THE EQUILIBRIUM RATE OF UNEMPLOYMENT IN THE NETHERLANDS**

BY

D.P. BROER, D.A.G. DRAPER, AND F.H. HUIZINGA*

Summary

The rise in unemployment in the 1970s and its subsequent persistence have challenged the conventional wisdom embodied in the standard Phillips curve, namely that equilibrium unemployment is fairly constant over time. This paper attempts to explain the apparent non-constancy of equilibrium unemployment by developing and estimating a structural model in which equilibrium unemployment is endogenous and results from the interactions of wage bargaining and the price and employment determination of firms. We find that the three major determinants of equilibrium unemployment are tax rates, the replacement rate and the real interest rate. The rise in unemployment in the 1970s and early 1980s was mainly due to a rise in the first two factors. That equilibrium unemployment remained high when tax rates and the replacement rate were reduced in the 1980s and early 1990s is attributed to the rise in real interest rates during this period.

Key words: equilibrium unemployment, labour demand, wage bargaining, price setting

1 INTRODUCTION

The high level of unemployment in OECD Europe remains one of the puzzles of empirical macroeconomics. In recent years the unemployment rate shows a tendency to fall in some countries, but overall its level remains high (OECD (1997)). This is somewhat surprising in view of the considerable policy effort that has been made to redress the adverse supply conditions that are generally held responsible for the high rate of unemployment. This raises the question whether these policy reforms were ineffective, or still have to yield their full benefit. Is the present high rate of unemployment in Western Europe a consequence of slow adjustment to structural reforms and are we heading towards an era of low unemployment, or are other factors at work, that prevent us to reap the benefits of the reforms? This paper considers these questions in a structural empirical model of wage and price setting and employment dynamics for the Netherlands.

* CPB Netherlands Bureau of Economic Policy Analysis, P.O. Box 80510, 2508 GM The Hague, The Netherlands; e-mail: dpb@cpb.nl, dagd,@cpb.nl, fhh@cpb.nl; Phone (070) 338 33 80; Fax (070) 338 33 50.
** We are grateful for helpful comments by two anonymous referees, F. den Butter, R. Douven, A. Lammertsma, Th. van de Klundert, S. Kuipers, R. Okker, and E. Sterken and for the statistical assistance of P. de Jongh.

De Economist **148**, 345–371, 2000.

In the sixties and seventies the unemployment debate was dominated by the properties of the Phillips curve. After the seminal contribution of Friedman (1968), the idea that this curve offers a menu of different unemployment-inflation combinations came to be abandoned. Instead, the 'natural rate' hypothesis was adopted, whereby the long-run value of unemployment consistent with constant inflation is a variable determined outside of the core macroeconometric model. Indeed, in virtually all empirical models of that time the natural rate was determined by the constant term of the Phillips curve. Within this framework the continuous increase in the rate of unemployment in Western Europe in the seventies was both unexpected and inexplicable.

To cope with this problem, several approaches have been followed. One possibility is to adopt an agnostic view of the natural rate and to use statistical procedures such as time-varying parameters (Gordon (1997)), to capture the shifts in the natural rate. Research along these lines is primarily useful to determine the current level of the natural rate, and hence to predict the direction of inflation. It does not shed much light on the causes of the increased unemployment or on its future development. In spirit, the time-varying natural rate is closely related to the concept of hysteresis, in which the equilibrium rate of unemployment depends on the past unemployment path of the economy (Blanchard (1986)). In essence, hysteresis implies that the natural rate follows a random walk.

Another approach attempts to find the structural causes of the increased unemployment by explicitly modelling labour market imperfections. The models that were formulated in the first half of the eighties may be subdivided into efficiency wage models, union wage bargaining models, and search models of unemployment. Katz (1988) provides a nice overview. All these models predict that there is a relationship between the *levels* of wages and unemployment, leading in effect to an upward sloping labour supply curve, also called a wage curve (Layard, Nickell, and Jackman (1991), Blanchard (1997)). Moreover, a strengthening of the position of workers, caused for instance by an increase in the replacement rate, will shift the curve up, leading to higher unemployment. Increases in the wedge between the product wage and the consumption wage also contribute to unemployment if the wedge increases the replacement rate (Pissarides (1998)). Empirical support for the existence of such a stable long-run relation between the levels of wages and unemployment is provided by Blanchflower and Oswald (1994) and Blanchard and Katz (1997).

While the new labour market theories have been successful in tracking down the causes of the upswing of unemployment in the seventies to an inward shift of effective labour supply, they have so far not been able to explain the European unemployment persistence of the nineties. Following the substantial cut backs in social security in the eighties, unemployment should have returned to its previous low levels within a few years. This however has not happened.

In recent years, a number of authors have attempted to reconcile the empirical evidence in favour of a wage curve with the observed unemployment persistence in Europe, by adding elements that affect labour demand. In these studies the return to capital plays an important role. Phelps (1994) and Phelps and Zoega (1998) point to the close correspondence that exists between the real rate of interest and unemployment in Europe since the eighties. In Phelps (1994) the rate of interest is an important determinant of labour demand. Hiring costs, costs of investment in job-specific capital, and the costs of creating stable customer markets are all affected by the real interest rate. A rising real interest rate depresses the creation of new jobs and the demand for new products. The result is an inward shift of the labour demand curve. Madsen (1998) also finds empirical support for Phelps's model in a panel of OECD countries.

Caballero and Hammour (1996) also claim that the labour demand curve has shifted inward. In their view, this happened because the rise in bargaining power of labour enabled it to appropriate a larger share of the rent. This has led firms to adopt technologies that are labour saving. Due to the putty-clay nature of capital, this process is slow to develop, and Europe still experiences the adverse effects of the welfare state of the seventies. Blanchard (1997) lends further support to this story by showing how it can also explain the observed gradual fall followed by a gradual rise of the capital income share in many OECD countries.

From this summary of the literature, we can identify a number of issues that are important in relation to the European unemployment problem, viz. the existence of a wage curve and its properties, the effects of the return to capital and of the interest rate on labour demand, and the speed of adjustment towards the long-run equilibrium. In this paper we attempt to shed additional light on these issues by specifying and estimating a structural model of wage formation, price setting and labour demand for the Netherlands. The case of the Netherlands is of particular interest since it was one of the countries hit hardest by the supply shocks of the seventies, when the term 'Dutch disease' was introduced by *The Economist* in 1977, and it is now one of the few European countries showing a clear improvement in unemployment (OECD (1997)).

Our model of wage formation is a union bargaining model. The main reason for this choice is that union bargaining and union presence in general is so obviously an important part of the Dutch labour market. Our bargaining model is of the 'right-to-manage' variety (Nickell and Andrews (1983)), again, to maintain close correspondence to actual labour market practice. It provides a role for the effects of product prices, the mark-up, unemployment, the replacement rate, labour productivity, and the wedge. On the production side, we specify a fairly standard model of labour demand and price formation, but with a substitution elasticity that is not a priori fixed at unity. This provides for an explicit role of capital costs not just in the demand for labour, but also, most importantly, in the wage bargaining solution, through its effect on labour productivity.

Our empirical results about the dynamic adjustment show that hysteresis is not a major issue. We find that the wedge, the replacement rate and the user costs of capital are important determinants of unemployment. The importance of the user cost of capital originates from the low estimated value of the elasticity of substitution. This effect distinguishes our approach from the contributions by Phelps (1994) and Blanchard (1997), that also seek the main determinant of unemployment persistence in the shifts in the labour demand curve, but through different channels. Our main conclusion is that in the period 1985-1996 unemployment remained high because of an increase in the relative user costs of capital that neutralized the beneficial effects of the cut-backs in social security payments.

The remaining part of the paper is organized as follows. In section 2 we discuss the model. The data used in estimating the model are described in section 3. Section 4 presents our estimation results as well as the estimate and decomposition of the natural rate of unemployment. Section 5 offers some conclusions.

2 THE MODEL

The wage bargain

The model we estimate consists of three equations, determining wages, employment and prices. We first present the equations for the steady state. Dynamics will be added later on in the form of an error correction specification. We first derive the wage equation from a bargaining model. Assume the union and the firm bargain about the total wage bill as follows:[1]

$$argmax(w)\colon \left(\frac{p_y y - lw}{p_c}\right)\left(\frac{w\,(1+se)^{-1}\,(1-sl)\,(1-td)}{p_c} - F\right)^{\alpha}, \qquad (1)$$

where p_y denotes the value added price deflator, p_c the consumer price deflator, y total output, w the wage rate, l employment, se the rate of employers' social security contributions and other labour costs (such as pension costs), sl the premium rate for the social security contributions paid by labour, td the rate of direct taxes paid by labour, F the fallback position of a worker, and α a measure of relative bargaining power.

In order to derive a simple expression for the first order condition, we define some additional elements. Let w_y denote the real product wage, defined as $w_y = w/p_y$. Let w_c denote the real consumption wage, defined as

1 The firm's gain function consists of operating profits. Total profits are given by operating profits minus some unspecified sunk or fixed costs. These could, for example, be hiring costs or capital costs. In equilibrium, these costs correspond to quasi rents that make the bargaining necessary. They also generate unemployment as a necessary force to reduce the union wage claims to a level compatible with general equilibrium, that is a level such that the firms' operating profits are high enough to cover the fixed costs.

$w_c = w(1 + se)^{-1}(1-sl)(1-td)/p_c$. Let Λ denote the wedge, defined as[2] $\Lambda = w_y/w_c$. Define rp' as $rp' = F/w_c$. So, rp' is the ratio of the utilities of unemployed and employed workers and can be thought of as a replacement rate.

The first order conditions to the bargaining problem may now be stated as:

$$\frac{w}{p_y} = \frac{\alpha}{1 - rp' + \alpha} h , \qquad (2)$$

where ($h = y/l$) denotes labour productivity. This equation indicates that if productivity h and the coefficient α are exogenous, the product wage only depends on rp'. So, if the wedge affects labour costs, it does so only indirectly, by altering rp', the ratio of the utilities of the unemployed and employed workers. Even if this is the case, the wedge does not enter the equation for w_y once we include rp'. Therefore, if we find an independent effect of the wedge next to a measure of the replacement rate, this must be because that measure of the replacement rate is not equal to rp'. We will elaborate this now.

The fallback position and the informal market

We may find an independent effect of the wedge next to a measure of the replacement rate if we include the informal sector or household production into the analysis. For instance, suppose that negotiations break down, and the worker becomes unemployed and tries to find work again.[3] If he succeeds he gets a wage which we assume to be equal to the wage he would have got if the first negotiations had resulted in an agreement, namely w. If he cannot find another job, he gets unemployment benefits equal to the replacement wage times that wage. While unemployed, he may also engage in activities in the informal sector. We assume that these activities are not taxed. This may be because these activities simply are not subject to taxation, such as household production, or because taxes are evaded (black market activities). In either case we think of the worker selling his labour directly to himself or to another consumer. The (implicit) wage is a fraction γ of the going total cost of his labour, including all direct and indirect taxes and premiums costs.

Letting P denote the probability of finding another job, rp the official replacement rate, the formula for the fallback position of the worker is:

$$F = P\, w_c + (1 - P)\,[rp\, w_c + \gamma\, w_y] , \qquad (3)$$

2 Note that the ratio of p_c over p_y equals 1 plus the indirect tax rate. Actually, it also includes terms of trade effects. If the value of output in the informal market is not shielded from changes in the terms of trade, p_c should be replaced by the consumer price with the terms of trade effects taken out.

3 One may also interpret the fallback positions F as the expected income to the worker during a strike. However, this would not affect the analysis.

It makes sense that the probability to find another job, P, depends negatively on the unemployment rate, u. If we assume that $P = 1 - u^{\epsilon}$ we get, after some arithmetic:[4]

$$rp' = 1 - u^{\epsilon}(1 - rp - \gamma \Lambda) . \quad (4)$$

Substituting this expression into (2) we get the equation for the wage level. Note that if we disregard the informal sector, that is, set $\gamma = 0$, the wedge again drops out of the analysis. Graafland and Huizinga (1999) estimate this non-linear version of the wage equation directly. To facilitate the more complicated system estimation in this paper, we linearize the wage equation:

$$\ln w = \ln p_y + \ln h + \chi_1 \ln \Lambda + \chi_2 \ln rp - \chi_3 u + \chi_0 . \quad (5)$$

In the wage equation the wedge enters as a single variable, that is, all sub-components have the same coefficient. An important assumption for this result is that gross wages are not sticky, which is a reasonable assumption for the long run. However, since most wage contracts specify gross wages, we may expect gross wages to be relatively fixed in the short run. An unexpected shock to employer social security payments then has to be absorbed by the employers in the short run, while unexpected shocks to employee taxes and social security payments must be born by workers. Many empirical studies have found that employer social security payments do indeed have a stronger effect on wage costs than employee taxes and social security payments. So, this may well be an additional effect for the short run.

The wage equation can also be seen as an equation determining the labour income share, denoted *lis* and defined as $lis = \ln p_a - \ln p_y - \ln h$. The labour income share resulting from the bargaining process rises with the wedge and the replacement rate and falls with the unemployment rate. For future reference, it is given explicitly as

$$\ln lis = \chi_1 \ln \Lambda + \chi_2 \ln rp - \chi_3 u + \chi_0 \quad (6)$$

Labour demand and price setting

The equations for the value added price and employment are derived from a model of firm optimization. A vexing problem facing applied economists in estimating factor demand relations is to find a functional form that is flexible, uses only a few parameters and satisfies the theoretical restrictions implied by economic theory. We assume that the production structure can be characterized by a

4 Note that if we had used the consumer price with the terms of trade effect taken out, as suggested in the previous footnote, the terms of trade would also disappear from this equation. Λ should then be interpreted as the wedge with the terms of trade effect taken out.

CES unit cost function[5] with labour augmenting technological progress and possible non-constant returns to scale, written as

$$C = \beta y^{\frac{1}{\xi}} c, \qquad c = [\theta p_l^{1-\sigma} + (1-\theta) p_k^{1-\sigma}]^{\frac{1}{1-\sigma}},$$

$$p_l = \frac{w}{p_{l0}\, g\, e^{\gamma_1 t + \gamma_2 t^2}}, \tag{7}$$

$$p_k = \frac{p_{ie}}{p_{k0}} \left(1 - \frac{(1-\delta)(1+\mathring{p}_i^e)}{1+(1-t_g) r} \right), \qquad p_{ie} = p_i \frac{1 - t_b(c_i + d_i)}{1 - t_b}.$$

Total costs C depend on the output level y, the efficiency corrected price of labour p_l, and the user cost of capital p_k (see the data appendix for a formal derivation of the user cost definition). The efficiency corrected price of labour equals the annual wage cost w divided by the effective working time g and the degree of labour augmenting technological progress, which is modeled by a quadratic time trend. This quadratic time trend is meant to capture locally the actual technological progress. Following Jorgenson (1986) the user cost of capital, p_k, is a function of the effective investment price p_{ie}, the depreciation rate δ and the real after tax interest rate. The latter depends on the nominal interest rate r, the overall income tax rate t_g and the expected inflation.[6] The effective investment price is the investment price corrected for tax facilities. The correction factor is determined by the corporate tax rate t_b, the investment tax credit c_i,[7] and the present value of depreciation rights of one guilder of investment expenditures d_i, To turn p_l and p_k into indices, their expressions are divided by their values in the base year p_{l0} and p_{k0}.

5 In previous work, one of us has applied a functional form suggested by Diewert and Wales (1987, 1995), the so-called *Symmetric Generalized McFadden* (SGM) cost function, see Draper and Manders (1996, 1997). This function meets all our criteria. Subsequent testing revealed however that a more restrictive CES specification cannot be rejected against the SGM cost function (CPB 1997).

6 The expected inflation rate, $\mathring{p}_i^e$, is computed from an optimal MA(2) forecast of investment prices.

7 In the Netherlands from 1977–1988 a variety of the investment tax credit existed (called the WIR), whereby a percentage of the investment expenditure was simply re-imbursed, rather than deducted before taxes. The net effect of this change on equation 2 is simply to replace c_i by c_i/t_b in the computation of the tax credit.

Shephard's lemma implies that the demand for labour equals

$$\ln l = \ln \beta + \ln \theta + \frac{1}{\xi} \ln y - \sigma \ln \left(\frac{p_l}{c}\right) - \ln p_{l_0} g - \gamma_1 t - \gamma_2 t^2 . \tag{8}$$

The price equation is based on profit maximization in an imperfectly competitive market. The price is set as a mark-up over marginal cost

$$\ln p_y = \ln M + \ln \left(\frac{\partial C}{\partial y}\right) , \tag{9}$$

where M denotes the mark-up. The mark-up depends on the price elasticity of demand, which under homothetic utility[8] depends on the own price p_y and the foreign competitor price p_{fc}. After linearization, the expression for the value added price becomes:

$$\ln p_y = \ln \mu_0 + (1 - \mu_1) \left[\ln \beta + \ln c - \ln \xi + \frac{1 - \xi}{\xi} \ln y \right] + \mu_1 \ln p_{fc} . \tag{10}$$

The term between square brackets equals marginal cost. If μ_1 is zero (foreign competitor prices do not matter in the long run), μ_0 equals the markup. The firms' price setting and labour demand equations imply another relationship for the labour income share denoted *lis*

$$\ln lis = \ln \xi - \ln M + \ln \left(1 - (1 - \theta) \left(\frac{p_k}{c}\right)^{1 - \sigma} \right) . \tag{11}$$

The labour income share resulting from profit maximization falls with the mark-up and with the relative price of capital if the elasticity of substitution is less than one.

In equilibrium, the two expressions for the labour income share have to be consistent. This implies that in equilibrium, unemployment must equal

$$u^* = \frac{1}{\chi_3} \left[\chi_1 \ln \Lambda + \chi_2 \ln rp + \chi_0 + \ln M - \ln \xi - \ln \left(1 - (1 - \theta) \left(\frac{p_k}{c}\right)^{1 - \sigma} \right) \right] , \tag{12}$$

8 See Nieuwenhuis (1986).

where a star denotes equilibrium unemployment. This expression shows four determinants of the equilibrium rate of unemployment: the wedge, the replacement rate, the mark-up, and the relative cost of capital.[9] The wedge may shift as a result 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 demands and, *ceteris paribus*, lead to an increase in the labour income share *lis*. 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 mark-up and the relative user cost of capital reduce the labour income share consistent with firm price and employment setting. So, the bargaining labour income share has to fall as well. To bring this about, the unemployment rate has to rise.

Note that the degree to which the relative capital costs affects equilibrium unemployment depends on the elasticity of substitution σ. A rise in the relative cost of capital always reduces the real wage the firm can pay to still maintain its level of profitability as measured by the mark-up. This follows directly from the factor price frontier.[10] The issue is how the unions will be induced to accept this wage cut. Without substitution, we get the standard mechanism of layoffs and unemployment. 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 demands, there is less need for unemployment to rise in this case. With 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 for increased unemployment at all.

An important difference with other recent labour market theories is that 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. Our own estimates in this paper confirm these findings. Blanchard (1997) 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). In the next paragraph we will give some global empirical evidence that these supply side models are not able to explain the developments in the nineties contrary to our model which combines the supply side with a standard labour demand model.

9 Note, technological progress does not have influence on the equilibrium rate of unemployment, because two conditions hold. First, they do not affect the labour income share resulting from the bargaining process, because they lead one to one to wage increases. Second, they do not affect the labour income share resulting from profit maximization, because technological progress is labour augmenting.

10 The factor price frontier represents the maximum rate of return that can be paid to capital for a given real wage level (Bruno and Sachs (1985)).

3 DATA

Figure 1 shows the 1965-1997 development of the unemployment rate and some key variables. The top left graph reveals a slow unemployment rate rise in the 60s and early 70s. Its steady increase up to 2.1 per cent in 1973 was hardly alarming. The first oil price shock at the end of 1973 brought about a jump with 1.5 percentage point up to 3.5 per cent in 1976, while the second oil price shock in 1979 pushed unemployment even further up to a peak of 9.7 per cent in 1983. The unemployment rate remained high, while the relative energy price is back to its pre oil price value after 1986. In 1997 6.6 per cent of labour supply was still

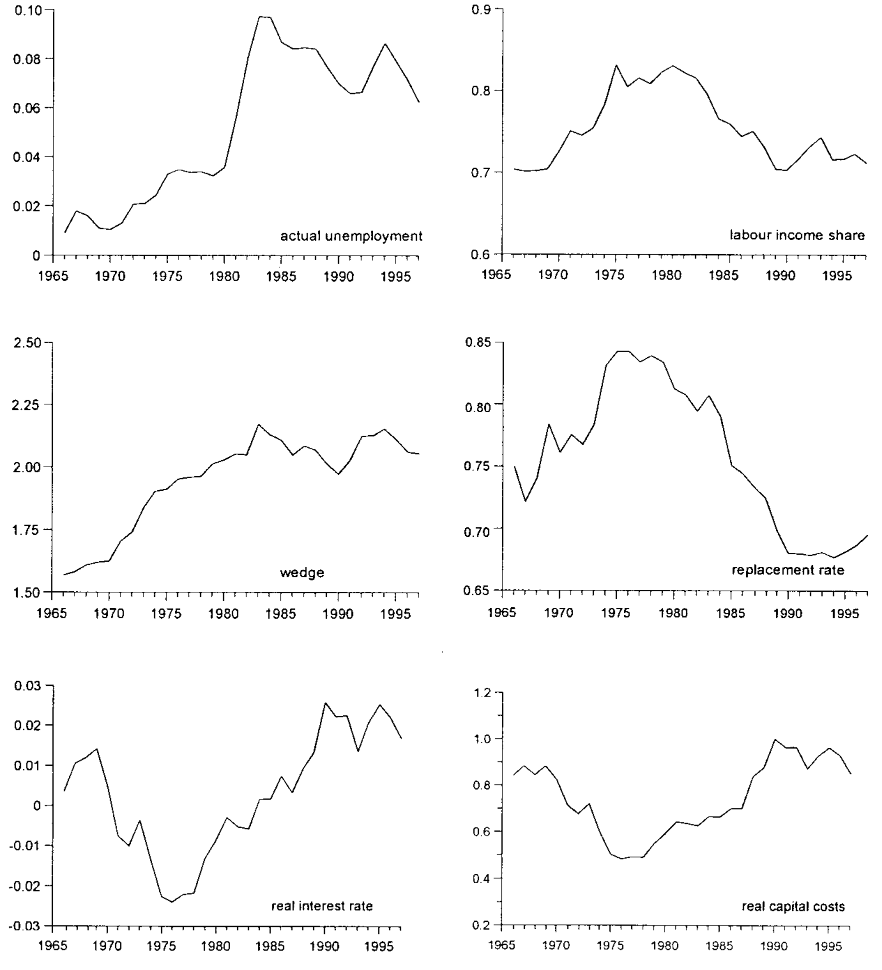

Figure 1 – Unemployment and some key variables

involuntary out of work. The other graphs may reveal some insight into the possible causes.

The top right graph shows that the labour income share is not constant. It reaches its peak in 1975-1980 with a value of 85 per cent. This indicates a substitution elasticity between labour and capital considerably less than one. This opens up the possibility of an effect of the real interest rate on unemployment[11]

Looking at the other graphs reveals that none can solely explain unemployment's development. Up till 1975, the rising wedge and replacement rate could explain the rise in unemployment. However the time lags have to be considerable, unless the decreasing real capital costs (p_k/p_y) exert some mitigating influence. In 1975, the replacement rate had reached an all-time high, and started a gradual decline that did not come to a halt until 1990. The wedge continued to increase until 1985 and remained roughly constant afterwards. This development may explain to some extent why the unemployment level has remained high in the eighties despite the falling replacement rate. On the other hand, the larger part of the increase in the wedge occurred already before 1975. Hence it is not clear given these two variables why unemployment persisted at its high level. Here the real capital costs come again to the fore. Indeed, in 1990 the real capital costs had arrived at a level above that of the sixties. This may have caused the unemployment persistence in the eighties and nineties. The two graphs at the bottom of figure 1 show that the development of real capital costs is dominated by movements in the real interest rate.[12]

4 ESTIMATION

All data used in our estimations are given in the data appendix. Before estimation, we extend the set of equations given above. First, we introduce the import price of energy (p_{me}) relative to the value added price, which measures possible productivity effects of the oil price shocks (see Bruno and Sachs (1985)). Since the oil shock is thought of as an additional productivity shock, we interpret it as affecting the efficiency parameter β in the cost function. We implement this by replacing β by $\beta + (\delta_{1oil} + \delta_{2oil}\,\Delta) \ln p_{me}/p_y$ in the cost function, and thus also in the price and labour demand equations. Note that, if μ_1 is zero, this relative import price does not affect the labour income share resulting from profit maximization, so that the expressions for the labour income share *lis* and equilibrium unemployment remain unaltered.

The second extension of the theoretical framework is in terms of the dynamics. For this we use the error correction (ECM) formulation. We impose the re-

11 See equations 12 and 7.

12 The relation between the real interest rate $(1 - t_g)r - \dot{p}_i^e$ and the nominal rate can at times be remote. The link is provided by expected inflation. See the data appendix for details about the construction of inflation expectations.

quirement that the equilibrium derived in the previous section will eventually be reached.

The dynamic wage equation we estimate is:

$$\begin{aligned}
\Delta \ln w &= \alpha_{11}\Delta \ln w_{-1} + (1-\alpha_{11})\Delta \ln w^* + \lambda_1 (\ln w^* - \ln w)_{-1} \\
&\quad + \sum \beta_{1j}\Delta^2 x_{1j} + \sum \gamma_{1j}(\Delta x_{1j} - \overline{\Delta x_{1j}}) , \\
\ln w^* &= \ln p_y + \ln h + \chi_1 \ln \Lambda + \chi_2 \ln rp - \chi_3 u + \chi_0 , \\
x_{1j} &\in \{\ln h, \ln \Lambda, \ln rp, u\} ,
\end{aligned} \tag{13}$$

where a star (*) denotes the long run and $\overline{\Delta x_{1j}}$ the average value of Δx_{1j}. Note, the constant term has not been included in the short-run equation because it cannot be identified. To get a good estimate of the constant term of the long-run equation we have to correct the differenced variables[13] for their average values. This particular formulation ensures that on a steady state growth path $\ln w$ will equal $\ln w^*$. The dynamic labour demand equation is written in the same way as

$$\begin{aligned}
\Delta \ln l &= \alpha_{21}\Delta \ln l_{-1} + (1-\alpha_{21})\Delta \ln l^* + \lambda_2 (\ln l^* - \ln l)_{-1} \\
&\quad + \sum \beta_{2j}\Delta^2 x_{2j} + \sum \gamma_{2j}(\Delta x_{2j} - \overline{\Delta x_{2j}}) , \\
\ln l^* &= \ln \left(\beta + (\delta_{1oil} + \delta_{2oil}\Delta) \ln \frac{p_{me}}{p_y}\right) + \ln \theta + \frac{1}{\xi} \ln y - \sigma \ln \left(\frac{p_1}{c}\right) \\
&\quad - \ln w_0 g - \gamma_1 t - \gamma_2 t^2 \\
x_{2j} &\in \left\{\ln \frac{p_{me}}{p_y},\ \ln y,\ \ln\left(\frac{p_1}{c}\right),\ \ln g\right\} .
\end{aligned} \tag{14}$$

This formulation ensures on a steady state growth path that $\ln l$ will equal $\ln l^*$. Note, the oil price variable has been implemented in the long-run labour demand equation. The addition in the short-run equation makes it possible to measure possibly asymmetric effects on productivity and prices. The time trend is not included in the short-run equation because its coefficient is hardly identified. The dynamic price equation is[14]

13 We investigated the time series properties of the individual series. We concluded that all variables are stationary after first differencing. This makes it sufficient to correct only the first differenced variables.

14 We tried both the import price p_m and the price of foreign competitors on the foreign markets p_{fc} as indicators of foreign competition.

$$\Delta \ln p_y = \alpha_{31}\Delta \ln p_{y-1} + \alpha_{32}\Delta \ln p_y^* + (1 - \alpha_{31} - \alpha_{32})\Delta \ln p_m + \lambda_3 (\ln p_y^* - \ln p_y)_{-1} + \sum \beta_{3j}\Delta^2 x_{3j} + \sum \gamma_{3j}(\Delta x_{3j} - \overline{\Delta x_{3j}}) ,$$

$$\ln p_y^* = \ln \mu_0 + (1 - \mu_1)\left[\ln\left(\beta + (\delta_{1oil} + \delta_{2oil}\Delta)\ln \frac{p_{me}}{p_y}\right) + \ln c - \ln \xi + \frac{1-\xi}{\xi}\ln y\right] + \mu_1 \ln p_{fc} \qquad (15)$$

$$x_{3j} \in \left\{\ln \frac{p_{me}}{p_y},\ \ln c,\ \ln y,\ \ln p_{fc}\right\}$$

The short-run dynamics have been implemented in a similar way. So it ensures in a steady state that $\ln p$ will equal $\ln p^*$.

So, in a steady state with constant growth rates it will hold that

$$\ln w = \ln w^* ; \quad \ln l = \ln l^* ; \quad \ln p_y = \ln p_y^* . \qquad (16)$$

So, our dynamic specification encompasses the non accelerating inflation rate of unemployment (NAIRU) hypotheses. Moreover our model gives an explanation of structural changes in the non accelerating inflation rate of unemployment.

We investigated the empirical relevance of the above system for the years 1966-1995. A good preliminary parameter estimate is necessary to get convergence due to the non-linear character of our model. For this purpose we started with the Engle Granger two step procedure. This amounts to first estimating the static long-run equations, simultaneously applying the proper cross-equation restrictions, and then applying the dynamic system conditional on the long-run static results just obtained. Next, we followed the 'from-general- to-specific' approach. So, we estimated the whole system in one step, using non-linear 3SLS.[15] Then, we tested restrictions against this general model,[16] using the Gallant Jorgenson statistic, corrected for degrees of freedom (see appendix). These estimates were

15 We used as instruments the constant term, $\ln y_{-1}$, $\ln a_{-1}$, $\ln a_{-2}$, $\ln(p_{ie}/p_i)_{-1}$, $\ln p_{fc}$, $\ln p_{fc-1}$, $\ln w_{-1}$, $\ln p_{i-1}$, $\ln p_{y-1}$, $\ln p_{y-2}$, $((1 + \mathring{p}_i^e)/(1 + (1 - t_g)r))_{-1}$, t, $\ln(p_c/p_y)_{-1}$, u_{-1}, u_{-2}, $\ln(1 - sl - td)_{-1}$, $\ln\Lambda_{-1}$, $\ln rp_{-1}$, dum_{66}^{81}, dum_{66-1}^{81}, dum_{66-2}^{81}, $\ln(p_{me}/p_y)_{-1}$, $\ln(p_{me}/p_y)_{-2}$, $\ln m_{w-1}$, $\ln p_{me}$, with m_w world trade. The dummy variable takes the value 1 for the period 1966-1981. Using the Hausman (1978) Wu statistic, we tested on weak exogeneity of competitor prices and of the import price of energy. Exogeneity was accepted for the first variable but not for the second. However, the latter result is hardly believable. So, we did not scrap this variable from our list of instruments..

16 Some authors claim that the wage equation cannot be identified because, as it is derived based on the firm's profit function and the union utility and fallback functions, no exclusion restrictions should be applicable that allow identification. However, in practice, equations like our wage equation

obtained without adjustment of the first differenced variables for their mean value (that is the $\overline{\Delta x}$-'s were not included, see for instance equation 13). This correction is necessary to get good estimates for the long-run equations. We did not estimate in one step because some of those variables are calculated during estimation ($\Delta \ln p_I/c$, $\Delta \ln c$). So, we can only use an iterative procedure to calculate their mean. So the last estimation result with adjustment of the first differenced variables for their mean value was obtained conditional on the second-to-last estimation results.

Tables 1, 2 and 3 present the results of the four estimation rounds of the whole dynamic system. The first set, labelled '1', is the result of the Engle Granger two step procedure. The second set, labelled '2', is the result of the one step overall estimation. The third set, labelled '3', is the result of imposing restrictions. The last set, labelled '4', is the result after correction of the first differenced series for their mean. For each set we present the point estimates on one line and the standard errors in italics on the line below. No t-statistics should be computed for the coefficients of the level variables with these standard errors because the distribution of the estimates is non-standard. However, the t-statistics for the coefficients of the variables in first differences and of the error correction terms have a standard distribution.

The estimation result '3' is obtained from the unrestricted equations '2' after imposing 22 parameter restrictions. The Gallant Jorgenson statistic is χ^2 distributed with 22 degrees of freedom, if these restrictions hold. Its value $\chi^2(22) = 28.2$ gives an upper tail area of 17 per cent, which is not significant. So, the restrictions are not rejected using a standard significance level. For all equations we find a good fit. The LM test statistics point to negative autocorrelation in the price equation.

The end-result '4' does not deviate very much from '3'.[17] We shall discuss this end result further. In the wage equation, we find significant long run effects of the wedge, the replacement rate and the unemployment rate on the wage level, confirming the existence of the wage curve. The point estimates indicate that the elasticities of a wage with respect to the wedge and the replacement rate are 0.28 and 0.29, which is also quantitatively not unimportant. The semi-elasticity with respect to the unemployment rate is -1.76, which is in line with results found elsewhere (see for instance Graafland and Huizinga (1999) and references contained therein).

---

perform reasonably well. This may be because there is only a small contemporaneous feedback of wages on employment and only little correlation between the error terms, so that the system is almost recursive. See Bean (1994) for a discussion.

17 We did not test this formally because both models are not nested.

TABLE 1 – DYNAMIC WAGE EQUATION[a)]

$$\Delta \ln w = (1 - a_{11})\Delta \ln w^* + a_{11}\Delta \ln w_{-1} + \lambda_1(\ln w^* - \ln w)_{-1} + \gamma_{11}\Delta \ln p_y + \gamma_{12}\Delta \ln h + \gamma_{13}\Delta \ln \Lambda + \gamma_{14}\Delta \ln rp + \gamma_{15}\Delta u$$
$$+ \beta_{11}\Delta^2 \ln p_y + \beta_{12}\Delta^2 \ln h + \beta_{13}\Delta^2 \ln \Lambda + \beta_{14}\Delta^2 \ln rp + \beta_{15}\Delta^2 u$$

$$\ln w^* = \ln p_y + \ln h + \chi_1 \ln \Lambda + \chi_2 \ln rp - \chi_3 u + \chi_0$$

equation	$\Delta \ln w^*$	$\Delta \ln w_{-1}$	$\left(\ln \frac{w^*}{w}\right)_{-1}$	$\Delta \ln p_y$	$\Delta \ln h$	$\Delta \ln \Lambda$	$\Delta \ln rp$	Δu	$\Delta^2 \ln p_y$	$\Delta^2 \ln h$	$\Delta^2 \ln \Lambda$	$\Delta^2 \ln rp$
1	0.52	0.48	0.43	−0.11	0.14	−0.10	0.11	0.42	0.24	−0.19	0.13	−0.04
	0.11	*0.11*	*0.22*	*0.11*	*0.16*	*0.14*	*0.10*	*0.32*	*0.15*	*0.24*	*0.10*	*0.09*
2	0.54	0.46	0.51	0.33	−0.47	0.06	−0.02	0.11	−0.03	0.10	0.02	0.09
	0.14	*0.14*	*0.24*	*0.18*	*0.32*	*0.22*	*0.12*	*0.52*	*0.20*	*0.24*	*0.12*	*0.10*
3[b)]	0.48	0.52	0.52									
	0.07	*0.07*	*0.12*									
4[c)]	0.54	0.46	0.44									
	0.09	*0.09*	*0.14*									

equation	$\Delta^2 u$	χ_1	χ_2	χ_3	χ_0	R^2	se	LM1	LM2
1	0.59	0.23	0.38	1.43	−0.39	0.97	0.008		
	0.45	0.05	0.04	0.19	0.03				
2	0.04	0.00	0.28	0.97	−0.30	0.98	0.007		
	0.51	*0.21*	*0.07*	*0.58*	*0.11*				
3[b)]		0.22	0.30	1.69	−0.40	0.96	0.009	0.5	−0.6
		0.07	*0.06*	*0.27*	*0.05*				
4[c)]		0.28	0.29	1.76	−0.43	0.94	0.011	0.8	−0.3
		0.09	*0.08*	*0.35*	*0.06*				

[a)] For notational convenience we do not present the first differenced variables relative to their mean (see equation 13). This correction has been applied only in equation 4. Estimation sample period: 1966–1995. We present the Lagrange Multiplier tests against auto-correlation as t-values: LM1 tests against significant first order autocorrelation; LM2 against significant second order autocorrelation.

[b)] Galant Jorgenson restriction test statistic: $\chi^2(22) = 28.2$ (P-value 0.17), post sample test for 1996–1997 $\chi^2(6) = 5.2$ (P-value 0.52).

[c)] Post sample test for 1996-1997 $\chi^2(6) = 5.2$ (P-value 0.52).

TABLE 2 – DYNAMIC LABOUR DEMAND EQUATION[a)]

$$\Delta \ln l = (1 - a_{21})\Delta \ln l^* + a_{21}\Delta \ln l_{-1} + \lambda_2(\ln l^* - \ln l)_{-1} + \gamma_{21}\Delta \ln \frac{p_{me}}{p_y} + \gamma_{22}\Delta \ln y + \gamma_{23}\Delta \ln \frac{p_l}{c} + \gamma_{24}\Delta \ln g$$
$$+ \beta_{21}\Delta^2 \ln \frac{p_{me}}{p_y} + \beta_{22}\Delta^2 \ln y + \beta_{23}\Delta^2 \ln \frac{p_l}{c} + \beta_{24}\Delta^2 \ln g$$
$$\ln l^* = \ln\left(\beta + (\delta_{1oil} + \delta_{2oil}\Delta)\ln \frac{p_{me}}{p_y}\right) + \ln\theta + \frac{1}{\xi}\ln y - \sigma \ln\left(\frac{p_l}{c}\right) - \ln w_0 g - \gamma_1 t - \gamma_2 t^2$$

equation	$\Delta \ln l^*$	$\Delta \ln l_{-1}$	$\left(\ln \frac{l^*}{l}\right)_{-1}$	$\Delta \ln \frac{p_{me}}{p_y}$	$\Delta \ln y$	$\Delta \ln \frac{p_l}{c}$	$\Delta \ln g$	$\Delta^2 \ln \frac{p_{me}}{p_y}$	$\Delta^2 \ln y$	$\Delta^2 \ln \frac{p_l}{p_c}$	$\Delta^2 \ln g$
1	0.44	0.56	0.11	−0.03	0.02	0.08	0.11	0.03	−0.06	−0.02	0.39
	0.08	*0.08*	*0.07*	*0.01*	*0.06*	*0.06*	*0.24*	*0.01*	*0.11*	*0.06*	*0.20*
2	0.82	0.18	0.21	−0.02	0.08	0.05	1.24	0.06	−0.34	0.04	−0.15
	0.12	*0.12*	*0.09*	*0.02*	*0.19*	*0.13*	*0.32*	*0.03*	*0.11*	*0.05*	*0.18*
3[b)]	0.49	0.51	0.32				0.49	0.02			
	0.05	*0.05*	*0.05*				*0.15*	*0.01*			
4[c)]	0.52	0.48	0.28				0.51	0.04			
	0.05	*0.05*	*0.05*				*0.15*	*0.01*			

equation	β	θ	ξ	σ	γ_1	γ_2	R^2	se	LM1	LM2
1	0.92	0.69	1.00	0.44	0.014	−0.001	0.85	0.006		
	0.03	*0.02*	(–)	*0.07*	*0.002*	*0.000*				
2	0.88	0.71	1.23	0.29	0.015	−0.001	0.94	0.003		
	0.04	*0.02*	*0.23*	*0.18*	*0.004*	*0.000*				
3[b)]	0.84	0.75	1.00	0.39	0.014	−0.001	0.89	0.005	−0.5	0.4
	0.02	*0.02*	(–)	*0.07*	*0.001*	*0.000*				
4[c)]	0.82	0.75	1.00	0.34	0.014	−0.001	0.88	0.005	−1.5	−0.5
	0.03	*0.03*	(–)	*0.08*	*0.001*	*0.000*				

[a)] For notational convenience we do not present the first differenced variables relative to their mean (see equation 14). This correction has been applied only in equation 4. Estimation sample period: 1966–1995. The long run dummy coefficients are presented in the price equation table

[b)] See note b, Table 1.

[c)] See note c, Table 1.

TABLE 3 – DYNAMIC PRICE EQUATION[a)]

$$\Delta \ln p_y = a_{31}\Delta \ln p_y^* + a_{32}\Delta \ln p_m + (1 - a_{31} - a_{32})\Delta \ln p_{y-1} + \lambda_3 \ln p_y^* - \ln p_y)_{-1}$$

$$+ \gamma_{31}\Delta \ln \frac{p_{me}}{p_y} + \gamma_{32}\Delta \ln c + \gamma_{33}\Delta \ln y + \gamma_{34}\Delta \ln p_{fc} + \beta_{31}\Delta^2 \ln \frac{p_{me}}{p_y} + \beta_{32}\Delta^2 \ln c + \beta_{33}\Delta^2 \ln y + \beta_{34}\Delta^2 \ln p_{fc}$$

$$\ln p_y^* = \ln \mu_0 + (1 - \mu_1)\left[\ln\left(\beta + (\delta_{1oil} + \delta_{2oil}\Delta)\ln \frac{p_{me}}{p_y}\right) + \ln c - \ln \xi + \frac{1-\xi}{\xi}\ln y\right] + \mu_1 \ln p_{fc}$$

equation	$\Delta \ln p_y^*$	$\Delta \ln p_m$	$\Delta \ln p_{y-1}$	$\left(\ln \frac{p_y^*}{p_y}\right)_{-1}$	$\Delta \ln \frac{p_{me}}{p_y}$	$\Delta \ln c$	$\Delta \ln y$	$\Delta \ln p_{fc}$	$\Delta^2 \ln \frac{p_{me}}{p_y}$	$\Delta^2 \ln c$	$\Delta^2 \ln y$	$\Delta^2 \ln p_{fc}$
1	0.38	0.27	0.35	0.29	0.00	0.01	0.09	−0.08	−0.01	0.09	0.00	0.05
	0.13	*0.07*	*0.13*	*0.11*	*0.02*	*0.11*	*0.11*	*0.09*	*0.01*	*0.12*	*0.12*	*0.06*
2	0.83	0.10	0.07	0.53	0.01	−0.72	−0.03	0.18	0.03	0.26	0.10	−0.07
	0.16	*0.07*	*0.14*	*0.10*	*0.04*	*0.14*	*0.21*	*0.09*	*0.03*	*0.11*	*0.11*	*0.05*
3 [b)]	0.87	0.13		0.48		−0.48	−0.20		0.03	0.14	0.18	
	0.05	*0.05*		*0.08*		*0.09*	*0.08*		*0.01*	*0.07*	*0.07*	
4 [c)]	0.89	0.11		0.42		−0.39	−0.20		0.05	0.08	0.08	
	0.06	*0.06*		*0.09*		*0.10*	*0.10*		*0.02*	*0.08*	*0.08*	

equation	μ_0	ξ	β	μ_1	δ_{1oil}	δ_{2oil}	R^2	se	LM1	LM2
1	1.11	1.00	0.92		0.05	−0.05	0.93	0.008		
	0.03	(–)	*0.03*		*0.01*	*0.01*				
2	1.50	1.23	0.88	−0.15	0.03	−0.07	0.96	0.006		
	0.33	*0.23*	*0.04*	*0.11*	*0.01*	*0.05*				
3 [b)]	1.26	1.00	0.84		0.04	−0.07	0.96	0.005	−5.0	−2.9
	0.03	(–)	*0.02*		*0.01*	*0.02*				
4 [c)]	1.21	1.00	0.82		0.04	−0.09	0.94	0.007	−4.1	−2.8
	0.04	(–)	*0.03*		*0.01*	*0.02*				

[a)] For notational convenience we do not present the first differenced variables relative to their mean (see equation 15). This correction has been applied only in equation 4. Estimation sample period: 1966–1995

[b)] See note b, Table 1.

[c)] See note c, Table 1.

The labour demand and price equations indicate that the substitution elasticity σ is around 0.35, quite different from unity.[18] Thus we may expect that the relative cost of capital will play a role in determining equilibrium unemployment. The variable for the oil shocks $\ln p_{me}/p_y$ turns out to have the expected sign in the long run: an increase of the relative oil prices which reduces overall productivity. However, we measure an opposite effect in the short run. The effect of competitor prices on domestic prices is significant for the short run, but the effect in the long run is negligible, as μ_1 is around zero. We find, therefore, that the mark-up of prices over costs is constant in the long run, at about 20%, as μ_0 is around 1.20. The return to scale parameter ξ has been restricted to 1 in the last round.

A prediction test is used to check whether the model estimated with 1966-1995 data also fits the post-sample years 1996 and 1997. For this purpose, the model is estimated for the extended period with addition of dummy variables for both years in all equations. The Gallant Jorgenson (1979) test was used to test the hypothesis that the coefficients of the dummy variables are insignificant. The test statistic was constructed with application of the Anderson correction factor for degrees of freedom (Kiviet (1986)). This is a straightforward extension of the Chow prediction test in the classical linear regression model to the non-linear simultaneous regression model estimated with three-stage least squares. The test statistic is not significant. So, our model passes the extended sample test.

Substituting the estimation results in the last estimation round into equation (12), we find the following relationship for the equilibrium rate of unemployment:

$$u = 0.16 \ln \Lambda + 0.16 \ln rp - 0.57 \ln \left(1 - 0.25 \left(\frac{p_k}{c} \right)^{0.66} \right) - 0.20 . \qquad (17)$$

With this equation we have constructed Figure 2, using a confidence interval of two standard errors around the point estimate. The standard errors have been calculated with the TSP analyze command and are conditional on the values for the exogenous variables in each period. The two standard error interval does not correspond to a standard 95% confidence interval because the distribution of some of the estimated parameters is non-standard.

The equilibrium rate deviates significantly from the actual rate over a large period due to large and multiple shocks. However, the adjustment speed is rather

18 Empirical research for the Netherlands points in general to low substitution possibilities. Estimating the long-term relationship for potential demand for labour, Fase et al. (1992) find a substitution elasticity of 0.068 for the MORKMON model. The CESAM and IBS-CCSO modellers (Kuipers et al. (1990)) obtained a value of 0.25 in a putty-clay setting. Lever (1993) finds 0.65 when he estimates the equilibrium unemployment rate. The operational CPB (1997) macro model JADE contains a value of 0.15 for the exposed sector and 0 for the sheltered sector.

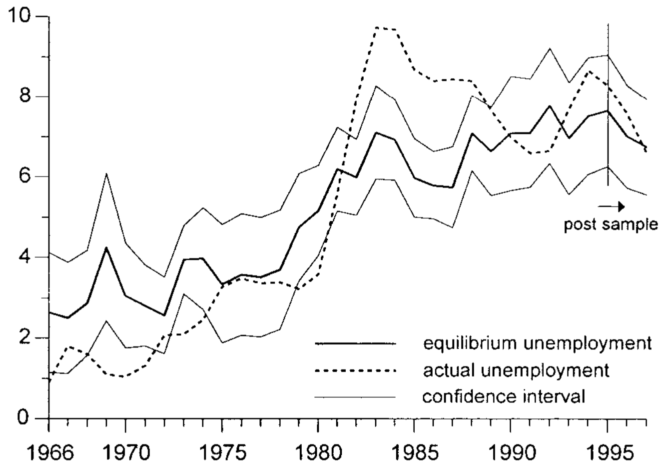

Figure 2 – Actual unemployment rate and estimated equilibrium unemployment rate (in %)

high. The adjustment speed is determined by the largest (real part of the) eigenvalues, which are 0.51, 0.58 and 0.60.[19] This implies that a (static) change in equilibrium is absorbed for more than 90 per cent in a period of 5 years. The long standing deviations between the actual and equilibrium rates have to be attributed to structural changes and are not due to slow adjustment. The relatively fast adjustment speed also implies that our results do not favor hysteresis as an explanation for the unemployment persistence.

It appears from Figure 2 that the equilibrium rate of unemployment is not much less volatile than the actual rate of unemployment. This is a consequence of the fact that, as an endogenous variable, its development depends on exogenous variables like tax rates and the real interest rate. To the extent that these variables shift, the equilibrium rate shifts too, and at the same time. The actual rate of unemployment will also show the effect of changes in these variables, but with a mean lag of several years.[20] One important conclusion that arises from this study is therefore that the old concept of the equilibrium rate of unemployment as a stable or slowly moving characteristic of the labour market of an

19 These are the eigenvalues of the companion matrix (the matrix of the feedback coefficients) of the estimated system, that is, they indicate the adjustment speed towards a static equilibrium in which w^*, l^* and p_y^* are exogenous. A full analysis of the adjustment speed would, of course, take account of the fact that the equilibrium also moves in response to a shock, and would additionally require, for instance, the dynamic modelling of equilibrium output since output is a major determinant of equilibrium employment l^*. Indeed, a proper analysis of the overall adjustment speed woud require a fully determined macro model. This is beyond the scope of this paper, although some information on this topic may be found in CPB (1997).

20 Of course, the actual rate of unemployment is also affected by business cycle indicators, like fluctuations in demand, that play no role in the determination of the equilibrium rate.

economy needs to be revised. The equilibrium rate is only stable insofar as its underlying determinants are stable. Indeed, the concept of a slowly-moving NAIRU, that forms the backbone of much recent work on inflation forecasting in the U.S. (see e.g. Gordon (1997)), is void of empirical content in times of rapid changes in the structural determinants of equilibrium unemployment.

Figure 3 and Tables 4 and 5 give a decomposition of the equilibrium rate for the years 1966-1995. The period 1966-1975 shows some increase of the equilibrium rate. The wedge and the replacement rate are rising but this is largely compensated by the fall in the user costs of capital. The equilibrium rate increases in the 1975-1984 period. The replacement rate is starting to fall, but the wedge and the cost of capital rise steadily. The equilibrium rate stays at its high level in the last period in our sample 1984–1995. The wedge remains on its high 1984-level but the replacement rate falls. The unemployment rate does not decrease because of the further increase in the relative user costs of capital in that period. The mark-up has no effect on equilibrium unemployment since in our estimates it is constant in the long run.

Table 5 gives a further decomposition of the influence of the user costs of capital and of the wedge. The fluctuations in the user costs of capital are driven mostly by the real interest rate. The increase in the wedge is mainly due to the increase in taxes and social security premiums, with only small effects of the terms of trade. In comparison with Madsen (1998), our results point to an even more important role of the real interest rate in the explanation of the development of unemployment in the eighties.

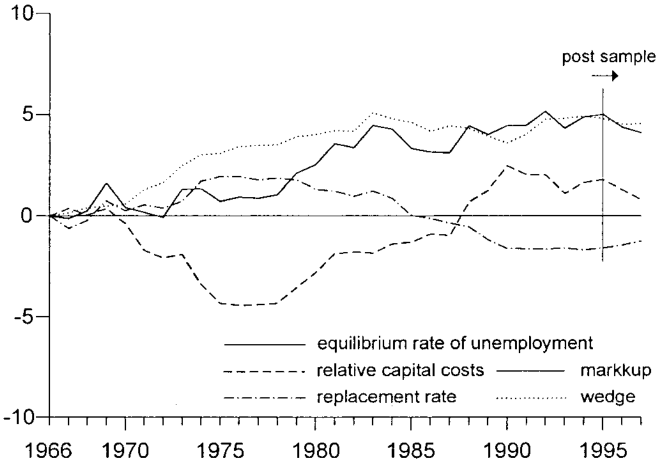

Figure 3 – Decomposition in the change in the equilibrium rate of unemployment (in %)

TABLE 4 – DECOMPOSITION OF THE CUMULATIVE CHANGE IN THE EQUILIBRIUM RATE OF UNEMPLOYMENT FROM 1966 (IN %)

	1975	1984	1995	1997
change in equilibrium rate of unemployment	0.7	4.3	5.0	4.0
– relative capital costs	−4.3	−1.4	1.8	0.8
– wedge	3.1	4.8	4.8	4.5
– replacement rate	1.9	0.9	−1.6	−1.3
– markup	0.0	0.0	0.0	0.0

TABLE 5 – DECOMPOSITION OF THE CUMULATIVE CHANGE IN THE EQUILIBRIUM RATE OF UNEMPLOYMENT FROM 1966; THE CONTRIBUTION OF THE RELATIVE CAPITAL COSTS AND THE WEDGE (IN %)

	1975	1984	1995	1997
relative capital costs	−4.3	−1.4	1.8	0.8
– real interest rate	−2.4	0.8	3.7	2.7
– fiscal instruments	−0.3	−1.1	0.0	0.0
– overall income tax rate	−0.9	−1.1	−1.0	-1.1
– terms of trade indicator	−0.7	0.0	-0.9	-0.8
wedge	3.1	4.8	4.8	4.5
– terms of trade	−0.3	−0.1	0.6	0.6
– taxes and social premiums	3.4	4.9	4.2	3.9

5 CONCLUSIONS

In this paper we show that the development of unemployment in the Netherlands over the period 1966–1995 can be explained by a structural model of wage bargaining, labour demand and price setting. Care has been taken to impose homogeneity restrictions on the adjustment dynamics that make the model consistent with a long-run NAIRU concept. The individual equations of this model show satisfactory explanatory power. Conspicuous results are a low estimated elasticity of substitution, at 0.35, a significant influence of the oil price shock through its effect on productivity and a strong feedback of unemployment on wage formation. Although the feedback to the static equilibrium is fairly fast, it nevertheless appears that the actual rate of unemployment can deviate from the natural rate for a considerable length of time.

The structural form of the model allows for a decomposition of the natural rate into its composite factors. It appears that the rise of unemployment in the early seventies is an adjustment to an already higher equilibrium rate. The influence of the increasing wedge between the real product wage and the real consumption wage and replacement rate is cancelled out by a fall in the capital costs.

The sharp increase in the second half of the seventies and early eighties can be attributed to increasing capital costs, while the wedge and replacement rate remained considerable. The persistence of high unemployment in the second half of the eighties and nineties, despite a falling replacement rate, appears to be due to further rising capital costs. Our analysis shows that the impact of capital costs on unemployment hinges crucially on a low elasticity of substitution. With an elasticity of substitution equal to unity, a long-run effect of capital costs on unemployment would not exist in our model.

Our results are in line with other recent studies, e.g. Blanchard (1997) and Phelps (1998), in that they all point to a substantial effect of capital costs on unemployment. We deviate from these studies by identifying the elasticity of substitution as the main parameter that regulates the importance of this effect. A desirable future extension of our work would be to repeat this analysis in a panel of countries, to see whether the difference in unemployment performance between countries can be related to differences in the capital-labour substitution. A second important extension is to include a description of capital formation into the model, both to provide a more complete description of the dynamics of employment and to be able to integrate the dynamic arguments of Phelps (1994) and Caballero and Hammour (1996) into the analysis.

DATA APPENDIX[21]

Definitions and data source (*in parentheses*[22])

- g — the contractual working time in hours (fte) of employees working in enterprises (CBS)
- l — employment enterprises (CBS)
- c_i — investment tax credits (CPB)
- d_i — present value of depreciation deductions over the life time of the assets (CPB)
- p_{fc} — price of foreign competitors on the foreign market (CPB)
- p_i — the price of total investments of enterprises (CBS)
- p_m — import prices (CBS)
- p_y — price value added enterprises (CBS)
- r — long term interest rate paid on government loans (CPB)
- rp — replacement rate, weighted average of welfare-, unemployment and disability benefits (CPB)

21 On request, the authors can supply both original data and data calculated during estimation such as the cost variable c. The parameters used to calculate these variables are the ones estimated in the third joint dynamic estimation round, labelled CRS in Tables 1, 2 and 3. The source for the original data is CPB .

22 CBS: Statistics Netherlands; CPB: Netherlands Bureau for Economic Policy Analysis.

t_b tax rate assessed on corporate profits (CPB)
t_g overall income tax rate (CPB)
u unemployment rate (CPB)
w the average earnings (fte) of employees working in enterprises (CBS)
Λ wedge between the real product wage and the real consumption wage (CPB)
y value added enterprises (CBS)

Aggregation level data
'Enterprises' encompasses the market sector, mining and quarrying, housing and non-market services. The market sector contains agriculture, manufacturing and transport, construction, trade, banking and other private services. The price of firms' investments includes buildings, equipment, means of transport, housing and infra structure.

Labour market figures
The unemployment rate is defined as the out of work labour force as a percentage of the total labour force, with the restriction that only people with a working week of at least 12 hours are taken into account. Starting point is employment in full time equivalents according to the 'Nationale Rekeningen' (national accounts) of Statistics Netherlands (CBS). Using the ratio between persons and full time equivalents from the 'arbeidsrekeningen' (labour accounts) of CBS the labour force in persons has been calculated. Together with the number of persons out of work from the CBS 'Enquete BeroepsBevolking, EBB' (labour force questionnaire) the total labour force and unemployment rate results. This unemployment rate deviates from the rate that can be derived with EBB data only. The OECD unemployment rate figures deviate due to a broader labour force definition: people working less than 12 hours are also taken into account.

The wedge is defined as the ratio between the total wage bill of firms and households' disposable income out of this income source. The replacement rate is a weighted average of welfare-, unemployment and disability benefits.

The user costs of capital
The definition of the user costs of capital follows from the firm's optimization problem

$$\max_k \; V_0 = \sum_{j=0} [(1-t_b)\,[F(k,l)\,p_y - lp_l] - [1 - t_b(c_i + d_i)]$$
$$[k - k_{-1}(1-\delta)]\,p_i]\,(1 + (1-t_g)\,r)^{-j}, \qquad (21)$$

with V the value of the firm and k the capital stock. The user costs definition follows from the marginal productivity condition of capital, which has to hold in the optimum

$$F_k p_y = p_i \frac{1 - t_b(c_i + d_i)}{1 - t_b}\left[1 - \frac{(1-\delta)(1+\mathring{p}_i^e)}{1+(1-t_g)r}\right] \equiv \tilde{p}_k\,, \tag{22}$$

with F_k the marginal product of capital. Assume a CES production technology, increasing returns to scale and labour augmenting technical progress. This yields the minimal cost function of the main text after re-scaling to obtain price indices with the value one for a certain base year. The effective price of investment goods is calculated as a weighted average. Figure 4 shows the development of the user costs of capital.

Expected inflation
The expected inflation also determines the user costs of capital. Assuming an ARIMA(0,1,2) process for inflation, thus $\Delta\mathring{p}_i = \epsilon + \theta_1\epsilon_{-1} + \theta_2\epsilon_{-2}$, we get with 1950–1997 data a relation that can be used to forecast inflation. We used a 10 periods ahead forecast of inflation as a proxy of the expected (long term) inflation $\mathring{p}_i^e$.

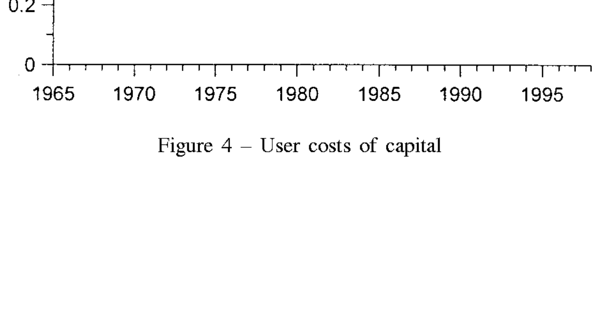

Figure 4 – User costs of capital

APPENDIX: TEST PROCEDURE

post sample performance

We make use of a formal test procedure to judge the post-sample performance. The Gallant Jorgenson (1979) restriction test statistic for 3SLS is used.[23] In the main text we present the statistics with (GJ_c) correction for the degrees of freedom. The statistics without degrees of freedom correction are denoted as (GJ). The correction factor is of the Anderson variety as discussed in Kiviet (1986). The test statistics are:

$$GJ = (T + m)\,(Q_0 - Q_1)\ ; \quad GJ_c = \left(T + \frac{m}{2} - \frac{k-1}{l}\right)(Q_0 - Q_1)$$

$$Q = \hat{\epsilon}'\,(S^{-1} \otimes Z(Z'Z)^{-1}Z')\,\hat{\epsilon}$$

with Q_0 and Q_1 the value of the minimum distance function for the null hypotheses and the maintained hypotheses, respectively, S a consistent estimate of the variance-covariance matrix of the residuals, Z the matrix of instruments, T the number of observations in the original sample, m the length of the post sample period, k the number of coefficients in the original model, l the number of equations. The test statistics are χ^2 distributed with degrees of freedom equal to the product ml, which is the number of restrictions.[24] The correction factor aims to get the right size in small samples.

Restriction test

We make use of the same type of correction. The correction factor is discussed in Evans (1982). The test statistics are:

$$GJ = T(Q_0 - Q_1)\ ; \quad GJ_c = \left(T - \frac{k}{l} + \frac{r}{2l} - 1\right)(Q_0 - Q_1)$$

with Q_0 and Q_1 the value of the minimum distance function for the null hypotheses and for the maintained hypotheses, respectively, T the number of observations in the original sample, r the number of restrictions, k the number of coefficients in the original model, l the number of equations. The test statistics are χ^2 distributed with degrees of freedom equal to the number of restrictions r.

23 See Hall (1995) for the way the test can be implemented.

24 The set of instruments is also extended with the dummy variables

REFERENCES

Bean, C.R. (1994), 'European Unemployment: A Survey,' *Journal of Economic Literature*, 32 (2), pp. 573–619.

Blanchard, O.J. (1997), 'The Medium Run,' *Brooking Papers on Economic Activity*, 2, pp. 89–158.

Blanchard, O.J. and L.F. Katz (1997), 'What We Know and Do Not Know about the Natural Rate of Unemployment,' *Journal of Economic Perspectives*, 11, pp. 51–72.

Blanchard, O.J. and L.J. Summers (1987), 'Hysteresis in Unemployment,' *European Economic Review*, 31, pp. 288–295.

Blanchflower, D. and A. Oswald (1994), *The Wage Curve*, Cambridge MA, MIT Press.

Bruno, M. and J.D. Sachs (1985), *Economics of Worldwide Stagflation,* Oxford, Blackwell.

Caballero, R.J. and M.L. Hammour (1996), 'The Macroeconomics of Specificity,' NBER Working Paper No. 5757, Washington D.C.

CPB (1997), 'JADE, a Model for the Joint Analysis of Dynamics and Equilibrium,' CPB Working Paper No. 99, The Hague.

Diewert, W. and T. Wales (1987), ' Flexible Forms and Global Curvature Conditions,' *Econometrica*, 55, pp. 43–68.

Diewert, W. and T. Wales (1995), 'Flexible Forms and Tests of Homogeneous Separability,' *Journal of Econometrics*, 67, pp. 259–302.

Draper D.A.G. and A.J.G. Manders (1997), 'Structural Changes in the Demand for Labor,' *De Economist*, 145, pp. 521–546.

Evans, G.B.A. and N.E. Savin (1982), 'Conflict among the Criteria Revisited: The W, LR and LM Tests,' *Econometrica*, 50, pp. 737–748.

The Economist (1977), 'Business Brief: The Dutch Disease,' 26 November.

Fase, M.M.G., P.Kramer and W.C. Boeschoten (1992), 'Morkmon II, the Netherlands Bank's Quarterly Model of the Netherlands Economy,' *Economic Modelling*, 9, pp. 146–204.

Friedman, M. (1968), 'The Role of Monetary Policy,' *American Economic Review*, 58, pp. 1–21.

Gallant, A.R. and D. Jorgenson (1979), 'Statistical Inference for a System of Simultaneous, Nonlinear, Implicit Equations in the Context of Instrumental Variable Estimation,' *Journal of Econometrics*, 11, pp. 275–302.

Gordon, R.J. (1997), 'The Time-Varying NAIRU and its Implications for Economic Policy,' *Journal of Economic Perspectives*, 11, pp. 11–32.

Graafland, J.J. and F.H. Huizinga (1999), 'Taxes and Benefits in a Non-Linear Wage Equation,' *De Economist*, 147, pp. 39–54.

Hall B.H. (1995), *Time Series Processor, Version 4.3, User's Guide*, Palo Alto, TSP International.

Hamermesh, D. (1993), *Labor Demand*, Princeton, Princeton University Press.

Hausman, J.A. (1978), 'Specification Tests in Econometrics,' *Econometrica*, 46, pp. 1251-1272.

Jorgenson, D.W. (1986), 'Econometric Methods for Modelling Producer Behaviour,' in: Z. Griliches and M. Intrilligator (eds.), *Handbook of Econometrics*, III, Amsterdam, Elsevier Science Publishers.

Katz, L.F. (1988), 'Some Recent Developments in Labor Economics and their Implications for Macroeconomics,' *Journal of Money, Credit, and Banking*, 20, pp. 507–522.

Kiviet, J.F. (1986), 'On the Rigour of Some Misspecification Tests for Modelling Dynamic Ralationships,' *Review of Economic Studies,* 53, pp. 241–261.

Kuipers, S.K., B.W.A. Jongbloed, G.H.Kuper and E. Sterken (1990), 'CESAM: The CCSO Annual Model of the Dutch Economy,' *Economic Modelling*, 7, pp. 202–250.

Layard, P.R.G., S.J. Nickell, and R. Jackman (1991), *Unemployment*, Oxford, Oxford University Press.

Lever, M.H.C. (1993), *Union Wage Formation and (Un)employment*, University of Maastricht Dissertation No. 93–17.

Madsen, J.B. (1998), 'General Equilibrium Macroeconomic Models of Unemployment: Can They Explain the Unemployment Path in the OECD?,' *Economic Journal*, 108, pp. 850–867.

Nieuwenhuis, A. (1986), 'Prijsvergelijkingen per sector,' CPB research memorandum No. 14, The Hague.

Nickell, S.J. and M. Andrews (1983), 'Unions, Real Wages and Employment in Britain 1951-79,' *Oxford Economic Papers*, 35, pp. 183–206.

OECD (1997), *Implementing the OECD Jobs Strategy*, Paris.

Pissarides, C.A. (1998), 'The Impact of Employment Tax Cuts on Unemployment and Wages: The Role of Unemployment Benefits and Tax Structure,' *European Economic Review*, 42, pp. 155–183.

Phelps, E.S. (1994), *Structural Slumps*, Cambridge MA, Harvard University Press.

Phelps, E.S. and G. Zoega (1998), 'Natural-Rate Theory and OECD Unemployment,' *Economic Journal*, 108, pp. 782–801.