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STRUCTURAL ESTIMATES OF EQUILIBRIUM UNEMPLOYMENT IN SIX OECD ECONOMIES

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Structural estimates of equilibrium unemployment in six OECD Economies

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Abstract

In Europe, neither unemployment rates nor institutions are uniform. In the EMU, countries have coordinated their monetary policy, and fiscal policy might follow. Does convergence in fiscal policy imply that unemployment rates will converge, too, or is diversified fiscal policy desirable? An answer to this question requires insight into the dependence on fiscal policy of the unemployment rate in equilibrium. This study estimates the equilibrium rate of unemployment and shows that it has been affected significantly by taxes and benefits. Uniform fiscal policy would not, however, harmonise the unemployment rates because the impact of policy varies widely across the OECD economies.

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1 Introduction

Though the OECD economies, and in particular the West-European economies, are highly interdependent, their economies behave differently. Differences in the level and development of the unemployment rate are important, both from a macroeconomic and a policy point of view. In Europe, the unemployment rate in 2000 varies between 3% in the Netherlands and 14% in Spain. Moreover, the development of the unemployment rate in the past decades had shown marked differences, showing a large increase in Spain, but a rather stable pattern in the United States.

In this paper, we attempt to explain these persistent differences in the unemployment rates from an equilibrium point of view. We estimate the equilibrium rate of unemployment for six OECD economies. Fluctuations in this equilibrium rate can be explained from fluctuations in the tax wedge, the replacement rate, the minimum wage rate and the user cost of capital. This dependence of the equilibrium rate of unemployment on several policy variables suggests that governments can influence the unemployment rate.

In the multi-country context of this paper, we will investigate not only whether unemployment might in equilibrium depend on fiscal policy, but also whether the link between fiscal policy and the unemployment rate is uniform across the six OECD economies in our sample.[1] We investigate whether differences in the response of the equilibrium rate of unemployment to fiscal policy contributes to the explanation of persistent variation in unemployment rates between countries in past decades. A confirmative conclusion implies that future reforms of fiscal policy should take into account the country-specific impact of institutional changes on unemployment. In the debate surrounding the design of fiscal policy in a monetary union, insight into the responsiveness of the member economies to fiscal shocks will be indispensable.[2]

There are several explanations for the dependence of the unemployment on fiscal policy.[3] First, Friedman (1968) argues that monetary policy in the long run affects only nominal variables. Real variables, like the unemployment rate, might be influenced in the short run, but then return to their natural rates in the long run. In the long run, real variables depend on real factors only. The question then arises, what are the real factors? Does fiscal policy permanently affect the real economy? Theories in which this relationship exists generally include imperfect wage formation, see Pissarides (1998). One example is the theory of search frictions on the labour market, where workers and firms have the opportunity to negotiate the wage rate. Policy

[1] The sample consists of Germany, France, the Netherlands, Spain, the United Kingdom and the United States.

[2] See Beetsma et al. (2001) for a survey of the literature on fiscal policy coordination in a monetary union.

[3] A prominent stream of empirical literature on the equilibrium rate of unemployment focuses on the relation between inflation and unemployment and tries to find the rate of unemployment at which inflation is stable, see Gordon (1997), and Richardson et al. (2000). This type of empirical literature is, however, unable to detect the causes of equilibrium unemployment.

affecting the relative positions of workers or firms might affect unemployment in the long run. Alternatively, the theory of efficiency wages assumes that firms set wages above the market-clearing level to induce high effort by workers. This paper adopts a third alternative, in which unions are assumed to negotiate the wage rate, which results in a wage rate exceeding the market-clearing level, which then creates unemployment.[4] This approach, known as the monopoly union approach, was introduced by Leontief (1946) and popularised by Layard et al. (1991).

In the negotiations, unions take into account the net wage rate and the fallback position of workers. Both can be influenced by fiscal policy or economic conditions. The economic condition relevant in the negotiations is the unemployment rate, because unions take into account the fact that a high wage rate might reduce the demand for labour, which implies that a fraction of the union members might become unemployed. Three types of fiscal policy are distinguished in the paper. The replacement rate, which is influenced by the government's decisions on the generosity of the social security system, affects the fallback position of workers in the wage negotiations. An improvement in this fallback position reduces the income reduction of becoming unemployed and pushes the wage rate upward. Besides the unemployment benefits, the fallback position might also be affected by changes in the minimum wage rate. The third policy variable that might affect the wage rate is the wedge. This variable is important if taxes affect labour income and the alternative sources of income differently.

Empirical support for the relationship between the wage rate and the unemployment rate is provided by Blanchflower and Oswald (1994) and Blanchard and Katz (1997), among others. The support is strong for European economies, but the wage level relation is often rejected for the United States, see Blanchard and Katz (1999). This support for the existence of a wage curve implies that the key prediction of the monopoly union model is not rejected empirically. Evidence for the influence of taxes and the replacement rate on the wage rate can be found in Graafland and Huizinga (1999). With respect to the replacement rate, they conclude that the empirical evidence is scarce and mixed. The relation between the tax wedge and the wage rate is more robust, but the estimates vary widely. The question whether the differences across countries are institutional or due to the use of different data sources and various theories cannot be answered with a survey of the available evidence. A contribution of this paper is to estimate the relation between wages, unemployment and fiscal policy for six OECD economies in a uniform framework.

Labour demand by firms implies a second relation between wages and employment – in fact

[4] The fact that workers and unions do not negotiate employment makes this approach inefficient, cf. McDonald and Solow (1981), but we adopt it because "explicit simultaneous bargaining on wages and employment is most unusual" (Teulings and Hartog, 1998, p144). One of the reasons why firms and unions do not negotiate the employment level is that firms continuously adjust their employment level via hiring and firing. Continuous negotiations on the employment level would therefore be very costly, see Nickell (1990).

a negative relationship. In reaction to an increase in their wage costs, firms reduce their employment level if their production function exhibits decreasing returns to scale. A crucial parameter in this labour demand relation is the elasticity of substitution between labour and capital, which measures the sensitivity of labour demand to relative changes in the price of labour. This relative price, in turn, depends on the price level of alternative inputs such as capital.

In equilibrium, the wage curve and the labour-demand equation determine the wage rate and the unemployment rate. This equilibrium rate of unemployment therefore depends on the determinants of both curves, like the wedge, the replacement rate, the minimum wage rate and the cost of capital. An important spin-off in this paper is to measure the equilibrium rate of unemployment and show how it depends on the structural determinants. Key questions are whether the structural approach can provide reliable estimates of the equilibrium rate of unemployment and whether dependence on the structural determinants is uniform across the OECD economies. Broer et al. (2000) showed that these factors are important determinants of equilibrium unemployment in the Netherlands. We investigate whether this also holds for Germany, France, Spain, the United Kingdom and the United States. Nickell (1998) and Blanchard and Wolfers (2000) show in cross-section and panel-analyses that the replacement rate and taxes, among others, contribute significantly to unemployment in the OECD. However, they do not provide country-specific evidence and are therefore unable to answer the question which institutions are important in which country. Country-specific evidence is provided by Bean et al. (1986), who show that taxes contributed significantly to unemployment in the United States, the United Kingdom and the Netherlands, but hardly in Germany and France. We deviate from Bean et al. (1986) by adding the replacement rate and capital costs as explanations for the equilibrium rate of unemployment, in a different framework. This theoretical model is described in section 2. The empirical results are shown in section 3.

2 The model

We develop a small structural model for the labour market. Key relations of this model are the wage equation and the labour demand curve. The wage equation is an extension of Layard et al. (1991), which has also been adopted by Broer et al. (2000), whereas labour demand stems from cost minimisation by firms. From both equations, the equilibrium rate of unemployment follows.

2.1 The wage equation

Unions and firms are the dominant players on the labour market. We assume that firms can set the employment level, whereas unions and firms negotiate the wage rate. Unions represent the workers and aim at maximising the surplus of work S_W over the income from alternatives:

$$S_W = \frac{w^N}{p_c} - \lambda\ \xi\ \frac{w^N}{p_c} - (1-\lambda)\ [\rho\ \frac{w^N}{p_c} + \gamma\ \frac{w}{p_y}] - \lambda\ (1-\xi)\ \frac{w^N_{\min}}{p_c}, \tag{2.1}$$

$$w^N = w(1+t_e)^{-1}(1-t_d), \quad w^N_{\min} = w_{\min}(1+t_e)^{-1}(1-t_d).$$

The return to employment is the net real wage income of workers, which is the gross wage rate $w(1+t_e)^{-1}$ deflated by the consumer price p_c, and corrected for taxes and premiums, where t_e and t_d are taxes and premiums paid by employers and employees, respectively.

The alternatives to work for unions consist of several parts, which are weighted with the probability λ that a worker finds another job and with the probability $(1-\xi)$ that this new job is in a sector with a minimum wage. The first alternative for workers is to find another job with probability $\lambda\xi$. If workers and unions bargain over the wage, the results do not cover all firms and unions. Consider the case where workers push up the wage rate, with the consequence that firms do not hire all of the union's workers. Here, the option of accepting a job not covered by the negotiations becomes relevant. It is plausible that the probability of getting another job λ depends on the unemployment rate u, so $\lambda = \lambda(u)$.

The second alternative is benefit income that workers might receive if they remain or become unemployed. Benefits are linked to the gross wage rate, and are generally taxed. This implies that the net-replacement rate ρ might enter the solution for the negotiated wage rate.

Thirdly, home production might generate income for unemployed workers. We assume that the productivity at home is limited, such that the return to home production is a fraction γ of the wage rate. Home production is not subject to indirect taxes, which implies that the return to home production must be deflated by the value-added price p_y. An advantage of home production is that it is free of taxation. If taxes or premiums are increased, then workers' net returns to employment falls, but the return to home production is unaffected. The assumption about home production therefore introduces the wedge as a determinant of the wage rate, independent of the net-replacement rate.[1]

Finally, the negotiated wage rate might depend on the minimum wage w_{min}. The most obvious reason a minimum wage might affect the wage rate is that low-productive workers become unemployed. The increase in unemployment tempers the wage rate, but the higher average productivity level might push the average wage rate up. Alternatively, if minimum wage jobs are not covered by unions, they might be part of the fallback of workers in the negotiations, where we assume that unemployed workers have a possibility ξ of being hired in the minimum-wage sector. An improvement in this fallback option might raise the negotiated wage rate. This alternative reason provides an impact from the minimum wage rate, independent of labour productivity and unemployment.

Firms aim at hiring labour to maximise profits. We assume that the single alternative to firms is to close the vacancy. The surplus of the firm S_F in the negotiations with a single worker can therefore be written as:

$$S_F = p_y h - w, \tag{2.2}$$

where h is labour productivity. In the right-to-manage model of the labour market, workers and firms share their surpluses by negotiating the wage rate. The level of employment is not part of the bargaining process, but is determined by firms. However, the labour demand function of firms is known by both firms and unions, and is taken into account in the negotiations.

In the appendix we show that maximising the generalised Nash product of the surpluses of unions and firms leads to a nonlinear wage equation.[2] This wage equation can be linearized to:

$$\ln w = \ln p_y + \ln h \; + \; \chi_1 \ln \Lambda \; + \; \chi_2 \ln \rho \; + \; \chi_3 \ln \frac{w_{\min}}{w} \; - \; \chi_4 u \; + \; \chi_0 \; . \tag{2.3}$$

where Λ is the wedge between gross wage costs and net wage income.[3] The wage equation is defined in real terms, because both workers and firms are interested in the real return to employment. Labour productivity enters the wage equation with a unit coefficient, which implies that workers benefit from an increase in the productivity of labour. The wedge between labour costs and the net wage rate enters the wage curve because unions trade off employment versus home-production. A wedge coefficient between zero and unity implies that an increase in taxes is borne partly by workers and partly by firms. An increase in the replacement rate or the minimum wage rate reduces the difference between wage income and the alternatives. This

[1] An untaxed source of income (or welfare) is necessary for the wedge to affect the wage rate. The untaxed source of income we opt for is home production. Alternatively, welfare from leisure might be introduced as the untaxed source of welfare. In contrast, benefits are generally taxed, such that an increase in taxes raises both labour income and benefit income equivalently, leaving the wage rate unaffected. Graafland and Huizinga (1999) show that in the empirical literature the wage rate depends on both the wedge and the replacement rate.

[2] See Graafland and Huizinga (1999) for the derivation and estimation (for the Netherlands) of a similar non-linear wage equation.

[3] The wedge is defined as $\Lambda = w_y / w_c$, where $w_y = w / p_y$ and $w_c = w^N / p_c$, which implies that $\Lambda = \frac{p_c(1+t_e)}{p_y(1-t_d)}$.

improves the bargaining position of unions, allowing them to negotiate a higher wage rate. Finally, the unemployment rate enters the wage curve for two reasons. First, it affects the probability that a fired worker can find a job in another firm. In addition, it measures the fraction of workers receiving unemployment benefits.

2.2 Labour demand equation

Firms use labour and capital in the production process. The demand for these inputs is determined by minimisation of costs. We assume that technological progress is labour augmenting, which implies that the production of a unit of output requires a diminishing amount of labour over time. Measured in efficiency units, however, the shares of labour and capital are assumed to be fixed. Adopting a CES-cost function, the costs per unit of output are:

$$c \;=\; \left[\theta\, p_l^{1-\sigma} \;+\; (1-\theta)p_k^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \;, \quad p_l \;=\; \frac{w}{p_{l\,0}\; e^{\gamma_1 t \,+\, \gamma_2 t^2}} \;, \tag{2.4}$$

where θ is the labour share, σ is the substitution elasticity between labour and capital, p_k is the user cost of capital, p_{l0} is p_l in the base year, and $\gamma_1 t + \gamma_2 t^2$ is a proxy for the laboursaving technological progress. The demand for labour follows from the minimisation of total costs, which is the cost per unit of output c times output y, with respect to the level of employment l:

$$\ln l \;=\; \ln\theta \;+\; \ln y \;-\; \sigma\, \ln\left(\frac{p_l}{c}\right) \;-\; \gamma_1 t \;-\; \gamma_2 t^2 \;. \tag{2.5}$$

In the base year, where $t = 0$ and prices and costs equal unity, the parameter θ is equal to the labour income share. Over time, the labour income share can vary only if the substitution elasticity σ is unequal to unity. Countries with large variability in the labour income share likely have a low elasticity of substitution, and vice versa. In estimating equation (2.5) we will assume that marginal costs are equal to the value added price: $c = p_y$.

2.3 Equilibrium rate of unemployment

The wage equation (2.3) and the labour demand equation (2.5) can both be written in terms of the labour income share. Equation (2.3) shows the labour income share that follows from the wage negotiations. Equation (2.5) represents the optimal labour income share for firms operating on a perfectly competitive goods market. In equilibrium, both expressions for the labour income share must be consistent.[4] This implies that, in equilibrium, unemployment must equal

$$u^* \;=\; \frac{1}{\chi_4}\left[\chi_1 \ln\Lambda \;+\; \chi_2 \ln\rho \;+\; \chi_3 \ln\frac{w_{\min}}{w} \;-\; \ln\left(1 \;-\; (1-\theta)\left(\frac{p_k}{p_y}\right)^{(1-\sigma)}\right) \;+\; \chi_0\right] \tag{2.6}$$

where u^* denotes equilibrium unemployment. This expression shows four determinants of the equilibrium rate of unemployment: the wedge, the replacement rate, the minimum wage rate and

[4] Draper and Huizinga (2000) elaborate on the equilibrium labour income share.

relative capital costs. The wedge may shift because of changes in tax rates or because of a change in the terms of trade. An increase in the wedge and the replacement rate push up wage demand and, ceteris paribus, lead to an increase in the labour income share if $\sigma<1$. However, the labour income share consistent with firm price and employment setting has not changed. To maintain equilibrium, the unemployment rate has to rise. An increase in the markup and the relative user cost of capital reduces the labour income share consistent with firm price and employment setting. Thus, the labour income share that results from the wage bargaining must also fall. To bring this about, the unemployment rate has to rise.

The degree to which the relative labour price or the user cost of capital affects equilibrium unemployment depends on the elasticity of substitution. A rise in the relative cost of capital always reduces the real wage the firm can pay and still maintain its level of profitability. This follows directly from the factor price frontier. The issue is how the unions will be induced to accept this wage cut. Without substitution, the standard mechanism of layoffs and unemployment is obtained. If there is scope for substitution, firms will also respond by reducing the capital/labour ratio, which over time reduces labour productivity. Since lower productivity directly reduces union wage demand, there is less need for unemployment to rise here. With a Cobb Douglas technology, the reduction in labour productivity exactly matches the reduction in the real wage the firm can pay. Union wage demands then also exactly match this wage reduction, and there is no need at all for increased unemployment.

The impact of the elasticity of substitution is an important difference with other recent labour market theories, where we do not presuppose a substitution elasticity of 1 (as, for instance Layard et al. (1991) and Blanchard and Katz (1997)). Available empirical evidence for the Netherlands does not generally point to an elasticity of substitution close to unity, cf. Broer et al. (2000), and the estimates in this paper confirm these findings. Blanchard (1997) finds much higher elasticities of substitution. However, he estimates the elasticity of complementarity (the inverse of the substitution elasticity). This yields an upwardly biassed estimate of the elasticity of substitution, see Hamermesh (1993).

A second important difference with the literature is the absence of labour productivity as an explanation of the equilibrium rate of unemployment. Ball and Mankiw (2002) state that the most promising hypothesis is that the decline in the NAIRU (in the 90s) is attributable to the acceleration in productivity growth. In our framework, labour productivity does not affect the equilibrium rate of unemployment because in our model the wage elasticity of labour productivity equals one in equation (3), and the output elasticity in equation (5) equals one, as well. Whether these restrictions are valid is an empirical issue to which we return in the next section.

2.4 Data

To give an impression of the labour market developments in the countries of our sample, we present the series for the labour income share and the rate of unemployment in figure 2.1.[5] The labour income share is interesting because it will be constant only if the substitution elasticity is equal to one. In the wage equation, the labour income share is linked to the rate of unemployment, among other determinants, and the graphs of both variables may provide a first indication whether a negative relation might exist between the level of the labour income share (or the level of the wage rate) and the level of unemployment.

The graphs of the labour income share show that this share is quite stable in Germany, the United Kingdom and the United States, whereas it shows large fluctuations in the Netherlands and Spain. The unemployment rate shows a distinct upward trend in the European economies, with clear signs of unemployment reduction in the 1990s in the Netherlands and the United Kingdom.

[5] Details about the data sources are provided in the appendix.

Figure 2.1 Labour income share and unemployment rate (1960-1998)

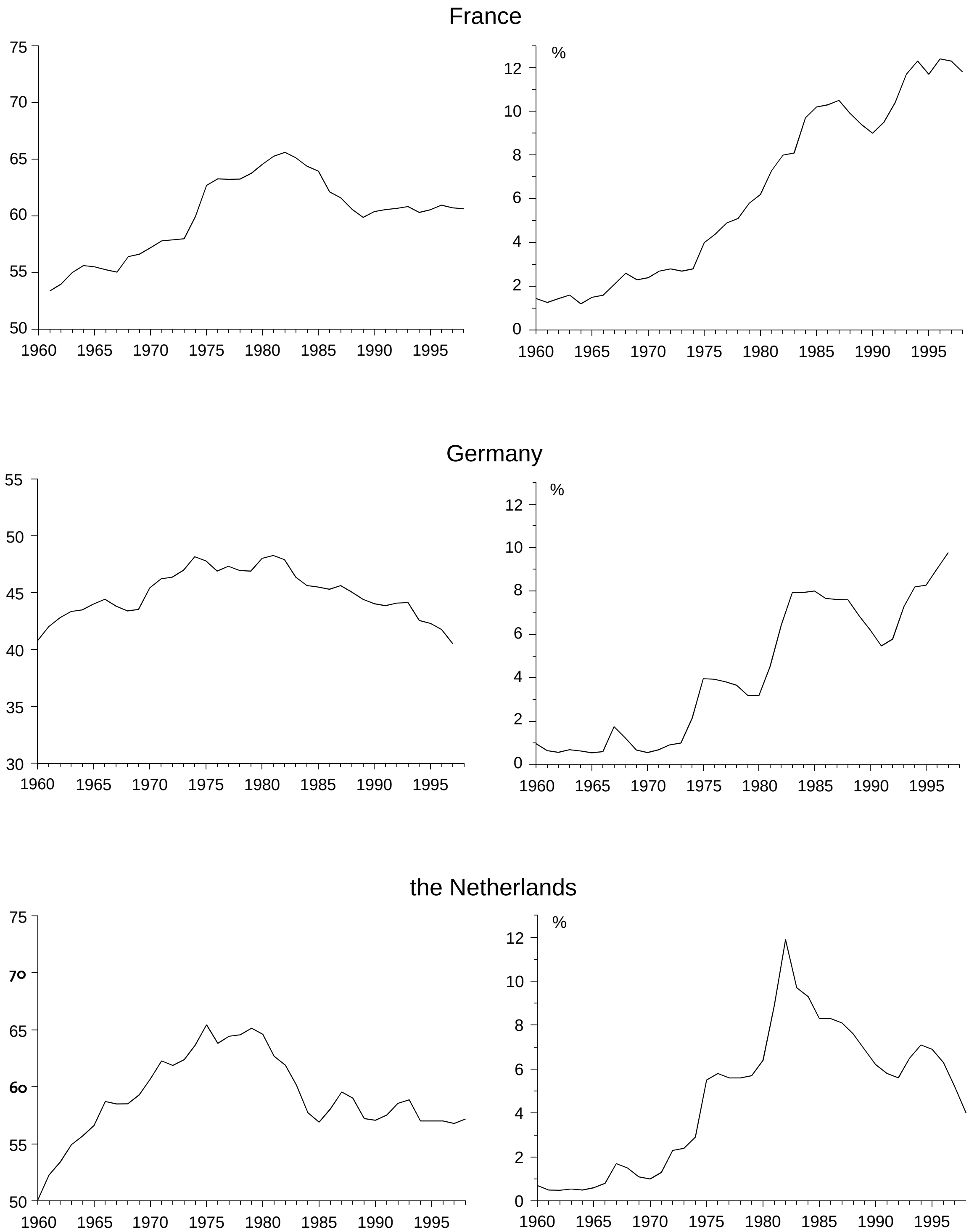
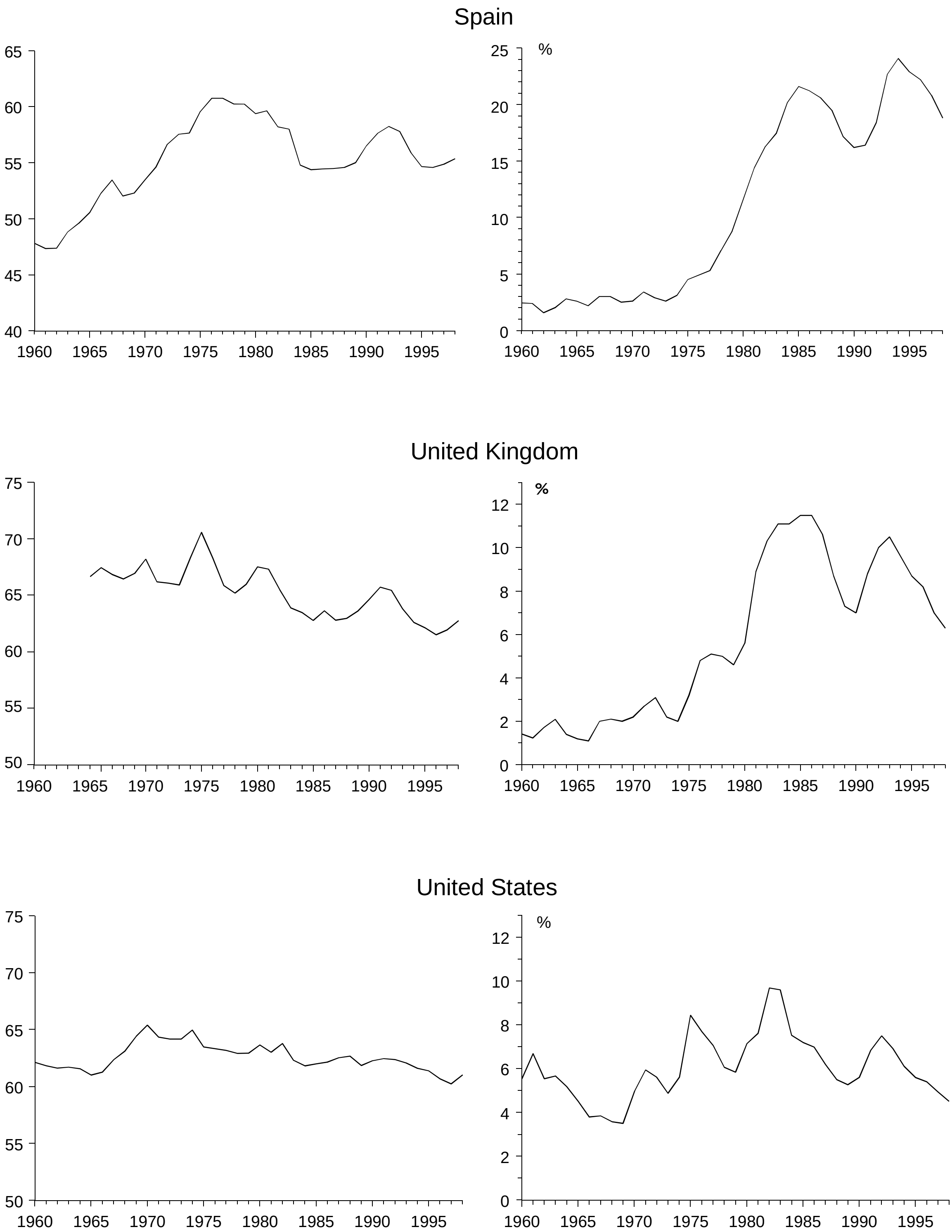


Figure 2.1 continued: Labour income share and unemployment rate (1960-1998)



3 Estimation results

The key equation of the model is the expression for the equilibrium rate of unemployment in equation (6), where it is shown how it might depend on structural factors like the wedge, the replacement rate and the relative price of capital. In this empirical section, the central question is how much? How much is the equilibrium rate of unemployment influenced by the identified structural factors? This question must be answered in two steps. First, the wage and labour-demand equations are estimated. Next, we calculate the equilibrium rate of unemployment from these equations and show how it depends on the structural factors.

The wage and employment equations were estimated for each country separately. In the wage equation, different sets of exogenous variables were included because some variables were not available (like the replacement rate for the United States) or do not exist (like the legal minimum wage rate in Germany, the United Kingdom and the United States). In addition, the minimum wage rate was not included in the wage equation for the Netherlands, because minimum wages and the replacement rate are closely tied.

The estimation of the wage and employment equations can be considered as the first step in an error-correction estimation, see Engle and Granger (1987). The second step, the estimation of the short-run dynamics, is less important for the main argument of this paper and is therefore discussed in the appendix.

3.1 Wage equation

The wage equation is based on wage bargaining between unions and firms. Wage bargaining is present in all countries of our sample, though at different levels and with different scope. In the United States, most collective agreements are negotiated at the plant or employer level, see Teulings and Hartog (1998). The coverage of these agreements is limited to the union members, which are only a quarter of all workers. Siebert (1997) therefore concludes that wage formation in the United States comes close to being a market process. This contrasts with most European countries, where the coverage of wage negotiations is high: the wages of three-quarters of the employees result from wage negotiations, see Layard et al. (1991).[1] This is not primarily the result of a much higher share of unionised workers in the European countries, but more importantly due to the extension of collective agreements to non-union workers. In addition, wages are often not determined at the firm level, but at the level of the industry or the economy, see Siebert (1997).

The estimation results for the wage equation are summarised in Table 3.1. For each country, the real wage rate was regressed on labour productivity, the wedge, lagged unemployment and a

[1] Within our sample, the United Kingdom is an exception, where the coverage of collective agreements is less than 50%; see OECD (1997).

constant. In addition, the replacement rate, the minimum wage rate deflated by the product price, and dummies were included for several countries. We show in the appendix that these variables are integrated,[2] which implies that the wage equation estimates should be treated as co-integration relations. Therefore, a likelihood ratio test will be use to test the significance of the parameters.

Table 3.1 Wage equation estimates

Country	Sample	$\ln\Lambda$	$\ln RR$	$\ln(\frac{w_{min}}{p_y})$	$u(-1)$	χ_0	DW	DF
France	1970-1998	0	0.14	0.25	− 0.79	− 2.26	1.30	− 3.29
		(-)	(0.05)	(0.05)	(0.40)	(0.39)		(0.07)
Germany	1970-1994	0.73	0		− 2.10	− 1.06	1.55	− 4.76
		(0.12)	(-)		(0.26)	(0.05)		(0.00)
The Netherlands	1970-1998	0.13	0.75		− 1.07	− 0.32	1.24	− 3.62
		(0.06)	(0.08)		(0.23)	(0.02)		(0.03)
Spain	1971-1998	0.21		0.25	− 0.68	− 0.55	1.01	− 3.12
		(0.11)		(0.04)	(0.11)	(0.03)		(0.10)
United Kingdom	1965-1998	0.20	0.05		− 0.79	− 0.42	1.02	− 3.56
		(0.06)	(0.02)		(0.12)	(0.03)		(0.03)
United States	1969-1998	0			− 0.40	− 0.44	0.24	3.38
		(-)			(0.24)	(0.02)		(0.05)

Estimated equation: $\ln w = \ln p_y + \ln h + \chi_1 \ln\Lambda + \chi_2 \ln\rho + \chi_3 \ln(w_{min}/p_y) + \chi_4 u + \chi_0$
DW: Durbin-Watson statistic.
DF: Dickey-Fuller test for the stationarity of the residuals.
The second row for each estimation contains standard errors for the parameters and the p-values for the Dickey-Fuller test.
0: variable has been included, but appears to be insignificant, or wrongly signed and has therefore been restricted to zero.
Dummies:
For France, we have included a dummy for the periods 1980-1984 (coefficient: 0.04) and 1989-1992 (coefficient: − 0.03).
For Germany, we have included a dummy for the unification period, 1991-1994 (coefficient: − 0.07).
For Spain, we have included a dummy for the period, 1984-1985 (coefficient: − 0.04).

The key result of the estimations of the wage equation is that the lagged rate of unemployment reduces current wages. The size of the effect and the significance varies between countries. The effect of changes in the unemployment rate may be extremely important in Germany, where an increase in the unemployment rate of 1%-point reduces the wage rate by more than 2%.

The wedge between wage costs and net wages was not differentiated to its components but was included as a single variable.[3] This wedge turns out to affect the wage positively, excepting France and the United States, where the wedge coefficients are insignificant.[4] The positive

[2] In a few cases the unit-root test is unable to distinguish between a deterministic and stochastic unit root.

[3] Tyrvainen (1995) concludes that ‘in eight out of ten countries, an hypothesis of identical long-run response to changes in all relevant tax rates passed the test’ (p44). Among these eight countries are France and Germany.

[4] The insignificant wedge term for France, which was in the estimations often negatively signed, might be caused by the

wedge effect implies that households can shift part of their tax changes towards firms, and vice versa.

The impact of the replacement rate is significantly positive for the countries for which it is available (except Germany). The effects of changes in the replacement rate are quite small for France and the United Kingdom, and large for the Netherlands.[5] In these three countries, an increase in the replacement rate, which improves the fallback position of employees in the wage negotiations, allows workers to negotiate a higher wage rate. A similar story holds for the minimum wage rate, which can be another determinant of the fallback position of workers. In the countries for which the minimum wage rate is included, the wage rate depends positively on it. An exception is the Netherlands, where benefits are tied to the minimum wage, which implies that the minimum wage effect cannot be estimated independently from the replacement rate effect.

We have included a few additive dummies in the estimations. The unification dummy for Germany was mentioned already, where unification influenced West-German wages negatively. When multiplied with the unemployment rate (not reported), the dummy implies that the rate of unemployment has a stronger impact on the real wage rate after the unification than before. A similar observation was reported by Hansen (2000). The 1984-1985 dummy for Spain, a period in which wages were low, reflects the efforts made in preparation of joining the European community, see Blanchard and Jimeno (1995). The 1980-1984 dummy for France may point to the exchange crisis of 1981-1983, where according to Sicsic and Wyplosz (1996) 'an explicit move against wage indexation was deemed necessary to bring inflation down' (pp. 226-7).

Table 3.1 reports the Durbin-Watson statistic and the Dickey-Fuller statistic. Given that we estimated long-run equations, the reported DW statistics do not point to serious serial correlation in the wage equations for the European countries. In contrast, the DW statistic for the US is very low, because the residuals of the wage equation are trended downwardly. This might be induced by the restriction of the labour productivity coefficient to unity, well above the unrestricted estimation, see Table C.1. The Dickey-Fuller statistic for testing stationarity shows that the residuals of each estimation are stationary, where it should be mentioned that the trend in the unit-root test is significant for the United States. The stationarity of the residuals is confirmed by the error-correction estimations for the six countries in the appendix, in Table C.2, where the difference between the actual and equilibrium wage rate enters the short-run wage rate negatively.

Finally, we restricted the price and labour productivity parameters in the wage equation.

extremely high correlation between the wedge and the unemployment rate. Estimation over a shorter period (1971-1990), where the correlation is smaller, yields a positive wedge coefficient.

[5] Given these small effects, we cannot reject the conclusion by Bean (1994) that 'the evidence for a major role for unemployment benefits on to wages seems weak'. The Netherlands might be an exception, though Broer et al. (2000) report a lower coefficient of 0.35 for the replacement rate in the Netherlands.

Table C.1 in the appendix shows that the unrestricted estimation of these parameters is close to one, with the exceptions of France and the United States, where responsiveness of the real wage is respectively 0.55 and 0.83.

If we compare the estimates of the wage curve with (part of) the existing evidence, we find some interesting similarities and differences. Table 3.2 presents a survey of these results. In the early 1990s, Drèze and Bean (1990) published a collection of papers, most of which included wage-level estimations for nine European countries. Layard et al. (1991) estimated wage-level equations and calculated the NAIRUs for most OECD countries. Tyrvainen (1995) estimated a set of wage and labour demand equations; which he used for a few policy simulations, not for the calculation of the equilibrium unemployment rate. For a similar purpose, Barrell and Dury (2001) estimated the wage equation for 11 Euro countries. Finally, Morgan and Mourougane (2002) used a panel of OECD countries to estimate a wage equation with institutional variables. They observed significant effects from mismatch and union density, but non−robust results for the wedge and the replacement rate.

Others studies have linked the wage-growth to the wedge and the replacement. For example, Bean et al. (1986) observes significant wedge coefficients for France and the United States, but insignificant coefficients for Germany (negative coefficient), the Netherlands and the United Kingdom.

A summary of these estimation results is presented in Table 3.2. In addition, we included a few single-country studies. Clearly, if labour productivity is included in the wage equation, then its coefficient is restricted, generally to one. Though the wedge coefficients should be interpreted with care (because various studies might use different definitions), the table shows that in most countries labour taxes are shared between workers and firms. Thirdly, in the few studies that include the replacement rate, its effect on wages is positive, but uniformly less than 0.5. Our estimated coefficients for the replacement rate in France, Germany and Spain fit in this picture, but the coefficient for the Netherlands is large. Finally, a high unemployment rate depresses wages in all studies, but with different semi-elasticities. Any coefficient between zero and four can be found, and our variety of coefficients fits nicely in this picture. More specifically, the larger coefficient for Germany in our sample corresponds with the literature.

Summarising, the estimated equations represent the data well, excepting France and the United States. The weaknesses of the wage equation for France are the inclusion of two dummies and the low coefficient for labour productivity in the unrestricted estimation. Nevertheless, the restricted equations for France fit the data quite well, and can therefore be used for the calculation of the equilibrium rate of unemployment. The residuals of the wage equation for the United States are clearly trended and can therefore not be viewed as a good representation of the US wage determination.

The fact that the unemployment rate reduces the wage rate for all countries implies that the wage negotiation model can be maintained for the European economies in the sample. This is in

Table 3.2 Wage equations in the literature

	$\ln y - \ln l$	Λ	RR	u	$\ln u$
France					
Barrell and Dury (2001)	1.0*			− 1.06	
Layard et al. (1991)				− 2.22	
Tyrvainen (1995)	1.0*	0.42			− 0.29
Germany					
Barrell and Dury (2001)	1.0*			− 3.59	
Entorf et al. (1990)	1.0*			− 2.20*	
Layard et al. (1991)					− 0.55
Tyrvainen (1995)	1.0*	1.0			− 0.17
The Netherlands					
Barrell and Dury (2001)	1.0*			− 1.64	
Broer et al. (2000)	1.0*	0.28	0.29	1.76	
Layard et al. (1991)					− 0.66
Lever (1991)[a]	1.0*	0.76	0.17	− 1.49	
Spain					
Andrés et al. (1990)[b]	0.8*	1.0*		− 1.06	
Barrell and Dury (2001)				− 0.65	
Dolado et al. (1986)[b]	1.08	1.0	0.45	− 3.02	
Layard et al. (1991)				− 0.17	
United Kingdom					
Barrell and Dury (2001)	1.0*			− 2.06	
Layard et al. (1991)				− 0.98	
Layard and Nickell (1986)[b]	1.07	0.16	0.14	− 2.47	
Tyrvainen (1995)	1.0*	0.3			− 0.10
United States					
Layard et al. (1991)				− 0.32	
Tyrvainen (1995)	1.0*	0.0*			− 0.05

Dependent variable in all equations is the real wage rate ($\ln w - \ln p_y$).

*: restricted coefficient.

[a]: Lever (1991) estimates separate wedge terms; we report the estimated coefficient for the employers' social security contribution rate.

[b]: Andrés et al. (1990), Dolado et al. (1986) and Layard and Nickell (1986) include the capital-labour force ratio instead of labour productivity.

Tyrvainen (1995) does not make clear which parameters are estimated and which are restricted. He states, however, that the restrictions are data consistent.

line with the empirical evidence summarised in Table 3.2. It also confirms the conclusion of Blanchard and Katz (1999), that a wage-level equation can be estimated for European economies, but not for the United States.

3.2 Labour demand equation

Table 3.3 shows the results of regressions in which employment was regressed on output and the relative price of labour, see equation (2.5). The output coefficient was restricted to unity, where unrestricted estimations do not differ significantly from unity, see Table C.1.

Table 3.3 Labour demand equation estimates

Country	Sample	σ	θ	t	t^2	DW	DF
France	1970-1998	0.12	0.61	0.01	− 0.003	0.88	− 4.35
		(0.08)	(0.002)	(0.001)	(0.0001)		(0.00)
Germany	1962-1994	0.48	0.44	0.02	0	1.13	− 3.42
		(0.06)	(0.001)	(0.001)	(-)		(0.05)
The Netherlands	1970-1998	0.33	0.57	0.01	− 0.004	1.09	− 3.60
		(0.06)	(0.002)	(0.001)	(0.001)		(0.03)
Spain	1971-1998	0.27	0.55	0.01	− 0.001	0.71	− 3.68
		(0.06)	(0.003)	(0.001)	(0.0001)		(0.02)
United Kingdom	1965-1998	0.67	0.63	0.02	0	0.89	− 5.06
		(0.09)	(0.003)	(0.002)	(-)		(0.00)
United States	1969-1998	0.92	0.61	0.04		1.45	− 3.34
		(0.13)	(0.002)	(0.04)			(0.06)

Estimated equation: $\ln l = \ln\theta + \ln y - \sigma(\ln w - \ln p_y) - \sigma(\gamma_1 t + \gamma_2 t^2)$
See explanation of Table 3.1.
For France, we included a dummy for the period 1988-1992 (coefficient: -0.02).

The main message of the estimated labour demand equations in Table 3.3 is that the substitution elasticity between labour and capital lies uniformly between zero and one. Only in the case of France does the elasticity not differ significantly from zero. Germany, the United Kingdom, and the United States, however, have high elasticities of substitution, which is in line with their relatively flat curve for the labour income share.

The normalisation of the wage rate and the GDP deflator to one in the base year (generally 1995) implies that the constant term of the labour demand equation matches the labour income share in that year. Therefore, it is not surprising that θ shows up significantly for every country.

The significant coefficients for the trend and its square (in most countries) show that technological progress increases the demand for labour, though at a decreasing rate.

The test-statistics show that serial correlation is not a severe problem in the labour demand equations and that the residuals of the labour demand equations are stationary. The stationarity of the residuals is confirmed by the error-correction estimations in Table C.3 of the appendix. Finally, we tested whether the unit restriction on the output coefficient is valid. Table C.1 in the appendix shows that unrestricted estimates of this coefficient are not significantly different from unity.[6]

The empirical observation that the elasticities of substitution are less than unity corresponds with the empirical literature, of which three papers will be cited. First, Rowthorn (1999) surveys the literature on substitution elasticities and shows that the median of the estimates is 0.58, and in only seven of 33 cases the estimated coefficient exceeds 0.8. Most of his sample consists of empirical studies for the United States or the United Kingdom. The single multi-country study they include is Drazen et al. (1984), with a substitution elasticity of 0.21 for ten OECD countries. Second, Drèze and Bean (1990) include several country-specific studies on the labour market, and their estimates are less than unity for France, Germany and Spain, but exceed unity for the United Kingdom and the United States. Finally, Blanchard (1997) regresses the labour-capital share on the real wage rate for a panel of 15 OECD-countries and concludes that, assuming an average capital share of 0.35, the implied elasticity of substitution is a little under 1.0. In the simulations, Blanchard uses a substitution elasticity of either 1.0 or 2.0.

Summarising, the long-run labour demand equations fit the data reasonably well. The substitution elasticities vary between zero and one and are relatively high for Germany, the United Kingdom and the United States.

3.3 The equilibrium rate of unemployment

Given the long-run wage and labour demand equations, we use equation (11) to calculate the equilibrium rate of unemployment. This is by definition the unemployment rate at which both the wage rate and employment are at their equilibrium levels. An unemployment rate exceeding its equilibrium level reduces wage growth, because the parameters on unemployment in Table 3.1 are negative. This stimulates the demand for labour and reduces in turn the level of unemployment. Therefore, u^* in equation (11) can be considered as a stable equilibrium relation only if both the wage level and employment level equations, estimated in Table 3.1 and 3.3 respectively, can be considered as such.

Given that the unemployment rate enters the wage-level equation significantly for all countries, u^* can in principle be calculated for all countries, too. However, the wage-level equation for the United States is highly unreliable, leaving upwardly trending residuals, which makes the interpretation of u^* as the equilibrium unemployment rate rather problematic. The next graphs show the equilibrium and actual unemployment rates for all countries except the

[6] Because the unit coefficient on labour productivity also holds for the wage equation (with the possible exception of France), the hypothesis that labour productivity is a significant determinant of the equilibrium rate of unemployment has to be rejected. See Ball and Mankiw (2002) for the opposite view.

United States.

Fluctuations in the equilibrium unemployment rates stem from fluctuations in the wedge, the replacement rate and capital costs, see equation (11).[7] The decomposition of the equilibrium unemployment rate in its components is shown in the right-hand side graphs of each country. The decomposition of equilibrium unemployment into its factors differs between countries for two reasons. First, the sizes of the shocks might differ (e.g. because some governments reduce the benefits whereas others do not). Second, the dependability of the equilibrium unemployment rate on shocks depends on the institutions in each economy, which are reflected in the estimated coefficients for the wage and labour-demand equations. For example, a given reduction in the replacement rate implies, according to our model, a much sharper reduction in the equilibrium unemployment rate in the Netherlands than in the United Kingdom. This might reflect the more centralised and widespread wage negotiations by unions in the Netherlands. Similar decompositions to the shocks and institutions can be found by Bean (1994) and Blanchard (1999).

[7] The capital costs in the graphs were approximated by the relative price of labour w/p_y.

Figure 3.1 Equilibrium unemployment and its structural determinants

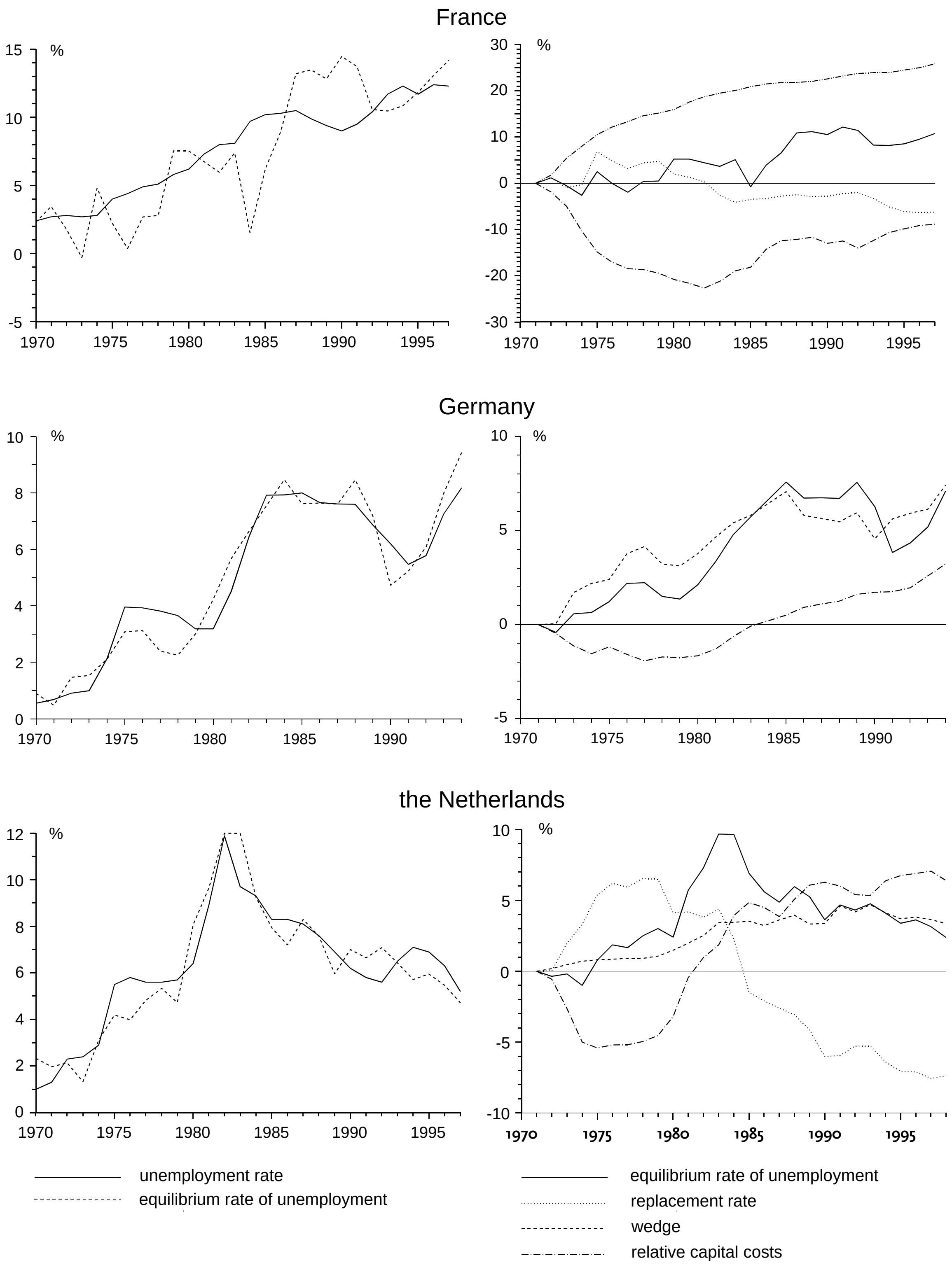
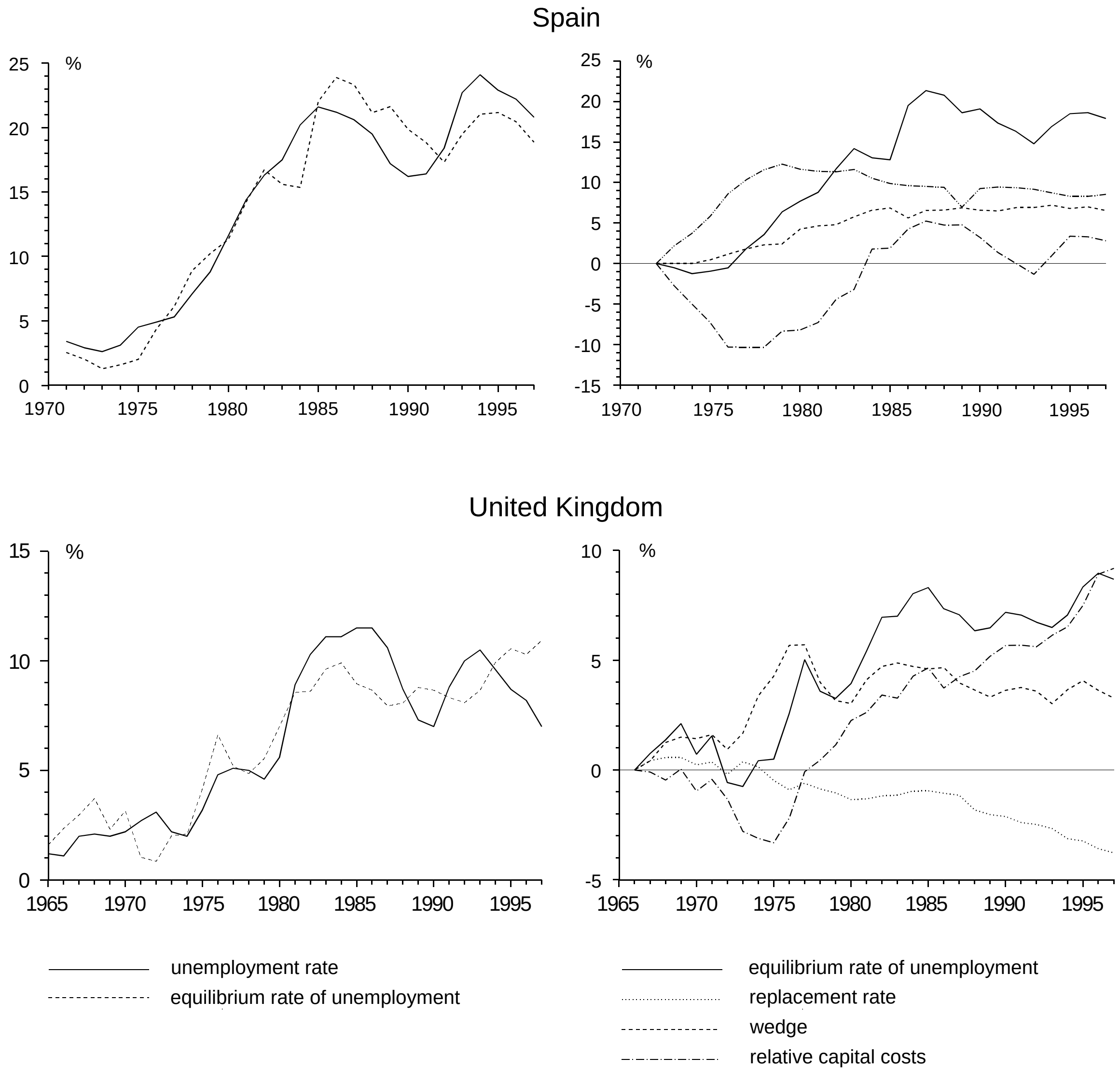


Figure 3.1 continued: Equilibrium unemployment and its structural determinants



The equilibrium unemployment rate in France is mainly determined by the relative capital costs and the minimum wage rate. In the period 1970 - 1985, the increase in the minimum wage rate and the reduction in the capital costs offset each other. From 1985 onwards, the increase in the costs of capital pushed the equilibrium unemployment rate upwards. In Germany, fluctuations in the equilibrium unemployment are strongly related to fluctuations in the wedge, which of course stems from the high wedge coefficient in the wage equation, see Table 3.1. In addition, the unification had a strong negative impact on the equilibrium rate of unemployment. The replacement rate, which started to decline around 1980, is a key determinant of the reduction of the equilibrium unemployment rate in the Netherlands. The second important determinant is the relative cost of capital, which initially tempers the growth in the equilibrium unemployment rate, but pushed it significantly upward in the period 1980-1985.[8] In Spain, all factors contributed to the rising level of the equilibrium unemployment rate: the wedge increased strongly between 1965 and 1997, as the sum of taxes and premiums as a share of GDP rose from 20% to 45% in this period, with a small decline in the final years. The change in the wedge accounts for about one-third of the fluctuation of the equilibrium unemployment rate, which is in line with the conclusion of Blanchard and Jimeno (1995) that fiscal policy cannot explain differences in the unemployment rate between Spain and Portugal. It contrasts, however, with the observation by Estrada et al. (2000), who estimate that workers are able to transmit 50% of direct tax changes to labour costs. In my framework this would yield a much larger wedge effect on the equilibrium unemployment rate. Remarkably, in the United Kingdom the decline in the unemployment rate in the nineties did not stem from a reduction in the equilibrium level; in fact, the equilibrium unemployment rate has risen.[9]

A common observation from the graphs of the equilibrium unemployment rates for the five European economies is that they fluctuate strongly and depend significantly on policy measures like the wedge and the replacement rate. Policymakers might therefore reduce the equilibrium unemployment rate (towards which the actual unemployment rate moves) by reducing taxes and benefits.

A second similarity between the graphs of the five countries is that their rate of unemployment was modest until about 1975, but increased significantly thereafter. In the period 1980 -1985 the unemployment rate reached a (local) maximum in all countries. The picture for the 1985 -1995 period is less uniform. The unemployment rate declined significantly in the Netherlands and the United Kingdom, but remained high in France, Germany and Spain. For the equilibrium unemployment rate, a similar story can be told: essentially the same pattern until

[8] The strong dependence of the equilibrium unemployment rate on the replacement rate mimics the results of Broer et al. (2000), but contrasts with the conclusion of Dur (2001), who points to the supply of labour as a key determinant of unemployment.

[9] The persistently high level of equilibrium unemployment was also observed by Nickell (1997), who identified ‘the systematic shift in demand against the unskilled’ (p23) as the main cause. It contrasts with the conclusion by Henry et al. (2000), who argue that the equilibrium unemployment rate in the UK has been reasonably stable through time.

1985 and divergence after that. In all countries, the upswing in the equilibrium unemployment rate in the period 1980-1985 has been induced by rising capital costs.[10] In addition, stabilisation of the equilibrium unemployment rate afterwards can be linked to the stabilisation of capital costs, excepting the Netherlands, where the equilibrium unemployment rate declined due to the reduction in the replacement rate. In the other countries, the equilibrium rate of unemployment hardly depends on the replacement rate. This confirms the conclusion of Bean (1994) that an exogenous increase in the generosity of benefits does not seem to have been a prime factor causing the rise in unemployment.

[10] The influence of capital costs differs across countries for two reasons. First, the crucial parameter measuring the impact of capital costs on equilibrium unemployment, the substitution elasticity, differs across countries. Second, the relative cost of capital is measured in efficiency units, which implies that it depends on the estimate of technical growth, which is approximated by $\gamma_1 t+\gamma_2 t^2$.

4 Conclusions

We have used a structural approach to estimate equilibrium unemployment rates for several European economies. In this approach, the estimation of equations for the wage rate and employment are crucial. The estimates of both equations are reliable for the European economies in the sample (France, Germany, the Netherlands, Spain and the United Kingdom), but the wage-level equation does not satisfactorily represent the data for the United States. This can be explained by the low level of union coverage in the United States, in contrast to the European economies.

The equilibrium unemployment rates calculated from these equations closely follow the actual unemployment rate. Fluctuations in the actual unemployment rate can therefore be explained largely by fluctuations in the equilibrium rate. The equilibrium unemployment rates in the European economies depend on policy variables like the wedge, the replacement rate and the statutory minimum wage and, in addition on capital costs. However, the relation between equilibrium unemployment and its determinants varies significantly across countries. In some countries, like the Netherlands, the replacement rate influences the equilibrium unemployment rate significantly. In other countries, like Germany, the wedge plays a major role. This implies that unification of fiscal policy would not lead to uniform unemployment rates in equilibrium.

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Appendix A Derivation of the wage equation

The generalised Nash product of the wage negotiations can be written from equations (2.1) and (2.2) as:

$$argmax(w_i): \quad \left(\frac{p_y y \; - \; l w_i}{p_c}\right) \left(\frac{w_i\,(1+t_e)^{-1}\,(1 \; - \; t_d)}{p_c} \; - \; F\right)^{\alpha}, \qquad \text{(A.1)}$$

$$F \; = \; p\; q\; w_c \; + \; p\;(1-q)\;\frac{w_{\text{min}}\,(1+t_e)^{-1}\,(1 \; - \; t_d)}{p_c} \; + \; (1-p)\;\left[\rho\; w_c \; + \; \gamma\;\frac{w}{p_y},\right]$$

where F is the fallback position of workers and α is the relative bargaining power of workers. The surplus of firms is normalised by deflation with the consumer price index. The subscript i is added to the wage rate to indicate the difference between wages that can be varied in the negotiations and the average wage rate. In equilibrium $w_{\mathrm{i}}=w$ holds. The first-order condition of (A.1) with respect to w_i is:

$$\frac{w}{p_y} \; = \; \frac{\alpha}{1 \; - \; F/w_c \; + \; \alpha}\; h\;, \quad w_c \equiv \frac{w\,(1+t_e)^{-1}\,(1 \; - \; t_d)}{p_c}, \qquad \text{(A.2)}$$

where $w_{\mathrm{i}}=w$ is imposed. Use the definition of the fallback position of workers in equation (A.1) to rewrite F/w_{c} as:

$$F/w_c \; = \; p\;q \; + \; p\;(1-q)\;\frac{w_{\text{min}}}{w} \; + \; (1-p)\;[\rho \; + \; \gamma\;\Lambda]. \qquad \text{(A.3)}$$

Use this equation and the fact that p is a function of u, with $p'(u)<0$. Then equation (A.2) can be linearized to equation (2.3) in the text.

Appendix B Data

Annual data for wages, prices, output, employment and unemployment is taken from the AMECO-database. For Germany, we have combined this data with data from DIW, Berlin. From the AMECO database we also used the indirect tax and social security series for the Netherlands. The tax and premium series for Germany have been constructed by DIW; for France, Spain and the United Kingdom, these series were provided by OFCE, Paris. This institute also constructed the replacement series for France, Germany, Spain and the United Kingdom and the minimum wage rate (in real terms) for France. For the Netherlands, we used the CPB series for the replacement rate. The Spanish minimum wage rate was taken from the Eurostat database. The wage rate is defined as the compensation of employees per head.

Table B.1 shows the unit-root (Dickey-Fuller) test for the real wage rate w/p_y, labour productivity h, the wedge Λ, the replacement rate ρ, the minimum wage rate deflated by the consumer price index w_{min}/p_c, and the unemployment rate u. The table show that most series include a unit root at the 5%-significance level. The exceptions are the real wage rate in Germany and France, labour productivity in Spain and the minimum wage rate in France and Spain, where the unit-root test is unable to distinguish between a stochastic and deterministic trend.

Table B.1 Unit root test

	$\ln(\frac{w}{p_y})$	$\ln h$	$\ln \Lambda$	$\ln RR$	$\ln(\frac{w_{min}}{p_c})$	u
Level						
France	− 2.83	− 2.38	− 0.13	− 0.74	− 4.56	− 1.41
Germany	− 2.95	− 1.29	− 2.21	− 1.73		− 1.68
Netherlands	− 2.43	− 1.93	− 1.60	− 0.48		− 2.28
Spain	− 1.48	− 2.92	− 2.19		− 2.96	− 1.96
United Kingdom	− 1.48	− 1.34	− 0.76	− 0.21		− 1.38
United States	0.23	0.97	− 0.46			− 1.63
First difference						
France	− 2.05	− 4.34	− 4.55	− 4.76	− 4.16	− 3.65
Germany	− 2.39	− 3.84	− 4.51	− 3.72		− 2.82
Netherlands	− 3.05	− 4.76	− 4.99	− 3.43		− 3.46
Spain	− 2.70	− 3.16	− 3.98		− 3.40	− 2.86
United Kingdom	− 4.05	− 4.03	− 3.58	− 6.26		− 3.15
United States	− 3.99	− 4.70	− 5.32			− 4.15

We report the Augmented Dickey-Fuller statistic including a constant and up to 2 lags. Samples: see Table 3.1. The 5% critical value is -2.86.

Appendix C Additional estimates

The coefficients on labour productivity and product prices in the estimation of the wage equations in Table 3.1 and the coefficient of output in the estimation of the labour demand equation in Table 3.3 were restricted to unity. In this section of the appendix we test these restrictions using the Wald-test, or Likelihood Ratio (LR) test, with the results reported in Table C.1. The restriction of the labour-productivity coefficient to unity has to be rejected for France, Spain and the United States. However, the estimated coefficient for Spain is reasonably close to unity, and the restriction to unity does not importantly affect the estimated coefficients for the unemployment rate, for the wedge and for the minimum wage rate. The restricted equations are therefore still considered to be good representations of the wage determination. The same cannot be argued for France and the United States. The estimated coefficient for France is well below one, whereas the restriction of the labour productivity coefficient in the US to unity yields trended residuals. The Wald-test rejects the restriction of the unit coefficient of the output price for the Netherlands, the United Kingdom and the United States, though the coefficients are quite close to unity. Finally, the unit restriction of the output coefficient in the labour demand equation was not rejected by the data at the 5% significance level, with the exception of Germany.

Table C.1 Test on unit coefficients for labour productivity and GDP-deflator in the wage equation and output in the employment equation

	$w : y/l$		$w : p_y$		$l : y$	
	Coefficient	LR-test	Coefficient	LR-test	Coefficient	LR-test
France	0.55	28.26	1.02	0.06	0.93	2.52
Germany	1.02	0.14	1.03	0.56	0.77	7.38
The Netherlands	1.13	4.46	1.06	8.00	0.89	1.20
Spain	1.12	7.92	1.03	4.80	1.07	0.82
United Kingdom	0.95	1.08	1.05	7.16	0.79	3.80
United States	0.83	61.50	0.96	45.66	0.93	1.80

The table shows the unrestricted estimations of labour productivity $(w : y/l)$ and GDP-prices $(w : p_y)$ in the wage equation and output in the labour demand equation $(l : y)$. The restrictions are tested with the Likelihood Ratio statistic (Wald test), which is distributed as a χ^2 distribution with 1 degree of freedom. The critical values of this distribution are: 2.71 (10%), 3.84 (5%) and 6.63 (1%) for the significance levels in brackets.

C.1 Dynamic wage and labour demand equations

We have estimated error-correction equations for the growth of wages and employment. The error-correction equations are specified as:

$$\Delta x = \xi^x \Delta x_{-1} + \xi_0^y \Delta y + \xi_1^y \Delta y_{-i} + \xi^{ec}(x - x^*)_{-1}, \quad x = w, l \tag{C.1}$$

where x denotes the log of wages or employment, y are several exogenous variables, and x^* is the long-run value of the wage rate, or the employment level. Exogenous variables and lagged endogenous variables have been excluded from the equations if they are insignificant. In the estimations, we take the long-run equations, as shown in Tables 3.1 and 3.3, as given.

Table C.2 Dynamic wage equation

$$\Delta w_F = 1.38\Delta p_y + 0.39\Delta(y/l) + 0.42\Delta w_{-1} - 0.72\Delta p_{y.-1} - 0.34(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.12 \quad R^2 = 0.98 \quad DW = 2.47$$

$$\Delta w_G = 1.51\Delta p_y + 0.63\Delta(y/l) + 0.31\Delta(y/l)_{-1} - 0.65\Delta u_{-1} - 0.02 - 0.21(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.15 \quad R^2 = 0.95 \quad DW = 1.91$$

$$\Delta w_{NL} = 0.76\Delta p_y + 0.64\Delta w_{-1} - 0.32\Delta p_{y.-1} - 0.49(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.14 \quad R^2 = 0.95 \quad DW = 1.49$$

$$\Delta w_S = 0.40\Delta p_y + 0.68\Delta(y/l) + 0.52\Delta w_{\min} - 0.81(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.19 \quad R^2 = 0.97 \quad DW = 1.82$$

$$\Delta w_{UK} = 1.11\Delta p_y + 0.76\Delta(y/l) + 0.46\Delta w_{-1} - 0.60\Delta p_{y.-1} - 0.46\Delta(y/l)_{-1} - 0.64(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.18 \quad R^2 = 0.96 \quad DW = 2.19$$

$$\Delta w_{US} = 0.66\Delta p_y + 0.44\Delta(y/l) + 0.47\Delta w_{-1} - 0.01 - 0.26(w_{-1} - w^*_{-1})$$
$$se(EC) = 0.12 \quad R^2 = 0.90 \quad DW = 2.15$$

w^* is the equilibrium wage rate, calculated from equation (3) with the estimated parameters of Table 3.1. $\triangle w = w - w_{-1}$ is the absolute change of the wage rate. The second row of each equation presents the standard errors (se) of the error-correction parameters, the sum of squares of the residuals (R^2) and the Durbin-Watson statistic.
The dynamic wage equation is estimated for France (F), Germany (G), the Netherlands (N), Spain (S), the United Kingdom (UK) and the United States (US).

The dynamic wage equations for France (F), Germany (G), the Netherlands (NL), Spain (S), the United Kingdom (UK) and the United States (US) are shown in Table C.2. The long-run equations can be considered as equilibrium relations because wage growth depends negatively on the difference between the actual and equilibrium wage rate. However, the standard error of the error-correction parameter is for some countries, like Germany and the United States, rather large.[1]

The adjustment speed towards equilibrium is rather large for Spain and the United Kingdom, moderate for France and the Netherlands, and quite small for Germany. Given the weak fit of the wage-level equation for the United States, it is remarkable that it enters the dynamic wage equation significantly. The reason is that the trend in the long-run residuals has been set off by the trends in the growth rates of wages, prices and labour productivity.

[1] The t-values of the error-correction term for Germany and the United States are about 2. The critical values of testing α_{EC}=0, are generally larger than 3. Critical values for equations including dummies might differ from those reported in that paper.

In all countries, wages respond immediately and positively to changes in the output price and labour productivity, where the price response often exceeds unity. In Spain, wage growth is rather sensitive to changes in the minimum wage rate.

Table C.3 Dynamic labour demand equation

$$\Delta l_F = 0.49\Delta y - 0.14\Delta(w/p_y) + 0.46\Delta l_{-1} - 0.14\Delta y_{-1} - 0.003 - 0.19(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.07 \quad R^2 = 0.84 \quad DW = 2.17$$

$$\Delta l_G = 0.53\Delta y - 0.26\Delta(w/p_y) + 0.46\Delta l_{-1} - 0.01 - 0.33(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.10 \quad R^2 = 0.92 \quad DW = 1.29$$

$$\Delta l_{NL} = 0.44\Delta y - 0.25\Delta(w/p_y) + 0.60\Delta l_{-1} - 0.003 - 0.44(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.08 \quad R^2 = 0.86 \quad DW = 2.27$$

$$\Delta l_S = 0.62\Delta y - 0.32\Delta(w/p_y) + 0.49\Delta l_{-1} - 0.01 - 0.37(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.15 \quad R^2 = 0.84 \quad DW = 1.93$$

$$\Delta l_{UK} = 0.36\Delta y - 0.38\Delta(w/p_y) + 0.22\Delta l_{-1} - 0.001 - 0.55(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.09 \quad R^2 = 0.89 \quad DW = 2.21$$

$$\Delta l_{US} = 0.63\Delta y - 0.48\Delta(w/p_y) + 0.19\Delta y_{-1} - 0.002 - 0.45(l_{-1} - l^*_{-1})$$
$$se(EC) = 0.16 \quad R^2 = 0.93 \quad DW = 1.95$$

l^* is the equilibrium employment level, calculated from equation (2.5) with the estimated parameters of Table 3.3. $\triangle l = l - l_{-1}$ is the absolute change of the wage rate. The second row of each equation presents the standard errors (se) of the error-correction parameters, the sum of squares of the residuals (R^2) and the Durbin-Watson statistic.
The dynamic wage equation is estimated for France (F), Germany (G), the Netherlands (N), Spain (S), the United Kingdom (UK) and the United States (US).

The dynamic labour demand equations for the six countries are shown in Table C.3. The long-run equations can be considered as equilibrium relations because employment growth depends negatively on the difference between the actual and equilibrium levels of employment. The response of employment to deviations from the equilibrium is fast in the United Kingdom, whereas the other labour markets are less flexible. The positive coefficients for output in the six equations imply that higher output growth stimulates employment growth. In contrast, an increase in the growth rate of real wages induces a reduction in employment growth, where this effect is particularly strong in the United States. Finally, the combination of a low value of the error-correction parameter and a high value of the parameter on lagged employment point to high persistence in employment growth in countries like Germany and France. In contrast, employment in the United Kingdom and the United States is much less persistent, which indicates that labour markets in the Anglo-Saxon countries are more flexible than the other labour markets.

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