth of productivity with an estimated coefficient of 0.68 (standard error of 0.21).
d) The estimation period is one semester shorter than that reported in Table 1 due to data availability.

Table 4 reports estimates of equation [2] (where the restriction $a23 = -a22$, the hysteresis hypothesis, is imposed) for a number of countries. In the case of Australia the improvement relative to the equation with just the unemployment rate is dramatic. As well as improving the explanatory power of the equation, the coefficient estimates on both the activity variable and the inflation term become significantly different from zero, and the coefficient on the inflation term corresponds more closely to *a priori* beliefs. For the United Kingdom, there is a marginal improvement in the equation and the recent equation errors reported in Table 3 are reduced somewhat. For the other countries, incorporating a natural rate specified in this way makes little difference to the estimation results and hence the more straightforward specification of equation [1] is maintained. Thus the hypothesis of hysteresis in the natural rate appears to be strongly supported by the data for Australia and, to a lesser extent, the United Kingdom; for Japan, Germany, Canada and Austria, the hypothesis does not appear to be inconsistent with the data[6].

B. The inflation variable

1. *Should real or nominal wages be the dependent variable?*

Formal or informal indexation of wages to present or past inflation is a feature of virtually all developed economies [cf. Braun (1976) and Sachs (1979)]. But the form that indexation takes varies widely among countries and also among industries within the same country depending upon, among other things, the degree of unionisation and the rate of inflation. Even when there is explicit indexation, however, it rarely provides for 100 per cent indexation of wages to prices. Formal contractual indexation is also incomplete in a number of other dimensions: it generally only applies to a portion of the labour force; it usually only applies to a part of the total wage bill, often excluding fringe benefits and overtime, for example; it is not continuous but lags actual price movements; and it is often based on price indices more narrowly defined than aggregate measures of inflation. Informal indexation, which can be expected to share many of the above characteristics and may result, for example, from implicit contracts embodying a commitment to the maintenance of real or relative wages, may also be important in countries where the labour force is not highly organised.

These institutional characteristics of the wage determination process suggest that a unitary coefficient on current inflation should not be imposed. On *a priori* grounds, the unit coefficient would apply to expected inflation or some distributed lag of past inflation rates, since it seems unlikely that the growth of real wages would change indefinitely in response to changes in inflation unless "real" variables, such as the terms of trade, were altering. But even here, the unit coefficient might best be considered an *a priori* guide to the expected size of the estimated coefficient – not significantly different from unity – rather than a precise value to be imposed in all cases. This is especially true for the relationship between an aggregate measure of earnings, such as national accounts wages per employee, and an aggregate measure of inflation, such as growth of the implicit price deflator for consumer expenditures.

As can be seen in Table 1, the freely estimated *a1* coefficients range from about 0.9 to 1.0 and are never significantly different from unity. In the equations for Germany without productivity growth and for Australia, the estimates are about 0.6. As shown in the second German equation in Table 1, the inclusion of productivity growth raises the inflation coefficient to near unity. When the natural rate of unemployment is specified as a moving average as in Table 4, the inflation coefficient in the Australian equation increases to 0.9 and becomes significantly different from zero.

2. *Expected or past inflation*

The existence of indexation and the fact that it is an *ex post* adjustment of wages to changes in prices, suggests that past inflation, rather than expected inflation, is the more relevant concept for determining wages in anything other than an accelerating hyperinflation. Microeconomic studies of wage formation often stress the importance of relative wages which also indicates a backward-looking adjustment of wages to prices. Commonly, expectations are assumed to be

Table 5. **Alternative specifications of inflation expectations** *(pe)*[a]

	Constant	Unemployment rate			Expected inflation	Past[b] inflation	*SEE*	*DW*	$\bar{R}^2$	Estimation period
		U	*Log U*	*1/U*						
A. *pe* as the forecast from a reduced-form inflation equation										
United States	1.22 (0.25)	0.11 (0.04)			0.48 (0.06)		0.38	0.82	0.76	65I-82II
	2.42 (0.23)	−0.31 (0.06)			0.18 (0.06)	0.84 (0.12)	0.23	1.70	0.90	65I-82II
Japan	−2.74 (1.32)			8.00 (2.86)	1.01 (0.17)		1.28	1.30	0.88	71I-81I
	−4.11 (0.81)			9.65 (1.70)	0.58 (0.13)	0.51 (0.10)	0.75	2.15	0.96	71I-81I
Germany[c]	0.93 (1.33)		−0.48 (0.25)		0.89 (0.25)		1.02	2.41	0.63	64I-81II
France	1.92 (0.41)	−0.09 (0.10)			0.85 (0.17)		0.83	1.40	0.77	65I-82I
United Kingdom	1.35 (0.96)	0.15 (0.14)			0.84 (0.13)		1.85	1.55	0.65	66I-82I
Canada	3.85 (1.10)	−0.32 (0.12)			0.82 (0.15)		1.04	1.75	0.73	61I-82II
B. *pe* as the forecast from an auto-regressive inflation equation										
United States	1.37 (0.28)	0.17 (0.04)			0.42 (0.06)		0.42	0.71	0.70	65I-82II
Japan	−5.63 (0.95)			12.73 (1.79)	1.07 (0.13)		0.99	1.60	0.93	71I-81I
Germany[c]	0.55 (0.92)		−0.58 (0.24)		1.07 (0.27)		0.99	2.62	0.65	64I-81II

Germany[c]	0.55 (0.92)		−0.58 (0.24)		1.07 (0.27)	0.99	2.62	0.65	64I-81II
France	1.88 (0.35)	−0.20 (0.10)			1.01 (0.16)	0.72	1.80	0.82	65I-82I
United Kingdom	3.23 (0.90)	0.18 (0.16)			0.47 (0.10)	2.15	1.63	0.52	66I-82I
Canada	4.84 (0.99)	−0.44 (0.12)			0.78 (0.14)	1.03	1.77	0.73	61I-82II
C. Perfect foresight, i.e. $pe_t = p_{t+1}$									
United States	1.32 (0.29)	0.12 (0.04)			0.43 (0.07)	0.42	1.28	0.68	65I-82II
Japan	−3.89 (1.72)			12.70 (3.41)	0.61 (0.18)	1.71	1.48	0.78	71I-81I
Germany[c]	1.05 (0.70)		−0.48 (0.23)		0.81 (0.19)	0.96	2.61	0.66	64I-81II
France	2.32 (0.41)	−0.02 (0.10)			0.54 (0.13)	0.90	1.35	0.73	65I-82I
United Kingdom	2.05 (0.89)	0.14 (0.14)			0.72 (0.12)	1.91	1.55	0.62	66I-82I
Canada	4.02 (1.32)	−0.26 (0.14)			0.67 (0.16)	1.17	1.62	0.65	61I-82II

a) See notes *a* and *b* to Table 1. Estimated by ordinary least squares except for the second equations for the U.S. and Japan. Note that the estimation periods differ from Table 1 due to data availability.

b) Past inflation is as specified in Table 1, note *b;* for the United States only the eight-semester inflation term is used.

c) The three German equations include a two-semester moving average of productivity growth with estimated coefficients of 0.59 (standard error of 0.22), 0.63 (0.22) and 0.61 (0.20), respectively.

adaptive, i.e. specified as a distributed lag on present and/or past inflation rates, and hence the empirical results are unable to distinguish among the alternative hypotheses of whether it is past inflation or backward-looking expectations of inflation which are relevant.

Given a backward-looking specification, the length of the lag on past inflation should be related to institutional features such as the speed of indexation and the length of contracts. In particular, one would expect longer lags on past inflation in North America, where staggered three-year contracts are the norm in the unionised sector, than in Europe or Japan which are characterised by a one-year bargaining cycle and, in some countries, economy-wide indexation. The lags reported in Table 1, note b are generally consistent with these institutional differences. Except for the United States, the price impacts are evenly distributed and complete in one to one-and-a-half years. For the United States the lags extend for four years with roughly half of the total impact complete in the first year. More complicated distributed lag specifications such as geometric or polynomial distributed lags did not improve the results. The size of the estimated coefficient on past inflation, of course, is not independent of the length of the lags[7]. The preferred lag specifications reported in Table 1 are thus based on both institutional considerations as well as the *a priori* presumption referred to above that this coefficient should be near unity.

The institutional grounds for specifying forward-looking price expectations do not appear to be strong. The theoretical grounds are based, at least in part, on a desire to avoid a specification that would imply the existence of persistent money illusion. Forward-looking price expectations were incorporated into the wage equations in a number of ways, all in the context of single equation estimation methods and all focusing on the one-period-ahead expectation. One assumption was rational expectations with perfect foresight, i.e. it was assumed that $pe_t = pe_t + 1$ in equation [1]. Rational expectations based on a more limited information set were also assumed by defining pe_t to be the one-period-ahead forecast from an estimated price equation, either a reduced-form equation incorporating the most important exogenous (to the wage-price block) influences on prices such as the money supply, or an equation estimated by time-series methods[8].

Table 5 reports the estimated Phillips curve equations for six countries with the inflation term replaced by the three forward-looking measures of inflation. For the United States, France (except in panel B) and the United Kingdom, the estimated unemployment rate coefficient becomes perversely signed and/or insignificantly different from zero when estimated with the alternative specification of inflation expectations. The size of the estimated coefficient on expected inflation also tends to be lower than those reported in Table 1. Otherwise, as a broad generalisation, most of the features of the estimates in Table 1 are maintained.

Equations were also estimated with a combination of forward-looking and adaptive inflation expectations. For the United States this was done by replacing the two-semester moving average of inflation in the original specification (see note b to Table 1) with the alternative inflation expectation terms used in Table 5 while maintaining the second inflation term of an eight-semester moving average. These equations are reported in panel A of Table 5 for the United States and Japan, the only countries for which the results were interesting. For the United States, this hybrid model is much closer to the original specification and the results are much improved, particularly with regard to the estimated unemployment coefficient, compared to the pure expectation equation. For both the United States and Japan, the sum of the coefficients on the two inflation terms is near unity.

It is difficult to arrive at strong conclusions from these results. This is not surprising since the test incorporates both specific hypotheses of expectations formation as well as hypotheses about wage determination. Limited as these tests for forward-looking inflation expectations are, they do not suggest a significant improvement over a specification using current and past inflation. The data appear to support institutional evidence suggesting that nominal wages, at least when inflation is not accelerating, reflect an *ex post* adjustment to inflation.

C. Other variables

1. Labour productivity

The textbook neo-classical theory of income distribution equates wages to the marginal revenue product of labour [cf. Kuh (1967)]. Actual wage bargaining in some countries indicates that, at least during specific periods, average productivity growth may be an important determinant of wage increases. Given the hiring and firing practices of firms, it is likely to be trend rather than actual productivity developments which are relevant. Trend productivity growth will, by definition, be relatively stable, and is usually considered to be incorporated into the constant term. A shift in trend productivity would then show up as an intercept shift. Two obvious events which might have been associated with changes in trend productivity are the 1973 and 1979 oil price increases [cf. Gordon (1984)]. These were tested for but the data did not suggest important intercept shifts at these dates[9].

Various specifications of current and distributed lags on productivity growth have been included in the estimated equations but were always insignificant and/or wrongly signed except for Germany and Switzerland. The second Swiss and German equations reported in Table 1 include, respectively, contemporaneous and a two semester moving average of the growth of aggregate productivity (defined as real GDP per employed person). Including productivity growth increases the overall explanatory power, and in the German equation also increases the coefficient on the inflation term from 0.6 to close to unity. Thus cyclical productivity movements appear to have a significant impact on German and Swiss wage developments, a result consistent with wage bargaining in these countries which often explicitly takes account of productivity developments.

2. *Real wage bargaining and "catch-up"*

As noted above, the short-run Phillips curve can be derived from bargaining models of wage determination [cf. Henry, *et al.* (1976) and Andersen (1984)]. These models emphasize that the presence of trade unions and large corporations suggests a bargaining process closer to a bilateral monopoly than perfect competition; indeed, in some bargaining models the neo-classical assumption of a competitive labour market is assumed to be largely irrelevant in many sectors of the economy. Within this context the bargaining process is carried out over nominal wages although trade unions are mainly concerned with achieving a target real disposable wage. In these models increases in taxes can lead to tax-push inflation as wage earners demand higher nominal wages to offset the reduction in disposable income.

It is usually assumed that the actual change in nominal wages is mainly explained by the gap between the target real disposable wage and the previous real disposable wage. A crucial question is how the target real disposable wage is determined by the unions and the relative weight they put on demand factors in the labour market, as measured by the unemployment rate, past or expected inflation, the rate of growth of productivity and the average tax rate on household income, or alternatively one minus that rate, the retention ratio. The outcome of the bargaining process, of course, also depends upon the willingness or ability of firms to concede wage increases, which is assumed to depend upon the state of the labour market and the ability of firms to pay, i.e. profits. There could also be a backward-shifting of employers' contributions for pensions, social security, etc. Assuming a linear relationship, the bargaining model can be specified as an expanded version of equation [1] which includes (in X, the vector of other relevant variables) the growth of productivity, the change in the retention ratio, some measure of profits and, importantly, the lagged real disposable wage. The presence of the last variable indicates that any failure to achieve a target real wage in one period results in more aggressive nominal wage claims subsequently as an attempt is made to "catch-up" on past real wage shortfalls. Note that in the absence of this variable, lags in the response of wage growth to inflation imply that a change in the level of real wages occurs whenever inflation changes.

Table 6 summarises the results of testing some of the additional variables suggested by bargaining models. The results with regard to profits are somewhat surprising[10]. In Japan where institutional aspects strongly indicate an important role for profits they were never significant and incorrectly signed when entered together with the reciprocal of the unemployment rate, and the logarithm of the lagged real disposable wage; when profits were entered without the lagged real disposable wage, the unemployment rate became perversely signed. For Canada, the profits variables were positive and significant only in equations with no activity variable, and then other aspects of the equation were less satisfactory. For the United States and

Table 6. Bargaining models[a]

	Constant	Unemployment rate: U	Unemployment rate: log U	Unemployment rate: 1/U	Inflation term[b]	Log of lagged real: Disposable wage	Log of lagged real: Profits[c]	Growth of: Retention ratio	Growth of: Employers' tax rate	Growth of: Productivity	SEE	DW	$\bar{R}^2$	Estimation period
United States[d]	2.64	−0.30			1.34	−7.44		−0.51			0.46	1.40	0.62	65I-82II
	(0.55)	(0.16)				(8.27)		(0.57)						
	0.31	−0.31			1.17		0.56				0.22	2.12	0.91	65I-83I
	(1.24)	(0.06)					(0.29)							
Japan	−3.47			8.42	0.84	−6.75		10.09			0.88	1.72	0.94	71I-83I
	(1.51)			(5.09)	(0.14)	(5.49)		(27.67)						
	−13.32			−15.05	1.16		7.25				0.95	2.14	0.92	68I-82II
	(2.92)			(7.34)	(0.13)		(2.09)							
Germany[e]	10.00		−1.24		0.58	3.46		−0.19		0.67	0.90	2.47	0.70	64I-82I
	(6.25)		(0.38)		(0.29)	(1.92)		(0.17)		(0.21)				
	9.10		-0.97		1.36	−2.55		0.11		0.51	1.11	1.98	0.59	64I-82I
	(4.55)		(0.42)		(0.36)	(1.34)		(0.55)		(0.34)				
	−4.21		−1.02		1.17		1.15			0.75	0.89	2.66	0.71	64I-83I
	(1.91)		(0.34)		(0.22)		(0.50)			(0.19)				
France	30.47	−0.81			0.77	−3.18		−0.36	−0.07	0.18	0.69	2.06	0.85	64II-83I
	(60.94)	(0.28)			(0.25)	(6.36)		(0.30)	(0.07)	(0.14)				
	0.16	−0.13			0.92		0.66				0.69	1.95	0.84	64II-83I
	(5.00)	(0.22)			(0.14)		(0.83)							
United Kingdom	−16.26	−0.34			1.12	2.22		0.27		0.42	1.34	2.13	0.81	65I-82II
	(37.81)	(0.14)			(0.17)	(4.44)		(0.21)		(0.21)				
Italy	87.71	−0.18			1.41	−6.14		75.79	−0.11		1.93	1.78	0.75	62II-81II
	(68.50)	(0.52)			(0.34)	(5.17)		(136.86)	(0.20)					
Canada	86.35	-0.58			1.16	−9.50		0.04			0.96	2.07	0.77	61I-83I
	(54.00)	(0.10)			(0.22)	(6.33)		(0.20)						
	4.88	−0.52			0.93		1.45				0.95	2.12	0.77	61I-83I
	(0.94)	(0.12)			(0.13)		(1.75)							
Australia[f]	3.23	−0.89			0.43	1.12		-1.28		0.03	2.04	2.07	0.61	69II-83I
	(5.38)	(0.64)			(0.61)	(11.20)		(0.56)		(3.00)				
Netherlands	38.08		−1.92		0.95	−12.30		−0.05		0.18	1.13	2.20	0.66	69I-82II
	(18.95)		(0.53)		(0.26)	(6.83)		(0.17)		(0.23)				

a) See note *a* to Table 1.
b) The lag distributions are given in note *b* to Table 1.
c) Profits are defined as the logarithm of the share of national accounts gross operating surplus in GDP. The alternative measure of the real return on capital gave similar results. For Canada the profits variable is entered as a growth rate.
d) The estimated price coefficients (standard errors) on the two- and eight-semester moving averages are: 0.19 (0.16) and 1.15 (0.55) in the first equation; and 0.26 (0.08) and 0.91 (0.16) in the second equation.
e) In the second and third equations, the unemployment rate is entered relative to a four-year moving average as in Table 4, i.e. as *log (U/U*)*.
f) The unemployment rate is entered relative to a four-year moving average as in Table 4, i.e. as *U-U**.

Germany profits were significant, if marginally so, though affecting the coefficient on inflation somewhat. With regard to the logarithm of the lagged real wage, this was marginally significant for the Netherlands and Germany, where, however, it competes with the profits variable. The two tax rate variables were never significant except for the growth of the retention ratio in Australia, but other aspects of this equation were unsatisfactory.

Another aspect of some bargaining models is the distinction between the wage concept as seen from the employers' and employees' viewpoint[11]. Aside from changes in taxes, this distinction can be captured by including in the nominal wage equations the difference between the growth of the personal consumption deflator and the growth of the GNP deflator. This additional variable proved to be important only in the Swiss wage equation where, in addition to improving the fit of the equation, it reduced substantially the serial correlation of the errors and increased the significance of the other independent variables. The presence of this variable, with an estimated coefficient of -0.5, has important implications for the behaviour of Swiss wages: if both consumer and domestic output price inflation increases by 1 per cent, wage growth can be expected to also increase by 1 per cent; but if consumer price inflation increases by 1 per cent because of an increase in import price growth, the growth of domestic output prices remaining unchanged, nominal wage growth will increase by only 0.53 per cent[12].

These tests of the bargaining model have yielded largely negative results. This may be due in part to the aggregative nature of the wage, profits and tax data. As its name implies, the bargaining model is most applicable to economies characterised by centralised wage bargaining, which is not a feature of most of the countries studied here[13]. The inability to find significant tax effects on wages is disappointing but not surprising. Measures of aggregate average tax rates will be affected by many factors which are unrelated to changes in the relevant statutory tax rates. As a generalisation, in most countries the institutional grounds are not compelling for assuming a direct link between taxes and wages, and this is probably particularly true for small changes in taxes. When assessing the possible consequences of large changes in taxes, however, it would clearly be prudent to make alternative assumptions about possible wage impacts.

3. *Incomes policies and other country-specific variables*

The growth of minimum wages is included in the equations for the United States and France. Some type of legal minima also exists in Japan, Canada (where they are provincial not national), the Netherlands and Australia. In principle, other variables which are often stressed as important determinants of the natural rate, such as unemployment benefit replacement ratios, measures of unionisation, etc., should also enter the wage equation. Data limitations have prevented the inclusion of these variables, although an intercept shift in the Canadian equation in 1970II may represent an increase in the natural rate due to changes in the provisions of the unemployment insurance programme [cf. Green and Cousineau (1976)].

There have also been explicit wage controls or guidelines, and sometimes an associated catch-up after their removal. Although it is difficult to adequately capture the impacts of incomes policies using dummy variables, the results do not suggest these policies have had important lasting effects on aggregate wage developments. In addition, socio-political events, such as those which occurred in France and other European countries in the late 1960s, have resulted in, or been associated with, unusual wage developments. To the extent that these dummy variables capture the effects of significant exogenous events, to exclude the dummy variables would result in biased coefficient estimates. The inclusion of the dummy variables, which are concentrated around 1970 and 1974, improve the tracking performance of the equation but, in general, have little impact on the size or significance of the other coefficient estimates (cf. Table 11 in the Appendix where equations are reported with all dummy variables omitted). Table 7 contains a description of the dummy variables together with the estimated coefficients and standard errors.

D. Stability

Given the wide range of variation in wage growth, inflation, unemployment rates and economic policy over the estimation period, it is important to examine the stability of the estimated equations. This has been done using the technique of recursive regressions, which tests for gradual changes in individual parameters, and with Chow tests. The tests are discussed and reported in the Appendix. In general the estimated equations are stable. An exception is the United Kingdom where stability is rejected when the sample period is divided at end 1979. It is interesting to note, however, that stability is not rejected for the U.K. equation reported in Table 4, which incorporates the hypothesis of hysteresis in the natural rate. For the other countries equations estimated to 1979II do a good job of predicting wage growth from 1980I to 1983I. There is little basis, therefore, for describing recent wage moderation as unusual, or indicative of a structural change.

IV. IMPLICATIONS FOR INFLATION AND THE NAIRU

Nominal wage developments are the dominant proximate factor determining inflation pressures in the short run. Actual inflation developments will depend to a large extent on the degree to which policy does or does not accommodate inflation pressures. The analysis presented above indicates that, for the countries studied

Table 7. **Country-specific variables**

	Description	Non-zero values for dummy variables	Estimated coefficient	Standard error
United States	Dummy variable for unusually large wage increases.	1.0 from 70II to 72I	0.68	(0.13)
	Dummy variable for wage controls and subsequent removal.	1.0 from 73II to 74I, and –1.0 from 74II to 75I	–0.47	(0.13)
Japan	Dummy variable for unusual seasonal pattern.	1.0 in 74I and 75I, and –1.0 in 74II and 75II	–4.21	(0.57)
Germany	Dummy variable for the events of 1969.	1.0 from 69II to 70I	2.33	(0.45)
France	Dummy variable for the events of 1968.	1.0 in 68II and –1.0 in 69I	1.77	(0.69)
United Kingdom	Dummy variable for unusually large wage increases, perhaps in anticipation of the imposition of wage controls.	1.0 in 70I	4.14	(1.50)
	Dummy variable for unusually large wage increases, perhaps associated with the newly-elected Labour government and the contract policy.	1.0 from 74II to 75I, and –1.0 from 75II to 77II	4.19	(0.58)
Italy	Dummy variable for the events of 1969-70.	1.0 in 70I	6.78	(2.03)
	Dummy variable for unusually large wage increases.	1.0 from 73I to 73II	5.79	(1.45)
	Dummy variable for the new agreement on the indexing system.	1.0 from 76II to 77I	4.26	(1.54)
Canada	Dummy variable representing the possible impact on the natural rate of changes in the provision of unemployment insurance benefits.	1.0 prior to 70II	–1.34	(0.50)
	Dummy variable for unusually small wage increases.	1.0 in 70I	–2.76	(0.98)
	Dummy variable representing possible effects of the Anti-Inflation Board policies.	1.0 from 77II to 78II	1.54	(0.60)

the Anti-Inflation Board policies.

Australia	Dummy variable for unusually large wage increases, possibly associated with and award in the National Wage Case by the Arbitration Commission.	1.0 from 74I to 74II	5.43	(1.94)
Austria	Dummy variable for unusually large wage increase, perhaps reflecting buoyant profits and unusually strong demand.	1.0 in 71I	5.45	(1.21)
Switzerland	Dummy variable for exceptionally large wage increases in the construction sector during a period of strong excess demand for labour, which spread rapidly to other sectors of the economy.	1.0 in 70II	2.48	(0.94)

Note: Except for Australia, these estimated coefficients are from the equations reported in Table 1. For Germany the relevant equation includes productivity growth. For Australia the relevant equation is reported in Table 4. For Switzerland the relevant equation includes productivity growth and the difference between the growth of consumer prices and domestic output prices.

here, the augmented Phillips curve explains actual wage inflation over the period from about the mid-1960s to the early 1980s reasonably well, and is structurally stable. The estimated equations should therefore be informative about the prospects for short- and long-term inflation developments.

A. Implications for short-term inflation developments

The impact on wages of the unemployment rate is important for understanding recent as well as prospective wage developments. The analysis indicates that wage inflation is related to the level of, rather than the change in, the unemployment rate. Indeed, the change in unemployment appears to have no significant independent influence on wage growth, which suggests there are not important speed limits to the rapidity with which growth occurs. In terms of the short-run dynamics of the wage equation, a maintained reduction (increase) in the unemployment rate will result in a sustained increase (decrease), without overshooting, in the rate of wage inflation.

The perception that recent wage growth has been unusually moderate may have been due, at least in part, to the presumption of a non-linear Phillips curve. A linear rather than a non-linear specification of unemployment appears to be more consistent with recent wage developments in many countries. With the exception of Japan, for those countries where the data suggest a non-linear relationship, a logarithmic specification is preferred to the more non-linear specification of the reciprocal of the unemployment rate. The implication for inflation prospects is that if unemployment is reduced, the effect of this reduction, *ceteris paribus,* will be to increase wage growth, i.e. some of the wage inflation reduction due to the recession in the early 1980s will be reversed. And conversely, if unemployment rates continue to rise, this will tend to further reduce wage growth.

Nominal wages also respond to past and, potentially, to expected inflation developments. Except for the United States, the estimates reported above indicate that wage growth rapidly (within a year) reflects the full extent of any changes in consumer price inflation. Thus, during periods when factors such as direct excess demand effects, productivity and commodity price growth strongly influence consumer price inflation, this can be expected to affect wages rapidly via price/wage links and, if accommodated, set in train a wage-price spiral, either upward or downward. During the early 1970s there was clearly an upward spiral; recently, commodity prices have tended to lower consumer price inflation and this has been reflected in low wage growth. In the United States, however, nominal wages respond relatively slowly to inflation. This inertia means that wages have generally tended to follow, rather than lead, price developments. The long lags on the inflation term mean that the inertial component of U.S. wage behaviour is now established at a relatively low level, and will probably be reduced further.

In the context of a bargaining model of wage determination, it is sometimes argued that increased profits or stagnant real wages could lead to subsequent pressures for an increase in wages in order to recoup or catch-up on previous real wage losses. In the analysis presented above, however, there was little empirical support at the macroeconomic level for the "catch-up" hypothesis. With the possible exceptions of Germany and Japan, there is also little statistical evidence that profits as conventionally measured at the macroeconomic level have important impacts on aggregate wage developments. Nevertheless, such pressures cannot be ruled out, particularly in countries where profits appear to be unusually high.

In summary, the decline of wage growth in the early 1980s and continued moderation through 1985 is relatively well explained by the high rates of unemployment and the additional downward pressure on consumer price inflation from commodity prices, direct demand effects on prices and, in some countries, exchange-rate movements. All of these phenomena, of course, are traceable to the widespread adoption of non-accommodating monetary policies after the second oil-price shock. International linkage effects undoubtedly intensified the disinflation process. Forward-looking expectations of lower inflation, perhaps traceable to policy pronouncements, may also have played a role, although these are difficult to verify empirically.

B. The long-run Phillips curve and the NAIRU

In the medium to long run, wage developments cannot be looked at in isolation since inflation and inflation expectations must also be considered as endogenous. This makes it possible, in principle, to compute the level of the unemployment rate which is consistent with stable inflation and inflation expectations – the NAIRU.

The approach usually adopted for computing the NAIRU can be demonstrated using the augmented Phillips curve as given in equation [1] and the following cost mark-up price equation and an adaptive expectations equation:

$$p_t = b0 + b1 \, \Sigma \, L1_i(w + s - q)_{t-i} + b2 \, \Sigma \, L2_i \, pm_{t-i} + b3.Z_t, \qquad [4]$$

$$pe_t = \Sigma \, L3_i \, p_{t-i}, \qquad [5]$$

where p is the rate of change of prices, s is the rate of change of one plus the effective tax rate on employers' contributions, q is trend productivity growth, pm is the rate of change of import prices and Z is a vector of other relevant variables. The $L1_i$ are distributed lag coefficients which sum to unity, and similarly for $L2_i$ and $L3_i$. If Z does not include any relevant cost variables, the constraint $b2 = 1 - b1$ would be appropriate; and depending on the contents of Z, $b0 = 0$ may also be appropriate. Long-run equilibrium of the wage-price block will be characterised by stable inflation, wage growth, etc. and realised expectations, i.e.:

$$pe_t = p_t = p_{t-i}, \qquad [6]$$

and similarly for the other variables. The reduced-form wage equation from the wage-price block can be solved for by substituting equations [4], [5] and [6] into equation [1]. Dropping time subscripts, and normalizing on the unemployment rate consistent with this long-run wage-price equilibrium, the equation for the NAIRU $(\bar{U})$ is:

$$\bar{U} = (1/a2)[(a0 + a1.b0) - (1 - a1.b1)w + a1.b1(s - q) + a1.b2.pm + a1.b3.Z + a3.X]. \qquad [7]$$

Based on this approach, the structural determinants of the NAIRU are trend productivity growth, trend changes in the terms of trade, the tax rate for employers' contributions and minimum wages. As noted above, other structural factors such as replacement ratios, etc. have not been included in the equations and hence play no role in the calculated NAIRUs. The NAIRU given in equation [7] depends on wage inflation, so the long-run Phillips curve computed in this way is not vertical. Two assumptions are required for a vertical long-run Phillips curve: *i)* that nominal wage growth eventually adjusts completely to price inflation, i.e. $a1 = 1$; and *ii)* either that the economy is closed, i.e. $b1 = 1$ and $b2 = 0$, or that exchange rates adjust so that domestic costs and import prices change at the same rate over the relevant run, i.e. $w = pm$. With these assumptions, and assuming $b2 = 1 - b1$, equation [7] reduces to:

$$\bar{U} = [a0 + b0 + b1(s - q) + b3.Z + a3.X]/a2, \qquad [8]$$

i.e. there is no relationship between wage inflation and unemployment and hence the long-run Phillips curve is vertical.

Using the parameters of the estimated wage equations and parameters for the price equations in the INTERLINK model, it is possible to compute NAIRUs based on equation [7]. As indicated above, stable equilibrium values for the determinants of the NAIRU are needed. These are not available so average growth rates for *w, pm, s* and *q* have been used; as these average growth rates change, the calculated NAIRUs will also change. The use of actual, rather than equilibrium values for the determinants of the NAIRU may bias the estimates towards actual unemployment rates.

Table 8 reports estimates of the NAIRU computed in this way and indicates the sources of the changes in the NAIRU. In general, these estimates are consistent with those found in the literature [cf. Braun (1984) Englander and Los (1983) and Layard *et al.* (1984)]. It must be noted that the confidence intervals around these estimates are likely to be very large reflecting imprecise coefficient estimates and mis-specification in the wage and price equations. For this reason, as well as the

Table 8. **NAIRU estimates**

	Time period	Average unem-ployment rate	NAIRU estimates[a] (1)	(2)	Changes in the NAIRU due to:[b] s	q	pm	w	Other
United States	1967-1970	4.0	3	4½					
	1971-1975	6.0	6	5½	½	½	2	0	
	1976-1980	6.8	6	6	0	0	0	0	
	1981-1983I	8.8	6½	6	−½	1	0	0	
Japan	1971-1975	1.4	1	1					
	1976-1980	2.1	1½	1½	0	0	½	0	
	1981-1983I	2.3	2	2	0	0	0	0	
Germany	1967-1970	1.0	1	3					
	1971-1975	1.8	1½	2	0	−½	2	−1	
	1976-1980	3.6	3	3½	0	0	0	1½	
	1981-1983I	6.3	8	5	0	0	3½	1½	
France	1967-1970	1.8	2½	6½					
	1971-1975	2.7	3½	2½	0	0	5	−3	½ −1
	1976-1980	5.2	3	3	½	1	−1	−1	−½ ½
	1981-1983I	8.3	8	4	−½	½	4½	0	½ 0
United Kingdom	1967-1970	2.3	1	5½					
	1971-1975	3.0	7½	3½	½	−½	8½	−2	
	1976-1980	5.4	7½	7	0	4	−3½	−½	
	1981-1983I	10.5	6	8	−1	1	−2½	1	
Italy	1967-1970	5.4	4½	7½					
	1971-1975	5.8	7	5½	−½	1	4	−2½	
	1976-1980	7.1	6½	6	0	1½	−1	−1	
	1981-1983I	8.9	6½	5½	−½	0	½	0	
Canada	1968-1970	4.8	4	6					
	1971-1975	6.0	7	6½	0	−½	2½	−1	0 2
	1976-1980	7.7	8½	7½	0	1	0	0	½ 0
	1981-1983I	9.9	7½	7½	0	½	−1	−½	0 0
Austria	1973-1975	1.4	1	1					
	1976-1980	1.9	1½	1½	0	0	0	½	
	1981-1983I	3.3	2½	2	0	½	0	½	
Netherlands	1970-1975	3.6	4	3					
	1976-1980	5.7	5	5½	−½	1	−1	2	
	1981-1983I	11.4	10½	8½	0	1	2½	2	

a) The NAIRU estimates in column 1 are calculated using averages of the relevant data for the indicated sub-periods; in column 2, the estimates use the average rate of growth of import prices over the complete estimation period given in Table 1.

b) These are the determinants of the NAIRU as given in equation [7]. For the non-linear wage equations these changes are approximations. *s* is the rate of change of one plus the effective tax rate on employers' contributions, *q* is trend productivity growth, *pm* is the rate of change of import prices and *w* is the growth of wages. For France, the other variables are the growth of the minimum wages and the growth of one plus the average indirect tax rate; for Canada, the other variables are the growth of the user cost of capital and the dummy variable referred to in Table 7.

analytic fuzziness of the NAIRU concept when applied to economies out of long-run equilibrium, the policy relevance of the estimated NAIRUs may not be great. At best, estimates of the NAIRU may provide rough guides as to when inflationary pressures stemming from the labour market might arise. For all countries, unemployment rates in the second half of 1984 are above the estimated NAIRUs, sometimes substantially so, suggesting that the net demand effect on wage growth is currently negative and likely to stay so in most countries even if unemployment rates are lowered substantially.

However, the hypothesis of hysteresis in the natural rate, which appears to be strongly supported for Australia and, arguably, the United Kingdom, has somewhat different implications. The negative impact on wage inflation of the current gap between the natural and the actual unemployment rate will eventually disappear as the natural rate increases. In this case there is no well-defined natural rate or NAIRU. Thus even without taking account of inflation and inflation expectations, not only is there no long-run relationship between wage growth and the level of the unemployment rate, there is no unique equilibrium rate of unemployment independent of the dynamic path to that equilibrium [cf. Buiter and Gersovitz (1981)].

V. REAL AND NOMINAL WAGE FLEXIBILITY

The concepts of real and nominal wage rigidity have been used with increasing frequency over the last few years to explain differing developments in unemployment, especially between Europe and the United States. Wage flexibility is, of course, a very broad and ambiguous concept and there are many possible measures of "flexibility" [cf. Klau and Mittelstädt (1985)]. Here we focus on two specific measures which are a function of only the estimated parameters from the nominal wage equations. Discussion of these measures of real and nominal wage rigidity provides an excellent framework within which cross-country comparisons of the estimated equations can be highlighted.

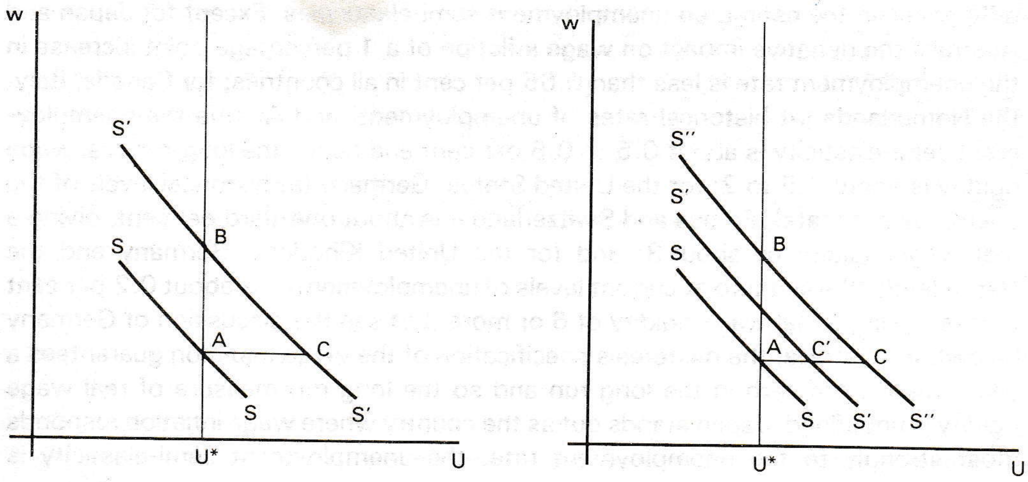
Studies by Sachs (1979) and Branson and Rotenberg (1980) focused on the amount of nominal inertia in the determination of nominal wages. With long (short) lags on past inflation in the wage equation, real wages will be flexible (rigid) in the face of an inflationary shock because nominal wages are rigid (flexible). Thus real wage rigidity is the opposite of nominal wage rigidity. These studies characterised the United States as having real wage flexibility and nominal wage rigidity due to the relatively long lags between inflation and wage changes. Other major industrialised countries were characterised by real wage rigidity and nominal wage flexibility due to the greater degree of indexation of wages to prices. Given this definition, the estimated wage equations reported above would support this distinction between the United States and other countries.

Grubb *et al.* (1983) and Gordon (1984) argue that the degree of nominal inertia in the wage equation is not sufficient to demonstrate the presence of real and/or nominal wage rigidity. Although real and nominal wage rigidity are supposed to explain unemployment developments, the above measures, for example, say nothing about how much unemployment will result from a given shock. Grubb *et al.* suggest a more appropriate measure of real wage rigidity is the increase in the unemployment rate required to offset the *long-run* inflationary consequences of a real shock, where a real shock is one that leads to a different equilibrium real wage (for example, a fall in productivity growth relative to trend or a shift in the terms of trade). In effect, this is an indicator of the degree of non-accommodation, measured in terms of unemployment, which would be necessary to maintain inflation constant in the face of an adverse shock[14]. Thus real wage rigidity will be higher the less responsive are nominal wages to the unemployment rate.

A closely related measure of real wage rigidity was used in OECD *Economic Outlook 33* (July 1983, pp. 48-9): real wage rigidity was defined there as the *short-run* elasticity of nominal wages with respect to inflation minus the short-run semi-elasticity of nominal wages with respect to the unemployment rate[15]. Thus, real wage rigidity will be higher the more rapidly nominal wages respond to a price shock (as in Sachs and Branson and Rotenberg) and the less responsive they are to the unemployment rate (as in Grubb *et al.*).

The geometric interpretation in terms of a stylised Phillips curve analysis is as follows (Figure A, left panel). Starting from an initial equilibrium position A, consider

FIGURE A



a real shock such as a deterioration in the terms of trade which increases actual inflation. Since it is a real shock, the equilibrium level of real wages will fall and, with accommodating policies, inflation will increase. As the increase in inflation is incorporated into inflation expectations, the short-run Phillips curve SS will shift up, say to S'S' and, for an unchanged unemployment rate, inflation will stabilize at a permanently higher level at B. What is of interest here is the increase in unemployment which would be necessary to offset the incipient increase in wages implied by the increased inflation, i.e. the degree of non-accommodation measured in terms of increases in the unemployment rate. In the figure, unemployment must increase from A to C. With unemployment above the natural rate *(U^*)*, wages decelerate thus offsetting the wage-price spiral which would otherwise have led to point B. If the incipient inflationary wage pressure lasts only one period, i.e. if inflation expectations respond immediately and fully to the increased inflation, the unemployment rate can then return to its original level, U^*. Suppose, alternatively, that the increased inflation gets incorporated into inflation expectations evenly over two periods, i.e. the short-run Phillips curve shifts up by equal amounts in each period (right panel). The short-run measure of real wage rigidity indicates that the unemployment rate must increase to C' in the first period and remain there for two periods.

Estimates of real wage rigidity are reported in Table 9 using the ratio of both the short- and the long-run elasticities. For those countries with a non-linear Phillips curve, the semi-elasticity of wages with respect to the unemployment rate will depend upon the level of the unemployment rate (cf. Table 2). In these cases, the calculations in Table 9 use the average unemployment rate over the estimation period as well as the unemployment rate in the first half of 1984.

As none of the long-run inflation elasticities are significantly different from unity, the long-run measures of real wage rigidity differ primarily because of differences in the estimated unemployment semi-elasticities. Except for Japan and Australia the negative impact on wage inflation of a 1 percentage point increase in the unemployment rate is less than 0.65 per cent in all countries: for Canada, Italy, the Netherlands (at historical rates of unemployment) and Austria the unemployment semi-elasticity is about 0.5 to 0.6 per cent and hence the long-run real wage rigidity is about 1.5 to 2; for the United States, Germany (at historical levels of the unemployment rate), France and Switzerland it is about one-third per cent, giving a real wage rigidity of about 3; and for the United Kingdom, Germany and the Netherlands (the last two at current levels of unemployment) it is about 0.2 per cent or less, giving a real wage rigidity of 6 or more (but see the discussion of Germany below). In Australia, the hysteresis specification of the wage equation guarantees a semi-elasticity of zero in the long run and so the long-run measure of real wage rigidity is undefined. Japan stands out as the country where wage inflation responds most strongly to the unemployment rate: the unemployment semi-elasticity is

Table 9. **Real and nominal wage rigidity**

	Unem-ployment rate	Elasticity of nominal wages with respect to[a]			Real wage rigidity		Mean lag in the wage and price equations[c]	Nominal wage rigidity
		Prices		Unem-ployment rate[b]	Short run	Long run		
		Short run	Long run					
		1	2	3	4 = 1/3	5 = 2/3	6	7 = 4 × 6
United States	any	0.22	1.01	0.33	0.67	3.06	5.00	3.35
Canada	any	0.31	0.95	0.57	0.54	1.67	1.50	0.81
Japan	1.7	0.93	0.93	3.31	0.28	0.28	0.50	0.14
	2.7			1.31	0.71	0.71		0.35
Australia[d]	any	0.45	0.90	1.78	0.25		3.00	0.75
		0.33	0.66	0.48	0.69	1.38		2.07
Germany[e]	2.7	0.44	0.88	0.25	1.76	3.52	2.00	3.52
	8.5			0.08	5.50	11.00		11.00
					0.58	0.61		1.16
France	any	0.47	0.94	0.31	1.52	3.03	3.00	4.56
United Kingdom	any	0.33	0.99	0.17	1.94	5.82	2.50	4.85
Italy	any	0.96	0.96	0.65	1.48	1.48	3.00	4.44
Austria	3.9	0.48	0.97	0.58	0.83	1.67	3.00	2.49
	4.5			0.50	0.96	1.94		2.88
Netherlands	5.1	0.47	0.94	0.44	1.07	2.14	2.00	2.14
	14.0			0.16	2.94	5.87		5.88
Switzerland[f]	any	0.52	1.04	0.30	1.73	3.47	3.00	5.19
		0.01	0.53	0.30	0.03	1.77		0.09

a) The elasticities are from the estimated wage equations reported in Table 1; the unemployment rate enters the wage equations unlagged.

b) For Japan, Germany, the Netherlands and Austria, the estimated Phillips curves are non-linear and so the semi-elasticity of nominal wages with respect to a 1 percentage point increase in the unemployment rate is baseline dependent. For these countries the semi-elasticity is calculated from the average unemployment rate in the estimation period (the first line) and also the unemployment rate in the first semester of 1984 (the second line).

c) The mean lags on inflation in the wage equations are 3.5 for the United States; 1.0 for Canada and the United Kingdom; 0 for Japan; and 0.5 for all other countries. The mean lags on the wage term in the price equations are 0.5 for Canada and Japan; 1.5 for the U.S., Germany, the U.K. and the Netherlands; and 2.5 for the other countries.

d) The first line is based on the equation which incorporates the hypothesis of hysteresis in the natural rate reported in Table 4; the second line is based on the standard Phillips curve reported in Table 1.

e) The estimates of wage rigidity reported in the third line incorporate a short-run productivity impact on nominal wages as discussed in the text [cf. Coe and Gagliardi (1985) Appendix C].

f) The calculations assume no change in short-run productivity. In the first line it is assumed that the real shock increases both consumer and output prices by 1 per cent; in the second line it is assumed that consumer prices increase by 1 per cent but that output prices remain constant.

between 1 and 3, depending on the level of the unemployment rate, and hence the measure of real wage rigidity is only about 0.3 to 0.7.

The ratio of the short-run elasticities may be more interesting when inflation and unemployment have different lag structures. The difference between the indicators of real wage rigidity based on the short- versus the long-run elasticities is most apparent in the calculations for the United States. For the United States the long-run elasticity of nominal wages with respect to inflation is unity, although the short-run (half-year) impact is only 0.22; both the short- and the long-run semi-elasticity with respect to the unemployment rate is 0.33. Hence, in a long-run comparative-static sense, the unemployment rate would have to increase by 3 percentage points to offset a real shock which temporarily increased inflation by 1 per cent. But in the first period, the incipient increase in wages is only 0.22 and hence the unemployment rate would only have to increase by 0.67 percentage points to prevent an acceleration of wages.

Except for the United States, Japan and Italy, past inflation enters as either a two or a three-semester moving average and hence the short-run inflation elasticity is either one-half or one-third of the long-run elasticity. For Japan and Italy, only contemporaneous inflation enters so the short- and the long-run elasticities are equal. When real wage rigidity is calculated as the ratio of the short-run elasticities regional differences emerge: Japan, Australia and North America have the lowest degree of short-run real wage rigidity due to the high responsiveness of wages to unemployment or, in the case of United States, a slow response of wage growth to inflation; because of relatively rapid indexation and low cyclical responsiveness of wages, Europe is in general characterised as having a higher degree of real wage rigidity, with Austria being the most flexible of the European countries due to the relatively high cyclical responsiveness of nominal wages.

The estimated wage equations for Germany and Switzerland are unusual because they include additional variables which can be expected to increase wage flexibility, as defined above. If German unemployment changes to offset an incipient wage increase, it is likely that there will be a pro-cyclical movement of productivity which will lower nominal wage increases and hence a smaller increase in unemployment will be necessary. Assuming an Okun coefficient of 2, it is estimated in Coe and Gagliardi (1985) that the measure of real wage rigidity incorporating the cyclical productivity effect for Germany is about 0.5 to 0.6, depending on the level of the unemployment rate and whether the short- or the long-run elasticities are used. These estimates are reported in the third line for Germany in Table 9.

Cyclical productivity growth also appears in the Swiss wage equation. But given the cyclical nature of net immigration, as well as the relatively small estimated coefficient, it is not clear that there would be a pro-cyclical movement in productivity which would have an important impact on real wage rigidity as calculated in Table 9. If, however, the real shock is from a deterioration in the terms of trade, the presence in the Swiss wage equation of the difference between consumer and output price inflation has important implications for real wage rigidity. A deterioration in the terms of trade which increased consumer prices by 1 per cent, but had no impact on domestic output prices, would result in virtually no increase in inflation in the short run, and only a 0.53 per cent increase in the long run. In this case, given in the second line for Switzerland in Table 9, real wage flexibility is enhanced because the estimated Swiss equation implies that labour is willing to accept the terms-of-trade induced reduction in the real wage.

Grubb *et al.* also suggest that an appropriate indicator of nominal wage rigidity is given by the product of the above measure of real wage rigidity and the sum of the mean lag on inflation in the Phillips curve equation and the mean lag on wages in the price equations. Thus the longer are the lags in the wage and price equations, the greater will be nominal wage rigidity. If there are no lags, there will be no nominal wage rigidity, i.e. nominal wage rigidity requires some nominal inertia in the system. Given these definitions of real and nominal wage rigidity, it is clear that they can co-exist, i.e. real wage rigidity does not imply nominal wage flexibility nor *vice versa.* Nominal wage rigidity, defined in this way, thus gives an indication of how long (the mean point-half-years) unemployment will have to remain above the natural rate in order to offset the inflationary consequences of the real shock. As shown in Table 9, Japan has the lowest degree of nominal as well as real wage rigidity; and due to the relatively long lags in the United States, nominal wage rigidity is considerably higher in the United States than in Canada, Germany, Australia and Austria, but somewhat lower than in France, the United Kingdom and Italy.

In conclusion, it is important to recall that these measures of real wage rigidity show how much nonaccommodation would be necessary to offset the inflationary consequences of a shock, not necessarily how much nonaccommodation actually takes place. Furthermore they are derived from the estimated wage equations and the results are sensitive to changes in specification and, for a number of countries, to the level of the unemployment rate used in the calculation. The short-run indicator of real wage rigidity tends to support the conventional wisdom that real wages in North America, Japan and Australia are more flexibile than in Europe; within Europe, Germany, Austria and Switzerland appear to have the most flexible real wages. Regional differences in the degree of long-run real or nominal wage rigidity are less pronounced. But using any of the indicators, it is clear that Japan is the country which stands out as having the most flexible wages.

NOTES

1. The equations for Japan, Italy and Canada are different from those reported in Coe and Gagliardi (1985), and an equation for Switzerland has been added. The changes, which are relatively minor, have been made in light of full model simulation results. An important motivation for this work has been to improve the wage block in the INTERLINK model, which is used by the Economics and Statistics Department of the OECD for simulation analysis as well as forecasting. This has implied a number of constraints on the analysis: data are semi-annual macroeconomic aggregates and independent variables should be endogenous to the model or exogenous policy instruments. Consequently, the data used may not always be the most appropriate to test some of the specific hypotheses.
2. Unemployment rates for specific sectors of the labour market such as prime-age males are also often used in wage equations; previous OECD Secretariat work has not found important differences from using these more narrowly-defined unemployment rates. In the Italian wage equation, if an unemployment rate adjusted for workers in the Cassa Integrazione Guardagni, a public institution which pays the temporarily unemployed out of social security funds, is used in the wage equation, the unemployment semi-elasticity falls about 0.1 and other aspects of the equation deteriorate substantially. An alternative, less direct, activity variable is the rate of growth of real output or industrial production. When contemporaneous or a two-period moving average of real GDP growth is substituted for the unemployment rate in equation [1] it is generally significant and correctly signed, but the explanatory power of the equation always falls and the serial correlation of the errors increases. As can be seen in Table 1, even in countries such as Japan and Austria where the aggregate unemployment rate has been relatively stable over the estimation period, the estimated coefficients are nevertheless well determined.
3. This specification is discussed in the forthcoming OECD Survey for Switzerland. Because of data limitations, it was not possible to use money growth as an instrument in the Swiss wage equation.
4. Compared to the logarithmic specification for Japan, the reciprocal specification gave more damped wage-price responses in full model simulation exercises, which were considered to be more realistic. For Switzerland, the range of the employment rate variable is from about 95 to 105.
5. Specified in this way, hysteresis in the natural rate is essentially a (long lagged) change in the unemployment rate specification. An alternative test of this hypothesis would be to use data on long duration unemployment as a proxy for "natural" unemployment.
6. Grubb *et al.* (1983), also report empirical results consistent with the hypotheses of hysteresis in the natural rate. Note that the hysteresis specification for the U.K. is stable and less sensitive to the inclusion of dummy variables than is the standard specification, see Tables 10 and 11.
7. The size of the estimated coefficient on the inflation term increases as the lag is lengthened from 0 to −3 for the United States, the United Kingdom, Canada, Austria and the Netherlands, and decreases for the other countries [cf. Coe and Gagliardi (1985), Table 5].
8. The estimated reduced-form and time-series inflation equations, from which inflation expectations (forecasts) have been derived, are reported in Coe and Gagliardi (1985).
9. With the possible exception of the U.S. (1979) and Germany (1974) where the dummy was sometimes significant but had deleterious effects on the equation as a whole. As noted above, the constant term also implicitly incorporates a constant natural rate. It is interesting that in the equations reported in Table 4, which incorporate explicit proxies for the natural rate, the only equation where the constant is insignificant is for Germany, which is also the only country where productivity growth enters explicitly.

10. Profits were specified in two alternative ways: national accounts gross operating surplus as a share of GDP; and national accounts gross operating surplus relative to the gross capital stock, i.e. as a measure of the rate of return on capital. These measures of profits as well as the retention ratio (defined as the ratio of national accounts household disposable income to total income) and the tax rate for employers' contributions were entered alternatively in change, percentage change and logarithmic form.

11. This distinction is emphasized by studies which explicitly specify labour demand as being dependent on the post-tax product real wage (post-employer-tax wages deflated by an output price) and labour supply as a function of the post-tax income real wage (post-employee-tax wages deflated by a consumer price) [cf. Knoester and van der Windt (1985) and Wren-Lewis (1982)]. Aside from the differing movements of employers' versus employees' wage taxes, the growth of the two concepts will diverge as *i)* the growth of government and investment prices differ from consumer prices, or their weight in total output changes, or *ii)* the terms of trade or the openness of the economy changes. Of these, changes in the terms of trade are likely to be the most important, especially in small open economies.

12. Similarly, if domestic output price growth increases by 1 per cent because of an increase in export price growth, consumer price inflation remaining constant, wage inflation will increase by 0.51 per cent.

13. Von Beyme (1980), pp. 75-6 reports the following data on trade union membership as a per cent of the labour force: Austria 60, the United Kingdom 50, Australia 50, the Netherlands 40, Germany 39, Japan 33, the United States 24, France 23 and Italy 22. In a recent study of wage determination in the United Kingdom, Sumner and Ward (1983) are also unable to find significant effects from lagged real wages. Andersen's (1984) results support the bargaining model for Germany and the United Kingdom and Knoester and van der Windt (1985) also report significant tax impacts.

14. In the context of their model, real wage rigidity is simply the reciprocal of the semi-elasticity of wages with respect to a 1 percentage point increase in the unemployment rate, i.e. the long-run coefficient on the unemployment rate in a linear Phillips curve. A semi-elasticity since it refers to the percentage change in wages resulting from a 1 percentage point (not per cent) increase in the unemployment rate.

15. Because Grubb *et al.* impose the identical geometric lag structure on both the unemployment rate and inflation in their estimated wage equations (i.e. they include a lagged dependent variable), the ratio of their short- and long-run elasticities are identical.

APPENDIX

A. Stability tests

Recursive regressions test for gradual changes in parameters by running regressions over intervals which are extended one period at a time, with the recursion done both backwards and forwards [cf. Johnston (1984)]. Based on the recursive regression residuals, the Cusum and Cusum^2 statistics test the null hypothesis that the estimated coefficients from the different sub-samples are the same. The recursive regressions are not strictly comparable to those reported above since they are based on ordinary least squares, rather than two-stage least squares, and exclude all dummy variables. The results of the recursive regressions are reported in Table 10. Based on the Cusum test, the null hypothesis of equation stability is only rejected in the case of the forward recursion for Germany; based on the Cusum^2 test, stability is rejected for Japan, Germany, Italy, Australia and Austria. The results with alternative linear/non-linear specifications gave similar results.

Developments in the Quandt log likelihood ratio, which can be computed from the recursive regressions, suggest points where more sudden structural shifts may have occurred. Shifts in the estimated constant terms, as well as in some of the estimated slope coefficients, were tested using dummy variables. Except for Canada, only short-lived shifts in the constant term proved to be significant and these are reported in Table 7. The stability of the equations including all the dummy variables reported in Table 7 and based on two-stage least squares estimation has been examined using Chow tests. The sample was split into sub-intervals prior to and after the 1973 and 1979 oil shocks. The Chow test statistics are also reported in Table 10. For all countries except Austria the null hypothesis of equation stability over the period prior to 1973 compared to the period from 1974 onward cannot be rejected. There is evidence of more recent structural change only for the United Kingdom. Thus, for Japan, Germany, Italy, Australia and Austria, the inclusion of dummy variables may have captured the instability indicated by the test statistics from the recursive regressions.

B. The influence of dummy variables

The preferred equations estimated without any dummy variables are reported in Table 11.

C. Data definitions and sources

For all countries except the United States, Japan, Australia, Austria and Switzerland, the *wage* variable is constructed as the private sector national accounts wage bill per dependent employee in the private sector. For the United States the wage variable is the adjusted hourly earnings index for production workers in the non-farm business sector. For Japan it is the index of total wages and salaries, including bonus payments, per regular worker in all industries. For Australia it is total compensation in the non-agricultural sector, including private pension contributions and non-monetary income. For Austria it is the total national accounts wage bill per dependent employee. For Switzerland, it is the national accounts private sector wage bill divided by total employment; this series has been interpolated from annual data using the index of manufacturing wages as a reference series.

Table 10. **Stability tests**

	Test statistic					
	Chow[a]		Recursive regressions[b]			
	Divided at		Cusum		Cusum²	
	End 1973	End 1979	*f*	*b*	*f*	*b*
United States	–0.79	1.34	0.91	0.85	0.16	0.11
Japan	2.27	1.21	0.52	0.59	0.31*	0.37**
Germany[c]	1.44	0.32	1.09*	0.66	0.33**	0.31*
France	–0.20	–1.21	0.83	0.54	0.17	0.24
United Kingdom[d]	0.39	3.19*	0.37	0.49	0.25	0.25
	0.11	1.59	0.39	0.30	0.20	0.23
Italy	–0.82	–0.29	0.31	0.33	0.27*	0.26*
Canada	0.34	0.37	0.71	0.43	0.21	0.18
Australia	0.15	0.73	0.64	0.58	0.19	0.31*
Austria	7.09**	0.69	0.83	0.41	0.53**	0.54**
Netherlands	0.52	1.85	0.69	0.78	0.25	0.15
Switzerland[e]	1.23	0.33	0.75	0.46	0.28	0.27

a) Based on the two-stage least squares regressions reported in Table 1 (Table 4 for Australia) and including the dummy variables reported in Table 7.
b) Based on ordinary least squares regressions specified comparable to those in Table 1 (Table 4 for Australia) and excluding all dummy variables. *f* (*b*) denotes the test statistic from the forward (backward) recursion.
c) The equation includes a two-semester moving average of the growth of productivity.
d) The second line refers to the equation reported in Table 4 which incorporates the hypothesis of hysteresis in the natural rate.
e) The equation includes productivity growth and the difference between the growth of consumer prices and domestic output prices.
* Stability rejected at 5 per cent but not 1 per cent.
** Stability rejected at 1 per cent.

Consumer prices are the implicit National Accounts deflator for private consumption expenditures; domestic output prices are the implicit GNP deflator. The *unemployment rate,* which is based on national definitions, is total unemployed as a percentage of the civilian labour force. *Productivity* is defined as real GDP divided by total employment.

For most countries the *average tax rate* is defined as the sum of direct taxes on households and total social security contributions (both employees' and employers') as a percentage of total household income. For Germany and the Netherlands it is defined as the sum of total taxes on wage income and employees' social security contributions as a per cent of total household income. The *employers' contribution tax rate* is defined as the sum of employers' contributions for social security and private pensions and insurance as a per cent of total wages and salaries.

Profits were defined as national accounts gross operating surplus as a per cent of GDP and also as the gross operating surplus as a per cent of the gross capital stock, i.e. as a measure of the rate of return on capital. See Chan-Lee and Sutch (1985).

Data sources are OECD, *National Accounts, Quarterly Labour Force Statistics* and *Main Economic Indicators* as well as individual country national accounts.

Table 11. **The basic augmented Phillips curve without dummy variables**[a]

	Constant	Unemployment rate: U	Unemployment rate: $\log U$	Unemployment rate: $1/U$	Inflation term	Other	*SEE*	*DW*	$\bar{R}^2$	Estimation period
United States[b]	2.28	−0.19			0.80	0.01	0.35	1.08	0.79	65I-83I
	(0.29)	(0.09)			(0.13)	(0.01)				
Japan	−2.94			8.78	0.96		1.94	3.00	0.66	68I-83I
	(1.31)			(2.17)	(0.19)					
Germany	3.46		−1.18		0.43		1.33	1.48	0.36	64I-83I
	(0.60)		(0.25)		(0.28)					
	1.60		−0.91		0.71	0.65	1.24	1.56	0.45	64I-83I
	(1.01)		(0.26)		(0.30)	(0.27)				
France	2.23	−0.27			0.83	0.17	0.75	1.99	0.82	64II-83I
	(0.32)	(0.08)			(0.13)	(0.03)				
United Kingdom[c]	3.62	−0.19			0.65		2.43	1.42	0.37	65I-83I
	(0.95)	(0.15)			(0.18)					
	3.19	−0.66			0.71		2.29	1.53	0.44	65I-83I
	(0.83)	(0.28)			(0.16)					
Italy	6.35	−0.69			1.03		2.67	2.06	0.49	62II-83I
	(1.52)	(0.31)			(0.17)					
Canada	3.57	−0.52			1.15		1.18	1.73	0.65	61I-83I
	(0.58)	(0.11)			(0.13)					
Australia[c]	3.85	−0.61			1.04		2.49	1.83	0.42	69II-83I
	(1.60)	(0.24)			(0.32)					
	1.42	−1.73			1.29		2.31	1.90	0.50	69II-83I
	(1.46)	(0.55)			(0.33)					
Austria	3.75		−2.88		0.75		1.53	2.85	0.39	70II-83I
	(1.57)		(0.84)		(0.44)					
Switzerland	−33.66	0.32			1.00	0.24 −0.55	1.00	1.87	0.65	65II-83I
	(11.86)	(0.12)			(0.10)	(0.10) (0.15)				

a) See notes to Table 1.
b) The inflation term is specified as separate two- and eight-semester moving averages with respective coefficients of 0.38 (standard error of 0.12) and 0.42 (0.21).
c) In the second equation, the unemployment rate is specified as *U-U** as in Table 4.

BIBLIOGRAPHY

Andersen, P.S. (1984), "Real wages, inflation and unemployment", BIS Working Papers, No. 9 (July).

Artus, P. (1983), "Formation conjointe des prix et des salaires dans cinq grands pays industriels : peut-on comprendre les écarts entre les taux d'inflation ?", *Annales de l'INSEE* (January-March), pp. 267-311.

Branson, W.H. and Rotenberg, J.J. (1980), "International adjustment with wage rigidity", *European Economic Review* (May), pp. 309-332.

Braun, A.R. (1976), "Indexation of wages and salaries in developed economies", *IMF Staff Papers* (March), pp. 226-71.

Braun, S. (1984), "Productivity and the NIIRU (and other Phillips curve issues)", Working Paper No. 34, Board of Governors of the Federal Reserve System (February).

Buiter, W.H. and Gersovitz, M. (1981), "Issues in controllability and the theory of economic policy", *Journal of Public Economics* (February), pp. 33-43.

Chan-Lee, J.H. and Sutch, H. (1985), "Profits and rates of return in OECD countries", OECD/ESD Working Papers, No. 20 (May).

Coe, D.T. and Gagliardi, F. (1985), "Nominal wage determination in ten OECD economies", OECD/ESD Working Papers, No. 19 (March).

Englander, A.S. and Los, C.A. (1983), "Recovery without accelerating inflation", *Quarterly Review,* Federal Reserve Bank of New York (Summer), pp. 19-28.

Friedman, M. (1968), "The role of monetary policy", *American Economic Review* (March), pp. 1-17.

Gordon, R.J. (1984), "Wage price dynamics and the natural rate of unemployment in eight large industrialised nations", Paper presented at the OECD Workshop on Price Dynamics.

Green, C. and Cousineau, J.M. (1976), *Unemployment in Canada: the Impact of Unemployment Insurance,* Economic Council of Canada.

Grubb, D., Jackman, R. and Layard, R. (1983), "Wage rigidity and unemployment in OECD countries", *European Economic Review* (March/April), pp. 11-39.

Heap, S.P.H. (1980), "Chooosing the wrong 'natural' rate: accelerating inflation or decelerating employment and growth?", *Economic Journal* (September), pp. 611-20.

Henry, S.C.B., Sawyer, M.C. and Smith, P. (1976), "Models of inflation in the United Kingdom: an evaluation", *National Institute of Economics Review.*

Johnston, J. (1984), *Econometric Methods,* 3rd ed., McGraw Hill.

Klau, F. and Mittelstädt A. (1985), "Labour market flexibility and external price shocks", OECD/ESD Working Papers, No. 24 (July).

Knoester, A. and van der Windt (1985), "Real wages and taxation in ten OECD countries", Erasmus University, Rotterdam Institute for Economic Research Discussion Paper Series No. 8501 g/m.

Kuh, E. (1967), "A productivity theory of wage levels – an alternative to the Phillips curve", *Review of Economic Studies* (October), pp. 333-60.

Laidler, D.E.W. and Parkin, M. (1975), "Inflation: a survey", *Economic Journal* (December), pp. 741-809.

Layard, R., Basevi, G., Blanchard, O., Buiter, W. and Dornbusch, R. (1984), "Europe: the case for unsustainable growth", Center for European Policy Studies (No. 8/9).

Modigliani, F. and Tarantelli, E. (1976), "Forze di mercato azione sindacale, e la curva di Phillips in Italia", *Moneta e Credito* (June).

Robertson, H. and McDougall, M. (1980), "The structure and dynamics of RDXF, September 1980 version", *Bank of Canada Technical Report 26*, pp. 119-23.

Sachs, J. (1979), "Wages, profits and macroeconomic adjustment: a comparative study", *Brookings Papers on Economic Activity* (No. 2), pp. 269-333.

Santomero, A.M. and Seater, J.J. (1978), "The inflation-unemployment trade-off: a critique of the literature", *Journal of Economic Literature* (June), pp. 499-544.

Sumner, M.T. and Ward, R. (1983), "The reappearing Phillips curve", *Oxford Economic Papers*, Special Supplement (November), pp. 306-20.

Solow, R.M. (1985), "Unemployment: getting the questions right", mimeo, Paper presented to the Conference on the Rise in Unemployment (May).

Thirlwall, A.P. (1983), "What are estimates of the natural rate of unemployment measuring?", *Oxford Economic Bulletin of Economics and Statistics* (May), pp. 173-79.

Tobin, J. (1972), "Inflation and unemployment", *American Economic Review* (March), pp. 1-18.

Von Beyme, K. (1980), *Challenge to Power: Trade Unions and Industrial Relations in Capitalist Countries*, Sage Publications (London).

Woodham, D.M. (1984), "Potential output growth and the long-term inflation outlook", *Quarterly Review*, Federal Reserve Bank of New York (Summer), pp. 16-23.

Wren-Lewis, S. (1982), "A model of private sector earnings behaviour", Treasury Working Paper No. 23 (July), H.M. Treasury.