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WAGE INFLATION AND STRUCTURAL UNEMPLOYMENT IN IRELAND

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Abstract**:** In this paper we represent structural unemployment by relating observed unemployment to wage inflation. An estimated series for the non-accelerating wage rate of unemployment (NAWRU) shows that the unemployment gap between observed unemployment and the structural rate provides a good reflection of prevailing aggregate demand conditions and indicates that our estimated NAWRU series is a good measure of the Irish structural unemployment situation. The estimated NAWRU was at a high level throughout the 1980s and declined over time such that any excess labour slack was dissipated by the mid-1990s. Between 1994 and 2001 we report that the observed unemployment rate was below our estimated NAWRU indicating that the substantial inflationary pressure on wages was justified for this period. Very recently, the gap between our estimate of the structural rate and observed rates of unemployment is not very substantial and reflects a healthier situation vis-à-vis wage inflationary pressures which are supported by inward migration and productivity increases becoming embedded in our economy.

Keywords: Wage Inflation, Unemployment, Productivity
JEL Classifications: C13, C22, E24, E31

1. INTRODUCTION

The notion of a structural rate of unemployment is central to dominant economic theories explaining labour market behaviour and the relationship between unemployment and inflation. Structural unemployment estimates for a small open economy engaged in a common currency and having undergone significant buoyant economic growth, are particularly problematic and controversial. At the same time, foreign prices due to our open economy position play the major role in the measurement of our price inflation. We will assume that domestically-generated inflationary pressures for Ireland show up mainly in wages. Wages, representing the majority share of production costs, are widely regarded as the principal factor determining the

[1] The views expressed in this paper are those of the author and do not necessarily represent those of the Central Bank and Financial Services Authority of Ireland.

competitiveness and export share of a small open economy.[2] It is timely to study the effects and determinants of wage inflation in Ireland and examine specifically its response to aggregate demand pressures – measured by the slack in the labour market or the gap between observed unemployment and the structural rate of unemployment over the period 1980 to 2005.[3]

Central Banks, in particular, find it helpful to make empirical estimates of the structural rate of unemployment measured by the non-accelerating inflation rate of unemployment (the NAIRU). It serves as an input into various assessments of inflationary pressures, fiscal positions and structural issues. This paper employs a Kalman filter estimate of unobserved states to measure a quarterly NAWRU – the rate of unemployment at which *wage* inflation is stable. The NAWRU indicator is based on the idea that actual unemployment below structural unemployment is associated with inflation above its expected value. This method, similar to that employed by Richardson *et al.* (2000) and Laubach (2001) is used to identify how the Irish economy since 1980 has successfully achieved a reduction in the NAWRU. The method has the advantage of considering the unobserved structural rate of unemployment as a time-varying variable. Methodological extensions to previous studies include: inserting productivity as an cointegrating variable with the unemployment gap for Ireland, testing a Stock and Watson (1998) procedure to estimate the signal-to-noise ratio instead of taking standardised, rule-of-thumb measures; as well as making use of Irish quarterly data up to the end of 2005.

The novel approach of applying the Kalman filter technique with an explicit exogenous variable, such as aggregate productivity, allows us to quantify how changes in this variable change with the unemployment gap. The significant presence of total factor productivity (TFP) gains implies that a buoyant economy that causes unemployment to remain low for a prolonged period is thus associated with a decline in the unobserved structural rate of unemployment. As unemployment falls, a shift in the composition of employment associated with higher effective demand (narrowing labour market slack) is significantly aided by aggregate productivity. The improvement in the skill set of the labour force and more effective use of capital changes the structure of the labour market such that there could be an actual reduction in the inflationary pressures associated with any given level of unemployment in the long run.

The paper is structured as follows: the next section outlines indicators of wage inflation and unemployment since 1980 which suggest that *a priori* that labour market structural conditions have changed over the period implying that the NAWRU could not have been constant for the duration to 2005. Section 3 outlines alternative approaches to estimating a structural rate of unemployment. We conclude that a semi-structural approach modelled as an unobserved components model with a Kalman filter, allowing for productivity movements should generate a good representation of the time-varying NAIRU in an Irish context. The empirical results are outlined in Section 4 and discussed in Section 5. A concluding section follows.

2. CONTEXT: THE IRISH LABOUR MARKET

Labour cost is primarily measured with a unit labour cost measure of earnings at an aggregate level. On that basis, annual nominal wage inflation in Ireland has eased from rates in excess of

[2] This is particularly true when the exchange rate instrument, an effective mechanism for improving international competitiveness, is no longer available (FitzGerald, 2001).

[3] The natural rate of unemployment is the rate of unemployment, which according to Friedman (1968), is 'ground out by the Walrasian system of general equilibrium equations'.

15 per cent in the early 1980s. Figure 1 shows an average of 5.3 percent for 2004 following a peak of 9 per cent in quarters 2 and 3 in 2000 with further moderation having occurred since.[4]

Against a backdrop of buoyant labour demand, forecasts suggest that aggregate wage inflation is unlikely to fall below 4 per cent in the current economic environment but the detailed picture at industry level shows that the trend is by no means uniform. Nominal earnings growth in building and construction has continued to outpace the manufacturing wage rate, however very recent indications for 2006 and early 2007 report a reversal of this trend. Given the change in the structure of employment in this mostly domestically traded sector, the trend clearly implies that migration inflows dampened cyclical wage pressures by the end of 2005.

Figure 1: Wage Inflation Y-o-Y

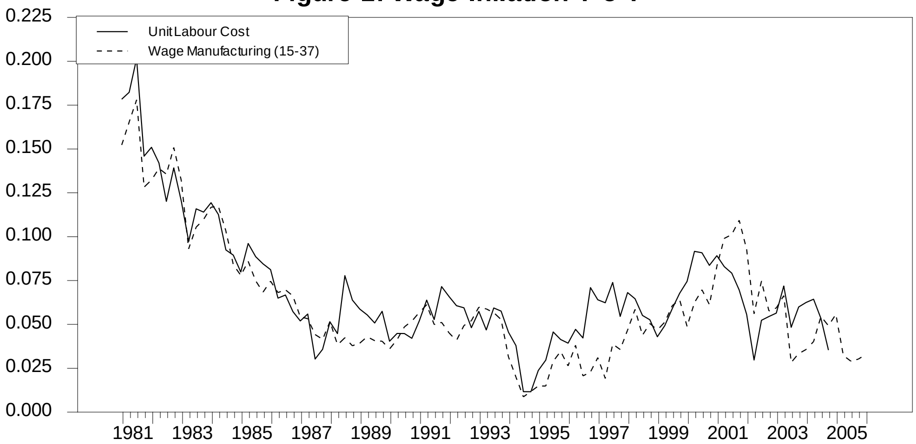
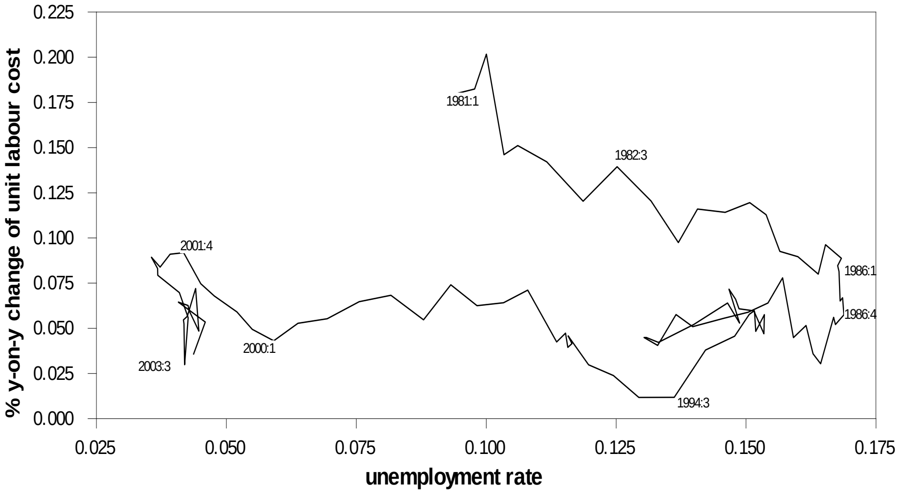


Figure 2: Unemployment Rate 1980q1 to 2005q4

The decline in the Irish unemployment rate since the 'twin peaks' of 1986 and 1994 occurred quite suddenly until 2000 and has since stabilised at less than 5 per cent (Figure 2), implying a Phillips curve with at least three different slopes: a strong negative slope between 1980 and 1994 with a flatter (albeit still negative) slope between 1994 and 2000. Since then the Phillips curve is showing signs of having turned vertical (Figure 3).

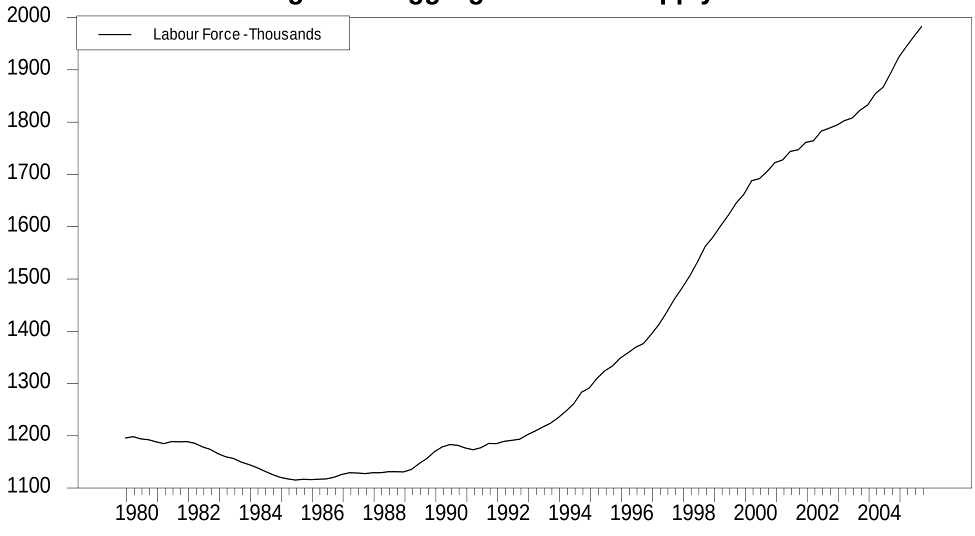
[4] There may be differences between the traded and non-traded sectors of the Irish economy: the quarterly manufacturing wage rate should broadly represent the former while the hourly wage rate in the Building and Construction sector is used to capture wage inflation in non-traded sectors.

Figure 3: Irish Phillips Curve based on Wage Inflation



As a result, it is plausible that the presumed natural rate of unemployment could have shifted during the past two and a half decades. During the early 1980s, wage inflation was historically unstable, albeit on a downward trend; at the same time, the unemployment rate was increasing. By the mid 1980s, the unemployment rate had reached in excess of 15 per cent but wage inflation had stabilised. In recent years, the wage inflation rate appears less stable and is allied with an unemployment rate remaining consistently below the 5 per cent level.

Figure 4: Aggregate labour supply



Ireland has witnessed large changes in total labour supply and participation in recent years. Figure 4 shows the extent of the increases over the period. Little attention has focused in the literature on the relationship between participation and the NAWRU, mainly because the NAWRU is neutral with respect to the size of the labour force and the level of participation. While an increase in participation (or inward migration) will increase the unemployment rate in the first instance, wage setting should imply that inflationary pressures fall. This is reflected by the cyclical component of unemployment and there is no reason to suppose that the NAWRU will change as a result, other than in the short-run. The long-run NAWRU is unaffected because any rise in labour supply needs to be matched by an equal rise in labour demand, employment and output to keep inflation steady. Increased participation and/or inward migration are therefore analogous to productivity growth.

3. DERIVING ESTIMATES OF STRUCTURAL UNEMPLOYMENT

At the empirical level,[5] robust estimates of the NAIRU have proven elusive such that the measurement of the structural rate of unemployment is far from uncontroversial. There are three main explanations for the large degree of uncertainty in estimates of the NAIRU/NAWRU:

- Different measurement methodologies for measuring the NAIRU and not knowing the correct parameters of the model (as with any econometric estimation) lead to important divergences in estimates.
- The potentially stochastic random nature of the NAIRU/NAWRU means that it may well differ in the short, medium and the long-term. Moreover, the equilibrium rate of unemployment may have changed in several instances through time.
- Most models require an estimate of inflationary expectations to explain inertia in wages and prices. Often, expectations are set equal to the previous period's wage/price inflation so $\Delta w_t^e = \Delta w_{t-1}$. Other options are to use survey methods of wage expectations or some other moving average function of previous rates.

As such, there are a number of different techniques that could be used to measure a NAWRU. This section briefly discusses the commonly used techniques and explains why this study concentrates on a multivariate filtering approach over structural, reduced-form or purely statistical models.

3.1 Structural models

The most information-complete method to derive the NAIRU is to use a structural model where the NAIRU is the equilibrium of a model of aggregate wage and price setting behaviours (see for example, Layard *et al*., 1991, Phelps, 1994). These models usually assume full adjustment of firms and workers to all shocks so the derived equilibrium measure of unemployment corresponds most closely to the long-run equilibrium rate of unemployment.[6] The key advantage of structural models is that they provide more information on the determinants of the NAIRU, as well as its level, and are based on a theoretical framework that explains how macroeconomic shocks and policy instruments impact on the long-term equilibrium rate of unemployment. However, structural models are not considered as the preferred estimation method as they cannot be calculated in a timely manner; they face a number of challenging econometric and measurement issues and therefore are likely to be inaccurate; and they rely on assumptions about underlying behaviour of economic agents for which there is no consensus (Richardson *et al.,* 2000).

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[5] We only refer to recent theoretical debates affecting the NAIRU in passing as the focus of this paper is on deriving an empirical estimate of the natural rate (see Fabiani and Mestre, 2000; McAdam and McMorrow, 1999 for a full discussion of the New Keynesian Phillips Curve).

[6] The natural rate hypothesis by Friedman (1968) and Phelps (1968) is that there is some natural or normal (structural) rate of unemployment that is determined by real not nominal forces below which … any short-term improvements relative to the NAIRU resulting from stimulatory monetary policy will be accompanied by higher rates of inflation.

3.2 The reduced form approach

A second group of methods allows the structural rate of unemployment to be estimated on the basis of a behavioural equation explaining inflation; typically, the expectations-augmented Phillips Curve. It also allows one to control for a range of factors wider than the inflation/unemployment relationship.[7] These advantages make the reduced form approach the most popular technique in recent studies. However, the reduced form approach also has a number of disadvantages: it requires some form of estimation of inflation expectations; it is atheoretical which has the advantage of not relying on assumptions about behaviour. On the plus side, it leaves the interaction between unemployment and inflation indeterminate so there is a range of options about measurement of the underlying natural rate.

3.3 Pure statistical models – univariate estimation

Pure statistical models have the advantage of being timely and relatively easy to calculate. In order to define the NAIRU, only information on the singular behaviour of the observed rate of unemployment is used. The unemployment rate is decomposed into permanent (in general, non-stationary) and transitory (stationary, capturing the business-cycle fluctuations) elements. Under this approach the permanent component in observed unemployment is identified as the NAIRU.

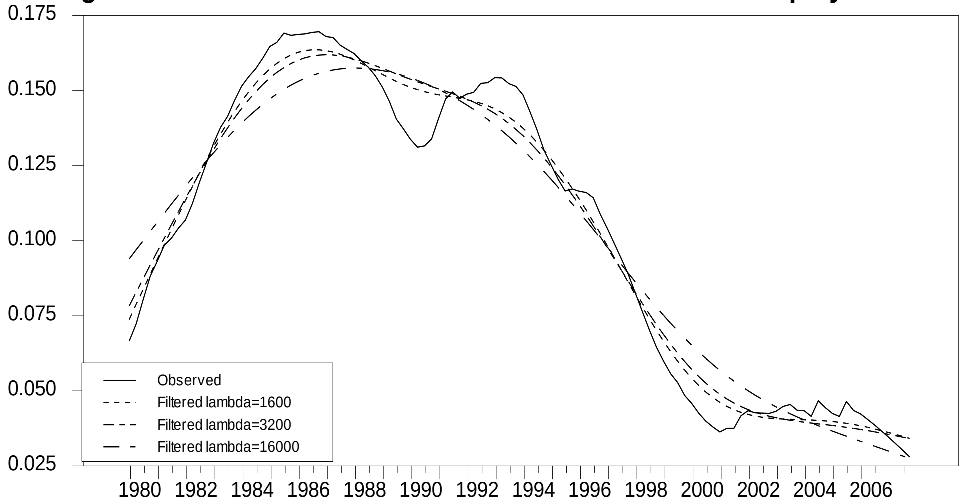
While univariate statistical methods allow indicators of trend unemployment to be estimated in a timely and consistent way, there is no theoretical framework or economic structure underlying the filtering technique as they are based on just one behavioural equation without taking any information on inflation into account. This is probably one of the main reasons why filtered unemployment series are often found to be significantly correlated with inflation dynamics (see for example Bank of England, 1999).

The Hodrick-Prescott (H-P) filter identifies the permanent component as a weighted moving average of lags and leads of the observed data on the employment rate. The span of the moving average has to be selected, which in turn affects the degree of smoothing that identifies the trend component of unemployment.[8] A moving average is used in calculating the trends and the specific problem of the (undue) influence of the end-point is raised. The estimations become less precise as we approach the end period of the observed data but at the same time are very influential and could be substantially modified with new information – revisions or extensions of the actual data series. In order to overcome the problem of end-of-sample imprecision of the estimates, two additional years of out-of-sample forecasts (univariate) have been used to filter the time series. The standard smoothness parameter ($\lambda = 1600$) is used as a benchmark. This lambda aims to eliminate the cyclical element between two and eight years from time *t* or 24 and 32 quarters.

[7] Elmeskov (1993) originally used a simplified version of this approach in a NAWRU setting. Two extensions of his original approach have been used in recent practice: one as a modified version of the original technique; the other is based on a reduced form approach using a multivariate HP filter. These latter approaches used wage-inflation Phillip curves as a means of excluding the effects of those supply shocks that affect prices but not the labour market (see OECD, 1999).

[8] The H-P filter removes the high frequency components when calculating the deviations from trend (but the noisy or even the seasonal terms could still be present).

Figure 5: Univariate filtered NAIRU and Observed Unemployment



Using data for the observed unemployment rate, Figure 5 shows that the filtered series (representing the NAIRU) is extremely dependent on the structure of the observed unemployment data. Further, a higher lambda (curvature parameter) produces filtered results that are strikingly similar to the default smoothness level. Most of the filters behave like simple moving averages and so perform poorly if there are sudden or large changes in the unemployment rate, such as that experienced in the Irish context. It is assumed that underlying (but unspecified) forces/mechanisms drive unemployment back to its trend NAIRU rate after a shock and that those fluctuations around the trend are temporary.

3.4 Multivariate filtering approach

Finally, the so-called "semi-structural methods" involves a hybrid of the two previous groups of methodologies. A growing NAIRU literature supports the use of the semi-structural estimation approach, which combines taking 'economic information' on board as well as filtering to identify a time-varying path for the NAIRU, without requiring specific information on its determinants (OECD:2000:5). On the plus side, this approach remains consistent with a variety of structural approaches, leaving aside theoretical debates concerning their form. In empirical operation, the method simultaneously minimises the squared unemployment gap subject to a smoothness constraint and a goodness-of-fit restriction from the Phillips curve framework.[9] In this paper, it is best implemented as an extension or special case of the Kalman (1960) filter. The Phillips curve is augmented with an additional (transition) equation with information about the unobserved NAWRU.

Where the dependent variable is a measure of earnings inflation, it may be argued that such a measure should be adjusted for productivity or trend productivity i.e. that productivity growth plays a role in determining earnings growth. This is achieved by adding aggregate productivity growth (TFP) to our list of exogenous regressors. Typically lagged values of productivity growth appeared to be insignificant in the model tested, though this was not the case for the change in productivity growth.[10]

[9] This is done via a prediction error decomposition method (Harvey, 1990: 100). The Kalman filter is a recursive procedure for computing the optimal estimator of the state vector at time t, based on information up to and including time t and the filter enables the estimate of the state vector to be continually updated as new observations become available. All observations – the full information set – are used for the smoothing process.

[10] This specification implies a fast pass-through from productivity to earnings.

4. ESTIMATION PROCEDURE AND RESULTS

In this section we proceed with the semi-structural approach and present the results of an unobserved components model, made popular by Gordon (1997). Inflation is assumed to depend only on nominal factors in the long run (i.e. the coefficients of lagged inflation are constrained to add up to unity). This long-run nominal homogeneity restriction allows the Phillips curve to be expressed in terms of the first difference of inflation and guarantees the existence of an equilibrium value for unemployment. This equilibrium variable (the NAIRU) is treated as endogenous and estimated simultaneously with the parameters of the model as an unobserved variable.

The model must be written in state-space form and allows one to undertake the simultaneous maximum likelihood estimation of the Phillips curve equation together with the smoothing of the transition equation with a Kalman filter.

The specification used follows the basic model used by the Bank of England with the additional TFP term (Greenslade *et al.*, 2003):

$$\Delta w_t = \rho(L)(u_t - u_t^*) + \alpha(L)(\Delta p_{t-1}) + \theta(L)TFP + \beta(L)X_t + \varepsilon_t^{\Delta\pi} \qquad (1)$$

with
$$\begin{aligned} &\varepsilon_t^{\Delta\pi} = N(0,\sigma_{\Delta\pi})^2 \\ &u_t^* = u_{t-1}^* + \varepsilon_t^{u*} \\ &\varepsilon_t^{u*} = N(0,\sigma_{u*}^2)) \text{ and } \operatorname{cov}(\varepsilon_t^{\Delta\pi}, \varepsilon_t^{u*}) = 0 \\ &u_t^* - u_t = \delta_1(u_{t-1}^* - u_{t-1}) + \delta_2(u_{t-2}^* - u_{t-2}) + \varepsilon_t^{gap} \end{aligned} \qquad (2)$$

Equation (1), the measurement equation, is a standard triangular Phillips curve and models the change in wage inflation (Δw_t)[11] (not levels) as a function of temporary supply shocks (X_t); the unemployment gap ($u_{t-1} - u_{t-1}^*$) to measure the stance of aggregate demand and the unobserved structural rate or NAWRU (u_t^*). This latter variable is the state variable which is unobserved and time varying (such that it follows a random walk). Productivity is measured with an exogenous filtered measure of total factor productivity (McQuinn and Whelan, 2006). In this way we specifically test for productivity persistence or reverse hysteresis in the effect of productivity shocks. Empirically, we will initially test lagged nominal wage growth and contemporaneous and lagged price inflation in order to capture the process of expectation formation and inertial effects observed in virtually all inflation rate time series (Mankiw, 2000). Downward wage rigidity is thus assumed and implies a more realistic dynamic behaviour of wage adjustment (Whelan, 2002).

Unit root tests reveal that Irish wage inflation rate is an *I(1)* series and only its first differences follow an *I(0)* process. The model is expressed as year-on-year wage inflation *changes* (wage inflation levels could be influenced by short-run nominal facts absent from the specification). Inflation changes in Equation (1) are assumed to be explained by the lagged unemployment gap (u_t- u_t^*) to proxy aggregate demand pressures in the economy exerting pressure on wages. Lagged inflation/inflation expectations pick up an inertia effect.

[11] This is a way of imposing dynamic homogeneity, disentangling the NAIRU from nominal factors, to ensure a meaningful structural rate. Another way it can be imposed is to model wage inflation in levels but impose the sum of lagged inflation terms to be equal to one.

Equation (1) includes a set of variables X_t that may proxy for the shocks that affect inflation changes exogenously to the internal demand and labour market pressure – namely supply-shocks. Here we will test the import deflator, the oil price and changes in the sterling exchange rate to catch changes in trade conditions as well as relative changes in UK wage rates. Specifically, we are interested in the rate of total factor productivity. Productivity is known to have important and long-lasting supply-shock effect on wage expectations and its inclusion is hypothesised to have a significant effect on employment separation and vacancy rates, *ceteris paribus*, in the Irish context.

The state or transition equation, Equation (2), follows the seminal unobserved components model in Watson (1986) as it decomposes the actual unemployment rate into the trend component – the NAIRU – and the remaining cyclical unemployment gap. Equations (3) and (4) specify the trend and cycle unemployment in the form needed to set up a State Space model (see Appendix 1 for a detailed description of the State Space Model). The (cyclical) unemployment gap is modelled as a stationary autoregressive process of order 2,[12] which is the assumption made in Watson (1986) and Kuttner (1994) in the context of using an unobserved components model to estimate the output gap. Several other authors also use this specification for the unemployment gap including Apel and Jansson (1999) and Laubach (2001).

The NAWRU is assumed to change over time according to a random walk following Gordon (1997), which is also the standard assumption in the literature. As pointed out by Laubach (2001), the assumption that the NAIRU follows a random walk will conveniently work for the US but must be carefully considered for European countries that commonly have NAIRUs following *I(2)* processes. The assumption of the first order autoregressive process for developments in the NAWRU is of particular interest in an Irish context as it provides evidence of how slowly the NAWRU adjusts to long lasting supply shocks, such as productivity changes.

Unobserved components models universally assume that the random exogenous events or 'noise' ($\varepsilon_t^{\Delta\pi}, \varepsilon_t^{u^*}, \varepsilon_t^{gap}$) are *iid*, normally distributed and assumed to have mean zero and constant variances. As such, a Kalman filter can compute a log-likelihood function that allows estimation of the error parameters using the maximum likelihood method. The ratio of the variance of the two error terms ($\sigma_{\Delta\pi}^2 / \sigma_{u^*}^2$) is the signal-to-noise ratio, reflecting the assumption that the NAWRU is determined by structural factors that evolve gradually over time. Past studies have tended to arbitrarily select the signal-to-noise ratio, but this paper applies Stock and Watson's (1998) endogenous estimation to determine the signal-to-noise ratio.

The signal-to-noise ratio measures the volatility in the NAWRU in relation to volatility in wage inflation and so determines the smoothness of the estimated series. The standard approach is to *impose* a low value for σ_η proposing that any changes in the NAIRU are likely to be driven by structural changes in the labour market i.e. capturing the principle that the labour market evolves slowly but that precisely is what we are hoping to test for the Irish situation (For more detail on the Kalman filter, see Harvey 1990). By not exogenously restricting the standard deviation on the

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[12] In such an AR(2) process the value of the unemployment gap depends on its values in the previous 2 periods and a disturbance term with mean zero. This approach makes it possible to model the NAWRU as an I(2) variable and is more general than the random walk approach (with one lag with or without drift). A constant cannot be estimated for the NAWRU equation i.e. the program sets $E(u_t - u*_t) = 0$ implying that the unemployment gap oscillates around zero.

noise term in the NAIRU random walk (σ^2_{u*}), the standard deviation here is estimated as part of the likelihood estimation as per Stock and Watson (1998). This is particularly suitable in this case as the AR(2) process of the unobserved state equation appears to have very good explanatory power and does not produce a NAWRU which mirrors the observed actual employment rate i.e. a meaningful unemployment gap is observed without a very volatile NAWRU rate.

Initial values had to be chosen for the parameters of the model. As a general rule, these should be as close as possible to the true values to ensure that the optimisation process will converge. Our system was quite robust to the choice of the starting values.

Table 1 below shows the results of estimating a model for manufacturing wage inflation for the period 1980 to 2005. A general-to-specific estimation strategy was employed (omitting insignificant exogenous control variables). Final regressors were the current value of the unemployment gap (the 'demand' effect), lagged annual price inflation (core HICP) capturing inertia in the real wage effect and lagged change in the quarterly sterling exchange rate reflecting external trade conditions. The top section of the table gives the estimated coefficients for the transition equation where the dependent variable is the current unemployment gap. The results show a strong negative persistence between the first lag of the unemployment gap and the current gap, which has substantially diminished by the second lag.

The second panel of the results table shows the observation equation (Phillips curve) and reports that the changes in wage inflation are negatively correlated with the estimated unemployment gap. Since there is at least one lag, the effect of the change in the demand variable (the unemployment gap) on inflation is automatically captured (see Gordon (1997:16)).[13] We can say that up to 40 per cent of the estimated unemployment gap could "explain" the variation in wage inflation immediately.

The results show that our external trade environment is an important shock variable affecting wage inflation conditions. It is captured by changes in the sterling-Irish pound/Euro exchange rate. Other temporary supply shocks affecting inflation generally which could have been represented by real import prices or oil prices have been superseded by the exchange rate effect in our estimation and were dropped from our general specification of the observation equation.

[13] More than two lags of the cyclical fluctuation term i.e. the unemployment gap were tested but only two lags turned out to be significant with their sum slightly greater than 1.

Table 1: Output of the Kalman Filter estimate with TFP as exogenous variable

Maximum Likelihood estimates and Statistics

Sample: 1982:3-2005:4 (95 obs.)

Variables		Coefficients	s.e.	t-stat
Transition equation				
AR(1) uegap	δ_1	-0.7777	0.0050	6.05647***
AR(2) uegap	δ_2	-0.0325	0.0217	1.4964*
Var(ε^{nairu})	σ^2_{u*}	-0.0000	--	--
Phillips Curve (Observation equation)				
Intercept		3.0875	0.0095	23.7208***
$u_t - u*_t$	ρ_1	-0.4019	0.0015	-5.4348***
$u_{t-1} - u*_{t-1}$	ρ_2	-0.6878	0.0010	-8.7675***
π^{yoy}_{t-1}	α_1	1.0020	0.9238	1.0846
Δw_{t-1}	α_2	-0.0276	0.1099	-0.2511
ΔTFP_{t-1}	θ	0.6408	1.7831	2.4041*
GBP	β_er	0.0442	0.0248	1.7831*
Var($\varepsilon^{Phillips}$)	$\sigma^2_{\Delta\pi}$	-0.0001	--	--
Log likelihood		191.0815		

Variables:

Δw_{t-1}: First lag of the dependent variable

π^{yoy}: year on year inflation in core HICP in %

TFP: Year on year growth in % of TFP (HP smoothed)

Δ: 1st difference ($\Delta X_t = X_t - X_{t-1}$)

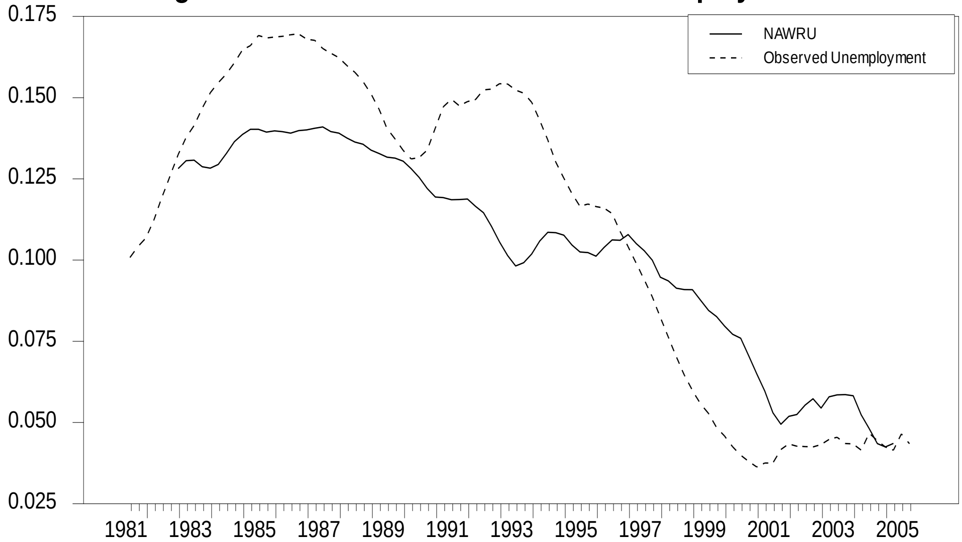
All variables are seasonally adjusted. Interpolated quarterly data pre 1995.

The productivity effect shown by the first difference in lagged TFP shows that unemployment dynamics are not the only reason for changes in the wage inflation rate. Irish wage inflation rates appear to have been at least partially justified by economy-wide increases in total factor productivity – all else equal. Rapid productivity growth raises the marginal productivity of new jobs, affects vacancies and lowers equilibrium unemployment – a 'capitalisation' effect. Second, rapid productivity growth tends to increase future real wages, perhaps making workers less inclined to press for higher wages now. As the value of the incumbent worker is raised in the current period, this offsets the view that faster productivity growth comes at the expense of labour downsizing and other 'creative destruction' mechanisms so increasing the inflow into unemployment (Davis *et al*., 1996).

Other researchers found that when the smoothness parameter for the unobserved structural rate is estimated endogenously, it has led to unsatisfactory results because the NAIRUs produced are very small and follow the observed unemployment rate almost identically. Stock (1999) and Stock and Watson (1999) found that when the true variances of (non-stationary) unobserved variables are small, the maximum likelihood estimates of the variances generally tend towards zero as we found for the measurement equation. In effect this occurs because the estimation can find a corner solution involving no fluctuations in the unobserved variable. This is why most researchers tend to fix the variance of the unobserved NAIRU or alternatively choose a set noise-to-signal ratio. All the estimates shown in this paper are *smoothed* NAWRU estimates (which use the full information set) rather than *filtered* estimates (which only use the information available at the time that the forecast was made).

Figure 6 below presents our NAWRU estimates and the implied unemployment gap for the period under consideration. As expected, changes in the NAWRU are less dramatic (occurring at a lower frequency) compared with changes in the overall unemployment rate that is made up of both structural and cyclical elements. In turn, the unemployment gap captures factors affecting the cyclical unemployment in the labour market and determines the level of labour market slack (the aggregate demand effect). The Kalman Filter estimates of the NAWRU thus yields plausible results indicating that the method captures the econometric properties of the NAIRU well. Significant improvements in the goodness-of-fit were observed only when productivity was included.[14]

Figure 6: Structural Rate vs. Actual Unemployment



The structural rate is used to interpret the unemployment situation of an economy as it represents the equilibrating/natural rate of unemployment defining the rate of labour utilisation compatible with stable inflation as the path of sustainable productive potential in the economy. It will have a direct impact on the level of the output gap and thereby the assessment of economic sustainability. In general, medium-term analysis and projections rely on pinpointing policies that will close the output gap over the medium term. As such, it indicates the rate of unemployment that, in a given year, and based on the actual history of unemployment, would be associated with a constant rate of nominal wage increases.

[14] As a robustness check, we tested the goodness-of-fit of our results by placing the Kalman Filter NAWRUs obtained into an OLS estimation of wage inflation and compared it to the NAIRU estimates obtained by the Hodrick-Prescott filter estimates (Figure 5) using adjusted R^2 and Akaike and Schwartz information criteria. The results showed that our Kalman Filter estimates of the structural rate of unemployment were much more informative.

Over optimistic evaluations of potential reductions in the NAIRU would lead to an over-estimation of potential and actual growth performance for an economy such as ours. In the short-term, the structural rate of unemployment could fall but a permanent shift depends on the persistence effects of shocks. More significantly, it is the gap between the structural rate and the actual rate that proves to be the best indicator of labour market reform and performance generally. The unemployment gap can be maintained for a substantial period of time before equilibrium forces move to close it – we find this time span to be 5 to 6 years for three separate episodes of noted unemployment gaps over the past 25 years.

Figure 3 suggests at least three distinct historical phases in wage inflation and structural unemployment pressures in Ireland.

- First, the coincidence of declines in the unemployment rate combined with a positive wage inflation rate between 1980 and 1994 was due solely to excess labour slack. FitzGerald and Hore (2002) hold the view that outward migration played the most prominent role for the cyclical nature of unemployment but only very slowly affected the structural unemployment rate.
- Second, between 1994 and 2001 declines in the structural rate dominated the process within the decline in observed unemployment. The structural effect was so significant that a negative unemployment gap prevailed. The sharp decline in the unemployment rate after 1994 would have left the labour market much tighter and exerted significantly higher pressure on wages had it not been for large structural rate declines.
- Between 2001 and 2005, the results show that the structural rate of unemployment stabilised while there were further cyclical declines in the unemployment rate due to the structural changes in the composition of the labour force. The associated rise in wage inflation is likely to have come about due to the dissipation of all slack in the labour market, favourable general economic conditions and labour market capacity constraints (particularly for certain types of skilled labour servicing the construction and other non-traded sectors). This simple explanation is appealing, as despite time-varying changes in the wage inflation-unemployment tradeoff, the natural rate of unemployment was not significantly affected (falling from 12.5% to just over 10% over the 14 year period).

5. DISCUSSION

So why did the fall in Irish structural unemployment not force wage inflation significantly higher?

5.1 Reverse hysteresis

It is now accepted that persistence in unemployment and the unemployment gap is affected by aggregate demand in the long run by what Blanchard and Summers (1986) termed hysteresis. For Ireland during times of rising unemployment, Walsh (2000) pointed to this phenomenon and the possibility that the equilibrium unemployment rate was drifting up with the actual rate during the 1980s. The increasing proportion of the unemployed who had been out of work for a year or more would lead to a degradation of their skills and employability, and coupled with a significant welfare trap, led to a situation where the unemployment rate could not be expected to fall even if there was an increase in the demand for labour.[15]

[15] The long-term unemployment problem was not helped by increasing evidence of a welfare trap in the trade-off between social welfare entitlements and stagnant real wage rates facing the Irish jobseeker (Layte and Callan, 2001). The already-low labour force participation rate fell further and by the end of the decade, renewed emigration led to a decline in the population of 16 to 65 year olds considered the active age of the population.

Most studies of hysteresis focused on its role in explaining increases in employment. However, Ball *et al* (1999) asked whether hysteresis was symmetric such that demand expansions could reduce the NAIRU as well as increase it. As discussed above, the Irish labour market moved from a situation of excess supply from 1994 and the structural unemployment rate is likely to have fallen faster than the observed unemployment rate. This period compares favourably with what Krueger and Pischke (1997) referred to as the US 'employment miracle', which they credited to greater wage flexibility allowing the absorption of many new entrants to the US labour market. Significant inward migration can explain the absence of an adverse reaction of the Irish economy to a negative employment gap between 2003 and 2005 but for the ten-year period 1994 to 2003 inclusive, an internal (or endogenous) restructuring of the unemployment gap occurred which we find can be explained by general productivity (TFP).

The reverse hysteresis argument is supported by several empirical and policy observations in the Irish context. First, in most OECD countries, part-time contracts contributed the bulk of any observed employment growth. The extreme example has been the Netherlands, where women working part-time in the service sector accounted for over half the total increase in employment between 1983 and 1997 (Garibaldi *et al*, 2002). In contrast, the Irish employment boom was biased towards full-time jobs (Walsh, 2004). While the share of part-time women in the total increase in employment doubled, the proportion of these who declared they were underemployed fell to less than one per cent of all females working part-time. Participation rates aside, any difference in the unemployment rates for men and women also disappeared in the period.

While the average level of education increased significantly over the period, both the participation and employment rates of those at the lower educational categories increased in tandem.[16] Explicitly modelling the educational structure of the labour force in our model was not possible - it is endogenous - but rising skill levels within the workforce is captured by the measure of productivity which produced significant results (Table 1).

5.2 Labour market policy

Many commentators ascribe successes in reducing unemployment to changing labour regulations and institutions, lower rates of taxation on labour lowering the reservation wage and changing population demographics. These are cyclical aspects regarded as compositional not quality effects in the labour force. Policies supporting the long-term unemployed included special employment schemes, such as the Community Employment Scheme, had peak participation by the mid 1990s but employment scheme participants as a proportion of the total number employed has fallen back ever since (Walsh, 2004). O'Connell (2000) criticised the outcome from these efforts but asserts that up to one percentage point of the total reduction in the peak unemployment rate may have been related to a plethora of labour market schemes and incentives including the use of a pre-retirement allowance moving a sizable number of those claiming unemployment payments out of the official definition of unemployed.[17] The provision of employment schemes reduced substantially since 2003 and there is no evidence that this has adversely affected labour market indicators since then.

[16] Quarterly figures from direct QNHS data examined from 2002 and old broader QNHS data by principal economic status from 1997 to 2002.

[17] Turner *et al* (2001, page 197 footnote 47) cite labour market reforms in the late 1980s to mid 1990s for reducing the NAIRUs of the Netherlands, New Zealand, Spain and the UK by a half percentage point per year over 4 to 5 years.

Ball *et al* (1999) express the view that an incomes policy arising from collective bargaining cannot be ignored in analysing the reduction in Ireland's unemployment rate.[18] The national pay agreements brought about a significant reduction in the tax wedge and associated replacement rates in return for wage constraint.[19] Combined with a favourable corporate tax regime, Ireland attracted a significant inward flow of FDI over the period to 2005 (Walsh, 2000). These three factors are generally agreed to have served to boost productivity growth.

Our results show that the steady improvement in competitiveness is the key explanation to explain the lack of inflation when by definition it should have risen when demand expansions pushed unemployment below the natural rate. As a small open economy, however, the productivity effect needs not necessarily to have occurred in Ireland. Capital and labour productivity gains could have been "imported" in a new economy setting and the domestic cost pressures superseded by international competitiveness pressures. Labour costs needed to be kept at a level such that export shares increased at the same time as the aggregate unemployment rate declined. A tapering-off of our positive competitive environment is probably what explains the return of inflationary trends in recent times.

Our analysis shows evidence of the wage inflation NAWRU stabilising in recent years at a historically low level. To the extent to which it has "bottomed out" leaving further declines in the NAIRU unlikely is hard to say but increases in cyclical unemployment (reversing any negative employment gap) in Ireland will ease the inflationary pressures for wages in the absence of further productivity improvement. Hall (2005) observes that when the labour market is tight and unemployment is low, employers devote substantial resources to recruiting workers. Job-finding rates for the unemployed are high. By contrast, when the market becomes slack and unemployment is rising, employers recruit less aggressively and job-finding rates are low. Further, transitions from strong markets with low unemployment and high vacancies to weak markets with high unemployment and low vacancies seem to occur without large measurable changes in driving forces. Even shocks confined to a small number of inter-related industrial sectors can stimulate large responses of general unemployment.

6. CONCLUSIONS

The structural rate of unemployment and associated non-accelerating wage inflation rate of unemployment are of major importance to the analysis of macro and structural economic developments although in practice these concepts are not well defined and there is considerable uncertainty concerning their measurement and policy use. This paper finds the Kalman Filter method, in line with Richardson *et al.* (2000), to provide satisfactory results. Meyler (1999) previously criticised a reduced-from Phillips curve method to estimate a NAIRU using Irish data. It is obvious why such criticisms could be made because Irish data do not substantiate any relationship between unemployment and price inflation generally. His solution was to differentiate domestically-generated inflation from price inflation generally. This paper, however, has formulated estimates for an Irish NAWRU in terms of *wage* inflation. The intuition was that, as price-takers in a small open economy, any potential for mark-up pricing forces aggregate prices and wages (as the vast majority of production cost) to move substantially in tandem. Domestically-generated price inflation is thus dominated by developments related to wages.

[18] Other factors such as the productivity conditions attached to the national wage agreements (in return for wage constraint) are also likely to have had an effect albeit difficult to measure in macroeconomic data.

[19] The analysis period does not cover the current social partnership agreement "Towards 2016". From 2004, the *Sustaining Progress* agreement became Ireland's National Reform Programme under the Lisbon Agenda for improved competitiveness, economic growth and greater job creation across Europe.

The reduced-form approach follows a long empirical tradition and has the major advantage of being directly related to the definition of the NAIRU. Its relative simplicity and transparency make it consistent with a variety of structural models. Besides the contribution in terms of the model specification to include additional productivity information explaining changes in the NAWRU, we used a very flexible dynamic linear model to obtain estimates of the structural rate of unemployment together with its mean squared errors from the unobserved components model. The NAWRU has shown itself to have declined consistently over time.

As a measure of the unemployment rate at which wage growth is stable, a measure of the structural rate of unemployment is vital in the calculation of the output gap i.e. whether the economy is indicating that it may not be flexible enough to enhance its global competitiveness or could struggle to increase its future potential output and capacity utilisation. The employment rate in 2005 was shown to be very close to the calculated structural rate implying a then unemployment gap of close to or slightly below zero. The 2005/6 capacity constraints in the labour market (arising from full employment in the domestic construction sector) and reliance on inward migration have since eased. Labour market developments affecting the total rate of productivity will be paramount in the future.

The semi-structural model was chosen with respect to its in-sample properties and the degree to which it was able to match the behaviour of the series: it has not been our aim to estimate a forecasting tool. We did not explicitly explore factors that might determine the future evolution of the structural rate or how policy actions might affect it. To better understand these issues, it would be necessary to use a richer theoretical structural framework such as the one described by Layard *et al* (1991) or Blanchard and Katz (1997) where the relationship between wage and price-setting are explicitly explored.

Our argument of reverse-hysteresis is that the decline in the natural rate of unemployment due to productivity increases was path-dependent. As the number of long-term unemployed persons fell, the latter exerted a significant influence on labour market developments and on wages in particular.

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APPENDIX – Modelling Technique

Specification of the STATE-SPACE MODEL

A State-Space model finds a relation between observed time series and an unobserved one (called the state variable). The observation equation(s), also called the measurement equation, specifies this relation while the state equation specifies the dynamic process driving the state. Both equations together define the space within which the state is allowed to move. The Kalman filter estimation undertakes a dynamic maximum likelihood model filtering and smoothing procedures for specified unobserved components in the model. First, a recursive process constructs the estimates for period *t* building on the information on the observed variables available at *t*-1, minimizing the forecast error. A second procedure smoothes the obtained estimate on the basis of the information available over the whole sample period.

Measurement

$$Y_t = cU_t + \varepsilon_t^O$$

with

$$y_t = \begin{bmatrix} u_t \\ \Delta\pi_t \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & \rho_1 & \rho_2 \end{bmatrix} \begin{bmatrix} u_t^* \\ u_t - u_t^* \\ u_{t-1} - u_{t-1}^* \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \\ \alpha_1 & \alpha_2 & \alpha_3 & \alpha_4 \end{bmatrix} \begin{bmatrix} \Delta\pi_{t-1} \\ \Delta\pi_{t-2} \\ \Delta\pi_{t-3} \\ \Delta\pi_{t-4} \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \\ \beta_1 & \beta_2 & \beta_3 & \beta_4 \end{bmatrix} \begin{bmatrix} x_t^1 \\ x_t^2 \\ x_t^3 \\ x_t^4 \end{bmatrix} + \begin{bmatrix} 0 \\ \varepsilon_t^{\Delta\pi} \end{bmatrix};$$

where the variance-covariance matrix of $\varepsilon(y)$ is: $\Sigma_{\varepsilon(y)} = \begin{bmatrix} 0 & 0 \\ 0 & (\sigma^{\Delta\pi})^2 \end{bmatrix}$

State

$$U_t = aU_{t-1} + \varepsilon_t^U$$

with

$$U = \begin{bmatrix} u_t^* \\ u_t - u_t^* \\ u_{t-1} - u_{t-1}^* \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \delta_1 & \delta_2 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} u_{t-1}^* \\ u_{t-1} - u_{t-1}^* \\ u_{t-2} - u_{t-2}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^* \\ \varepsilon_t^{gap} \\ 0 \end{bmatrix};$$

where the variance-covariance matrix of $\varepsilon(U) = \Sigma_{\varepsilon(U)} = \begin{bmatrix} (\sigma^{u*})^2 & 0 & 0 \\ 0 & (\sigma^{gap})^2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

The measurement equation is based on observed variables only (expected/lagged inflation rates and supply side proxies) and the Phillips relation slope parameter estimated as ρ_L for each lag

L. U_t is the transition vector of unobserved variables, composed of the coefficients associated with the unobserved NAWRU (u_t^*) variable to be estimated i.e. equilibrium employment, gap and NAWRU drift. In the transition system, $\varepsilon(U)$ is a vector of innovations, assumed to be normally distributed as shown by the variance-covariance matrix $\Sigma_{\varepsilon(U)}$ (often referred to as the Q matrix):

$$\varepsilon_t^U \sim N(0,Q)$$

This matrix has by assumption (imposed), all elements equal to zero except the diagonal ones associated with the NAWRU and the unemployment gap - σ_{ε^N} and $\sigma_{\varepsilon^{gap}}$ so that the only parameters which really vary with time are the NAIRU and the gap.

Estimation of Kalman recursive equations requires that initial values for the state vector are required but the impact of the starting values on current values for the states is considered negligible. The starting values for the NAWRU has been set to the corresponding observed value for unemployment, with the gap and drift initially set at zero as a consequence. This empirical strategy basically treats the standard formulation of the Phillips equation as a linear model and only when the tradeoff parameter ρ_L takes on a positive value is the alternative hypothesis that there is a drift or cyclical state of the economy tested. Following suggestions in the literature, a wide range of priors was tested assuming large starting values for the unobserved variance matrix. The standard deviation of the first lag of the system unobserved components was tried at 2 per cent for the NAWRU and at 0.75 percentage points for the NAWRU drift.

DATA

We use quarterly series for the manufacturing wage rate, UK sterling exchange rate and the unemployment rate. The manufacturing wage series is the hourly wage of all industrial workers employed in manufacturing sectors 15-37 based on the published quarterly data by the CSO since 1980. Data on the unemployment rate is taken from the Labour Force Surveys and interpolated into quarterly observations.

The system described above was estimated using the Kalman filter and maximising the dynamic log-likelihood function using the numerical algorithm BFGS in the econometric package RATS 6.0.