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# Time –Varying Nairu / Nawru Estimates for the EU's Member States

**by**

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# TIME –VARYING NAIRU / NAWRU ESTIMATES FOR THE EU'S MEMBER STATES

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# INTRODUCTORY REMARKS

In 1968 Friedman put forward the notion of a “natural” rate of unemployment to encapsulate the idea that a “normal” level of unemployment, roughly equivalent to the amount of frictional and structural unemployment, persists even when the labour market is in equilibrium. Since there are no direct measures of the natural rate, as it is essentially a theoretical construct, one must be satisfied with proxy estimates derived using various methods including that which draws on Tobin’s concept of the non-accelerating inflation rate of unemployment (i.e. the NAIRU).

The concept of the NAIRU should be seen in the context of the shift in the framework for analysis of the labour market over the last number of decades from one focussed on whether the labour market clears or not, to one which allows for imperfectly competitive goods markets and recognises that unions have a role to play in terms of wage determination. This shift to a bargaining framework of wage setting under imperfect competition is likely to lead to a NAIRU estimate which converges to an unemployment rate which is higher, because of the monopolistic element, compared with that under the classical competitive paradigm and its theoretically equivalent concept of the natural rate.

The essential objective of the present paper is to produce statistically significant and economically reasonable, time-varying, NAIRU estimates (TV-NAIRU's) for the Community's Member States which also have informational content in terms of inflation. While it is clearly difficult to estimate NAIRU's using variables to cover all the main contributory factors which are likely to be at play, it may nevertheless be possible to isolate the principal "sinners" by selecting a modelling strategy which is both theoretically robust and empirically respectful of a number of key pre-determined criteria, including in particular the inflation tracking performance of the estimated NAIRU's / unemployment gaps.

The TV-NAIRU approach attempts to provide an indication of the path the NAIRU has taken over a particular period, by including variables which capture the impact of significant supply side shocks, over the period in question, which would have been expected to influence the NAIRU. Examples of the latter over the last number of decades include the slowdown in trend productivity growth, the large external oil price shocks and the presumed deterioration, especially in Europe, in labour market flexibility. One can introduce this « time varying » element by using either a statistical model to determine the NAIRU, which allows the NAIRU to vary but ensures that this variation is smooth over time (eg Cubic Spline / Kalman Filter approaches) or an economic model approach which uses additional economic variables which capture the supply side shocks, mentioned above, to identify the NAIRU. The latter economic model approach is used in the present study for the period 1980-1999, with the introduction of variables like productivity, the real interest rate, the tax burden and replacement ratios etc having the effect of producing a « time-varying » NAIRU, which shifts over time due to changes in the respective determining variables.

It should be stressed at the outset that precise measurements of the TV-NAIRU are extremely difficult to produce because any measurement process is dogged by the existence of two fundamental sources of uncertainty. The first source of uncertainty emanates from the fact that the NAIRU must be estimated since it is unobserved, with many different modelling approaches and empirical specifications from which to choose, all of which give plausible, although different, point measurements of the NAIRU. The second source of uncertainty is the degree of doubt surrounding the NAIRU point estimates themselves, which are imprecisely calculated from a combination of stochastic variables and parameters, with the computing of confidence intervals for the latter highlighting the extent of the imprecision of the various methods used in the calculation. Given these latter uncertainties, it is hardly surprising to find that the NAIRU is increasingly been seen not as a robust point estimate but as a zone.

In overall terms, the methodology developed in this paper is not that different to that adopted by the OECD to produce its NAWRU series since both this paper and the OECD use a method which in essence assumes that the change in wage/price inflation is proportional to the unemployment gap i.e. the gap between the actual unemployment rate and the calculated NAIRU/NAWRU series. However, while the methodology adopted has similarities with the OECD's approach, there are some notable differences including in particular the inclusion of a number of structural variables such as real interest rates etc which try to give some indication of the sources of the change in the "reduced form" NAIRU over time. Furthermore, unlike the OECD methodology, the approach adopted in this paper uses standard estimation methods which allows for the computation of confidence intervals as well as permitting the statistical and economic significance of the preferred explanatory variables to be checked and validated. Only those structural variables which are statistically significant and have economically the expected coefficient sign are used in the final model.

The paper is structured as follows. In section one, following a short overview of the main NAIRU modelling methods, the details of the preferred modelling strategy which the paper intends to use to estimate TV-NAIRU's is presented, including the selection of appropriate variables to cover the main shocks, which occurred over the period since 1980, such as the productivity slowdown and real interest rate increases, as well as proxy variables to reflect the impact of institutional rigidities on reservation wage developments (i.e. taxation and replacement ratio variables). Section two goes on to give the results of the estimation process, with an important role found for the taxation and real interest rate variables in a majority of the Community's countries. Finally, section three tests the NAIRU results in terms of their ability to explain past movements in wage inflation and also in terms of their usefulness in output gap models of price inflation.

## SECTION 1 : NAIRU / NAWRU MODELLING STRATEGY : A THEORETICAL OVERVIEW

**1.1 NAIRU MODELLING METHODS :** There are two broad modelling approaches normally adopted in defining the NAIRU, firstly the expectations-augmented Phillips curve approach, which distinguishes a series of labour market variables as potential empirical determinants of the NAIRU, and secondly a number of statistical methods in which the time series properties of the macroeconomic variable(s) in question are used to identify the NAIRU. In general, the structural approach to estimating the NAIRU seems preferable since it allows for a better economic interpretation of the results. We find in this study that the structural approach works reasonably well for all EU countries, except Italy where it proved difficult to find an equilibrium unemployment rate with the chosen structural indicators.

The calculation of the equilibrium or steady-state (i.e. stable inflation) value of unemployment from an expectations-augmented Phillips curve framework constitutes a genuine estimate of the NAIRU given that the Phillips curve postulates a formal relationship between the unemployment rate and wage/price inflation. As regards this approach, the NAIRU is established at the point where a stable relationship exists between the deviation of unemployment from the NAIRU and unexpected inflation. Within this dominant Phillips curve framework two variants have emerged, namely the single equation inflation approach, an example being Gordon's "Triangle" model (see Gordon 1997), with the latter postulating that the inflation rate depends on a "triangle" of basic factors, namely expected inflation, demand conditions, as proxied by the unemployment gap, and supply side shocks, and the multiple equation wage-price model approach (e.g. the bargaining model)[1].

[1] **BROAD THEORETICAL FRAMEWORK UNDERLYING THE BARGAINING "WAGE-PRICE" MODEL APPROACH:** Wage-Price models can be set up in a wide variety of ways to reflect the international differences between the labour and product market systems of individual countries. One widely used wage-price model draws on the bargaining framework of wage determination. This latter bargaining view of the world interprets real wage developments as being the result of a bargaining process between employers and employees, the outcome of which reflects the relative degree of market power possessed by the actors involved. Workers bargaining power, for example, is negatively related to the prevailing rate of unemployment and positively influenced by factors which tend to push up real wage demands such as generous social welfare benefits, mismatch problems in the labour market and unionisation rates. Under this approach real wages are the outcome of a negotiated compromise between the respective parties with employees, basing their nominal wage demands on aspirations regarding a target real wage, and employers responding with views as to the feasible or warranted real wage. Bargaining models of wage determination suggest a process of wage bargaining closer to a bilateral monopoly than to perfect competition. This approach, commonly referred to in the literature as "the battle of the mark-ups", is associated with the work of Layard, Nickell and Jackman (1991) and is often purported to be the most appropriate one to be adopted in the European context.

**1.2 DESCRIPTION OF PREFERRED NAIRU MODELLING STRATEGY** : The modelling approach used in the present paper represents essentially a "hybrid" form of both Gordon's triangle model and of the bargaining framework underlying the labour market specification of the Commission Services Quest II model, where wage rules are postulated, which identify productivity, reservation wage/participation rate changes and labour market tightness as major determinants of workers wage claims. Wages in Quest II are in fact determined as a weighted average of the reservation wage ( unemployment benefits)[2] and labour productivity plus an additional mark-up term that depends on labour market conditions. In this framework unemployment can be explained in terms of structural characteristics of the labour market, such as adjustment costs for labour, the replacement rate, the bargaining strength of trade unions and tax rates.

**LABOUR MARKET MACRO MODEL:** In more specific terms, the structural unemployment estimates presented in this note use a simple macro model of the labour market which consists of a wage equation and a labour demand equation. The structural unemployment rate defined in this way would be the equilibrium of that system after wages and prices have adjusted.

***Wage Equation***: Given the fact that market clearing is an unrealistic description of European labour markets, which are characterised by substantial involuntary unemployment, the wage equation does not therefore rely on such a framework. It is assumed instead that wages are set in an imperfectly competitive fashion. It should be noted therefore that since the wage rule reflects wage setting in an imperfect market (e.g. union power, vacancy costs, search costs and efficiency wage considerations) the equilibrium reached in the labour market will generally be an equilibrium with involuntary unemployment. Standard macroeconomic models of the labour market (search-, union bargaining- and efficiency wage models) imply the following specification for the wage rule:

$$(1) \qquad W/P = w(rew(tl,ben), LUR, MPL)$$

Workers (trade unions) aim for a real wage **(W/P)** that depends, as mentioned earlier, on a reservation wage (**rew)**, labour market tightness **(LUR)** and the marginal product of labour **(MPL)**[3]. In particular workers will require that (net) wages are set equal to or above the reservation wage.[4] Therefore unemployment benefits **(ben)** and labour taxes **(tl)** can have an effect on the level of wages demanded by workers.

[2] A replacement ratio effect which impacts on the consumption/leisure choice.

[3] In some specifications, the wage equation is formulated in terms of the average product of labour instead of the marginal product. These differences do, however, not affect the basic results.

[4] From a theoretical point of view an ideal indicator would be the net replacement ratio. Unfortunately, benefits are not available over a sufficiently long period of time and obtaining a simple empirical measure for the replacement ratio is difficult since one must capture the effects of both benefit duration and coverage. Therefore we make the simplifying assumption that movement of tax rates reflect changes in the net replacement ratio. This is a reasonable approximation if the reservation wage is not taxed and follows labour productivity.

***Labour Demand Equation***: Labour demand is derived from the marginal product condition which determines the level of real wages the firm is willing to pay for a given capital intensity **(K/L)** and level of technology, as represented by total factor productivity **(tfp)**. Real wages which are offered by the firm depend positively on capital intensity (which depends negatively on the real interest rate **(r)** and corporate taxes **(tc)**) and on total factor productivity.

***(2) W/P=MPL(K/L( r,tc ),tfp)***

This condition can also be written as a price equation and can be presented as follows:

***(2') P=P(W,r,tc,tfp)***

**GENERATING STRUCTURAL UNEMPLOYMENT ESTIMATES**: Labour demand and labour supply then determine the equilibrium unemployment rate **(LUR*)** as a function of the interest rate, labour and capital taxes (henceforth denoted as tax) and tfp (and correspondingly a level of real wages (WR*) that is compatible with this unemployment rate).

***(3) LUR*=L(r,tl,tc,tfp) = b1*r+b2*tax+b3*tfp***
***b1>0, b2>0, b3=0***

Most theories imply restrictions on labour supply such that the long run effect of tfp on LUR* is zero[5]. Of course there can also be other factors influencing unemployment which are not captured by this formulation, such as specific events like German unification, large exogenous shocks to export markets (e.g. the break down of the former Soviet Union in the case of Finland), other structural reforms in the labour market affecting the bargaining position of trade unions and employers etc. We have used time dummies **(TD)** to represent these factors. Therefore we postulate the following specification for the equilibrium unemployment rate :

***(4) LUR* = b0*TD+b1*r+b2*tax+b3*tfp with b1,b2>0***

Because of real and nominal adjustment rigidities, wages and prices will in general deviate from their equilibrium levels. However, stability requires that the adjustment of wages and prices will be such that whenever the actual unemployment rate exceeds/falls short of LUR*, wages will tend to fall/rise, i.e. the coefficient **"a"** of the

[5] This is a fairly standard restriction usually imposed in macro formulations of the labour market and derives from the observation that in the very long run tfp and the unemployment rate have very different trends. However, there exists a wide variety of views on the relationship between technical change and employment. For example, some hypotheses point to the productivity slowdown as a major reason for the rise in the unemployment rate. Other hypotheses, however, suggest that there is a positive correlation between measures of tfp and the unemployment rate. For example, in an environment with skill biased technical progress and relative wage rigidity it is very likely that tfp and the unemployment rate are positively correlated. Some evidence to support this was, for example, found by Roeger and Wijkander (1999) for the three largest continental EU countries over the sample period 1970 to 1995. This correlation was particularly strong in the case of Italy and indispensable for obtaining a cointegrating relationship between unemployment and structural factors. As will be seen later on in this paper tfp is still needed in the case of Italy for the later sample period.

"unemployment gap" **(LUR*-LUR)** is positive. This equilibrating mechanism provides additional useful information from wage inflation **(Winf)** which helps to identify the NAIRU and therefore we estimate the NAIRU via the following specification, using non-linear least squares regression (NLS).

$$\textbf{(5)} \qquad \textbf{Winf}=a(\textbf{LUR}^*(\textbf{TD},r,\textbf{tax},\textbf{tfp})-\textbf{LUR})+\sum c(i)\textbf{Winf}(-i),$$
$$\sum c(i)=1 \quad a>0$$ [6]

This implies that LUR* can be identified from estimating equation (5).

For each country the following variables are used:

- **TD:** CONSTANT/ BREAK IN CONSTANT/ TREND : This refers to the classical concept of a natural rate and also requires little empirical knowledge.
- **R:** Ex post real long term interest rate.
- **TAX:** This is a comprehensive tax measure which includes all direct taxes plus social security contributions (SSC) as a share of the wage bill.
- **TFP:** Growth rate of real trend GDP.

The estimate for structural unemployment is given by those coefficients of LUR* and the corresponding unemployment gap (LUR*-LUR) which best explains wage inflation, given past levels of wage inflation.

The estimates from equation (5) allow an assessment to be made of the plausibility of LUR* both on theoretical as well as empirical grounds. The estimates of the coefficients of LUR* should be consistent with theoretical restrictions imposed by the wage and the labour demand equations on the structural unemployment rate (i.e. the coefficients **b**), and the coefficients should be significant. Also the unemployment gap should have explanatory power for explaining wage inflation, given past wage inflation i.e. the coefficient **a** should be significant.

**1.3 TAXATION AND WAGE DETERMINATION - RESERVATION WAGE / UNEMPLOYMENT BENEFIT SYSTEM INTERACTIONS**: In the model described above wage setting and labour supply decisions are crucially affected by the ratio between the net market wage and the reservation wage. In assessing the impact of taxation on employment it is important therefore to analyse how a change in taxes affects the reservation wage.

[6] Estimation of this equation requires an assumption with regard to the formation of expectations. Since the inflation process in many countries is dominated by inertia, with year-to-year changes in inflation being small, the most commonly adopted approach to providing an estimate of inflationary expectations is to use a distributed lag of past rates of inflation as a proxy for future inflation i.e. a backward looking specification. A stable inflation rate requires that the sum of the coefficients on the lagged inflation rate variables equal one. This latter homogeneity restriction implies the absence of any long run trade off between inflation and unemployment with the unitary coefficient encapsulating the idea that any given rate of inflation, if left to itself in the sense of no policy interventions to change it, is self-perpetuating.

With regard to the reservation wage effect on wages, the first thing to note is that the reservation wage is composed of unemployment benefits and the value of leisure, with the crucial determinant for tax effects being unemployment benefits. To the extent to which benefits are indexed to gross wages, a tax reduction increases the wedge between net wages and the reservation wage and increases the room to share the benefits of lower labour taxes between workers and firms. In contrast, if tax rates on benefits and wages were kept equal, the effect of taxation would be small and it would entirely disappear if the value of leisure goes to zero. This suggests that the interaction of the tax / benefit systems, and in particular the indexation link between benefits and wages (i.e. gross vs. net) plays a vital role in determining the effects of taxation on wage setting. However, it should be stressed that other institutional factors also play a role. The analysis by Calmfors and Driffill (1988) suggests that the bargaining structure plays an important part in determining the extent to which tax increases are shifted onto wages. In particular it has been argued that centralised and large unions would internalise the macroeconomic consequences of wage increases more strongly compared with equivalently strong but decentralised unions.

**1.4 RATIONALE FOR INCLUSION OF THE REAL INTEREST RATE VARIABLE**: While most of the variables which are used in the above estimation process would find widespread support in the literature, more controversial is the choice of the real interest rate variable. Higher real interest rates have a potential impact on unemployment via the knock-on effect on firms of increases in their cost of capital which reduces both investment and the capital stock and ultimately employment. To the extent that these additional financing costs are not taken into account in the wage bargaining system, equilibrating employees' real wage demands with the mark-up ambitions of employers may necessitate higher levels of unemployment. The big question, however, is whether it is credible to believe that these interest rate-induced unemployment increases are likely to be structural or cyclical in nature. Many commentators find the theoretical and empirical case for a secular growth in unemployment consequent to higher real interest rates difficult to justify and instead argue that the effects are likely to be temporary, with the real wage aspirations of workers likely to adjust over time in much the same way as with shifts in trend productivity, although the length of the transition phase could be considerable especially in countries with particularly inflexible institutional setups where the impact of shocks tend to persist.

The model developed above is sufficiently flexible to allow for the latter view of real interest rates interacting with a relatively rigid institutional framework here in Europe. The criteria adopted for the final model selection are based not only on theoretical considerations but in fact give precedence to the empirical explanatory power of the NAIRU series which is generated by the model in terms of tracking past trends in inflation. In addition, the real interest rate variable is only selected for those countries where a robust statistical relationship is shown to exist and where the parameter is correctly signed from an economic theory point of view. In this regard the model developed in the paper is essentially one for calculating a short-run NAIRU as opposed to a long run structural rate. Consequently, it is capable of picking up some transitory or persistence effects, emanating from perhaps a mixture of supply and

demand side influences, which will be resolved in the longer run when the price and wage dynamics have settled down and the long run steady state is finally reached.

The difficulty experienced in the present study in distinguishing structural as opposed to purely cyclical links between real interest rates and unemployment seems also to be reflected in the empirical literature on this topic, where diametrically opposing effects have been found. Some authors such as Darby, Ireland and Wren-Lewis (1992), Barrell, Pain and Young (1993), Manning (1992 and 1993), Phelps (1992 and 1994) and Scarpetta (1996)[7] point to significant positive effects on the NAIRU from real interest rate movements, whereas other papers, notably by Carruth, Hooker and Oswald (1993) and Bean (1994) show effects close to zero.

## DISTINCTION BETWEEN THE SHORT AND LONG RUN NAIRU CONCEPTS

The distinction between the short and long run NAIRU concepts is an important one, especially here in Europe, given the difficulties in estimating a long run NAIRU and of adjusting to the latter in an environment of hysteresis / persistence mechanisms. The essential difference between both concepts is that the long run NAIRU is characterised by stability in terms of both inflation and unemployment whereas for the short-run NAIRU, only inflation is stable. This latter stability is perhaps fragile in some countries since, the above-mentioned, hysteresis type mechanisms may impose limits on the speed with which the economy can return to the long-run NAIRU, with, for example, policies aimed at rapidly reducing unemployment being potentially costly in terms of inflation.

The short-run NAIRU concept should, in fact, be seen as a reduced-form as opposed to a structural concept, which encompasses not only the longer run structural determinants of the NAIRU (such as real interest rates, replacement ratios and tax burdens) but also reflects the dynamic adjustment of the economy to past economic shocks, as reflected in the impact of the unemployment gap on wage or price inflation. The preference in the present paper for calculating a short-run NAIRU reflects a number of arguments including the fact that for most European countries it is virtually impossible to measure a purely structural natural rate given the difficulty in finding credible indicators to pick up all the supply side factors which are likely to impact on the natural rate whilst at the same time ensuring that these latter factors are immune from the influence of cyclical determinants.

[7] Although in commenting on the results of the reduced form regressions on the total unemployment rate, Scarpetta states that "there is no evidence that over the 1983-1993 period that changes in the long term interest rates have significantly affected labour market conditions".

## SECTION 2 : EMPIRICAL TESTING OF "HYBRID" NAIRU / NAWRU MODEL

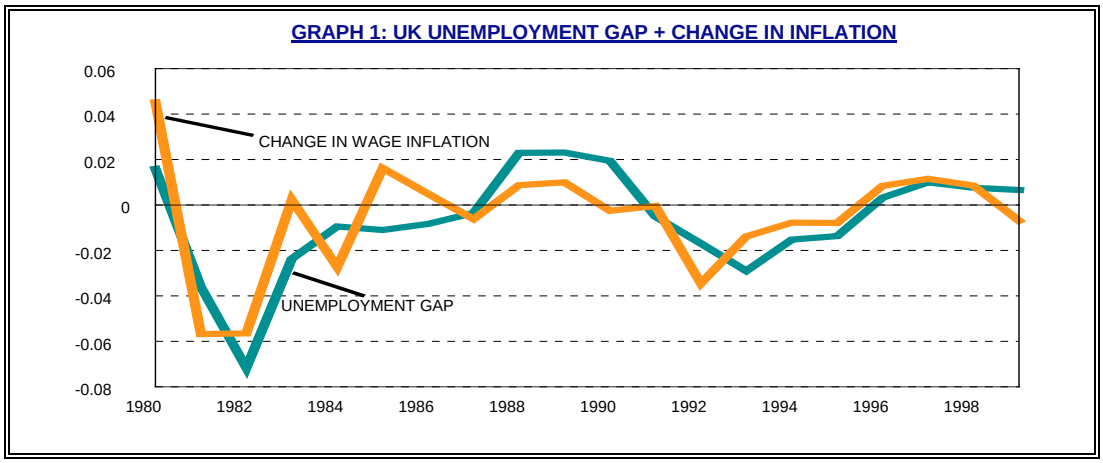
**2.1 OUTLINE OF TESTING STRATEGY :** In overall terms, the model developed in Section 1 revolves around a basic equation for explaining inflation in the different countries, with inflation being a function of the unemployment gap and a distributed lag of past inflation. Various permutations to this specification were used in the NAIRU estimation process including using different inflation indicators (wage inflation or general, economy-wide, inflation as measured by the GDP deflator), various structural variables (labour taxation, wider measure of tax pressure, gross and net replacement ratios, real interest rates, trend productivity growth as well as a demographic variable which was included to pick up changes in the ratio of the population of working age to total population) allied to different lag structures for the respective variables. In terms of the inflation variable used, one possible difference between countries is that unemployment gap developments may be a more useful predictor of wage inflation than of price inflation (this in fact is the case in all the countries, except Portugal and the Netherlands, and consequently in this paper we are normally measuring a NAWRU as opposed to a NAIRU).

**EXPECTED SIGN OF COEFFICIENTS** : Economic theory would suggest positive signs for the coefficients for lagged inflation, taxation and real interest rate variables and a negative coefficient for the trend growth variable. In a bargaining framework of wage determination, real interest rates and the NAIRU would be expected to be positively related, with the transmission channel between the two, as mentioned earlier, revolving around the idea of a wedge between the target real wage of employees and the feasible real wage on the employers side. Furthermore, for the most important term, the unemployment gap, which measures the influence of the gap on inflation, given that this is estimated as the NAIRU less the actual unemployment rate, one would expect to see a positive coefficient. This in fact is the case with all the equation results, with a positive coefficient on the unemployment gap term indicating that wage inflation seems to respond to disequilibrium in the respective labour markets. Given these feedback effects it is clear that this unemployment gap term could be used as a rough indicator of the relative real wage flexibility of the respective labour markets.

As illustrated in Graph 1, using the example of the UK (see Section 3 for Graphs for all the countries), the objective of the estimation process is to try to extract a NAIRU estimate which is linked not to inflation but to the change in inflation. In other words we are trying to choose the NAIRU estimate which gives the best fit over the historical sample period i.e. the NAIRU which is best at tracking past changes in inflation. A number of different methods of estimation were experimented with (eg trend estimation using the Hodrick-Prescott (H-P) filter[8], the constant NAIRU

[8] The Hodrick-Prescott (H-P) filter approach is a trend estimation method which basically uses a long-run moving average to detrend a particular series, in this case unemployment. Using the H-P filter is justified for calculating the natural component of unemployment since the latter concept assumes that factors affecting the natural rate are infrequent and are slow to change.

approach[9], the Perron trend break method and a « structural » approach ). In the end the « structural » approach (described in Section 1), using various specifications and lag structures, was adopted in all cases, except Italy (see discussion on Italy in Box 1 at end of Section 3), as being the best approach for generating a NAIRU / NAWRU which is good in terms of tracking the change in inflation.




In terms of the final variables selected, while the experiments with the gross and net replacement rate series got good results, they had to be abandoned in the end since the series were not long enough to produce NAIRU estimates up to 1999. However, it was found that the replacement rate variables acted as a proxy for the labour taxation variable. In overall terms, as shown in Table 3, it was the taxation and real interest rate variables which proved the best in terms of the equation results. The trend growth in productivity series yielded in general poor results which, on reflection, is perhaps not that surprising given the strong long-run link between real wages and real labour productivity trends.

**2.2 SUMMARY OF MAIN RESULTS**: As can be seen in Tables 1 and 2 and graphically at the end of this section, Member States are split evenly between those countries experiencing increases in the NAIRU over the period 1990-1999 and those witnessing a decline[10]. As shown in Table 3, the wage equations fit the data reasonably well in the majority of cases and the equations perform satisfactorily on the basis of the standard statistical criteria. The most important point to retain from the analysis undertaken is that in all of the Member States for which NAIRU's are estimated, that the unemployment gap would appear to be important in explaining past changes in either wage or price inflation, with effects of between 0.5 and 1 being

[9] Note: While the constant NAIRU estimation method delivered very poor results for the Community countries, it worked extremely well for the United States, yielding a NAIRU of 5.8% for the 1993-1999 period as a whole.

[10] It should be noted that if one looks at NAIRU developments over a longer period of time, the Community's Member States have, in general, experienced significant upward shifts in their Phillips curves, and consequently in their NAIRU estimates, reflecting significant changes to the structure of the respective labour markets since the early 1970s. Structural or equilibrium unemployment in the Community as a whole, according to a large number of studies, steadily rose from cycle to cycle, with a deterioration in the underlying responsiveness of the labour market being reflected in rising NAIRUs and persistence mechanisms.

registered in most cases. In addition, as indicated in section 3, the unemployment gap term is broadly stationary for all countries. In other words, testing for cointegration in this way suggests that the specification used for the various Member States seems sufficient to capture the trend in unemployment in those countries.

**TABLE 1 : NAIRU ESTIMATES (1990-1999)**

| | 1990 | 1993 | 1996 | 1999 |
|---|---|---|---|---|
| **Belgium** | 8.6 | 8.5 | 8.3 | 8.0 |
| **Denmark** | 6.6 | 6.5 | 6.1 | 5.6 |
| **Germany** | 5.6 | 6.2 | 7.4 | 8.8 |
| **Greece** | 7.3 | 8.0 | 9.1 | 10.1 |
| **Spain** | 18.5 | 18.9 | 18.2 | 16.6 |
| **France** | 9.6 | 10.2 | 10.7 | 11.3 |
| **Ireland** | 14.1 | 13.4 | 11.7 | 9.3 |
| **Italy** | 9.9 | 10.4 | 10.9 | 11.3 |
| **Netherlands** | 7.0 | 6.3 | 5.3 | 4.0 |
| **Austria** | 3.6 | 3.7 | 4.0 | 4.3 |
| **Portugal** | 4.9 | 5.5 | 5.4 | 4.2 |
| **Finland** | 4.7 | 17.0 | 14.6 | 12.2 |
| **Sweden** | 5.9 | 7.9 | 7.4 | 6.5 |
| **UK** | 9.3 | 8.7 | 7.8 | 6.8 |

**Table 2 : 1999 NAIRU + 90% Confidence Intervals [11]**

| | LOWER LIMIT | NAIRU POINT ESTIMATE | UPPER LIMIT |
|---|---|---|---|
| **Belgium** | 5.2 | 8.0 | 10.9 |
| **Denmark** | 2.5 | 5.6 | 8.6 |
| **Germany** | 6.8 | 8.8 | 10.7 |
| **Greece** | 3.7 | 10.1 | 16.6 |
| **Spain** | 13.8 | 16.6 | 19.4 |
| **France** | 8.6 | 11.3 | 14.0 |
| **Ireland** | 6.3 | 9.3 | 12.3 |
| **Italy** | 9.9 | 11.3 | 12.7 |
| **Netherlands** | 1.9 | 4.0 | 6.0 |
| **Austria** | 2.4 | 4.3 | 6.2 |
| **Portugal** | 0.0 | 4.2 | 8.5 |
| **Finland** | 8.7 | 12.2 | 15.8 |
| **Sweden** | 3.8 | 6.5 | 9.3 |
| **UK** | 3.7 | 6.8 | 9.9 |

[11] The confidence interval is calculated as the linear combination of the variables affecting the NAIRU multiplied with their respective coefficients. It must be regarded as an approximation to the true interval since with non-stationary variables the distribution of the coefficient estimate is only standard in the absence of a correlation between the residual of the cointegrating relationship and the residuals of the explanatory variables.

# TABLE 3: EQUATION RESULTS[12]

## WAGE EQUATIONS: NON-LINEAR LEAST SQUARES REGRESSION

| | UNEMP GAP | CON-STANT | REAL INTEREST RATE | TAX BURDEN | TOTAL FACTOR PRODY | LAGGED INFL | R-SQ[13] (D-W STAT) |
|---|---|---|---|---|---|---|---|
| BELGIUM | 0.996 (3.58) | 0.057 (3.21) | 0.549 (1.79) | | | 0.369 (1.93) | 0.64 (1.41) |
| DENMARK **** | 0.545 (2.16) | | 0.506 (1.95) | | 1.474 (1.73) | 0.669 (3.08) | 0.63 (1.97) |
| GERMANY * | 0.381 (3.28) | -0.293 (-2.42) | | 0.660 (3.02) | | 0.916 (6.16) | 0.89 (2.53) |
| GREECE **** | 4.624 (1.60) | | | 0.140 (22.27) | | 0.959 (4.08) | 0.48 (2.02) |
| SPAIN | 0.412 (2.46) | | 1.596 (2.08) | 0.530** (2.17) | | 0.718 (3.15) | 0.86 (2.13) |
| FRANCE | 0.524 (1.43) | -0.168 (-1.66) | | 0.493 (2.64) | | 0.985 (3.99) | 0.88 (1.74) |
| IRELAND | 0.524 (2.86) | 0.073 (4.50) | 0.998 (3.58) | | | 1.140 (6.00) | 0.90 (2.16) |
| AUSTRIA | 1.735 (3.29) | -0.064 (-2.39) | 0.491 (1.93) | 0.149 (3.16) | | 0.902 (6.73) | 0.72 (1.84) |
| FINLAND *** | 0.370 (2.17) | | 0.741 (2.51) | | | 1.150 (6.04) | 0.76 (2.11) |
| SWEDEN *** | 0.369 (2.55) | | 1.172 (5.84) | | | 0.445 (2.36) | 0.66 (1.90) |
| UK **** | 1.057 (4.01) | | 0.536 (3.07) | 0.164 (8.80) | | 0.634 (3.63) | 0.85 (1.62) |

## PRICE EQUATIONS: NON-LINEAR LEAST SQUARES REGRESSION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NETHS | 0.297 (1.95) | | 1.158 (7.82) | | | 0.989 (4.53) | 0.56 (1.84) |
| POR-TUGAL | 0.550 (3.56) | | 1.773 (4.67) | | | 1.158 (5.35) | 0.90 (1.40) |

***** **Germany: Dummy variables included to correct for unification.**

****** **Spain : Labour tax burden (not the total tax burden).**

******* **Finland and Sweden: Dummy variables included to allow for the jump in unemployment at the beginning of 1990's in both countries.**

******** **UK and Greece:Time trend included from 1991 onwards.**
**Denmark : Time trend included from 1995 onwards.**

[12] T-statistic appears in parentheses below the coefficient estimates.

[13] R-squared corrected for degrees of freedom.

However, while the sign and size of the model coefficients are economically meaningful, past experience suggests caution in using such models for predicting future price pressures, in isolation from the many other inflation indicators which are available. This is especially true given the normal parameter and model uncertainty which clouds any NAIRU / NAWRU estimates. While statistically significant estimates were obtained in the present exercise, as Table 3 shows the latter point estimates are not very precise, and as can be seen in Table 2 using the example of 1999, the confidence intervals around the point estimates for all countries are relatively wide, thereby reducing their usefulness as policy guides. These latter measurement problems are hardly surprising given the well-documented instabilities in the Phillips curve for many of the Community's Member States.

## 2.3 SPECIFIC COMMENTS ON THE EFFECTS OF THE TAXATION AND REAL INTEREST RATE VARIABLES

**TAXATION:** Concerning the effects of taxation, it is interesting to observe that the results presented in Table 3 are broadly consistent with previous results obtained by Daveri and Tabellini in their seminal 1997 article on the link between the observed rise in labour tax rates in Europe and the concomitant slowdown in economic growth and rise in unemployment over the period from the mid-1960s to the early 1990s. Since the employment effect of taxes was expected by the authors to depend on the bargaining structure, Daveri and Tabellini partitioned an OECD data set into the following three groups; firstly European countries where trade unions play a big role but are decentralised; secondly Anglo saxon countries where labour markets are more competitive; and finally Scandinavian countries where unions are large and centralised.

Though the present paper neither constrained regression coefficients within groups nor across groups, nevertheless similar coefficient groupings emerge from the regressions. Table 3 shows the largest tax effects (with similar size) for Germany, Spain and France. Similar to results obtained by Daveri and Tabellini, an increase in the tax rate by 1% point increases the structural unemployment rate by about half a point. Furthermore, the present research does not find a significant effect from taxation in the Scandinavian countries nor in Belgium and the Netherlands. Finally, only a very small tax effect is found for the UK. Results for Greece, Ireland, Austria and Portugal are not directly comparable because they are not included in the Daveri and Tabellini study.

**ARE THE EFFECTS ON NAWRU / NAIRU TRENDS EMANATING FROM REAL INTEREST RATES CREDIBLE OR ARE THESE EFFECTS MASKING DEMAND INFLUENCES ? :** It is very interesting to observe that the real interest rate variable plays a key role in NAWRU / NAIRU developments in 10 of the 13 countries. What is more surprising is both the size of the expected effects and the fact that for a number of countries which have experienced substantial declines in their structural unemployment rates that real interest rate developments would appear to be the main explanation. While structural reform clearly plays a role in terms of real interest rate developments, the latter association between real interest rates and

NAIRU declines might be a difficult one to explain to policy makers in the context of its implications for the broad thrust of structural initiatives in their respective countries.

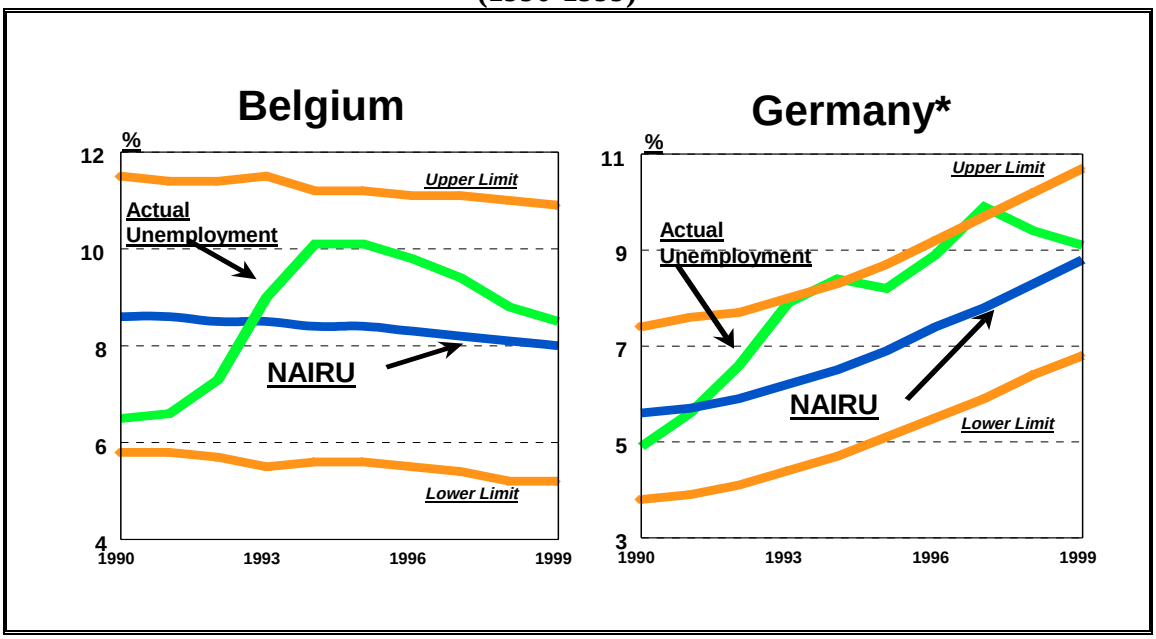
Because of these latter concerns, it was decided to try to examine whether, as stated earlier in the paper, these interest rate-induced trend unemployment changes are likely to be structural or cyclical in nature. In other words could any other variable be found which would work equally as well in the country equations as the real interest rate variable appeared to do ?. A large number of variables were tested, including the investment to output ratio, trend growth, competitiveness indicators such as real exchange rate movements, as well as dummy variables indicating dates of major labour market reforms[14]. However, none of these variables could significantly improve the fit of the estimated equation. It was finally decided to include a variable in the equation to mimic the effect of cyclical demand changes. This variable measures the deviation from trend growth (calculated as the residual of an OLS equation which regresses the log of the GDP series against time) and when included in the equations for a number of countries produced good results, especially for some of those Member States which have experienced large declines in their NAIRU's over the period in question, such as the UK and Ireland.

Regarding these latter results, however, it should be stressed that, despite the relatively good performance achieved by the deviation from trend growth variable in certain countries, this explanatory variable did not perform nearly as well as the real interest variable in overall terms. Consequently, it would appear that while a proportion of the real interest effects which are shown in our results may emanate from a short to medium term real interest effect on demand, it would also appear that real interest rate developments have an additional longer run (i.e. structural) influence on NAIRU / NAWRU trends.

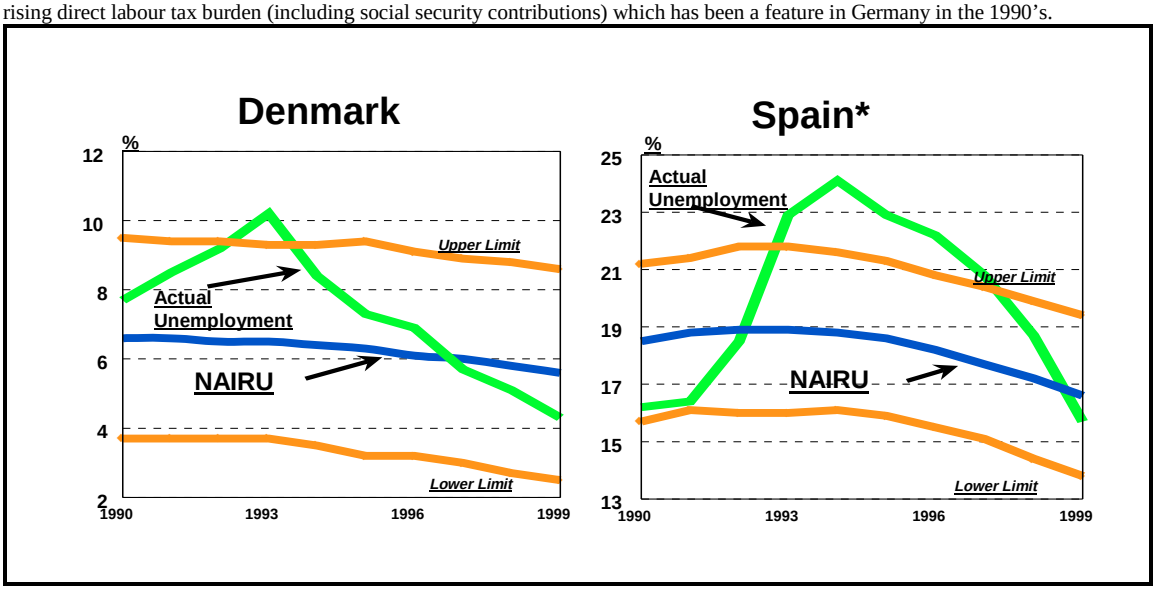
[14] Dummy variables are obviously only crude measures for labour market reforms. From a statistical point of view, it would certainly be preferable to have more precise time series indicators, measuring certain aspects of labour market rigidities, like adjustment costs, bargaining strength of unions, tax disincentives for certain categories of workers, etc. Unfortunately, such measures are hard to construct on a time series basis.

# NAIRU ESTIMATES, CONFIDENCE INTERVALS AND ACTUAL UNEMPLOYMENT[15]

**(1990-1999)**



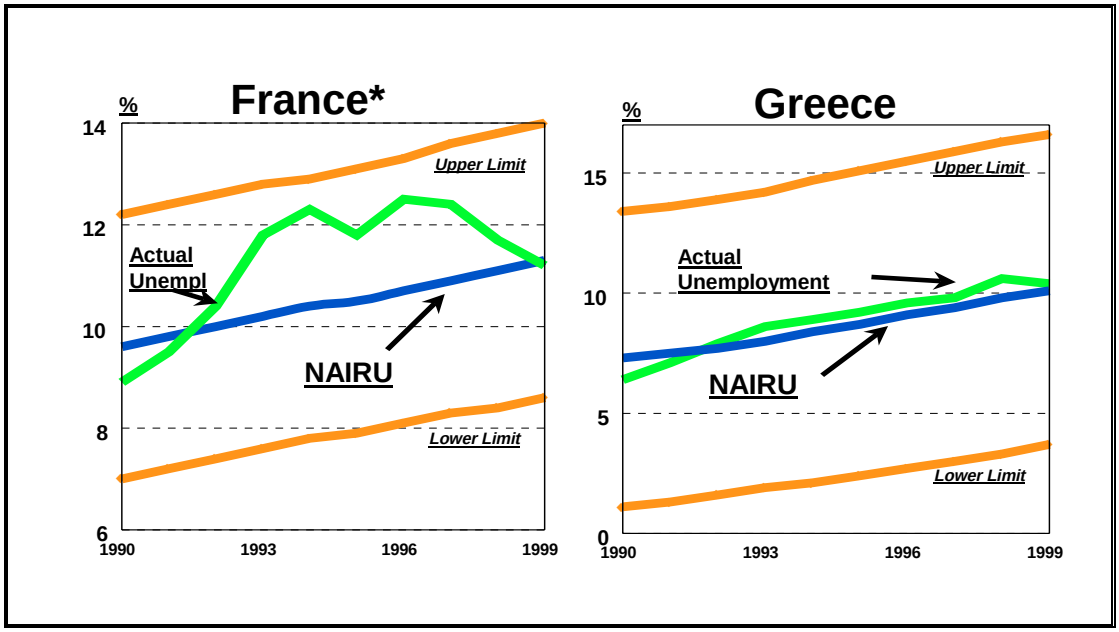

* **GERMANY**: With regard to the 1990's, the estimates for Germany suggest that structural unemployment has been rising in that country over the period. It is clear from the regression results that the trend of the NAIRU series is strongly influenced by the rising direct labour tax burden (including social security contributions) which has been a feature in Germany in the 1990's.



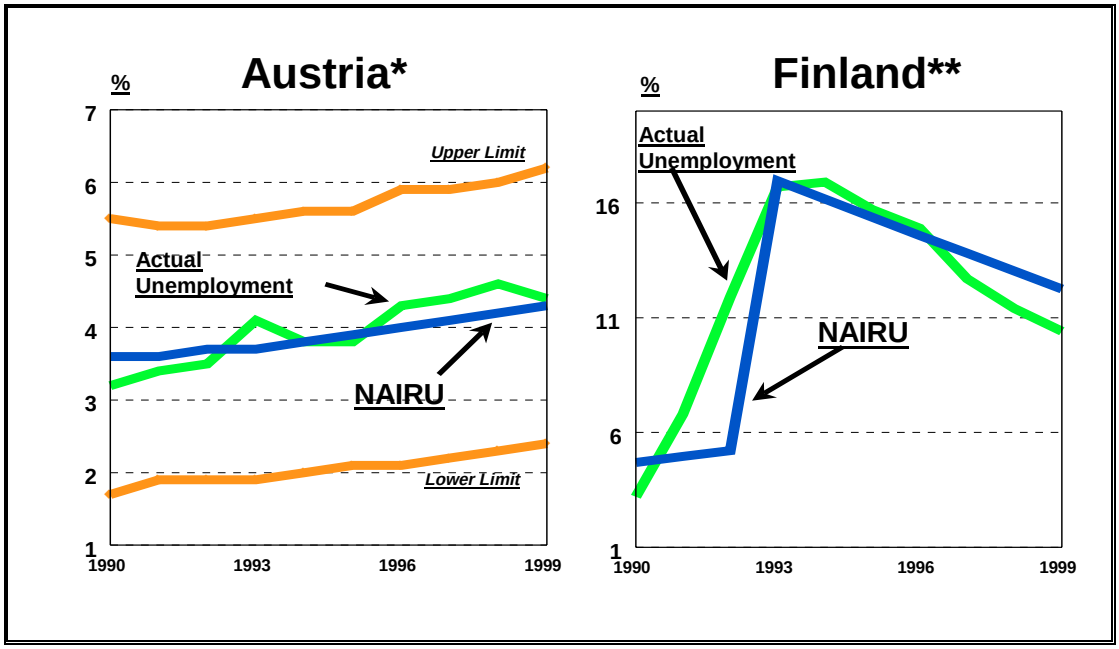

* **SPAIN** : The overall picture for Spain presented for the period as a whole indicates a relatively rapid decline in recent years in structural unemployment. This development is due to a strong decline in real interest rates in Spain. A lagged employment response to a reduction in effective labour taxes is also present. However, since labour tax rates have stayed roughly constant in recent years, they do not explain the recent fall in structural unemployment.

---

[15] As is the practice with the OECD's NAWRU series, the NAIRU/NAWRU series produced using the approach presented in this paper are smoothed using a HP filter to remove any erratic year to year movements. However, it should be noted that the graphs in section 3.2 of this paper, which compare unemployment gaps and changes in wage/price inflation use the unsmoothed NAIRU series since it is the actual year to year changes which we are interested in.

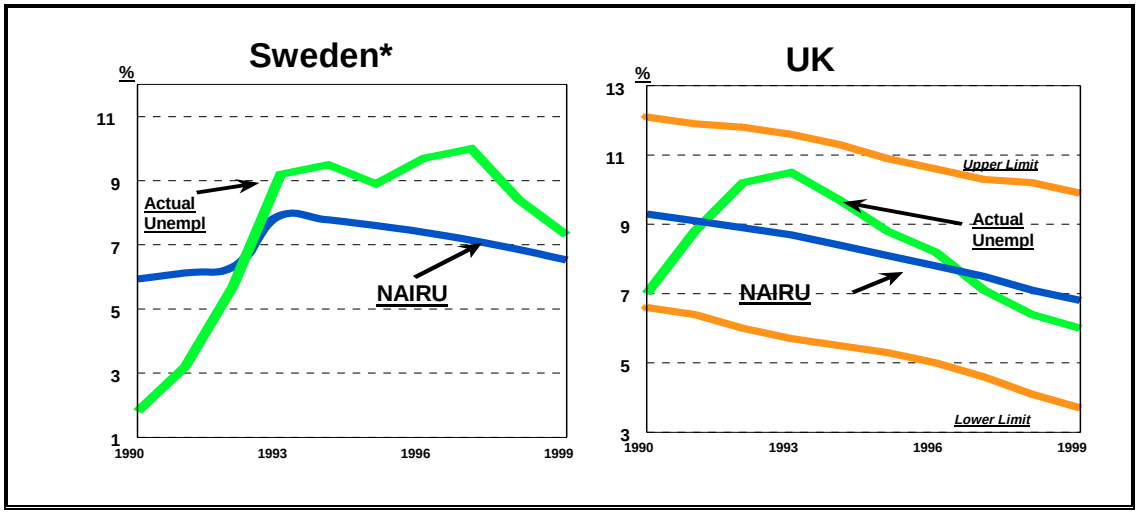



* **FRANCE :** The continuing rising trend evident in the results for France is not that surprising given that the final model selected places a lot of emphasis on the importance of the continuing rise in the overall burden of taxation in that country, with the preferred distributed lag specification (covering a period of the previous three years) suggesting that the effects of tax increases persist for a significant period of time.

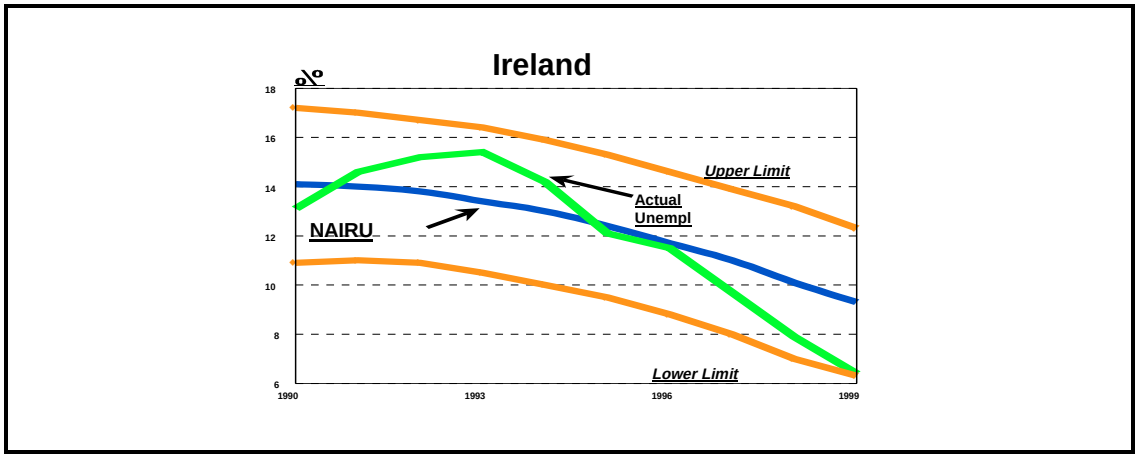


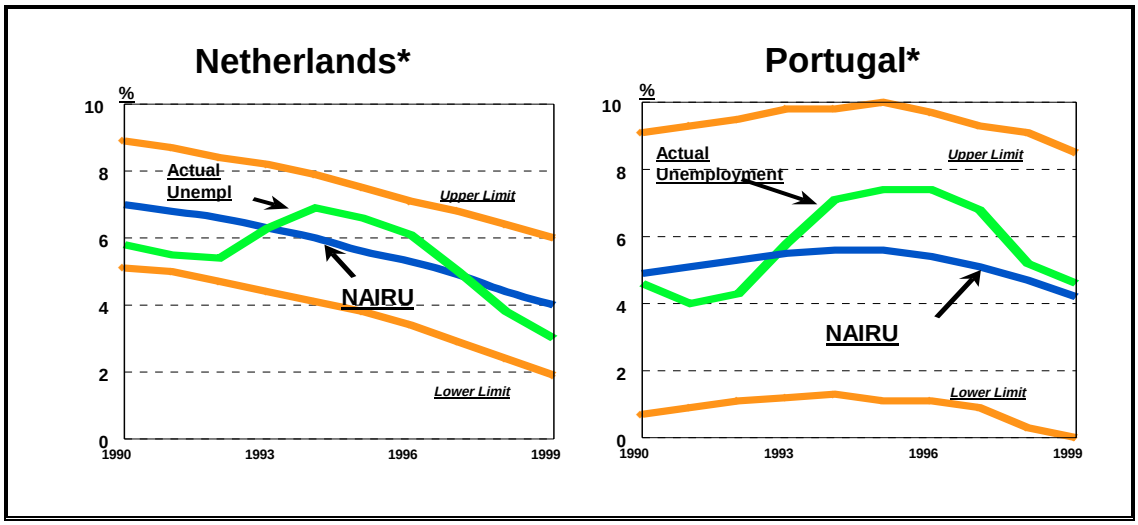

* **AUSTRIA** : The final specification used for Austria shows a role for the trend increase in tax pressure which has taken place in this Member State over the sample period chosen and also a role for real interest rate developments in determining the NAIRU. As can be seen from the graph in section 3.2, the final model chosen tracks the change in inflation reasonably well.

****FINLAND**: In terms of the determinants of the Finnish structural unemployment rate series, the NAIRU estimates, through the use of a dummy variable, allow for a jump in the structural unemployment rate in that country at the beginning of the 1990s. In addition, the regression results also indicate that real interest rates have a significant effect on the Finnish structural unemployment rate, however with a lag of about 2 years. (Note: Confidence intervals are not given in the graph for Finland because the break in the NAIRU series rendered the inclusion of such intervals difficult. In this regard, it is sufficient to point out that the confidence interval given for 1999 for Finland in Table 2 of the text is representative for the 1990's as a whole.)




* SWEDEN : In the case of Sweden the explanation concerning the break in the NAIRU series given earlier in the footnote for Finland can be equally applied (as indeed can the point made with regard to the exclusion of confidence intervals).




* NETHERLANDS AND PORTUGAL : It is important to note that the series for the Netherlands and Portugal are NAIRU's not NAWRU's.

## SECTION 3 : HOW GOOD ARE THE NAIRU ESTIMATES IN EXPLAINING PAST CHANGES IN WAGE/PRICE INFLATION ?

While Section 2 clearly demonstrates that the modelling strategy adopted yields meaningful NAIRU estimates in both statistical and economic terms, it is important to assess these results in a number of different ways in order to establish :

- ***firstly***, whether the model variables are capable of capturing the trend in unemployment in the various Member States i.e. can a hypothesis of no cointegration be rejected by the data. This essentially amounts to a test of whether the unemployment gap term is stationary or not for the individual countries. (Section 3.1).

- ***secondly***, to assess graphically whether the unemployment gaps generated, using the estimated NAIRU / NAWRU estimates, are capable of tracking past changes in wage or price inflation. (Section 3.2).

- ***thirdly***, how do the unemployment gaps, using the estimated NAIRU's, compare in terms of their inflationary explanatory power with unemployment gaps which are generated by a simple statistical smoothing technique such as the H-P filter. In other words, does the economic approach adopted in the paper yield any benefits over and above those of widely used univariate statistical methods? (Section 3.3).

- ***finally***, how useful are the NAIRU estimates generated in this paper in output gap models of price inflation. Again, as in section 3.3, the objective in this section is to try to assess whether it is really worthwhile to go to the trouble of estimating economically significant TV-NAIRU's. (Section 3.4).

**3.1 IS THE UNEMPLOYMENT GAP TERM A STATIONARY OR NON-STATIONARY PROCESS ?** : The distinction between a stationary and a non-stationary series is an important one and depends on whether or not the variable contains a unit root. If the unemployment gap series, LURGAP, is non-stationary (i.e. it may not be mean reverting) this would suggest that our modelling strategy is not picking up all the elements which are influencing the movements of LURGAP. Consequently, it is important to establish the order of integration of the LURGAP series, by determining the properties of the data using formal unit root testing i.e. is the LURGAP variable stationary in levels or does it have to be differenced a number of times before becoming stationary. If, for example, first differencing eliminates the trending behaviour in the variable, then we can say that the variable is I(1), i.e. integrated of order one.

It must be stressed that unit root testing is neither a simple nor definitive process but use of both the augmented Dickey-Fuller (ADF) test, which allows for a constant and has an adequate lag structure, combined with the sequential testing strategy which underpins the Phillips-Perron (PP) tests is widely accepted as being an appropriate testing strategy. Testing for the presence of a unit root can be carried out in several different ways with the approach adopted here being a combination of the ADF and PP tests. Given that the trend should already have been removed from the series, it is

only necessary to allow for the intercept term to enter the regression model. The null hypothesis to be tested is that the time series is non-stationary (i.e. it contains a unit root) against the alternative hypothesis of stationarity.

ADF and PP statistics for the level of the LURGAP variable are shown in the Table below and when compared with the MacKinnon critical values suggest stationarity or borderline stationarity, with the vast majority of the countries rejecting the null hypothesis of non-stationarity for either the ADF or PP tests at the 10% level. While these results do not appear to provide overwhelming support for stationarity, it should be borne in mind that these test statistics lose a lot of their explanatory power when the number of observations used are small, as in the present case. Recently, attempts have been made to increase the power of cointegration tests by taking into account the cross section dimension in cases where the time series are not very long but similar data are available across countries. The most general formulation of a panel cointegration test to date is the one from Pedroni (1997, 1999) which allows both fixed effects and heterogeneous coefficients across cross sectional units. Pedroni develops various panel cointegration tests and especially extends the ADF and PP tests. He shows that these panel cointegration statistics approximately follow a standard normal distribution after appropriate standardisation. As can be seen from the results of the panel cointegration test shown below, the hypothesis of no cointegration can be rejected at the 5% level for the panel of all EU countries.

**Statistical Stationary Tests for the EC's Member States**

**1. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests in Levels***

**- (Intercept included in test equation with 1 lag) -**

| | ADF TEST STATISTIC | PP TEST STATISTIC |
|---|---|---|
| Belgium | -2.87 | -2.51 |
| Denmark | -2.08 | -3.41 |
| Germany | -2.89 | -2.69 |
| Greece | -6.52 | -4.44 |
| Spain | -2.40 | -1.91 |
| France | -2.68 | -1.67 |
| Ireland | -1.99 | -2.70 |
| Italy | -2.99 | -1.96 |
| Netherlands | -3.00 | -2.27 |
| Austria | -2.49 | -2.55 |
| Portugal | -2.48 | -4.11 |
| Finland | -1.97 | -2.03 |
| Sweden | -1.46 | -2.65 |
| UK | -3.09 | -2.54 |

** MacKinnon critical values for rejection of hypothesis of a unit root*

*Intercept Included*

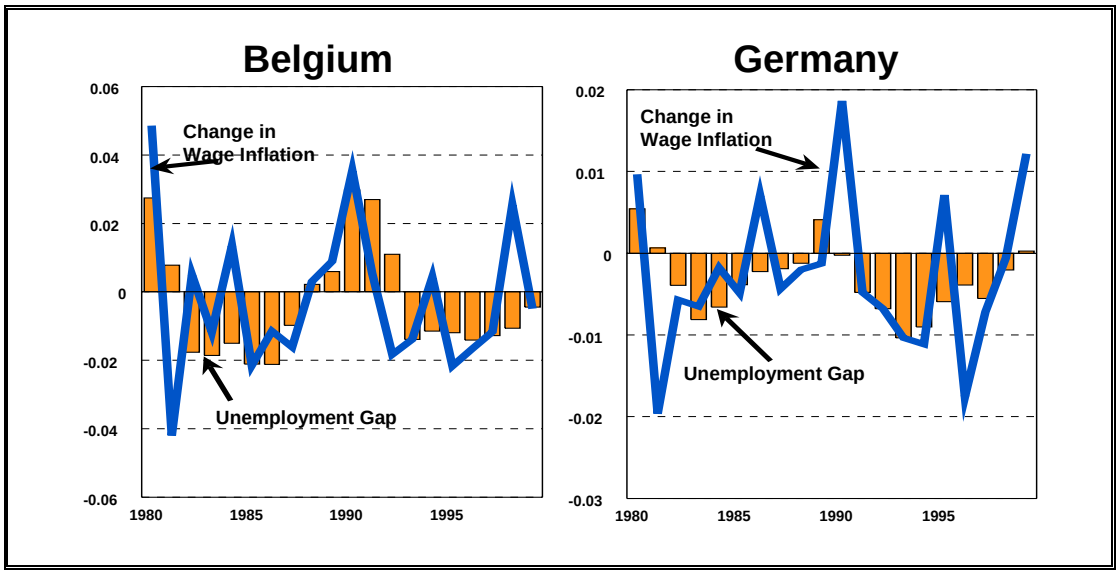
*1% critical value = - 3.49*
*5% critical value = - 2.89*
*10% critical value = - 2.58*

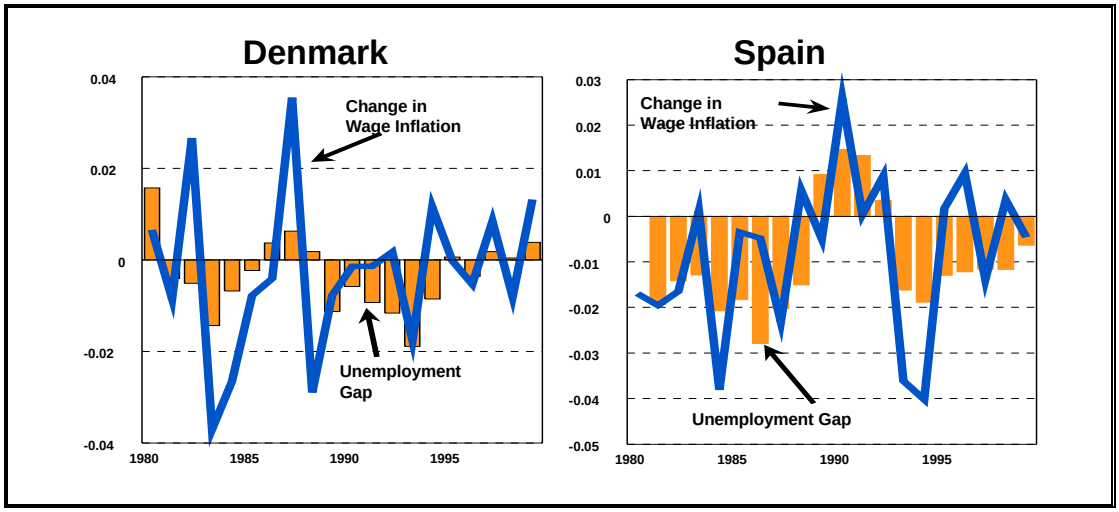
**2. Panel Cointegration Test (Pedroni 1999)**

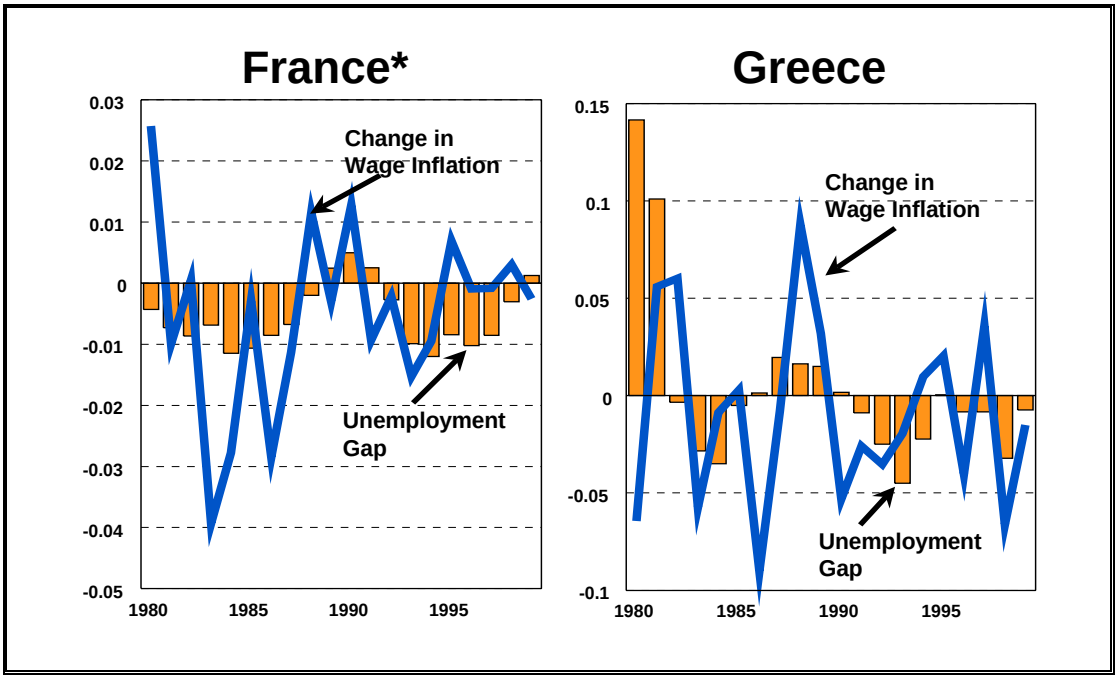
*Group PP Statistic = -1.89***
*Group ADF Statistic = -2.59***

***5% critical value = - 1.69*

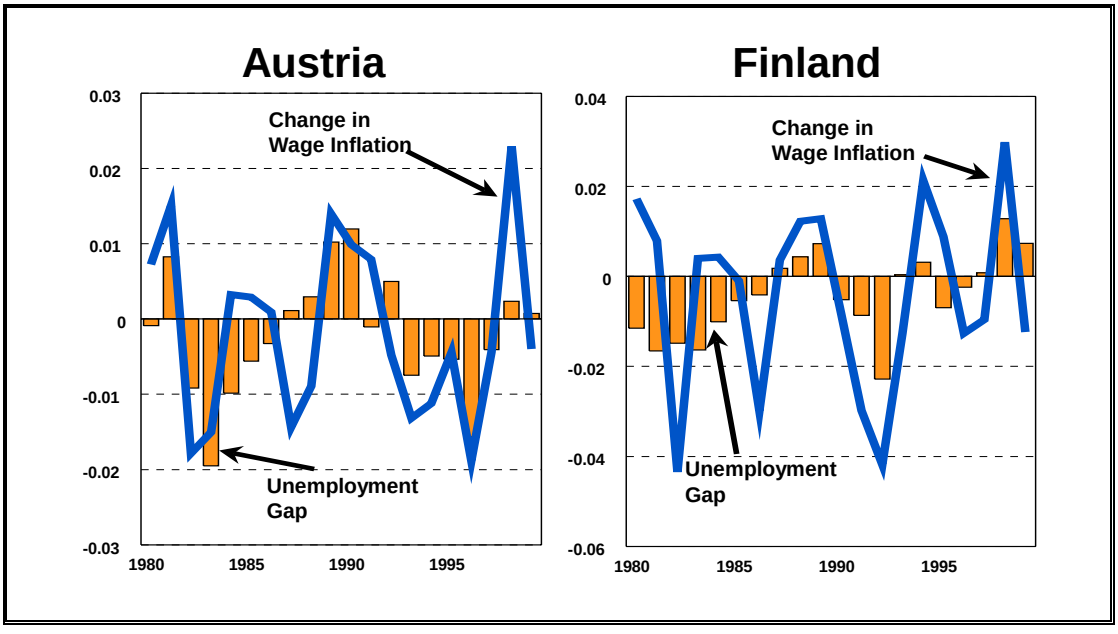
**3.2 UNEMPLOYMENT GAPS AND CHANGES IN WAGE / PRICE INFLATION (1980 -1999):** As the graphs below clearly indicate the estimated unemployment gaps are remarkably good, in most cases, at explaining past inflationary developments, at least in relation to wage developments. The results in terms of general price inflation are less good for the two countries, namely the Netherlands and Portugal, where the GDP deflator as opposed to wage inflation was used in the modelling process. In relation specifically to the latter countries, while the graph showing the relationship between the change in price inflation and the unemployment gap is not particularly good in terms of its tracking performance, one needs to remember that the change in price inflation is much more difficult to track using an unemployment gap, as opposed to an output gap, series with many non-labour market influences often playing a key role.

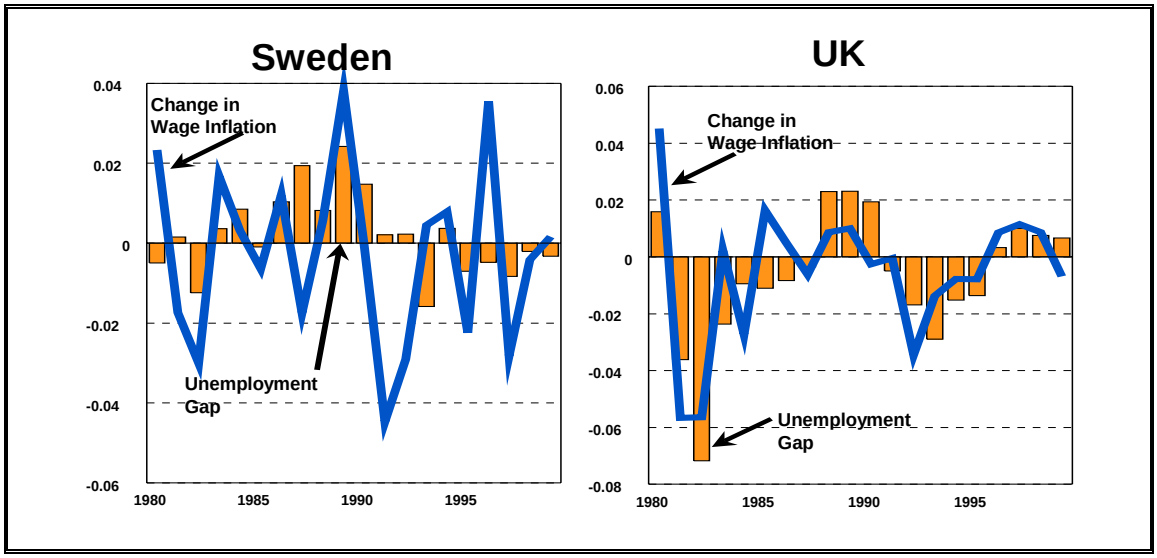


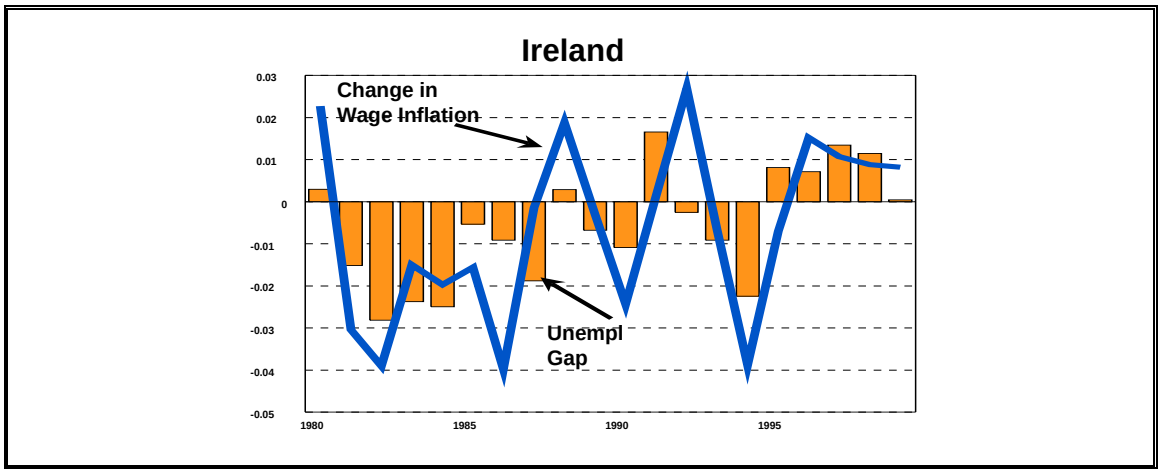



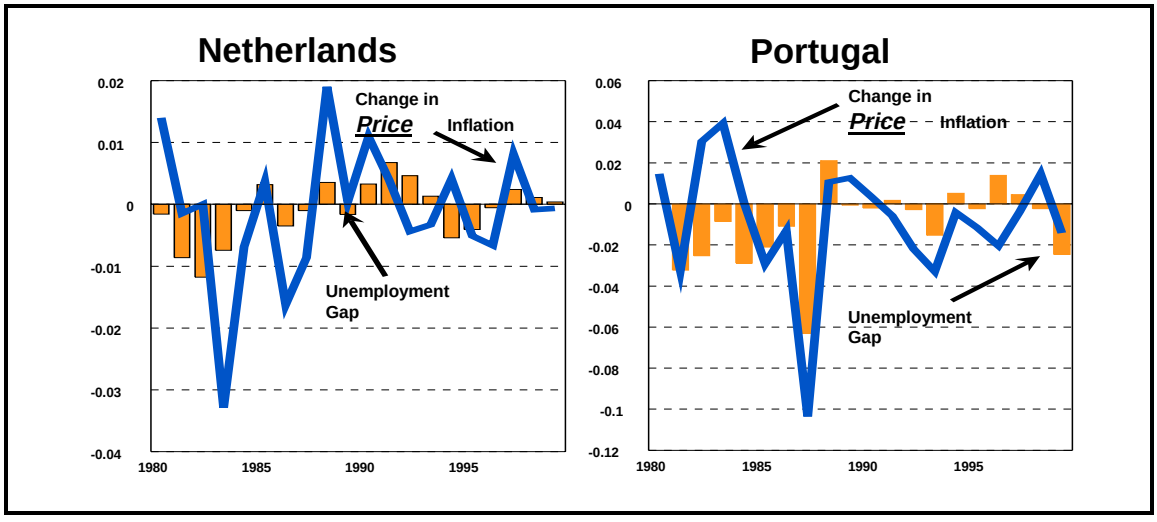



* **FRANCE :** In the above graph which shows unemployment gaps and changes in wage/price inflation, one sees that the NAWRU series (as included in the unemployment gap series) for the last two years appears to provide a very good approximation for changes in wage inflation. Over that period the estimated unemployment gap is virtually eliminated whilst at the same time wage inflation appears to be broadly stable. Some additional work was carried out to test the contention that the NAWRU series may not be picking up some break in the structural unemployment series in France in the early to mid-1990's. When one tests for such a break, using both shift and trend breaks, one finds some evidence of a shift break around 1992/93. However, it was decided to stick with the specification shown above since the inclusion of the shift break did not change either the absolute size, or direction of change, of the NAWRU series and, very importantly, while the tracking performance of the unemployment gap series relative to the change in wage inflation did improve for the period as a whole, it deteriorated badly at the beginning of the 1990's.




Sweden
Change in
Wage Inflation
Unemployment
Gap
0.04
0.02
0
-0.02
-0.04
-0.06
1980
1985
1990
1995
UK
Change in
Wage Inflation
Unemployment
Gap
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1980
1985
1990
1995


Ireland
Change in
Wage Inflation
Unempl
Gap
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
1980
1985
1990
1995


Netherlands
Change in
Price
Inflation
Unemployment
Gap
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
1980
1985
1990
1995
Portugal
Change in
Price
Inflation
Unemployment
Gap
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
1980
1985
1990
1995

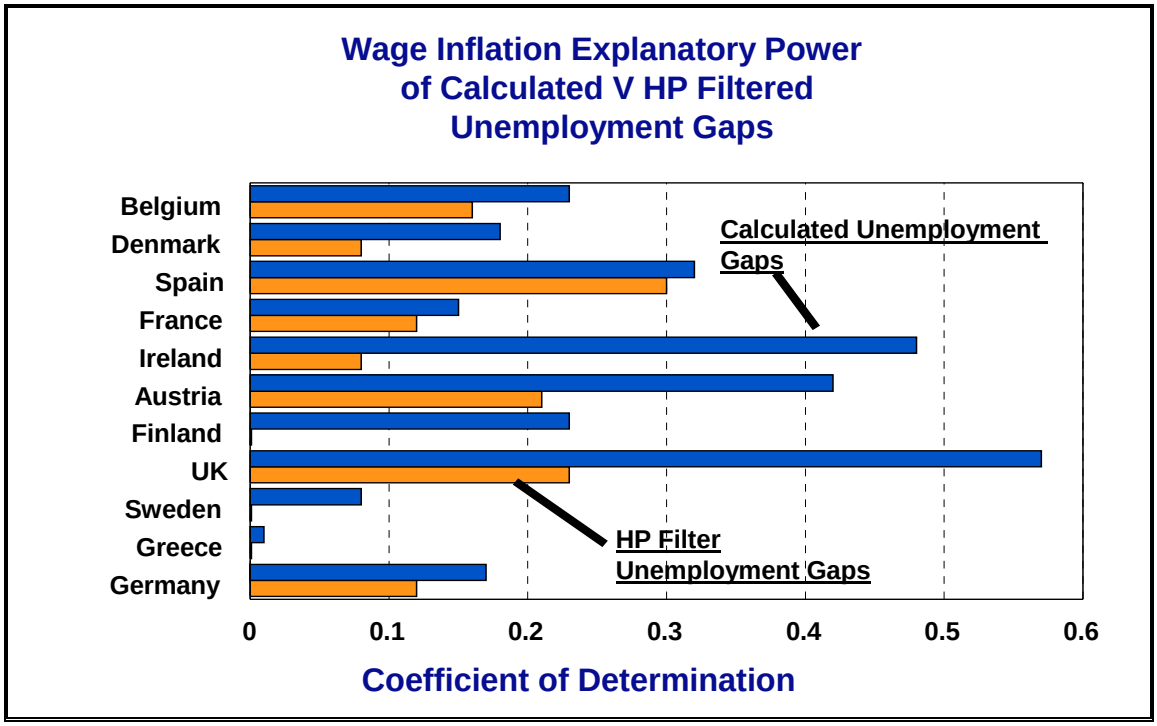
## 3.3 COMPARISON WITH H-P FILTER DERIVED UNEMPLOYMENT GAPS. HOW WELL DO THE ESTIMATED UNEMPLOYMENT GAP V HP FILTER DERIVED UNEMPLOYMENT GAPS EXPLAIN PAST CHANGES IN WAGE INFLATION ?

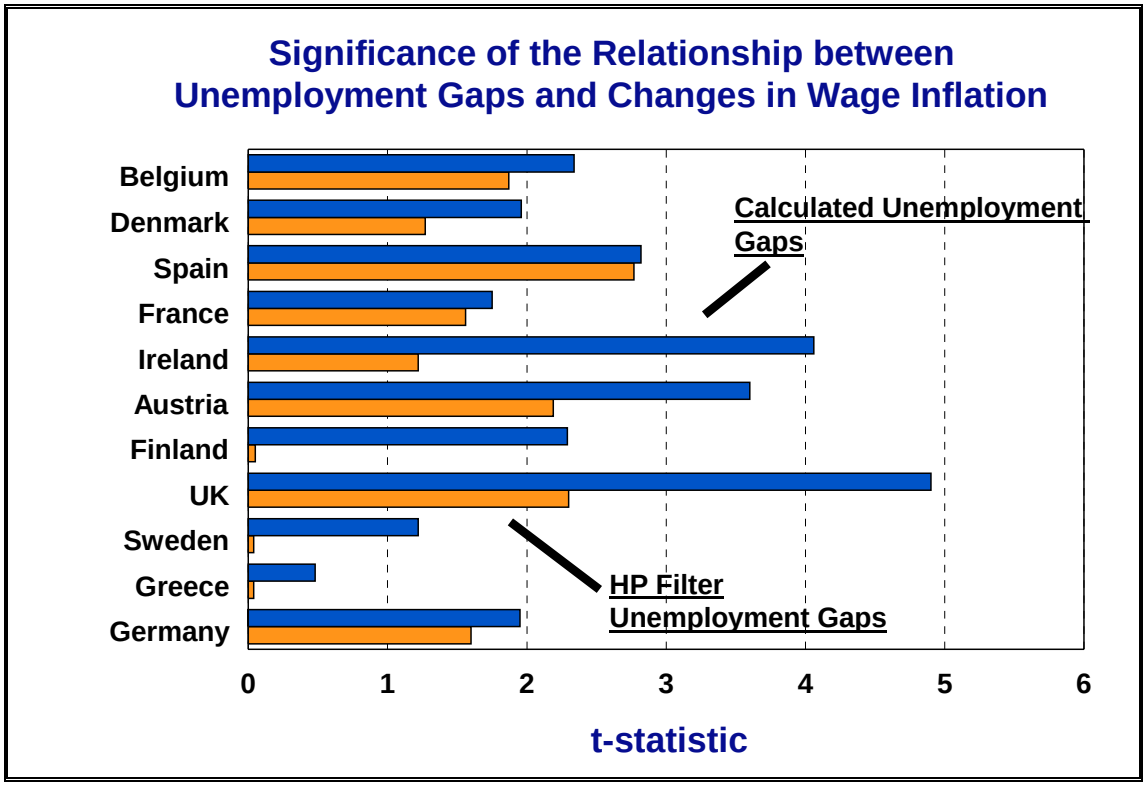
As the table and graphs below indicate, the results of this comparison are very encouraging for the methodology adopted in this paper, since they indicate that for each Member State there is a gain to be made by estimating an economically significant NAIRU series, with the gain in certain countries being very significant in terms of both the explanatory power of the NAIRU's and in terms of the significance of the relationship between the unemployment gaps and past changes in wage inflation.

**TABLE : ESTIMATED UNEMPLOYMENT GAP V HP FILTER UNEMPLOYMENT GAP**

| | Estimated Gap | | HP Filter Gap | |
|---|---|---|---|---|
| | **R-Squared** | **t-Statistic** | **R-Squared** | **t-Statistic** |
| **Belgium** | 0.23 | 2.34 | 0.16 | 1.87 |
| **Denmark** | 0.18 | 1.96 | 0.08 | 1.27 |
| **Germany** | 0.17 | 1.95 | 0.12 | 1.60 |
| **Greece** | 0.01 | 0.48 | 0.001 | 0.05 |
| **Spain** | 0.32 | 2.82 | 0.30 | 2.77 |
| **France** | 0.15 | 1.75 | 0.12 | 1.56 |
| **Ireland** | 0.48 | 4.06 | 0.08 | 1.22 |
| **Austria** | 0.42 | 3.60 | 0.21 | 2.19 |
| **Finland** | 0.23 | 2.29 | 0.001 | 0.05 |
| **Sweden** | 0.08 | 1.22 | 0.001 | 0.04 |
| **UK** | 0.57 | 4.90 | 0.23 | 2.30 |

## ESTIMATED UNEMPLOYMENT GAP V HP FILTER UNEMPLOYMENT GAP: HOW WELL DO THEY EXPLAIN PAST CHANGES IN WAGE INFLATION ?



## 3.4 REAL DISEQUILIBRIUM MEASURES: UNEMPLOYMENT V OUTPUT GAPS

The essential question to be addressed in this section is whether economic, as opposed to statistical, estimates of trend or structural unemployment can help in improving the inflationary explanatory power of output gap calculations (i.e. the gap between actual and potential output)?.

The first thing to stress is that the unemployment gap and the output gap estimates are linked in a number of different ways:

- ***Firstly,*** they are both real disequilibria measures - although one wouldn't necessarily expect both these measures of real disequilibrium to coincide in terms of their movements over time since non-labour market influences on price inflation must also be taken into account;
- ***Secondly,*** they are linked due to the fact that the unemployment gap is often used as an important input into the output gap calculations. It is this latter connection which the present section concentrates on.

This section presents two different sets of output gap estimates, both of which are based on a production function approach using the Commission's services QUEST model, but with one set of calculations using a Hodrick Prescott generated trend unemployment rate and with the other using the NAIRU estimates as calculated in the present paper. The objective is to see whether by using the economically derived NAWRU/NAIRU estimates, in preference to a statistical method such as the H-P filter, we can improve on the price inflation tracking performance of the resultant output gap calculations. Before going on to discuss the different calculations, a short digression is necessary to provide a quick overview of the production function approach for calculating output gaps in the Quest II model.

**PRODUCTION FUNCTION DERIVED OUTPUT GAPS**: The calculation of output gaps based on a production function approach assumes that at the aggregate level there exists a technical relationship linking output to various factor inputs - multiplied with their respective degree of utilisation - and the level of total factor productivity. The parameters of the production function essentially determine the output elasticities of individual inputs.

The concept of an output gap within the production function framework revolves around the idea that the gap can be decomposed into three cyclical variables, namely the deviation of unemployment from its normal level (i.e. the unemployment gap), the degree of excess capacity and finally, fluctuations of technology around its trend. Trend total factor productivity can be estimated from a simple vintage specification that is used in the QUEST model. The production function approach also requires estimates of "normal" unemployment rates. Simple detrending methods are usually used to calculate these but, as stated in the introductory paragraph to this section, the calculated NAIRU's are also used and the results of the two different measures of the output gap are compared in terms of their relative ability to explain past changes in price inflation.

It should be emphasised at the outset that applying a production function approach to calculating output gaps does not necessarily lead to significantly different output gaps

than those obtained via simple statistical methods. The production function approach essentially amounts to calculating cyclical components of the inputs. It is relatively easy to see that applying a linear filter with common weights to individual components is identical to applying the filter to the output series itself. A gain from using a production function approach can only be expected if it is easier to extract cyclical components from input factors (unemployment and total factor productivity) than from GDP itself or if it seems necessary to apply very different detrending methods to the individual inputs.

In overall terms, with a production function, potential GDP (Y) can be represented by a combination of factor inputs - employment (L) and capital (K) at the aggregate level -, corrected for the degree of excess capacity (UC) and multiplied with the technological level or total factor productivity (total factor productivity). In many empirical applications (including the QUEST model), a Cobb Douglas specification is chosen for the functional form as this greatly simplifies estimation and exposition. Thus potential GDP is given by:

$$Y = UC(L^{\alpha}K^{1-\alpha})TFP \qquad (1)$$

where $\alpha$ and $(1-\alpha)$ represent the output elasticities of labour and capital respectively.

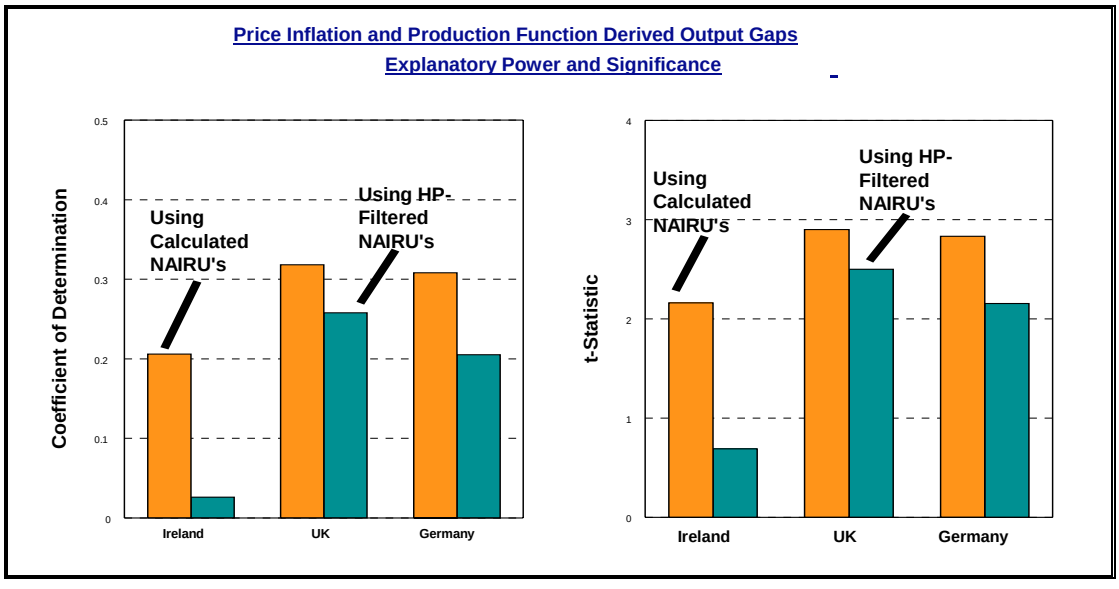
**OUTPUT GAPS BASED ON BOTH ECONOMIC & STATISTICALLY DERIVED TREND UNEMPLOYMENT:** As explained above, the production function approach to calculating output gaps requires estimates to be provided for equilibrium unemployment. For the purposes of the present exercise two approaches have been used to estimate the trend or structural unemployment rate, one mechanical (i.e. the H-P Filter) and one economically estimated (i.e. the Phillips curve derived NAIRU's as given in section 2 of this paper). A comparison of the inflation tracking performance of output gaps using both these methods is given in Table 2.

The most striking conclusion to be drawn from the Table overleaf, in relation to output gaps and price inflation, is how little output gaps explain of the change in price inflation. Of the 13 countries for which we have calculated NAIRU's, in only 3 of them, namely Ireland, the UK and Germany, do output gaps explain in excess of 20% of the change in price inflation over the period 1980 to 1999. With regard to the usefulness of the calculated NAIRU's relative to the HP-filtered NAIRU's, there would appear to be a sizeable gain in the information content of the calculated NAIRU's for the three countries in question, with the coefficient of determination and the overall significance of the relationship increasing for all 3 countries, especially Ireland (see graph overleaf).

## TABLE : HOW WELL DO OUTPUT GAPS EXPLAIN PAST CHANGES IN PRICE INFLATION ? A COMPARISON OF OUTPUT GAPS USING ESTIMATED NAIRU'S AND HP FILTERED NAIRU'S

| | OUTPUT GAPS | | | |
|---|---|---|---|---|
| | Using Estimated NAIRU's | | Using HP Filtered NAIRU's | |
| | R-Squared | t-Statistic | R-Squared | t-Statistic |
| **Belgium** | 0.0003 | 0.076 | 0.0002 | 0.063 |
| **Denmark** | 0.045 | 0.926 | 0.035 | 0.805 |
| **Germany** | 0.308 | 2.831 | 0.205 | 2.155 |
| **Greece** | 0.004 | 0.27 | 0.003 | 0.238 |
| **Spain** | 0.036 | 0.817 | 0.046 | 0.935 |
| **France** | 0.088 | 1.319 | 0.121 | 1.573 |
| **Ireland** | 0.206 | 2.162 | 0.026 | 0.692 |
| **Austria** | 0.013 | 0.496 | 0.012 | 0.474 |
| **Finland** | 0.032 | 0.773 | 0.0001 | 0.038 |
| **Sweden** | 0.0001 | 0.016 | 0.005 | 0.305 |
| **UK** | 0.318 | 2.899 | 0.258 | 2.500 |
| | | | | |
| **Italy*** | 0.443 | 3.785 | .452 | 3.857 |
| **Netherlands** | 0.078 | 1.231 | .019 | 0.589 |
| **Portugal** | 0.001 | 0.010 | 0.003 | 0.237 |

*NAIRU series is virtually identical to a HP filter



## *BOX 1 : ITALY*

***As mentioned earlier in the text, Italy is the only country in the EU where the « structural » method failed to produce a satisfactory NAIRU series. In other words, the macroeconomic indicators turned out to be insufficient to explain the trend movement of the Italian unemployment rate. This suggests that an important influencing factor is missing. In trying to resolve this problem 3 different approaches were adopted:***

- ***A univariate approach;***
- ***The inclusion in the standard specification of a variable which measures the deviation from trend growth over the estimation period; and finally,***
- ***The inclusion of a variable to allow for skill-biased technical progress.***

***UNIVARIATE APPROACH: A univariate trending method- the HP filter- was used to produce a proxy for the « structural » unemployment series. Univariate methods are essentially statistical as opposed to economic models of the NAIRU, with the underlying assumption being that unemployment always reverts to its mean or natural rate over time. If the latter assumption is true then the NAIRU can be defined uniquely in terms of the behaviour of the unemployment series itself. However, while the trend unemployment series for Italy produced using this approach appeared to give a reasonable proxy compared with actual unemployment, it was also clear that this series told us very little about the change in wage inflation in Italy over the period.***

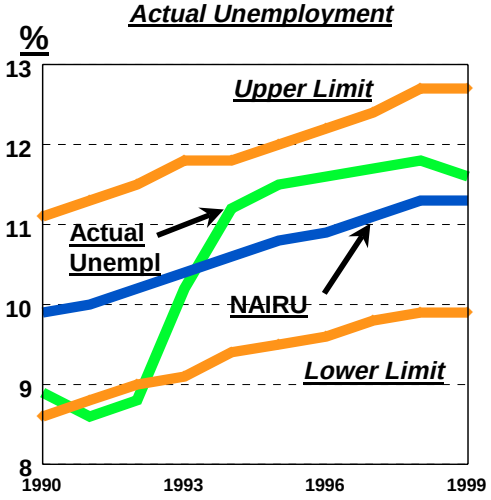
***DEVIATION FROM TREND GROWTH : Given the generally unsatisfactory results using the univariate method, it was decided to try a variable which essentially measures the deviation from trend growth over the period 1980-1999. When this variable was introduced in the basic equation, the results were substantially better in terms of the overall fit of the equation. Unfortunately, the unemployment gap series produced using this new NAIRU estimate was still poor in terms of tracking past changes in inflation.***

***SKILL-BIASED TECHNICAL PROGRESS: Given the poor inflation tracking performance using the above two methods, a variable for skilled biased technical progress was included in the basic specification. When this variable was introduced it performed reasonably well in terms of the basic equation results. This appears to confirm the results of a previous analysis by Roeger and Wijkander (see references) which showed that the inclusion of a proxy variable for relative wage rigidity in the presence of skill biased technical progress, namely the ratio between total factor productivity in manufacturing and services, provides cointegration in the case of Italy. However, while the structural unemployment series produced using the latter approach may appear (see graph overleaf) a reasonable proxy compared with actual unemployment, it is unfortunately still very poor in terms of explaining the change in wage inflation in Italy over the period in question.***

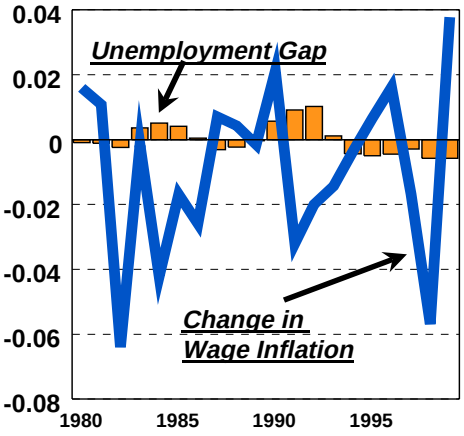
***COULD HYSTERESIS MECHANISMS PROVIDE PART OF THE EXPLANATION FOR THE ITALIAN CASE ?:*** ***From the above analysis, it would appear that in Italy that wages do not react very much to disequilibria in the labour market. Normally, higher levels of unemployment would be expected to help the adjustment process by putting downward pressure on wages, but with hysteresis present this downward pressure is rather muted and the economy takes considerably longer to return to its original equilibrium. Hysteresis consequently acts to prevent the necessary degree of real wage adjustment from occurring with the result that temporary shocks have permanent or persistent effects on unemployment. In this regard, it is significant to note that in a previous analysis (Mc Morrow –1997) it was found that Italy was the only country in the EU where the change in unemployment variable was substantially more important than the level of unemployment as an explanatory variable in wage developments. This may suggest that the change in the unemployment variable has an independent and significant influence on wage developments in Italy and that therefore "speed limits" on growth could be a problem in that Member State. i.e. inflation responds not only to the size of the unemployment or output gap, but to the speed at which the gap is closed, with the faster the recovery phase, the greater the risk that inflation will accelerate before the NAIRU is reached.***

# Italy

***NAIRU Estimates, Confidence Intervals and Actual Unemployment***




***Unemployment Gap + Change in Wage Inflation***



# SUMMARY AND CONCLUDING REMARKS

As stressed at the outset, estimating NAIRU's, especially those for European countries, is an exercise fraught with well documented difficulties, including uncertainties concerning both model selection, where a number of plausible but fundamentally different modelling approaches exist for their estimation, and empirical inadequacies, including often large confidence intervals surrounding the resultant NAIRU point estimates. With regard to the present study, while statistically significant NAIRU's were obtained, the latter point estimates have, in general, comparatively low t-statistics and consequently relatively large confidence intervals, thereby reducing their usefulness as policy guides. In addition, interpreting changes in NAIRU's should always be done with caution not only because of the unreliability of the estimates themselves, but also, and very importantly here in Europe, because of the possible presence of hysteresis mechanisms which have the effect that the NAIRU often gravitates towards the prevailing rate of unemployment.

Hysteresis is a feature of labour markets which have been "slack" for some time, in that they become less flexible and more inefficient through skill loss, reduced search effectiveness etc. with the present performance of such labour markets to an extent being dictated by the shocks which they have been subjected to in the past. This hysteresis argument forms part of the consensus view regarding European unemployment which purports that the high level of the latter is due to the interaction of two particular effects i.e. a combination of real shocks allied to relatively rigid institutional structures. Particular aspects of these latter structures, such as insider-outsider mechanisms, restrictive hiring and firing rules, generous systems of long-term unemployment benefit provision appear to result in the effects of negative shocks persisting over an extended period of time.

While conscious of the many problems, highlighted above, associated with NAIRU calculations, the approach in this paper has been to try to pinpoint a number of key "sinners", amongst the many possible contributory factors to the trend growth in unemployment, by isolating those causal variables which are statistically significant and are economically plausible and by testing the explanatory power of the resultant NAIRU and unemployment gap measures in terms of their ability to track past changes in wage inflation (or in the case of Portugal and the Netherlands price inflation).

The model developed has, at its heart, a basic equation for explaining inflation in the different countries, with inflation being a function of the unemployment gap and a distributed lag of past inflation. With regard to the unemployment gap term, which could be seen as a rough indicator of real wage flexibility in the respective countries, the NAIRU part of the gap is determined by a series of structural variables such as tax pressure, borrowing costs and trend productivity growth. By adopting this modelling strategy the paper can provide meaningful, **short-run**, NAIRU / NAWRU estimates which encompass not only the latter's longer run structural determinants but which

also mirror the dynamic adjustment of the economy to past economic shocks, as reflected in the impact of the unemployment gap on wage or price inflation[16].

The most important point to retain from the analysis undertaken is that, in all of the Member States for which NAWRU / NAIRU's are estimated, the unemployment gap term would appear to be important in explaining past changes in either wage or price inflation, with effects of between 0.5 and 1 being registered in most cases i.e. a 1% point change in the unemployment gap term leads to a 0.5 to 1 % point change in inflation in a majority of the Member States. This can be seen graphically in Section 3 of the paper, where the estimated unemployment gaps are shown to be remarkably good, in most cases, at explaining past inflationary developments, at least in relation to wage trends. In addition, the unemployment gap term is also broadly stationary for all countries which suggests that the specification used in the paper for the various Member States seems sufficient to capture the trend in unemployment in those countries.

The study also assesses the gains to be made from estimating NAIRU / NAWRU's using an economic approach, such as that used in the present paper, as opposed to simply using a statistical method such as the H-P filter to extract the trend unemployment rate. The results of the comparison of the economically estimated unemployment gaps with the H-P filtered generated gaps is in fact very encouraging for the methodology adopted in the paper, since it indicates that for each Member State there is a gain to be made by estimating an economically significant NAIRU series, with the gain in certain countries being very significant in terms of both the explanatory power of the NAIRU's and in terms of the significance of the relationship between the unemployment gaps and past changes in wage inflation. Furthermore, the paper suggests that the link between unemployment gaps and wage inflation is, in general, substantially stronger than between output gaps and general price inflation.

As regards the specific determinants of the NAIRU estimates, it is interesting to note in relation to the taxation effects that there are similarities between the results of the present study with those of an earlier study in this area by Daveri and Tabellini in 1997. As shown in Section 2 of the paper, the largest employment effect of taxes, as in the case of the Daveri and Tabellini study, are found in those continental European countries, such as Germany, Spain and France, where unions play a big role in a decentralised wage bargaining system. In the latter countries the present study suggests that a 1% point increase in the tax rate leads to an increase in the equilibrium unemployment rate of half a point. An important role is also found in the present study for the real interest rate variable in a number of the Community's countries and a tentative explanation is given as to why this might be so. This explanation highlights the difficulty in isolating the demand from the supply side effects of real interest rate changes, especially here in Europe since the unemployment cycle appears to have stretched out over the last number of decades. It is impossible to definitively

[16] See section 1.4 for a further discussion on the distinction between the short and long run NAIRU concepts.

say whether this lengthening is due to a deterioration in the supply side fundamentals or whether it reflects slow adjustment / persistence effects.

In overall terms, while the equation specifications used in the paper for some of the Member States may appear rather sparse it should be borne in mind, as highlighted in a lot of research in this area in the past, that whilst data may exist for a large range of possible explanatory factors for changes in structural unemployment, such as the benefit replacement ratio, the ratio of the minimum wage to the average wage, the degree of coordination in the wage bargaining process, the amount of expenditure on active labour market policies, real interest rates, the tax wedge, union density and employment protection legislation, many of the effects of the latter set of variables are highly correlated. This multicollinearity problem ensures that even if all these variables were included in our equation specification it would still remain very difficult to definitively establish the relative quantitative contribution of each factor to changes in structural unemployment over time. The final specification chosen for each country should therefore be seen as a type of summary reflection of a much more complex set of factors, with the small number of final variables chosen clearly encapsulating the effects of a much wider, related, range of influences.

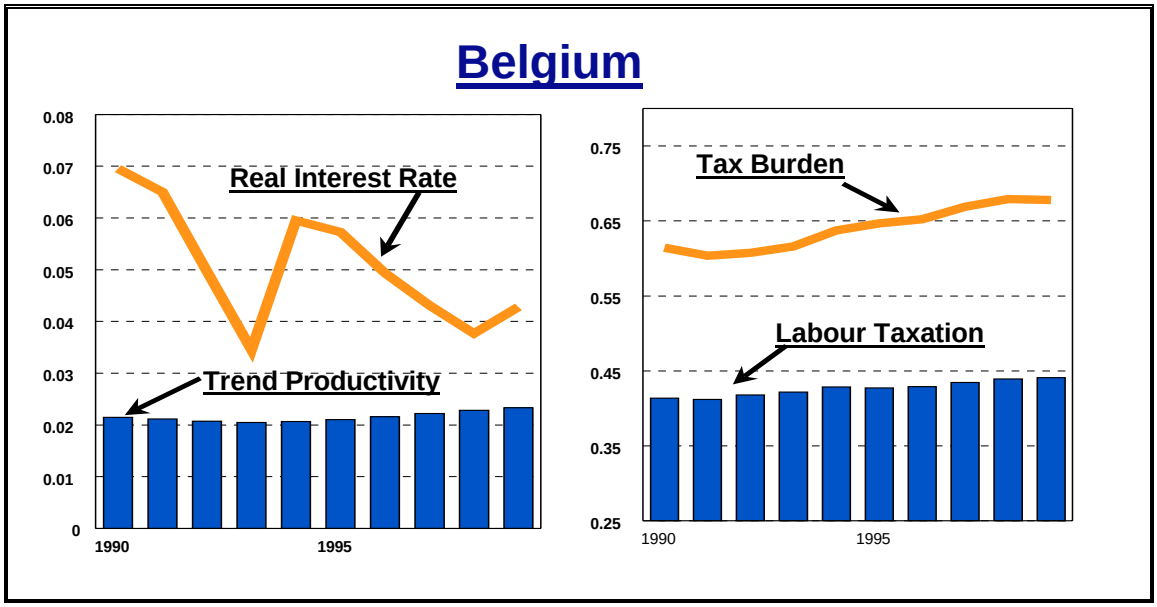
With regard to the policy implications of the analysis undertaken in this paper, the first point to note is that the NAIRU estimates produced tentatively support the hypothesis of a non-vertical **short-run** Phillips curve, with quantifiable feedback effects being identified from deviations in the actual unemployment rate from the natural rate to changes in the rate of wage/price inflation. While, of course, empirical support may exist for such a short-run trade-off, it would be fundamentally wrong to infer from this evidence that such a trade-off could be exploited for policy purposes. This is especially true here in Europe given the previously mentioned instabilities in the Phillips curve for the majority of the Community countries. In fact, given all the empirical and theoretical difficulties associated with the NAIRU concept, the individual point estimates produced in this paper for the various countries are likely, not surprisingly, to evoke a strong sense of dubiousness on the part of many national policy makers.

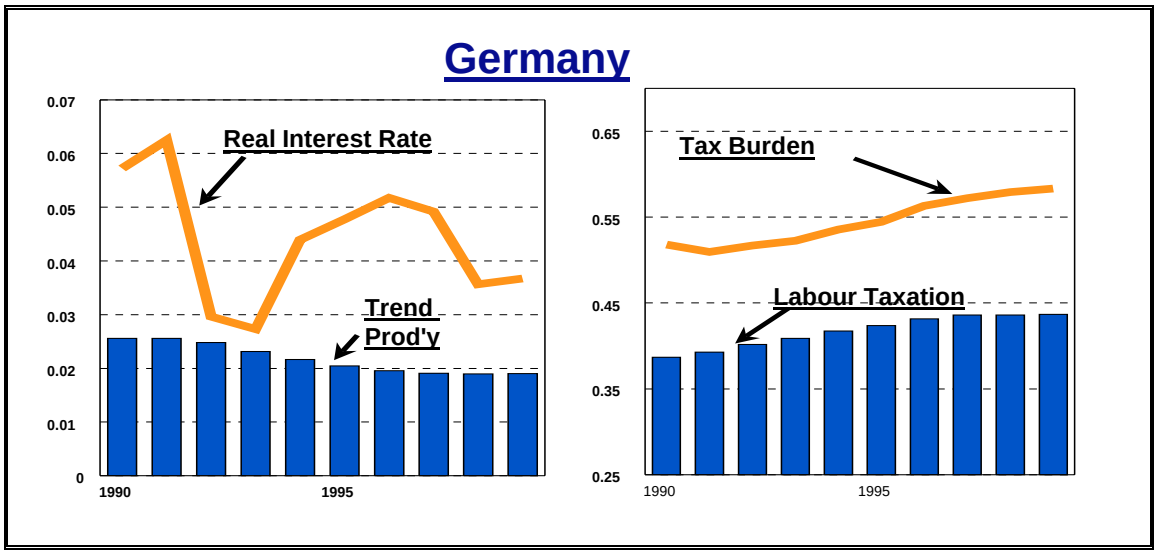
At a wider level, there would appear to be a growing sense of unease in a number of European countries, openly articulated in the vast literature on this topic, concerning both the theoretical and empirical underpinnings of the NAIRU concept, with this unease suggesting caution in attributing any policy role at all to the concept. In this regard it should be remembered that in addition to the practical measurement problems already alluded to, at a fundamental level the theoretical weaknesses, in particular hysteresis mechanisms, call into question even the existence of a unique long run NAIRU, i.e. it may be indeterminate or stochastic by nature. However, while the present authors share a lot of the latter concerns and feel that these problems render short-run NAIRU estimates, like the ones calculated in this paper, less than useful in the macro policy context, it is nevertheless felt that a case can still be made for sustaining the use of these estimates as a structural indicator for cross country, labour flexibility, comparisons. Regarding the latter, it is postulated that short-run NAIRU's contain useful information for structural policy and that calculating this

concept as an ex-post indicator of structural problems still remains its most important potential contribution to the policy debate.

Finally, in terms of future research, it is clear that a more disaggregated analysis is needed if one wishes to use these NAIRU estimates in any meaningful way in the structural policy making process in the various countries. In this regard, in most Member States, it is widely accepted that the fundamental problem regarding structural unemployment lies at the low end of the skill distribution. Action to address this problem is manifestly needed to enhance the employability of the unskilled and the inexperienced through active labour market measures whilst at the same time increasing the employment prospects of this group of workers through such measures as targetted reductions in employers social charges, appropriate action in terms of statutory wage floors and overhauling the system of social assistance to ensure that it is not acting to undermine incentives to work. Policy actions along the latter lines have already been introduced in a large number of Member States. In this regard it is clear that our present specification is not detailed enough to pick up the effects of such changes, including for example the introduction of important modifications to the tax regime for the low skilled, since the necessary, cross-country, data to include a meaningful skilled / unskilled breakdown is difficult to assemble. This is something which must urgently be addressed in any future research work in this area.

# ANNEX 1
## GRAPHIC PRESENTATION
## OF
## KEY EXPLANATORY VARIABLES*

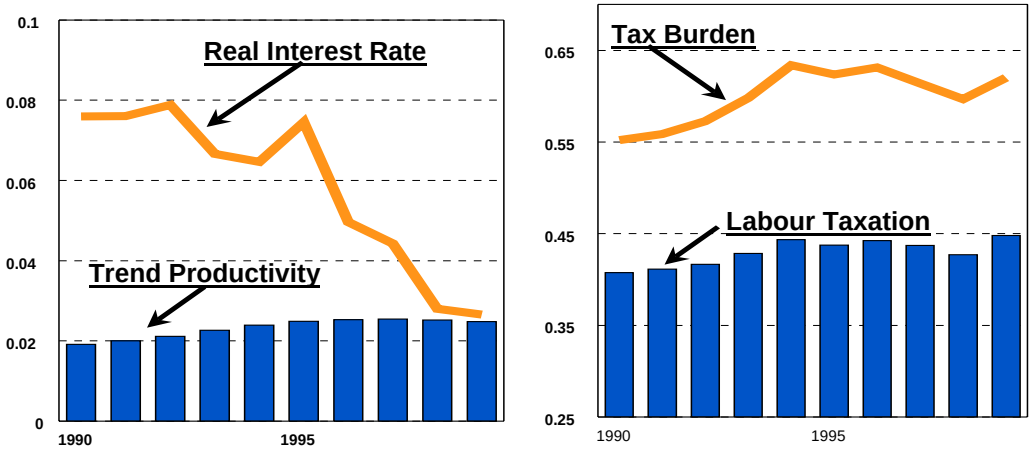


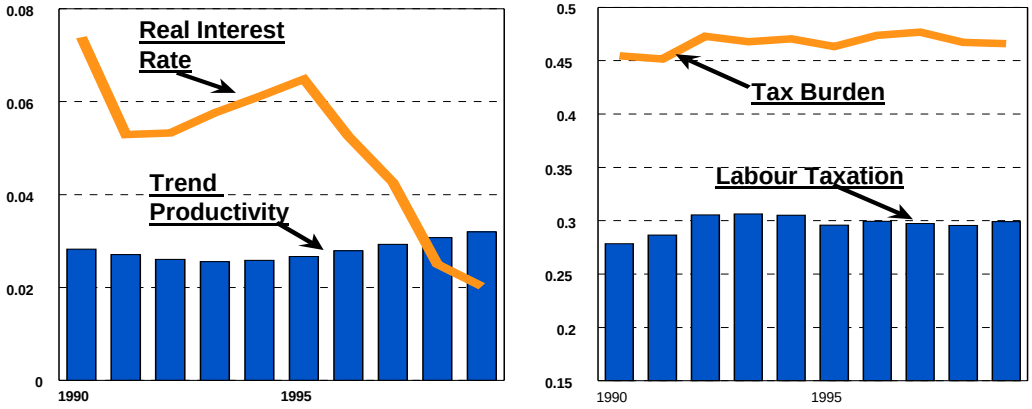

* **Tax burden** is measured as all current taxes on income and wealth plus total social security contributions as a proportion of nominal compensation of employees.

**Labour taxation** = the effective tax rate on labour income. This is measured as non-wage labour costs plus personal income taxes on labour income as a proportion of total gross wages.

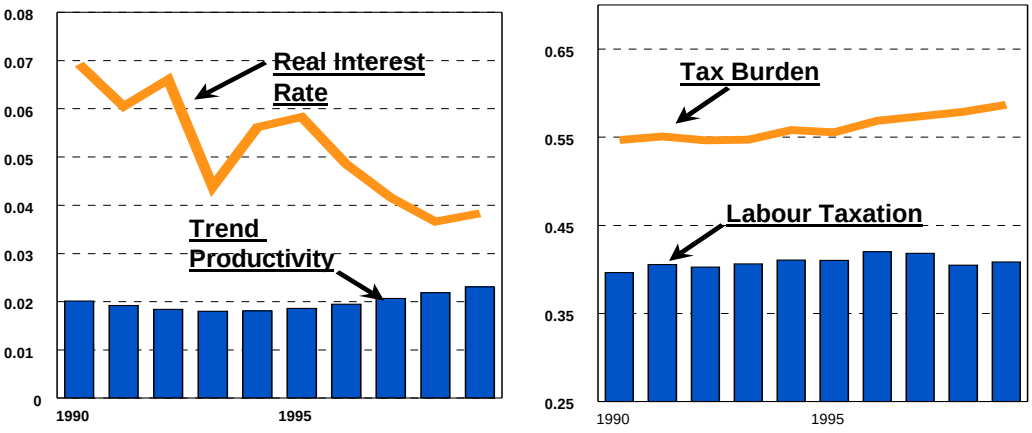
## Denmark



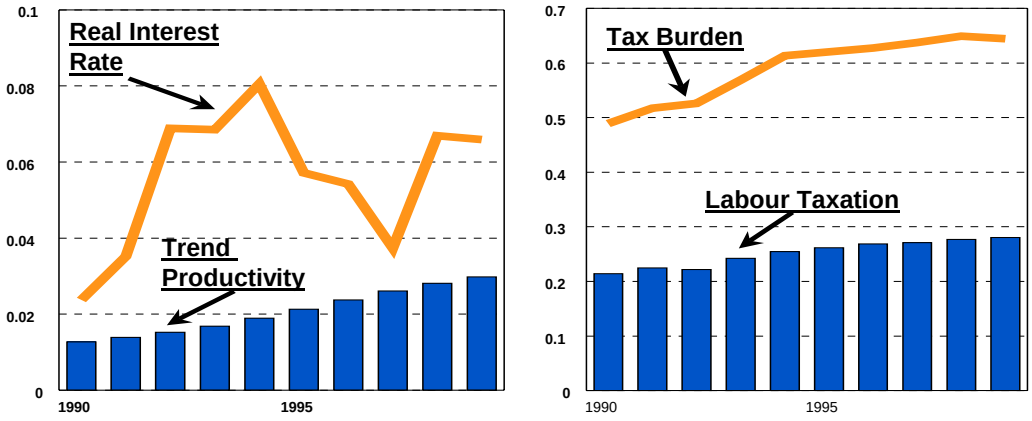

## Spain



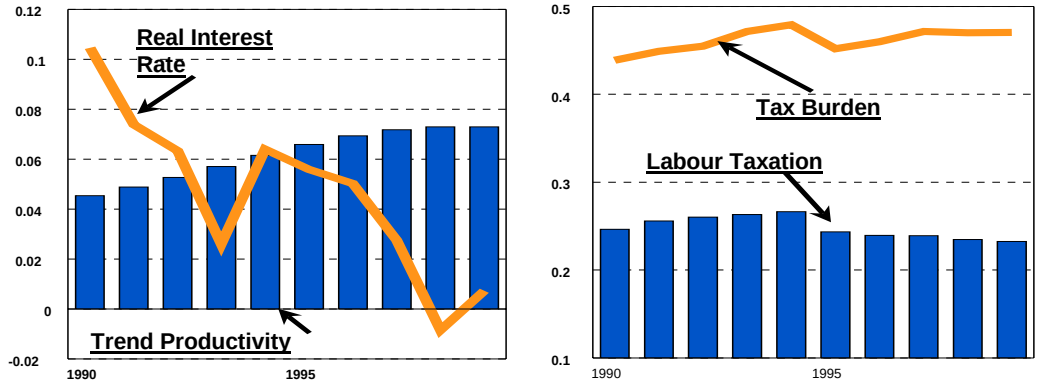

## France



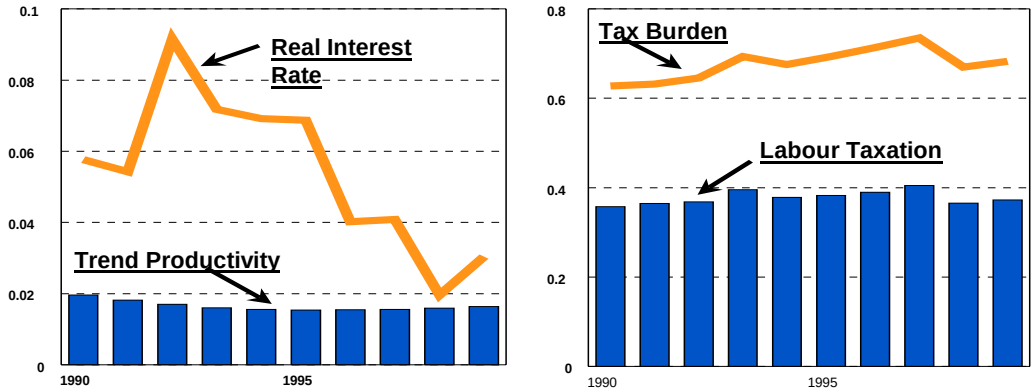
## Greece




## Ireland




## Italy



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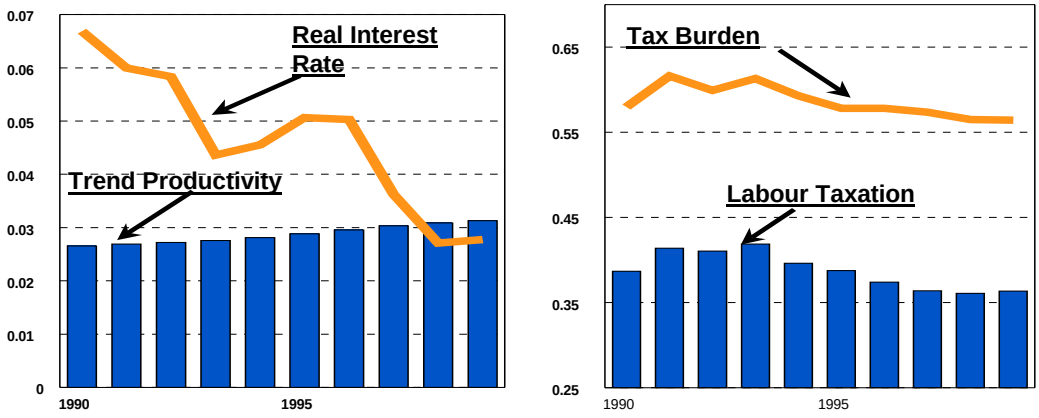
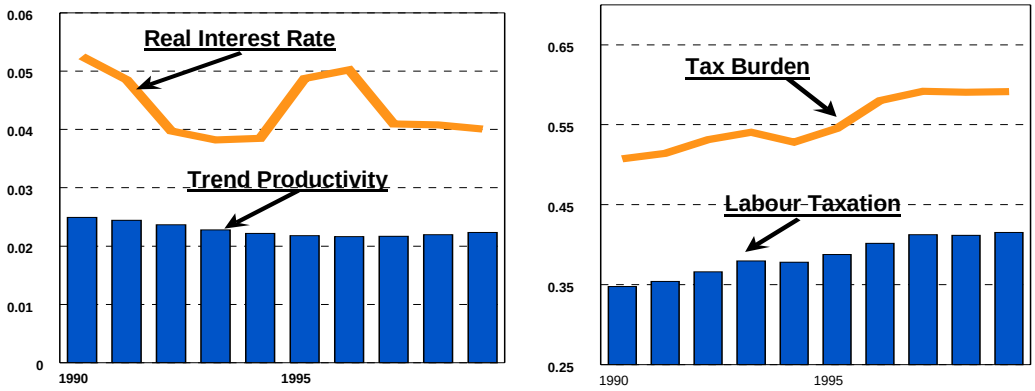
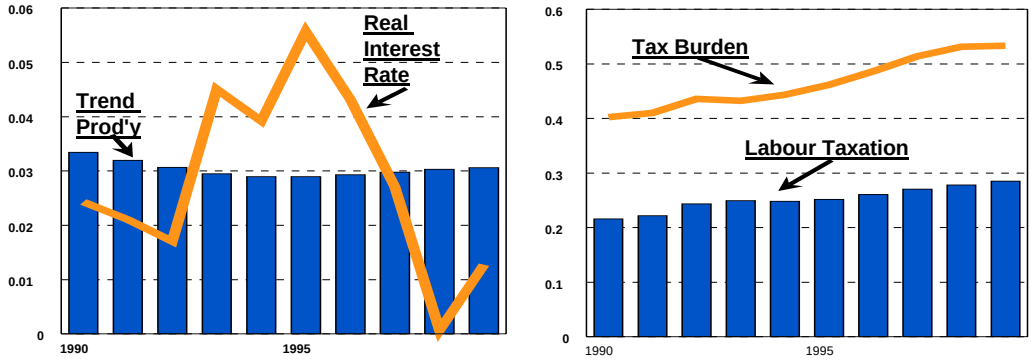


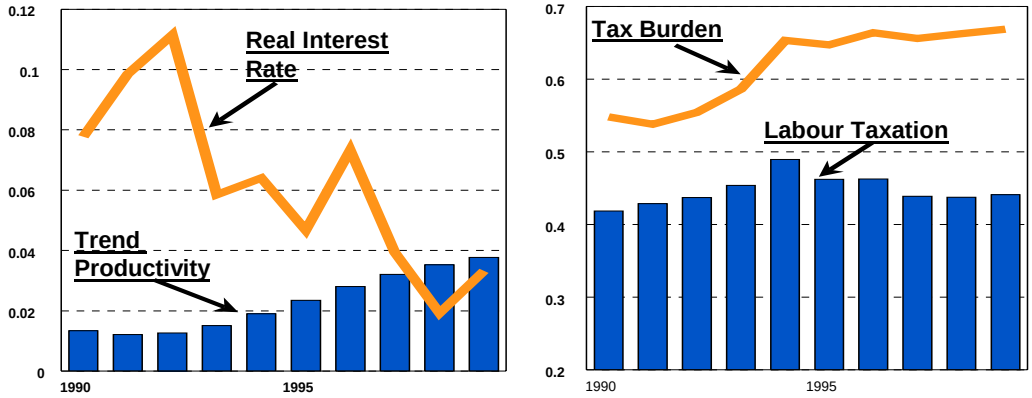

## Austria



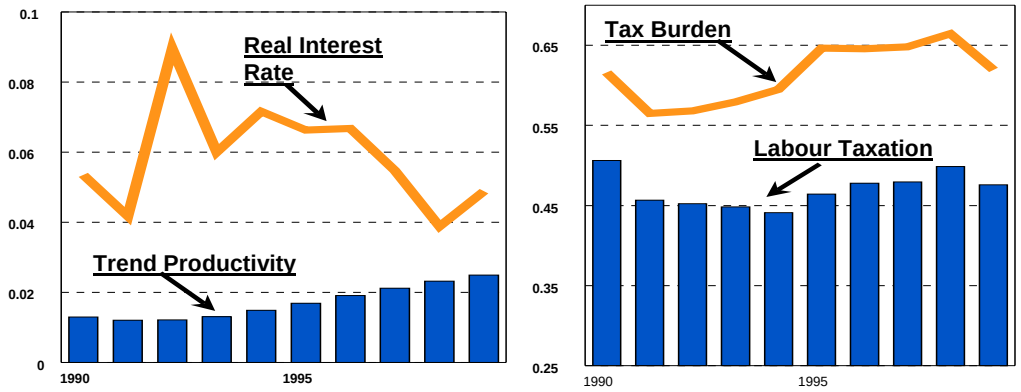

## Portugal



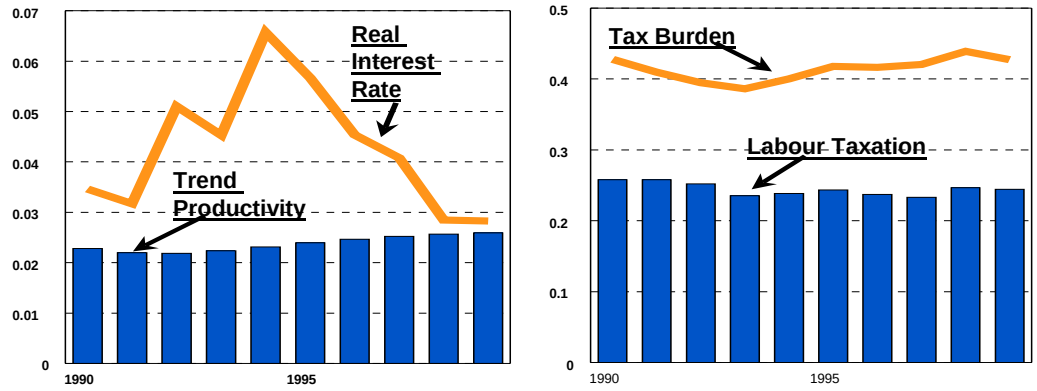
## Finland




## Sweden




## UK



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