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EQUILIBRIUM RATES AND WAGE FLEXIBILITY IN EUROPE

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ARE EUROPEAN LABOUR MARKETS SUFFICIENTLY FLEXIBLE TO COPE WITH EMU?

Whether European labour markets are sufficiently flexible to adjust efficiently to adverse shocks and thus avoid a rise in unemployment has been hotly debated for a couple of decades. Many studies have argued that European labour markets were less flexible that labour markets in other OECD countries. As a result of those rigidities, it was argued, the rate of employment corresponding to a given rate of inflation (the Non-Accelerating Inflation Rate of Unemployment or NAIRU) was uncomfortably high in most EC member states.

Whereas most studies have been based on *indirect* measures of flexibility, Rudy Douven of the Netherlands Bureau for Economic Analysis (CPB) has attempted to directly measure the responsiveness to shocks of five EU member states, the EU as a whole, the US and the OECD. In a paper published as an ENEPRI Working Paper, Douven, presents calculations of four indicators for labour market performance: flexibility, defined as the responsiveness of wages to change in unemployment, the equilibrium rate of unemployment, and the variability and persistence of this equilibrium rate.

Using an augmented Phillips curve in which the long-run equilibrium rate of unemployment is independent of the rate of inflation (the long-run Phillips curve is vertical), Douven calibrates the model for the OECD, the US, the EU, Germany, France, Italy, United Kingdom and the Netherlands. He finds, in particular, that in the four EMU countries (G, FR, I, NL), for almost two decades nominal wage growth was lower than the sum of core inflation and structural labour productivity growth. However, this wage moderation has not been sufficient to restore equilibrium in the labour market.

Combining the four indicators, Douven finds that the UK is a special case with a relatively high equilibrium rate of unemployment and strong flexibility. France and Italy, on the contrary, combine relatively low equilibrium rate of unemployment with strong persistence (hysterisis) and low flexibility. Germany and the US appear to be in a more balanced position with about average equilibrium rate of unemployment and "appropriate" flexibility. The Netherlands appears to be in a particularly favourable position with the actual unemployment rate close to the long-term equilibrium and a flexible labour market. However, as stressed by Douven, this may be due to a particular definition of unemployment. Using a broader definition of unemployment, including "hidden" unemployment might give results more in line with the other countries.

All in all, however, Douven argues that core inflation rates and labour productivity growth tend to converge and that future wage setting in Europe will depend more and more on labour market characteristics.

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R.C.M.H. DOUVEN*

ABSTRACT

This paper presents estimates of short-term and long-term equilibrium rates of unemployment. Estimates of equilibrium rates of unemployment in the literature often produce results that closely follow actual unemployment rates. This paper, in contrast, shows that in the past twenty years equilibrium rates may well have been substantially lower than actual unemployment rates in many European countries. This result indicates a considerable period of rather low wage flexibility and strong persistence.

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This paper is also available at <http://www.cpb.nl/nl/pub/onderzoek/157/om157.pdf>

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Equilibrium Rates and Wage Flexibility in Europe

R.C.M.H. Douven

1. Introduction

With the introduction of the euro national authorities in the European Union will lose some potential macroeconomic policy options to accommodate shocks. To accommodate the impact of shocks in the event of asymmetric disturbances, more flexibility will be needed on product and labour markets, an important element here being macroeconomic wage flexibility.[1]

Of course labour markets differ across countries. Any labour market is surrounded by an array of institutional arrangements that forms a complex web of incentives and disincentives on both sides of the market (Siebert, 1997). At the start of EMU it is interesting to study how labour markets in EMU may behave and how this behaviour compares with that of labour markets outside EMU. It is often argued that labour markets in Europe are rigid and inflexible, while labour markets in the US are dynamic and flexible. Although there seems to be an element of truth in this simple view the subject clearly calls for a more profound approach (see e.g. Nickell, 1997).

In this study we will characterise a labour market by four indicators. The first one is flexibility. Flexibility is defined as the responsiveness of wages to a change in unemployment under a fixed institutional setting. Since flexibility may depend on the particular institutional setting, we assume that institutions on the labour market are reflected in the long-term equilibrium rate of unemployment. Institutions change, and so we allow for the possibility that the equilibrium rate moves (slowly) over time. From this equilibrium rate we derive two more indicators: its average level and its variability. A fourth indicator is persistence. In a situation in which the equilibrium rate is low and flexibility is moderate, actual unemployment may still be high due to persistence.

We will construct these four indicators for labour markets in France, (West) Germany, Italy, the Netherlands, the UK and the European Union as a whole, together with one country outside Europe, i.e. the US. Furthermore, we consider the OECD as a whole. We will perform our estimations using a similar functional form, comparable yearly data and a similar period of estimation (1977-1998) for all countries. The analytic tool we use is the augmented Phillips

[1] For a recent overview, see Buti and Sapir (1998).

curve, with special emphasis on modelling the evolution of the equilibrium rate of unemployment.

A considerable amount of research has already gone into calculating equilibrium rates of unemployment. In addition to the structural approach,[2] we can distinguish in the literature the approach that circumvents the problem of explaining the determinants of the equilibrium rate of unemployment. If the (long-term) equilibrium rate is viewed as "ground out" by the microeconomic structure and behaviour of the economy, then it should shift slowly (see Gordon (1997)). Therefore, smoothness restrictions are often imposed on a function, only depending on time, representing the (long-term) equilibrium rate of unemployment. In the recent literature (see e.g. Cross et al. (1997), Debelle and Laxton (1997), Gordon (1997), IMF (1998) and Staiger et al. (1996,1997)) this method is mostly applied to estimate the NAW(I)RU (non-accelerating wage (inflation) rate of unemployment).[3] In this study we will follow a similar strategy.

The contribution of this paper is two-fold. The first contribution is reflected in the particular choice of the wage equation. Time-varying equilibrium rates are calculated from a wage equation in which inflation and trend productivity growth are fully passed along into wage growth. This strategy deviates only slightly from the above-mentioned NAW(I)RU studies, but it may have considerable consequences for the positioning of the equilibrium rates.[4] The second contribution is the explicit distinction between a time-varying long- and short-term equilibrium rate. The time-varying short-term equilibrium rate is split up into two parts.[5] The first part represents the time-varying long-term equilibrium rate and the second part represents elements of persistence. Both aspects are directly related to institutional characteristics of the labour market. It is still controversial whether elements of persistence play a role in the

[2] This avenue of research took off after the publication of Layard et al. (1991). Many economic, but also social and demographic reasons may explain the evolution of the equilibrium rate of unemployment. The empirical literature points at the tax-wedge, user costs of capital, productivity growth and all other types of labour market variables (replacement rate, unemployment benefits, union-related indicators etc.) as possible determinants (see e.g. Ball (1997), Nickell (1998), Tyrvainen (1994), and for the Netherlands, Broer et al. (1998)). Whether or not tax variables are important determinants is still controversial. For example, Blanchard and Katz (1997) find little evidence for tax variables.

[3] Note, furthermore, that in our view the short-term equilibrium rate of unemployment and the short-term NAW(I)RU are model-dependent phenomena, whereas the long-term equilibrium rate and long-term NAW(I)RU are equal. Thus, if there is no persistence all types of equilibrium rates are equal.

[4] The concept is more in line with a study of Blanchard (1998), who considers a direct relationship between the labour income share and the actual unemployment rate.

[5] For a similar strategy, see Layard et al. (1991).

equilibrium rate of unemployment. In a recent study Ball (1997) regresses the equilibrium rate on elements of persistence and on other labour market characteristics. His study points to evidence that is consistent with theories of hysteresis.

The paper is organised as follows. In the second section we present the underlying model. The third section presents the underlying theory and explains certain choices. In the fourth section we present the estimation results and derive the four indicators from our model. The fifth section compares our estimates of the short-term equilibrium rate with NAW(I)RU estimates from the literature. Section six concludes.

2. The model

Our starting point for estimation is a textbook version of an augmented Phillips curve (see e.g. Burda and Wyplosz (1993)):

$$w = B^{c} + h^{s} - \forall\,(u - u_l^{*}) - \exists\,)u + \;, \qquad (1)$$

This equation posits that the percentage change in the nominal wage rate w depends on four forces: the core (or underlying) inflation rate B^{c}, the growth in structural labour productivity h^s, the deviation of the actual unemployment rate u from the long-term equilibrium rate, u_l^*, and the change in the unemployment rate $)u$. Furthermore, a random error , is added. The adjustment parameter ∀ and persistent parameter ∃ are assumed to be constant and positive.

The underlying assumption of the model is that wages are determined by bargaining between employers and workers (or their unions). It is assumed that the homogeneity condition for prices and labour productivity holds. In the long run, i.e. a situation in which the growth in real wages equals the growth in labour productivity and in which the unemployment rate is constant, this guarantees that the Phillips curve is vertical and that unemployment equals its equilibrium rate u_l^*. After rewriting, the model reads as follows:

$$w - B^{c} - h^{s} - (\forall + \exists)(u - u_s^{*}) + \;,, \qquad (2)$$

with $u_s^* := \frac{\alpha}{\alpha+\beta}\, u_l^* + \frac{\beta}{\alpha+\beta}\, u(-1)$

After moving $B^c + h^s$ to the left-hand side, we obtain a new dependent variable: wage growth minus core inflation minus structural labour productivity growth. Deviations from zero from this variable correspond with deviations from the actual unemployment rate from its short-term equilibrium rate u_s^* which is represented on the right-hand side. The short-term equilibrium rate represents a weighted average of the constant long-term equilibrium rate u_l^*

and the lagged actual unemployment rate $u(-1)$. Persistence is strong if ∃ is large relative to ∀. In that case u_s^* is closer to $u(-1)$ than to u_l^* and the economy behaves as if its equilibrium is close to last period's actual rate. If ∃ = 0, no persistence is present and the long- and short-term equilibrium rate coincide. It may also be the case that no long-term equilibrium exists (∀=0) and only elements of persistence play a role. In that particular case we speak of hysteresis. Persistence can be explained by the erosion of human skills from prolonged unemployment or from insider-outsider mechanisms. The latter refer to situations in which persons holding jobs tend to safeguard their own employment in wage negotiations and thus prevent the degree of (real) wage adjustment that would be required to make the employment of job-seekers more attractive.[6] Note that equation (2) only slightly differs from the more standard NAW(I)RU specification. That our particular choice may have considerable consequences for the positioning of the (short-term) equilibrium rates is explained in Appendix A.

The underlying model exhibits the following rules of thumb:

- The long-term equilibrium rate u_l^* is the rate to which the unemployment rate tends in the long run.
- The short-term equilibrium rate u_s^* is the level of unemployment that is consistent with a stable pattern of wage growth (minus core inflation plus labour productivity growth) in the short run.
- Generally, a long/short-term equilibrium rate under/above the actual unemployment rate represents disinflationary/inflationary pressures on wage growth (minus core inflation, plus labour productivity growth) in the long/short run.[7]
- A strongly fluctuating long-term equilibrium rate u_l^* indicates flexible labour market institutions.[8] After estimating u_l^*, u_s^*, ∀ and ∃ we will construct the following four indicators:

[6] For a more general overview on these subjects, see Layard et al.(1991), Bean (1994) or McMorrow (1996).

[7] It may be possible that u_s^* lies above the actual rate and u_l^* under the actual rate of unemployment. This may be the case after a fast decrease of actual unemployment. In the short run we may then observe inflationary pressures, whereas in the longer run these pressures are more likely to become disinflationary.

[8] Note that this implication is only one way! We can draw no conclusions from a constant equilibrium rate of unemployment. It may also be very flexible.

1) Flexibility. Flexibility refers to the responsiveness of wage growth after increasing unemployment by 1% point, keeping structural labour productivity growth and core inflation fixed.

2) Persistence. As follows from our exposition above, persistence is measured by: $\frac{\beta}{\alpha+\beta}$

3) Average level of the long-term equilibrium rate u_l^* during the estimation period.

4) Standard deviation of the long-term equilibrium rate u_l^*.

The estimation part of the model is not straightforward, since the parameters ∀, ∃ and the time-varying parameter u_l^* are likely to be interrelated. Furthermore, these parameters may depend on the particular choice of core inflation and structural labour productivity growth. In order to estimate equation (2), we have to make certain choices in advance. They will be discussed in the next section.

3. Theory and choices

3.1 Why do we assume a *time-varying* long-term equilibrium rate, u_l^*, while leaving structural adjustment parameters, such as " and $, constant?

One of the main problems in estimation is that the impact of a certain labour market policy is often related to other complementary policies and institutions (see e.g. Coe and Snower (1997)). An institutional change is therefore difficult to capture by a change in one single parameter. More parameters are likely to change simultaneously. Although many studies assume time-varying parameters, most research is directed only towards time-varying (short-term) equilibrium rates of unemployment. A lot of research has been undertaken representing NAIRUs with Kalman filters or spline functions. Examples are Cross et al. (1997), Debelle and Laxton (1997), Gordon (1997) and Staiger et al. (1996, 1997). There is also a structural empirical study, Ielegems and Plasmans (1998), which assumes changing persistence- or adjustment parameters. Our own research in this field, using Kalman filters or polynomial functional forms to describe the time-varying parameters, yielded indeed that most gains in terms of fit were obtained by time-varying (short-term) equilibrium rates of unemployment, and then subsequently by time-varying ∀'s. The lowest gains were obtained by time-varying ∃'s. This research also indicated a strong positive correlation between ∀+∃ and u_s^*. In general, the smaller the distance between the estimated (short-term) equilibrium rate and the actual unemployment rate, the higher the estimated values for ∀+∃ that are found.[9] A summary of this research is presented in Appendix B.

3.2 Representation of the long-term equilibrium rate of unemployment

According to Friedman's (1968) interpretation: the long-term equilibrium rate is "grounded out" by the set of "Walrasian" microeconomic relations in the economy, including the structure and institutions of product and labour markets. In that case the long-term equilibrium rate should shift slowly (Gordon (1997)). This aspect will be represented by a smoothness restriction.[10] Using a smooth time-varying equilibrium rate may complicate identification. To see this, consider the following simple model:

$$w = B^{c} + (h^{s} - \forall\, (u - u^{*}) + ,, \quad \text{with } 0<(<1 \qquad (3)$$

where h^{s} is a smoothed version of actual labour productivity. Because u^{*} and h^{s} are now both smooth variables, identifying (will not be possible.[11] Thus, if one imposes a smoothness restriction on the equilibrium rate, then this has immediate consequences for (; we have to predetermine (. The most natural choice now is to assume that (=1, which resembles the fact that in labour-market equilibrium real wage growth equals structural labour productivity growth.

The class of smooth functions is still extremely large and not well defined. First of all, we experimented with polynomials and Kalman filter techniques to calculate the long-term equilibrium rate. Each of these approaches has its own specific problems.[12] These experiments were useful for obtaining ideas of defining a more compact class of functions. Finally, to provide an example, we decided to substitute (and estimate) the following class of asymmetrical density functions for the long-term equilibrium rate of unemployment:

[9] This should be kept in mind. If estimates indicate an increasing equilibrium rate below the actual unemployment rate, then this could also reflect a situation of a constant equilibrium rate with the adjustment parameters decreasing.

[10] Technically this aspect is also very appealing, since otherwise equation (1) would not be identified.

[11] To understand this aspect, rewrite the equation as follows: $w = B^{c} - \forall\, (u - (u^{*} + (/\forall\, h^{s})) + ,$. One immediately observes that if u^{*} and h^{s} are both smooth then the 'new equilibrium rate': $u^{*\prime} = u^{*} + (/\forall\, h^{s}$ is again smooth; it is thus not possible to distinguish properly between the original model (4) and the model: $w = B^{c} - \forall(u - u^{*\prime}) + ,$.

[12] Polynomials are restricted in the sense that the shape of the curve towards a possible maximum is always concave. Kalman filters have difficulties in explaining smooth jumps and can be very sensitive to starting values and the smoothness parameters, which have to be determined exogenously. This problem marks also the difference between research of US and European unemployment figures. Since

$$u_l^* := (_T - (_L\, L_T\, (1 - e^{-(_l\,(t-T)^2}) - (_R\, R_T\, (1 - e^{-(_r\,(t-T)^2}) \qquad (4)$$

t	*time*
T	*possible point of time where top of the function occurs*
L_T	*dummy equal to 1 till T , afterwards 0*
R_T	*dummy equal to 0 till T , afterwards 1*
$(_T, (_L, (_l, (_R, (_r$	*characteristic parameters of asymmetrical function*

A convenient way to visualise this equation is as follows. Consider two normal density functions with different mean and variance. Cut both functions at their mean. Paste now at the top, the left part of the first density function against (the top of) the right part of the second density function. What is left over can be called an asymmetrical density function.[13] Note that this function may contain only one top or trough.[14]

3.3 Unemployment enters in a logarithmic form

Recently, a lot of attention has been directed towards linearity of the wage equation (see e.g. Coe (1985), Debelle and Laxton (1997), Nickell (1998) or IMF (1998)). Experiments with non-linear functional forms can be summarised by the following general class:

$$w = B^c + h^s - f(u_l^*, u, u(-1), \forall, \exists) \qquad (5)$$

where f represents a non-linear function. This is a huge class of possible functions that may complicate matters considerably. For example, the speed of adjustment may become dependent upon the level of the equilibrium rate, shocks may work asymmetrically and we may have to distinguish between different types of equilibrium rates, such as deterministic and stochastic ones (see Debelle and Laxton (1997)). The current stance in the empirical literature seems to be that some form of non-linearity exists. What exact type of non-linearity, however, is still unclear. According to Nickell (1997) there are good theoretical and empirical reasons for believing that downward pressure on wages is a concave function of the

unemployment shows much more variabilty in the European countries than in the US, Kalman filters seem to be less useful.

13 Of course, all the standard properties of a density function vanish. The function can also become constant or simply an increasing function of time over the reference period if the top is outside this period.

14 From a general viewpoint this is of course not necessary. However, Kalman filter experiments and experiments with polynomials showed that this approximation worked reasonably well for all countries.

unemployment rate. Our empirical experiments with logarithmic functions did not reject this observation and led to the conclusion that logarithmic functional forms for unemployment performed on average somewhat better than linear functional forms.[15]

3.4 The choice of the explanatory variables

For example, if the labour income share tends to return to a certain level, we may as well have to include such a (level) error-correction specification into the equation.[16] The correct choice for core inflation and structural labour productivity growth is also not entirely clear. Some researchers claim that labour productivity is not fully transmitted into the wage rate (see e.g. McMorrow (1996) or Tyrvainen (1994)). Another example is the choice of only one lag of unemployment. It may well be the case that more lags are needed to describe the correct impact of hysteresis (see e.g. Akram (1998)).

We assume that core inflation, B^c, is a function of lagged inflation, where inflation is represented as a weighted average of lagged GDP-price inflation B_y and consumer price inflation B_c in the following way:

$$B^c = ,\, B_y(-t_p) + (1-,)\, B_c(-t_p) \tag{6}$$

This choice reflects the idea that, during bargaining, employers are mainly concerned about production prices, whereas employees prefer to bargain on the basis of consumer prices. Furthermore, wage contracts are negotiated for a given period of time. This choice is reflected in t_p.[17] The "optimal" share, , , and the "optimal" lag year, t_p, are determined by calibration (see Appendix C).

Structural labour productivity growth is a smoothed version of actual labour productivity. The smoothness aspect reflects the idea that productivity gains accrue only little by little into wages and are not a feature of the short-run. The smoothed version is obtained as follows:

$$h^s = 8\, h^s(-1) + (1-8)\, h \tag{7}$$

[15] We also estimated the optimal lag in unemployment and represented $)u$ in (1) by a distributed lag. Technically, we substituted for $)u$ in (1), (where in this example u is taken with a lag of -0.75): $)\log u(-0.75)+...+)\log u(-0.75-(k-1))$, where k varies by country and can obtain a maximum value of 3 (see Appendix C).

[16] For a discussion on this theme, see e.g. Blanchard and Katz (1997) or Fair (1997).

[17] The latter choice corresponds with a wage contract of length $2t_p$. If we assume that the observed wage rate corresponds with the wage received at the middle of the contract with length $2t_p$; then inflation at the time of bargaining is lagged t_p (see also Appendix C).

In this formula, *h* is actual labour productivity growth and 8 is a smoothness parameter. The higher 8 is, the smoother structural labour productivity growth will be.[18]

The previous discussion already contains one important message. Uncertainties surrounding the equilibrium rate of unemployment are likely to be considerable and will depend on the model selected. Considering the elusiveness of the concept, this is not so surprising and it seems already generally accepted (see e.g. Staiger et al. (1996, 1997)). Although our model fits the data well, we refrain from constructing uncertainty intervals around our estimates, since our model is a particular result of the choices made.

4. Estimation results

This section will discuss the main results and show how these results are related to the explanatory variables. The estimation results are extensively explained in Appendix C. First, we present in Figures 1a and 1b some sub-graphs of the (estimated) explanatory variables.

The estimated values of core inflation show a decreasing converging pattern towards a value around 2% in 1998. We also observe a gradual slowdown of structural labour productivity growth in all countries.[19] A different picture emerges if we take a look at the third sub-graph, the actual unemployment rates. The picture for the unemployment rates looks exactly the opposite. The figure starts off in 1977 with unemployment rates between 4 and 6%. Henceforth, unemployment rates diverge, featuring an M-shape. The initial increase in unemployment is followed by a slowdown at the end of the eighties. At the beginning of the nineties, however, unemployment starts to increase again; for some countries the slowdown has not set in yet.[20] The fourth sub-graph shows the dependent variable in equation (2), called *cclis* (core change in labour income share) in the sequel, and represents nominal wage growth minus core inflation plus structural labour productivity growth ($cclis = w\text{-}\boldsymbol{B}^{c}\text{-}h^{s}$).[21] In

[18] Again, calibration yielded smoothness parameters between 0.55-0.95. To calculate structural labour productivity growth, we also need a starting value. For this value we used for each country the average labour productivity growth of 1960-1975. For the exact values, see Appendix C.

[19] The exact reason for the slowdown is still unclear. In part, it is probably still due to the oilshock in 1973 (see e.g. Perron, (1989)). The sub-graphs also show the "catching up" idea towards the productivity levels of the US (see e.g. Wolff (1996)) Other possible explanations in the Netherlands are the increase of the number of less productive workers (Pomp (1998)), or the productivity slowdown in commercial services (Van der Wiel (1998)).

[20] Remarkable is the fact that the two countries with the highest inflation rates in 1977, France and Italy, show up as the ones with the highest unemployment rates in 1998. This suggests that these two countries paid a high price in terms of unemployment to achieve convergence in inflation.

[21] The variable *cclis* reflects the core change in the labour income share. If the labour market is in equilibrium, i.e. a situation in which u equals u_s* (= u_l*) and in which there are no exogenous shocks

equilibrium it would be expected that this variable coincides with the zero-line, which is also drawn in the sub-graphs. A remarkable pattern, however, emerges. We observe that *cclis* is negative during (almost) the whole period for the four EMU-countries, the EU and the OECD. Therefore, we expect the actual unemployment rates to exceed the short-term and long-term equilibrium rates of unemployment. Exceptions to this rule are the UK and the US. Both show an oscillating pattern around zero for *cclis*. For example, for the UK, periods of disinflationary wage pressures, such as 1981-1984 and 1991-1996 alternate with periods of inflationary wage pressures, such as in 1985-1990 and 1997-1998. This indicates that actual UK and US unemployment rates will oscillate around their equilibrium rates.

4.1 Long- and short-term equilibrium rates of unemployment

After estimation of the long-term equilibrium rate, we calculate the short-term equilibrium rate.[22] Both are, together with the actual unemployment rates for each country, presented in Figure 2. Both equilibrium rates give some interesting information.

As expected, the equilibrium rate patterns in Figure 2 differ among countries. The fact that actual unemployment exceeds the short- and long-term equilibrium rate over the reference period is in accordance with our expectations, given the negative *cclis* figures in the past twenty years. The UK and the US are the major exception to the rule. Rather low long-term equilibrium rates are found for the Netherlands and (West) Germany. Slightly higher rates are found for France and Italy. For Italy and the US, best results are obtained with a constant long-term equilibrium rate. In Italy, the short-term equilibrium rate lies closer to the actual rate than to the long-term equilibrium rate. This suggests that in Italy it will take a lot of time to bring unemployment back to the long-term equilibrium rate without providing inflationary pressures. In (West) Germany, the UK and the Netherlands the equilibrium rate increased, particularly during the first half of the eighties, but gradually declined thereafter, suggesting that after an initial worsening the labour-market situation improved again. For Germany and the Netherlands this is directly related to the peak values of *cclis* around 1988 in Figures 1a and 1b, sub-graph 4. For France, the equilibrium rates remained low for a long time but the

working on the economy, then we expect that the wage bargaining outcome will be such that nominal wage growth equals core inflation plus structural labour productivity growth; hence *cclis* = 0. This variable is not similar to the change in labour income share, since core inflation is not fully determined by actual GDP inflation and structural labour productivity is not equal to actual labour productivity. Actual labour income shares, however, also show a clear downward trending pattern in some large countries in Continental Europe (see e.g. Blanchard (1998)).

[22] The short-term rates are calculated in a similar way to the calculations performed in equation (2).

rise, starting at the end of the eighties, does not yet seem to have stopped. Direct estimations for the EU as a whole show an intermediate pattern for the equilibrium rate: a rise during the first half of the eighties and a stabilisation around 6% from 1988 onwards.

Despite the well-known aggregation problems of the European Union data, the long- and short-term equilibrium rate of the European Union seems reasonably well to reflect the average of the long- and short-term rates of its member countries. (West) Germany, France, Italy and the Netherlands all have lower long-term equilibrium rates, but this is compensated by higher long-term equilibrium rates of the UK and, presumably, by countries like Spain and Portugal (although these are not investigated in this paper).

Figure 1a: Variables in wage equation

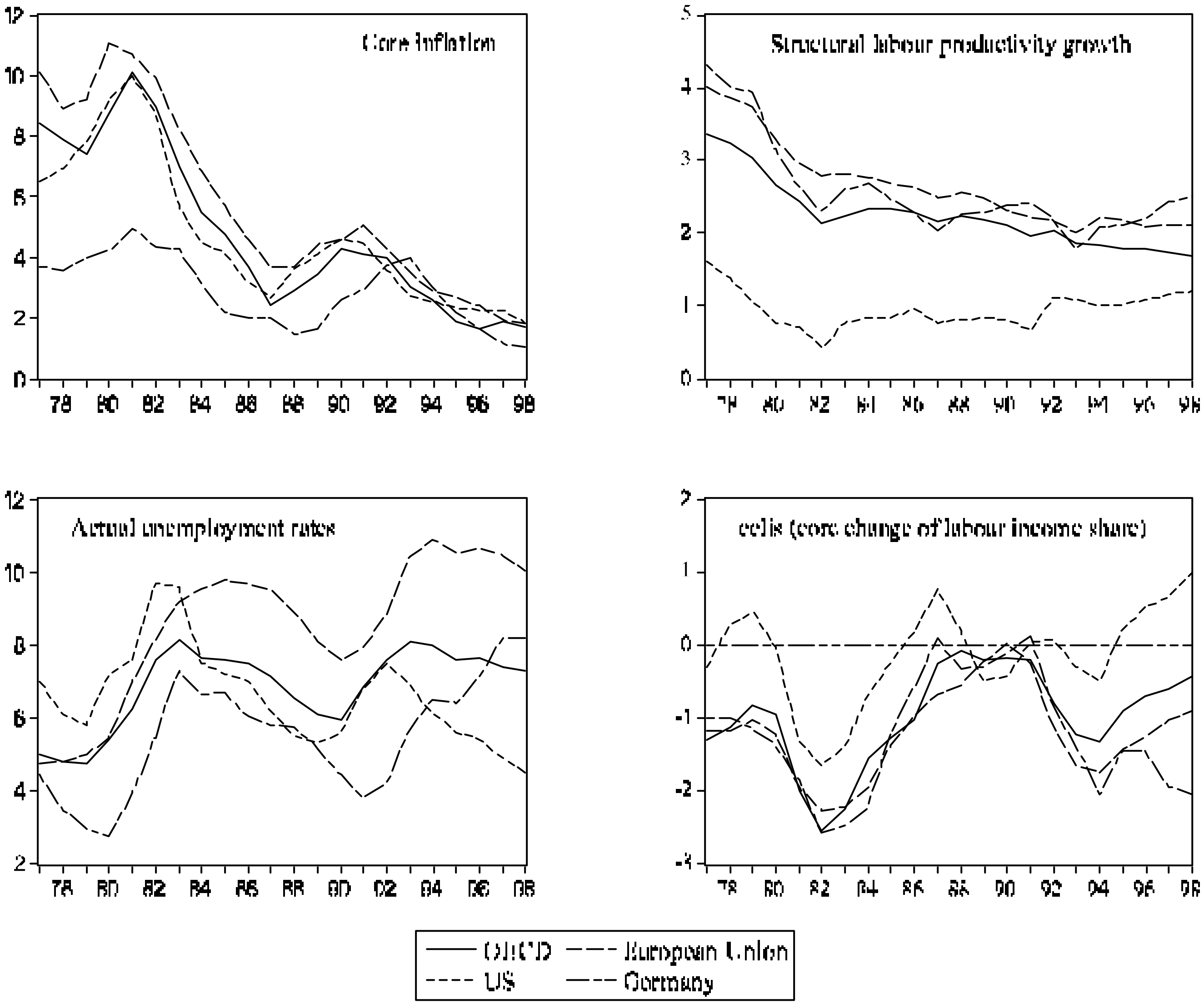


Figure 1b: Variables in wage equation

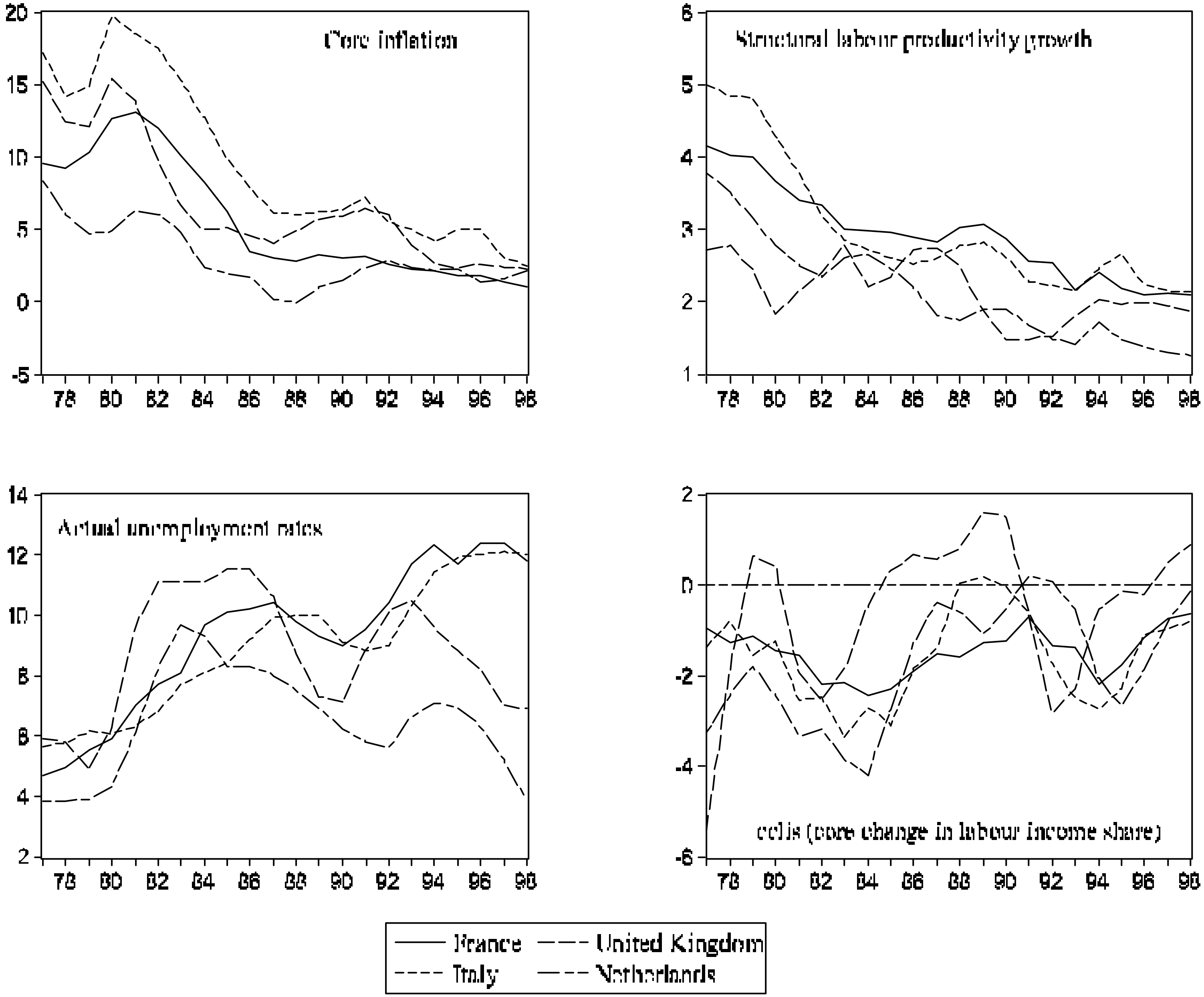
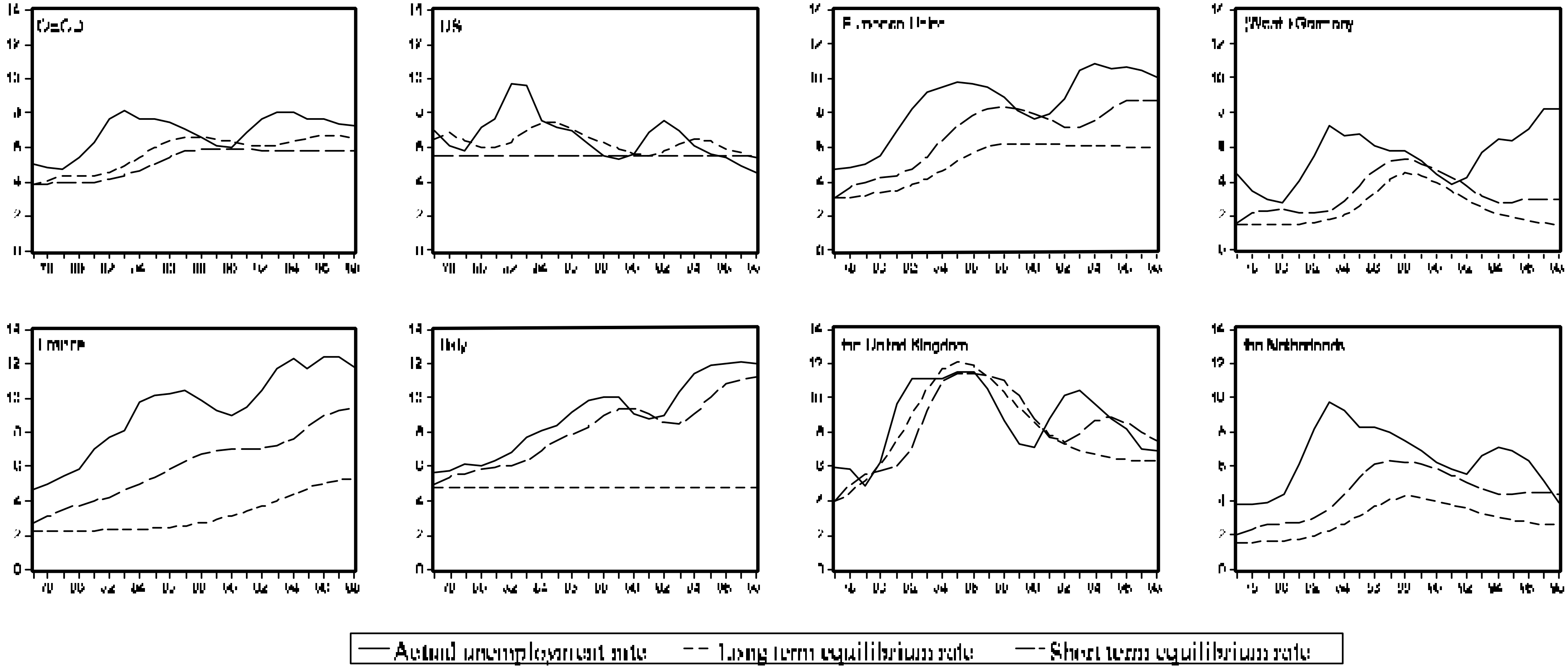


Figure 2: Actual unemployment rates and equilibrium rates



4.2 Indicators for the labour market

In this subsection we construct from the estimated model four simple indicators for the labour market.

1) Persistence

Persistence implies that once unemployment has risen it cannot be brought back quickly to the long-term equilibrium rate without a rising wage (*cclis*) rate. In our (non-linear) model it corresponds also with the fact that extra unemployment has a smaller effect on wages when unemployment is already high (compared to a tighter labour market). We use a simple measure for persistence: $\exists/(\forall+\exists)$. Table 1 presents the results obtained from our estimations. We found strong persistence in France and Italy. This will cause serious problems when it comes to reducing unemployment. In general, the presence of persistence makes it easier, in terms of (wage) inflation, to raise unemployment and harder to reduce it. For example, in the UK and the US persistence is also relevant, but persistence makes it easier, in terms of wage inflation, to restore labour-market equilibrium in times where unemployment is below the long-term equilibrium rate of unemployment (see e.g. Layard et.al. (1991)).

Table 1. Persistence

	OECD	US	EU	WGE	FR	IT	UK	NL
Persistence indicator*	0.44	0.64	0.56	0.45	0.70	0.92	0.69	0.48

* High values imply strong persistence.

2) Flexibility

Flexibility measures the responsiveness of wages with respect to an increase in actual unemployment. We measure this by the response on wages after a 1% exogenous increase in actual unemployment, leaving core inflation and structural labour productivity unchanged during the whole sample period. The average wage responses are presented in Table 2. We observe low flexibility in Italy and France, which suggests that in both countries the situation on the labour market is less taken into account in the wage-setting process.

Table 2. Flexibility

	OECD	US	EU	WGE	FR	IT	UK	NL
Flexibility of wages*	-0.32	-0.16	-0.28	-0.22	-0.05	-0.03	-0.24	-0.30

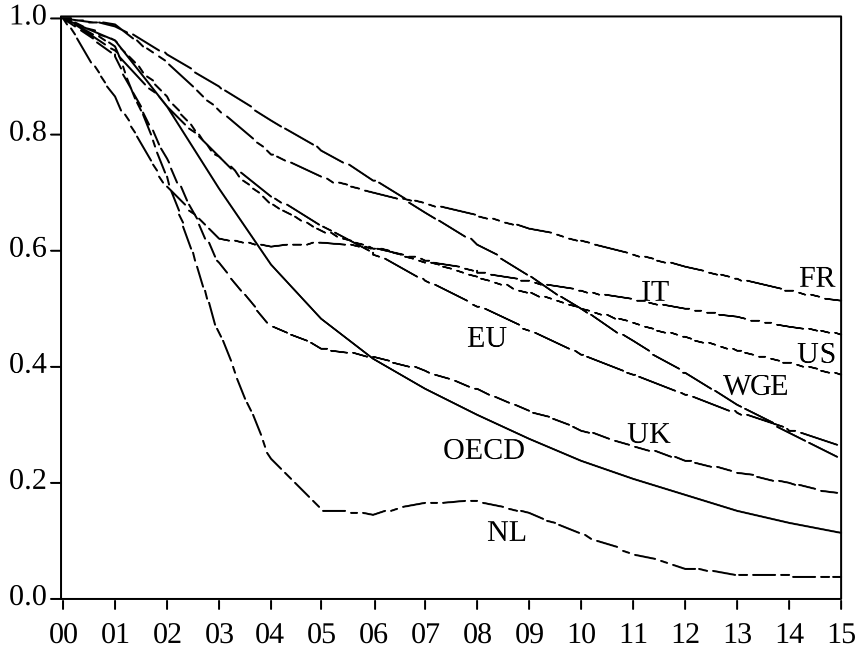
* Low absolute values imply rigid labour markets.

Similar results follow from the following fictitious experiment, in which we consider a simultaneous system by adding, for each country, a simple unemployment equation to the augmented Phillips curve. This gives us the opportunity to analyse the adjustment process of unemployment after an exogenous shock in unemployment. In order to perform this experiment, we used the following relationship for explaining unemployment:

$$\ln(u) = \ln(u(-1)) + 0.3 * \{0.5*cclis(-1)+0.3*cclis(-2)+0.2*cclis(-3)\} + shock \quad (8)$$

The unemployment equation describes unemployment as a function of lagged unemployment and a distributed lag of *cclis*.[23] For example, if wages rise – by constant core inflation and structural labour productivity – then unemployment increases. After combining equation (7) with our wage equation, we are able to perform our fictitious experiment. We raised *shock* in equation (7) by one percentage point in the first year. The outcomes with respect to unemployment are presented for the eight countries in Figure 3. We observe responses similar to Table 2. The Netherlands performs best and absorbs a one percentage point exogenous increase in unemployment by almost 90% in ten years. The results in the Netherlands are partly due to its good economic performance during the last four years. The results for the OECD are more difficult to explain. This may partly be due to data-aggregation problems.

Figure 3: Response of unemployment after a 1-year increase of unemployment with 1% point, using a fictitious unemployment equation



[23] All coefficients are calibrated. For the Netherlands, the values roughly correspond with other studies at CPB and fit reasonably well. This does not necessarily have to apply to other countries. For

3) Variability of long-term equilibrium rates

A strongly fluctuating long-term equilibrium rate indicates flexible institutions. In Table 3 we therefore present the standard deviations of the long-term equilibrium rates. Note that this is an imperfect measure. First of all, the measure does not distinguish between "positive" and "negative" flexibility. Second, negative and positive effects may have cancelled out. This may be the case in the US or Italy, where our estimations resulted in a constant long-term equilibrium rate of unemployment. Yet a noteworthy result using this measure is therefore the strong variability in the UK.

Table 3. Standard deviations of long-term equilibrium rates (1977-1998)

	OECD	US	EU	WGE	FR	IT	UK	NL
Standard deviation long-term equilibrium rate	0.8%	-	1.2%	1.0%	1.1%	-	2.4%	0.9%

4) Average level of long-term equilibrium rates

Table 4 presents the average values of the equilibrium rate of unemployment. Note, again, the high value for the UK. The UK seems to combine a relatively high equilibrium rate of unemployment with great flexibility. This is in contrast with France and Italy, for example, which seem to combine relatively low long-term equilibrium rates with low flexibility.

Table 4. Average long-term equilibrium values (1977-1998)

	OECD	US	EU	WGE	FR	IT	UK	NL
Average long-term equilibrium rate	5.1%	5.5%	5.1%	2.4%	3.1%	4.8%	8.0%	2.8%

Is it better to have a high equilibrium rate and much flexibility or a low equilibrium rate with less flexibility? This question is difficult to answer, although it seems that the UK is situated on one side of the spectrum and Italy and France on the other. The other countries show a more balanced pattern. The Netherlands, however, seems to combine the best of both worlds – with relatively high flexibility and a low long-term equilibrium rate of unemployment.

the US in particular, the adjustment coefficient 0.3 is probably too low. In this paper, however, we have concentrated only on differences in the wage equation.

4.3 Will wage setting be moderate in the future?

The observation that in the four EMU countries the long-term equilibrium rate lies below the actual rate of unemployment implies that moderate wage setting is still the rule. For the US, the equilibrium rate in 1998 lies above its actual rate, indicating possible upward wage (*cclis*) pressures. Also the long-term unemployment rate in the UK shows an oscillating movement around the actual unemployment rate.[24]

The situation in (West) Germany deserves special attention, as the gaps between actual unemployment, on the one hand, and the long- and short-term equilibrium rates, on the other, are rather large.[25] If the estimated equilibrium rates would prove correct and there would be no sudden change in policy (for example to a demand-oriented policy), then very moderate wage rises are expected in the years to come. The model forecasts a similar wage-setting behaviour as in the past, which corresponds for 1999 with rather modest nominal wage rises (of around 2%).

Unemployment in the Netherlands is currently close to its short- and long- term equilibrium. In 1998 we observe for the first time a situation in which the long-term equilibrium rate lies below the actual rate of unemployment and yet the short-term equilibrium rate lies above the actual unemployment rate. The reason for this occurrence is the sharp decline in actual unemployment in 1997 and 1998. In the short-term, therefore, our model forecasts inflationary wage pressures of about 0.6% higher than the sum of structural labour productivity growth and core inflation.

5. Results related to NAIRU estimates in the literature

The results of the short-term equilibrium rate of unemployment can, in principle, be compared with the standard NA(W)IRU estimates in the literature, under the additional assumption that expected wage inflation equals core inflation and structural labour productivity growth. To see this, rewrite equation (2) as follows:

$$w - w^{e} = -(\acute{a}+\hat{a})\,(u - u_s^{*}) + , \qquad (9)$$

[24] This asymmetry could imply a future risk for EMU, if the UK would join. Some researchers also point to a positive aspect. If labour markets' business cycles are less synchronised, then international risk-sharing of labour becomes possible. For the moment, however, labour mobility is rather low in Europe.

[25] The fact that in the past four years (West) Germany followed a policy of pronounced wage moderation translates the model into a very low long-term equilibrium rate of unemployment.

with w^{e} = ð ^{c} + h^{s}. However, most of the literature simply assumes $w^{e}= w(-1)$, or some distributed version of lagged values of wage growth. In that particular case, the estimated u_s* is often called the NAWRU. As put forward in Appendix A, our particular choice yields that for the European economies the short-term equilibrium rate u_s* is generally lower than the NAWRU estimates from the literature. This finding is strongly related to the fact that *cclis*< 0 during the past two decades for the European economies. This contrasts the current literature in which European NAWRU estimates fluctuate around the short-term equilibrium rate (see e.g. Ball (1997), OECD (1994)). European NAWRU estimates fluctuating around the short-term equilibrium rates are also found if the time-varying aspect of the NAWRU is only allowed to depend on labour productivity growth (see McMorrow (1996)). Replacing $w - w^{e}$ by its counterpart: inflation minus expected inflation, ð - ð ^{e} , does not really yield different results (see e.g. Cross et al. (1997) or IMF (1998)).

Since for the UK and the US *cclis* oscillates around zero, we do not find too much difference between our short-term equilibrium rates and those for the NAW(I)RU, as mentioned in the literature above. For example, our rates show a strong similarity with the NAIRU estimates in IMF (1998). This observation is also in line with Gordon (1998), who argues that the well-known stability of labour's share in the US since the early 1970s suggests that wage behaviour has not played much of an independent role in the inflation process.

We are not aware of any structural approach that results explicitly in estimates of short-term and long-term equilibrium rates of unemployment. These structural approaches normally result in determinants explaining a long-run relationship of unemployment. Since in these approaches the long-term equilibrium rate depends often upon the chosen co-integrating vector, uniqueness aspects play a much more important role than in single-equation exercises. Also the choice of institutional variables that should enter into the specification of the short- and long-term equilibrium rate becomes of major importance for the final results.

Our finding suggests that most labour markets in Continental Europe have been out of equilibrium for about two decades. This observation suggests also that a pronounced period of wage moderation has not led to a decrease in unemployment. There seems to be a very slow adjustment towards the long-term equilibrium rate. We did not investigate the reason for this finding in our paper, but Blanchard (1998) observes a similar result by relating labour income shares with unemployment rates. He argues that, possibly, wage moderation has not led to a decrease in unemployment because another type of shift has been at work, this time on the labour demand side. At a given wage and a given capital stock, firms have steadily decreased employment.

6. Conclusions

The fact that (core) inflation rates and (structural) productivity growth rates in Europe converge among countries implies that differences in future wage setting will depend more and more on differences in labour-market characteristics.

Our analysis, using an augmented Phillips curve, shows that for almost two decades in four countries in continental Europe nominal wage growth was lower than the sum of core inflation and structural labour productivity growth. This declining (trend) in the labour income share corresponds with a long/short-term equilibrium rate that continuously falls below the actual rate of unemployment. This finding is in contrast with NAW(I)RU estimates from the recent literature.

The estimation results are quite robust against different specifications of the model. The most important assumption for our result is that, on average, labour productivity gains are fully passed along into wages[26].

The precise level of the long/short-term equilibrium rate, however, is surrounded with more uncertainty. It is well known from the literature that equilibrium rates can be measured only very imprecisely (see Staiger et. al. (1996, 1997)). In this paper we did not, therefore, concentrate on uncertainty intervals of the equilibrium rates themselves, but rather experimented with Kalman filters and polynomial type of functions to check for robustness. As an example, we decided to represent in the underlying paper the long-term equilibrium rates by asymmetrical density functions. This type of function performed reasonably well for all countries during the years 1977 through 1998.

Our findings also suggest that in the past two decades wage moderation in four countries of Continental Europe has not been sufficient to restore equilibrium on the labour markets. A possible explanation for this phenomenon, which has not been investigated in this article, is that the demand curve for labour has shifted. Blanchard (1998) gives two potential lines of explanation. The first concerns shifts in the distribution of rents away from workers – for example the elimination of chronic excess employment by firms. The second explanation

[26] See footnote 10.

points to technological bias: firms in continental Europe are introducing technologies biased against labour towards capital.

From the model we obtain some characteristics of the various labour markets, which are presented by four indicators. These indicators are the average level of the long-term equilibrium rate, the variability of the long-term equilibrium rate, flexibility and persistence. Combining these indicators, we conclude that on one side of the spectrum the UK is a special case. It combines relatively high equilibrium rate with strong flexibility. On the other side of the spectrum France and Italy combine relatively low long-term equilibrium rates of unemployment with strong persistence and low flexibility. The trade-off patterns for (West) Germany and the US seem to be more balanced.

The best performance seems to come from the Netherlands. The Netherlands succeeded not only in bringing down the equilibrium rate of unemployment, but also succeeded in bringing the actual unemployment rate closer to the long-term equilibrium rate. Partly this performance is due to a strong institutional reform, which included lower replacement rates, lower taxes, and more flexible labour and commodity markets. But partly it is also due to a favourable definition of unemployment. Broadly defined unemployment, including hidden unemployment, is much higher in the Netherlands than in many other countries and may well exceed 20% (see also Bovenberg (1997)).

Appendix A

The wage equation and the NAIRU specification: What's the difference?

The NAIRU concept is related to the inflation rate and its simplest form can be stated as follows:

$$B = B^{e} - \forall \; (u - u^{*}) + ,, \qquad \text{(a1)}$$

In this equation u^* represents the NAIRU and B^e expected inflation. Some researchers estimate the unemployment rate consistent with stable wage inflation instead of price inflation. In that case, some researchers call the corresponding u^* the NAWRU, or even NAIWRU. Ball (1997) claims that there is no clear reason for focussing on wage inflation or on price inflation. We specify the NAWRU equation as follows:

$$w = w^{e} - \forall \; (u - u^{*}) + , , \qquad \text{(a2)}$$

If we now assume that $w^{e} = B^{c} + h^{e}$, we are simply back in model (2) of our paper. Note, however, that in NAW(I)RU papers this choice is not a common one; normally a lagged version of wage inflation is considered for expected inflation (B^{e}), or expected wage inflation (w^{e}).

In the long run, the difference between the NAW(I)RU and our model (2) does not seem to matter. If (wage) inflation is stable we simply have: $u = u^{*}$. Similar arguments hold for the wage model in our paper; if in the long run a stable nominal wage inflation equals a stable inflation plus stable labour productivity growth, then: $w = B^{c} + h^{e}$ and again $u = u^{*}$. Since the models (a1) and (a2) do not make an explicit distinction between the short run and the long run, one should treat them as short-run models.

The short run can also explain the empirical differences between the models. Consider the following example: assume that $B^{c} = B^{e}$, and compare the model:

$$w = B^{e} + h^{s} - \forall \; (u - u^{*}) + , , \qquad \text{(a3)}$$

with the model in (a1). Now assume that model (a1) equals model (a3), i.e. assume similar equilibrium rates and similar speed of adjustments $\forall$ and similar errors ,. In that case, it would also have to hold that growth in real wages follows structural labour productivity growth (w-B $= h^{s}$). This aspect, however, does not hold in the short run. For example, for countries in Continental Europe the growth in real wages was often higher than structural labour productivity growth. This empirical aspect translates the model in (a3) into equilibrium rates that are lower than actual unemployment. The key point is that, in principle, this reasoning will hold without knowing the exact evolution of inflation, which in model (a1) may result in equilibrium rates that oscillate around or are even higher than the actual rate of unemployment.

As an example, consider France in Figure A1. For each of the three models we present the dependent variables, after transferring the expectations terms to the left-hand side: in model (a1): $B - B^{e}$, in model (a2): $w = w^{e}$, in model (a3): $w - B^{c} - h^{s}$. For the expectations variable in model (a1) and (a2), we simply take a one-year lagged value: $B^{e} = B(-1)$, $w^{e} = w(-1)$, and for model (a3) we simply take *cclis* as constructed in our paper. Figure A1 shows that *cclis*<0, whereas this result does not hold for $B - B(-1)$, and $w - w(-1)$ in model (a1) and (a2). As a result, in model (a1) and (a2), $u*$ is likely to follow more closely the actual unemployment rates. Similar results are obtained if we perform this analysis for other countries.

Appendix B

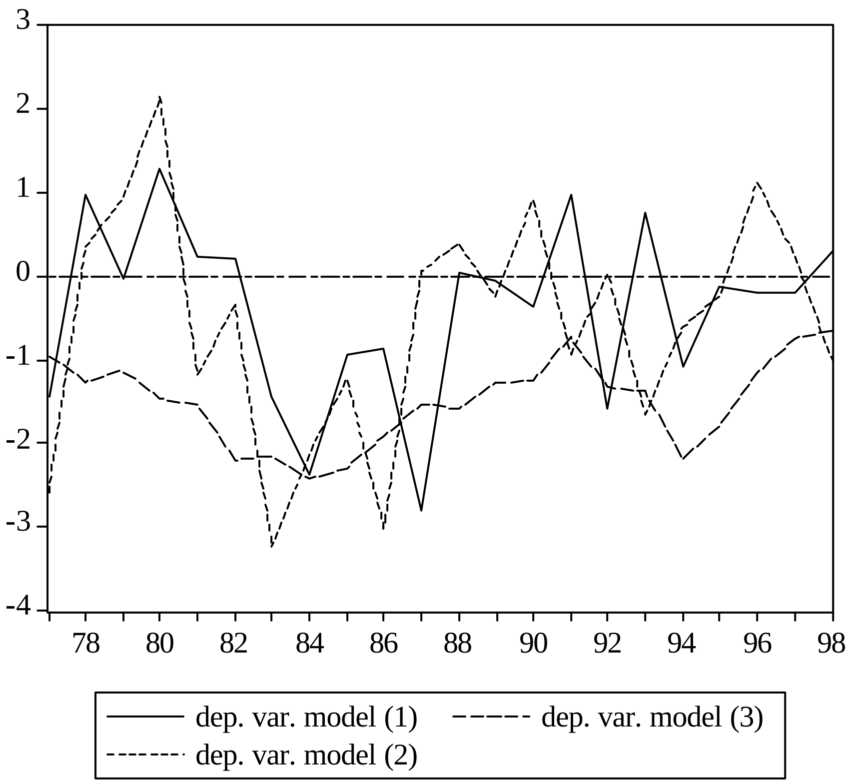
Estimation of time-varying " , $, (using Kalman filters and polynomials.[27]

The starting point of our experiments concerned the following equation:

w=B^{c} + h^{e} - ∀ (ln u(-1) - ln u*) - ∃)ln u(-1) + ,, (b1)

The first experiments concerned testing the variability of each parameter, ∀, ∃, and u* independently, using a Kalman filter approach and a polynomial approach.

Figure A1: France



1) A Kalman filter approach

For each parameter in question, we substituted a random walk model (the Kalman filter). We distinguish the following three possibilities:

(A1): $∀_t$ = $∀_{t-1}$ + ì$_t$, with ∃, (constant.

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[27] Recently, a lot of research has aimed in this direction, using Kalman filters and also spline functions. This research concentrated mainly on time-varying NAIRU's. Examples are Cross, Darby and Ireland (1997), Gordon (1997), Staiger, Stock and Watson (1996) and Debelle and Laxton (1997).

(B1): $\exists_t = \exists_{t\text{-}1}$ + ì$_t$, with ∀, (constant.

(C1): u_t* = $u_{t\text{-}1}$* + ì$_t$, with ∀, ∃ constant.

where we assume , ~N(0,ó$_,^2$) and ì$_t$ ~N(0, ó$_ì^2$).

The estimations concern always one time-varying parameter at a time. The other two parameters will be considered constant and are freely estimated, except for the case (A1) and (B1) where a fixed value for *u** is calibrated. For this value we use the pre-knowledge that during the sixties in all countries the long-term equilibrium rate is situated about ¾%-point above the average level of unemployment (see also Appendix C). Since *u** is assumed to be constant, it should retain this value. In the Kalman filter estimations the variance ó$_ì^2$ is calibrated to obtain a plausible goodness-of-fit statistic and to obtain a sufficiently smooth time-varying parameter. Finally, ó$_,^2$ is determined by the (EVIEWS) estimation programme.

2) A polynomial approach

In this section we substituted, instead of Kalman filters, polynomials. This involves substitution of ∀, respectively, ∃, respectively, *u** by a polynomial function. For example, in the case of a time-varying ∀ we substituted the following equation:

(A2): ∀$_t$ = Ó $_{k=0}$ $^{k=n}$ æ$_k$ * $time^k$, with ∃, *u** constant.

Using a similar procedure, we substituted a time-varying ∃$_t$ (B2) and ($_t$ (C2). We estimate the non-linear equation using a maximum likelihood method, under the assumption , ~N(0,ó$_,^2$). The degree of the polynomial (*n*) is calibrated; only if a polynomial of a higher degree performs substantially better (in terms of goodness-of-fit) will it be chosen; otherwise the polynomial with the lowest degree is chosen. The other constant parameters are treated in a similar fashion as discussed in the Kalman filter approach.

In Table B1 we present the most important results.[28] In the table we refer to Figure B1, where nine graphs are shown for three regions: the Netherlands, the EU and the UK. In each graph the time-varying parameter under estimation is shown, using a Kalman filter and a polynomial. Note that in the case of polynomials, we found for *u** only one top. Remark also that the Kalman filter estimations are not particularly smooth.

Conclusions from this type of research can be summarised as follows.

[28] More extensive estimation results are available upon request.

1) The time-varying aspect of ∃ (indicating persistence) contributes relatively little in obtaining a higher goodness-of-fit statistic. The low Durbin-Watson statistics suggest, furthermore, that the equation is mis-specified. Thus, it does not seem that we limit ourselves too much by assuming them to be constant.

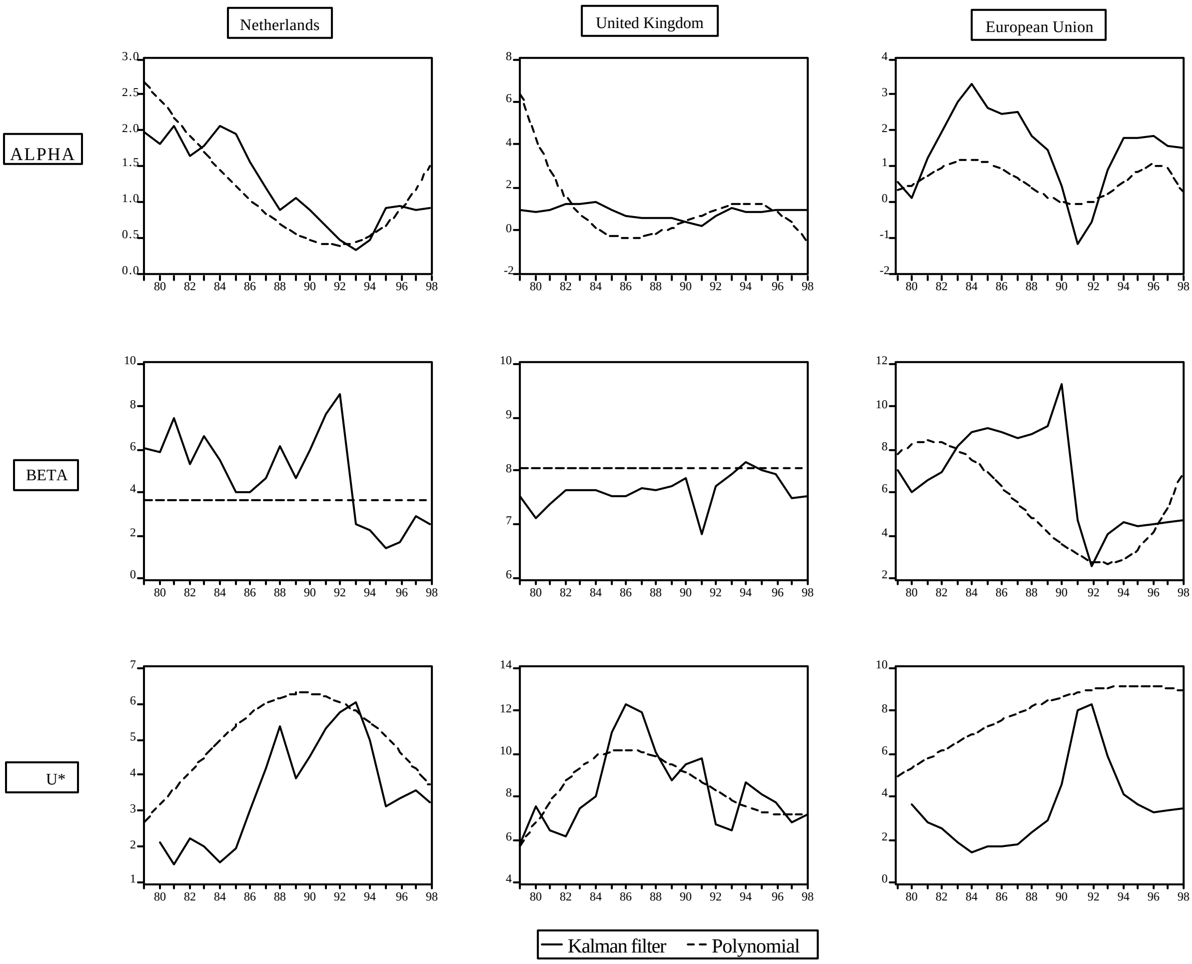
2) Time-varying ∀'s seem to explain a bit more. The relatively low assumed values for the equilibrium rate of unemployment seem to result in rather low ∀'s .The time-varying trajectory of ∀ follows often a path inversely related to the time-varying trajectory of u*, suggesting a strong negative correlation between the two.

Table B1. Estimation results of the wage equation 1977-1997 (for the dependent variable, we use wage growth minus core inflation and structural labour productivity growth)

	Model	R^2	DW	∀	∃	u*
Netherlands	∀ Kalman filter (A1)	0.54	1.8	fig.	2.4	1.5*
	∀ polynomial (A2)	0.51	1.8	fig.	1.3	1.5*
	∃ Kalman filter (B1)	0.33	1.4	1.0	fig.	1.5*
	∃ polynomial (B2)	0.31	0.8	0.9	fig.	1.5*
	(Kalman filter (C1)	0.69	2.2	2.3	1.3	fig.
	(polynomial (C2)	0.62	2.3	5.4	0.3	fig.
United Kingdom	∀ Kalman filter (A1)	0.48	1.6	fig.	7.2	4.0*
	∀ polynomial (A2)	0.59	1.4	fig.	4.8	4.0*
	∃ Kalman filter (B1)	0.45	1.6	0.6	fig.	4.0*
	∃ polynomial (B2)	0.28	1.0	0.8	fig.	4.0*
	(Kalman filter (C1)	0.84	2.3	5.0*	4.1	fig.
	(polynomial (C2)	0.64	1.9	6.0	5.2	fig.
European Union	∀ Kalman filter (A1)	0.81	1.8	fig.	5.9	3.0*
	∀ polynomial (A2)	0.69	1.8	fig.	5.6	3.0*
	∃ Kalman filter (B1)	0.37	0.9	1.0	fig.	3.0*
	∃ polynomial (B2)	0.26	0.9	1.0	fig.	3.0*
	(Kalman filter (C1)	0.58	1.0	1.1	4.9	fig.
	(polynomial (C2)	0.86	2.4	7.8	2.5	fig.

* Parameter fixed.

Figure B1. Time-varying parameter estimates of ∀ (ALPHA), ∃ (BETA) and u (U*), for three regions, using Kalman filters and polynomials.*



3) Time-varying equilibrium rates seem to contribute most toward improving the goodness-of-fit. Our conclusion is that the time-varying aspect of this parameter is worth investigating further. Remark that the long-term equilibrium rates tend to be higher than the expected historical (constant) value (1.5% for the Netherlands, 4% for the UK and 3% for the EU). The result of these higher values is that the speed of adjustment ($\forall$) tends to increase and the persistence parameter ($\exists$) decreases. This shows once more the possibility of a strong correlation between the three parameters.

4) These different estimations indicate already that there is a lot of uncertainty. In the case of Kalman filters, this uncertainty depends on the starting values and the chosen variances of the time dependent parameters.

The above mentioned conclusions seem to justify why we pay most attention in our research to time-varying equilibrium rates of unemployment and why we leave $\forall$ and $\exists$ constant. Of course, most likely is the case that all parameters are time-varying and that there is even some kind of underlying economic relationship among the parameters. We performed some empirical research in this field, but mainly failed due to identification problems. In that respect, the underlying research follows closely the empirical theory of the NAIRU, in which similar choices are made.[29] If we accept that there exists a correlation between the equilibrium rate of unemployment and $\forall$, then the introduction of non-linear functional forms becomes interesting.[30] In our research we deal in part with this aspect by choosing a logarithmic specification.

[29] References of this type of research are mentioned in the first footnote of this Appendix.

[30] Using a non-linear specification may change the properties of the model substantially. For example, shocks become dependent upon the level of the equilibrium rate of unemployment, the quantitative response of negative and positive shocks differs, and we may distinguish between two types of equilibrium rates: a deterministic and a stochastic one (see Debelle and Laxton (1997)).

Appendix C
Calibration and estimation results

We first repeat the characteristics of the model. The general model (see equation (1) in the main text) can be described as follows (with the inclusion of logarithms):

$$w = \mathrm{B}^{\,c} + h^{\,s} - \forall\,(\log u - \log u^{*}) - \exists\,)\,u + \,,, \qquad \text{(c1)}$$

where we have made the following choices. Core inflation ($\mathrm{B}^{\,c}$) is defined as follows:

$$\mathrm{B}^{\,c} = \,,\, p_y(\text{-}t_p) - (1\text{-},)\, p_c(\text{-}t_p), \qquad \text{(c2)}$$

where $\text{-}t_p$ represents a lag (see also (c4)). Structural labour productivity growth ($h^{\,s}$) is defined as:

$$h^s = 8\, h^s(\text{-}1) + (1\text{-}8)\, h \qquad \text{(c3)}$$

To calculate this value, a starting value is needed. For this value we took the average growth of labour productivity during 1960-1975. In Table C1a this value is given under the column-heading $h^e{}_{6075}$.

Unemployment enters with a lag. Thus, log u in (1c) is replaced by log $u(\text{-}t_u)$, which is a weighted average of actual and one-year lagged logarithmic unemployment:

$$\log u(\text{-}t_u) = (1\text{-}\, t_u) \log u + t_u \log u(\text{-}1) \qquad \text{(c4)}$$

The persistence term is modelled as follows:

$$)u = \log u(\text{-}t_u) \text{ -}1/k\ \acute{\mathrm{O}}_1^{\,k} \log u(\text{-}t_u\ \text{-}k)) \qquad \text{(c5)}$$

where k represents the number of lags. Finally, the equilibrium rate of unemployment enters via an asymmetrical density function:

$$u^{*} := (_T\ \text{-}(_L\, L_T\, (1 - \mathrm{e}^{\text{-}(_l\,(t\,\text{-}\,T)^2}) - (_R\, R_T\, (1 - \mathrm{e}^{\text{-}(_r\,(t\,\text{-}\,T)^2}) \qquad \text{(c6)}$$

where t represents time, T the possible point in time where the maximum of the function occurs, L_t a dummy equal to 1 till T , afterwards 0, and R_t a dummy equal to 0 till T , and afterwards 1. The remaining parameters characterise the shape of the density function.

We assume that all parameters in (c6) are positive.[31] If $t = T$, then the second and third terms on the right-hand side are equal to zero, and the long-term equilibrium rate u^{*} reaches its

[31] Experimentation yielded that the appearance of a trough was very unlikely in all countries. This probably has to do with the low starting value for the equilibrium rate in 1977.

maximum value ($(_T$. If $t < T$, the third term becomes zero and $u*$ approaches $(_T$-$(_L$ in the past. The asymptomatic value of (in the future is $(_T$ - $(_R$. The function also generates equilibrium values outside the estimation period. We used this fact by assuming that during the sixties in all countries the equilibrium rate was about ¾ %-point higher than the average actual unemployment rate (Table C1a represents this value under the column-heading $u*_{60}$). The assumption that the equilibrium rate lies above the actual rate corresponds with the fact that inflation rates and labour income shares increased slowly during that period. The exact value (within certain limits), however, is of minor importance for the final estimation results. This strategy restricts the starting value and reduces the number of parameters by one, leaving four parameters to estimate. Simultaneous estimation of $(_R$ and $(_r$ also yielded problems. Therefore, we fixed $(_r$ on an identical value for all countries.[32] If $u*$ contains a maximum, then the year, indicated by T, indicates where the maximum takes place. The value for the year T is obtained by trial and error, around the year suggested by the Kalman filter and polynomial approach, with goodness-of-fit as maximisation criterion.

Substituting these choices in the model leaves us with the following seven parameters to estimate: the lag value of the unemployment rate t_u, the smoothness parameter 8, the adjustment parameter ∀, the persistence parameter ∃, and the three parameters determining $u*$, namely $(_R$, $(_L$ and $(_l$. Note that our fitting procedure is a mixed process of calibration and estimation. Compared to a standard linear estimation procedure the following aspects have to be taken into consideration. First, fixing certain parameters in advance will hurt the correct size of the t-statistics, which may results in biased uncertainty intervals. Second, the specific choice of class for $u*$ is obtained with pre-estimation. Considering these facts we will present only goodness-of-fit statistics (R^2) and Durbin-Watson (DW) statistics in the tables.

In the estimations we transferred core inflation to the left-hand side and used, in the first instance, w-B^c as dependent variable.[33] A closer inspection of the residuals revealed that negative and positive residuals still showed an alternating pattern, which apparently can not be explained by changes in parameters or lag structures. Overshooting and undershooting of the actual wage growth rates can, however, be explained economically. Firstly, concluding wage contracts is not a continuous process of agreements, but more a yearly recurring process. Second, expectations may play a role as well, in particular expectations concerning

[32] Sensitivity analysis, within reasonable bounds, showed not too much variation in the final results.

[33] Since after calibration B^c is exogenous this transformation does not really matter for the outcomes.

inflation and unemployment. If these expectations do not prove to be correct, then often the damaged party wants to be compensated, at least partially, in the next round. Third, wage contracts are sometimes longer-lived than one year. For example, Buti and Sapir (1998) argue that wage-contract inertia is higher in the US, where wage bargaining is less synchronised and more staggered over time and wage contracts typically have a longer life (some three years) than in the EU, where wage bargaining is more synchronised and coordinated and we observe shorter-lived wage agreements (one to two years). Taking these aspects into account, we decided that it seemed more sensible to replace the dependent variable by a smoothed version. We used a three-year moving average. Technically, we replaced w-B^c by :

$$w\text{-}B^{c} = <_1 \cdot (w(-1)\text{-}B^{c}(-1)) + <_2 \cdot (w\text{-}B^{c}) + <_3 \cdot (w(+1)\text{-}B^{c}(+1)),$$

where the weights $<_1,<_2,<_3$ add up to one. The goodness-of-fit statistic (R^2) showed an improved of about 10% in most cases. The parameter estimates, compared to the experiment without averaging, however, did not change too much.

In Table C1a we present the calibrated values. These values are mostly obtained by a trial-and-error process, using the R^2 of the final equation as maximisation criterion.

Substituting the calibrated values into the model, direct estimation becomes possible. The result of these parameters is presented in Table C1b. To obtain a better interpretation of the goodness-of-fit statistic and the Durbin-Watson statistics, we present in Figure C1 for each country a graph with the actual and fitted dependent variable. Note that for Europe and Italy the Durbin-Watson statistics are rather low. One should, however, not worry too much about these values. A slightly more flexible functional form of u^*, than used in this paper, would probably be enough to solve these problems. In Table C1c we present some characteristics of the long- and short-term equilibrium rate. In three subsequent columns we present its estimated value in 1977, its estimated value at the year where it reaches its top, and its estimated value in the final year 1998.

Figure C1: Goodness of fit. The dependent variable (smoothed wage growth minus core inflation) and its estimated value.

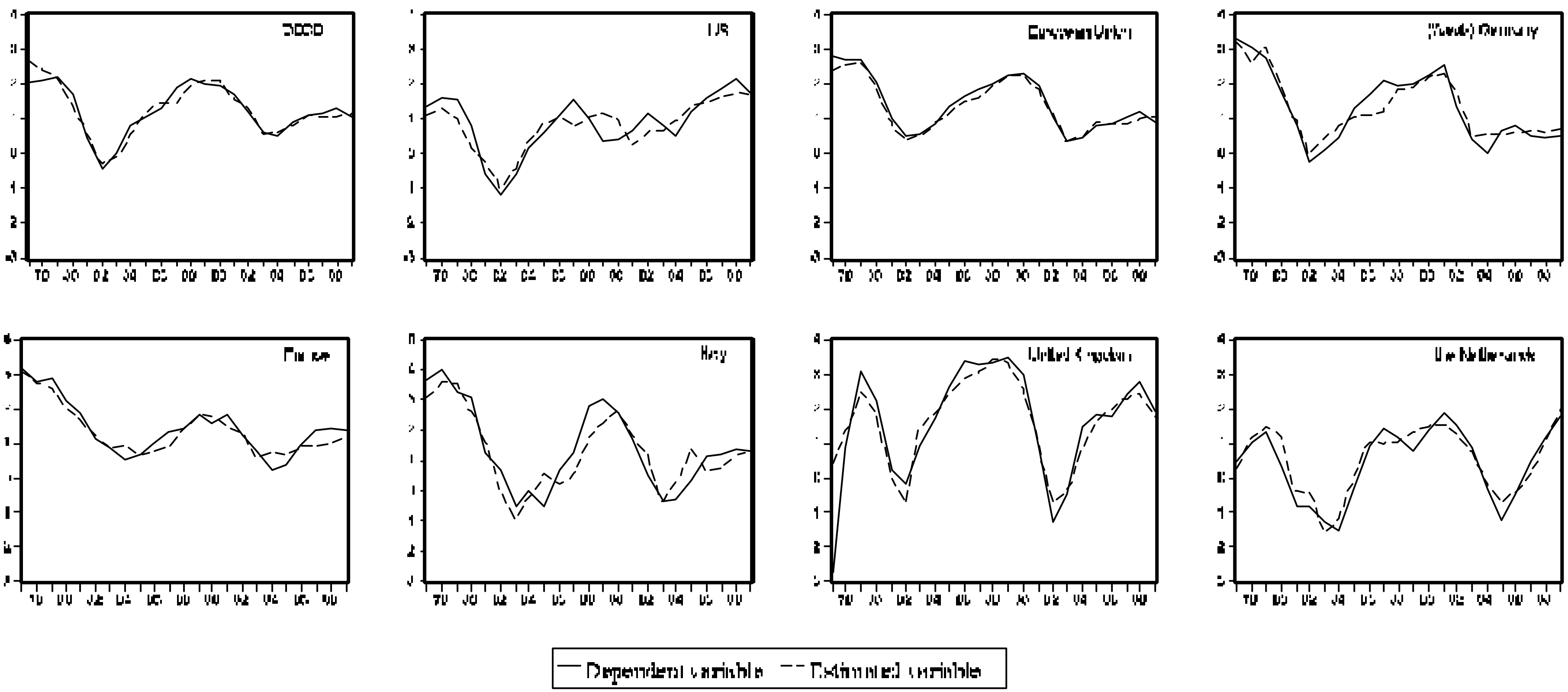


Table C1a. Calibrated parameters wage equation, 1977-1998

	,	t_p	8	h^e_{6075}	k	u^*_{60}	$(_r$	year u^*_{top}	$<_1$	$<_2$	$<_3$
OECD	0.3	0.8	0.5	3.4	3	3.9	0	1988			
US	0.5	0.8	0.8	1.6	3	5.5	-	-			
Europe	0.5	0.3	0.9	4.0	1	3.0	0	1988	¼	½	¼
W-Germany	0.8	0.8	0.8	4.0	1	1.5	0	1988			
France	0.0	0.3	0.8	4.4	3	2.3	-	1998			
Italy	0.8	0.3	0.6	5.2	2	4.8	-	-			
UK	0.3	0.5	0.8	2.5	2	3.0	0	1985	¼	½	¼
Netherlands	0.5	0.8	0.9	4.0	3	1.5	0	1988	¼	½	¼

Table C1b. Estimated parameters wage equation, 1977-1998, after substituting the calibrated values in Table 1a.

	R^2	DW	∀	∃	t_u	$(_T$	$(_L$	$(_R$	$(_I$
OECD	0.93	2.07	2.32	1.8	0.69	5.88	2.03	0.06	0.05
US	0.81	1.74	1.06	1.82	0.50	5.50	-	-	-
Europe	0.98	1.29	2.54	4.68	0.42	8.54	4.39	0.29	0.02
W-Germany	0.92	1.96	1.18	0.96	0.69	4.47	2.97	3.04	0.08
France	0.89	1.68	1.11	2.53	0.85	5.25	3.00	-	0.02
Italy	0.82	1.02	0.88	10.1	0.09	4.75	-	-	-
UK	0.93	1.97	2.66	5.92	0.60	12.11	8.86	5.84	0.03
Netherlands[a]	0.91	1.82	2.27	2.95	0.81	4.22	2.72	1.69	0.04

[a] We included a plus/minus-dummy for the years 1981-82, corresponding with wage measurements in 1981.

Table C1c. Some characteristics of the long- and short-term equilibrium rate of unemployment

	u^*_{1977}	u^*_{top}	u^*_{1998}		*year top*		$u^*_{s\ 1977}$	$u^*_{s\ top}$	$u^*_{s\ 1998}$
OECD	3.85	5.88	5.83		1988		3.81	6.55	6.58
US	5.50	5.50	5.50		-		6.50	-	5.37
Europe	3.05	6.19	6.00		1988		3.63	8.21	8.64
W-Germany	1.50	4.47	1.58		1988		2.17	5.09	3.09
France	2.25	5.19	5.19		1998		2.77	9.4	9.40
Italy	4.75	4.75	4.75		-		4.94	-	11.2
UK	3.99	12.11	6.32		1985		3.96	11.4	7.50
Netherlands	1.52	4.22	2.64		1988		1.99	6.28	4.40

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