

REVISITING THE NAIRU ESTIMATES FOR THE PORTUGUESE ECONOMY*

*Francisco Craveiro Dias***

*Paulo Soares Esteves***

*Ricardo Mourinho Félix***

1. INTRODUCTION

Several empirical studies have estimated the Non Accelerating Inflation Rate of Unemployment (NAIRU) for Portugal as having been fairly constant, despite some minor differences in the estimates therein presented. For instance, using a sample period beginning in 1983, Marques and Botas (1997) and Luz and Pinheiro (1993) estimated a NAIRU around 5.5 per cent that is somewhat smaller than the estimates of around 6 per cent obtained in Marques (1990) and in Gaspar and Luz (1997). The stability of the NAIRU seems to be a particular feature of the Portuguese economy, which is at odds with the results obtained for other European countries where the available estimates point to a non-constant NAIRU. For instance, Fabiani and Mestre (2000) present alternative estimates for the euro area NAIRU, that exhibit a clear upward trend, in particular, during the seventies and the eighties.

The first objective of this article is to revisit the NAIRU estimates for the Portuguese economy, evaluating, in particular, the maintenance of a constant NAIRU throughout the sample period (1983-2003). In order to address this issue, alternative formulations are used, in particular allowing explicitly for a time-varying NAIRU specification.

Secondly, this article analysis the flexibility of real wages to the prevailing economic conditions, which is a traditional argument presented to justify the stability of the Portuguese NAIRU. It

seems important to revisit this stylised fact, given the current new exchange rate framework. In fact, the flexibility of real wages might have been related with the sudden unexpected depreciation episodes of the former Portuguese currency — the escudo — that took place in the past and thus it could have been reduced by the gradual increase of the exchange rate stability along the integration process in the Economic and Monetary Union.

This article is organized as follows: section 2 briefly presents single equation methods most commonly used to compute the NAIRU estimates; section 3 describes the dataset used in the empirical analysis; section 4 presents the empirical results obtained using the alternative approaches to measure the NAIRU; section 5 analyses the flexibility of real wages ; finally, section 6 summarizes the main conclusions.

2. ALTERNATIVE APPROACHES

The natural rate of unemployment is a theoretical concept widely used in macroeconomics to define the excess demand/supply pressures stemming from the labour market. In particular, whenever the unemployment rate is below (above) the natural rate of unemployment there is an excess demand (supply) of labour that, therefore, exerts an upward (downward) pressure on real wages. Thus, the concept of natural rate of unemployment is a crucial element in the identification of the long-run equilibrium of labour market variables. It can be defined as the rate of unemployment that would prevail after all price changes in the econ-

* The views expressed in this article are those of the authors and not necessarily those of the Banco de Portugal.

** Economic Research Department.

omy freely adjust to their equilibrium values, in particular, the real wage rate.

However, the definition of the natural rate of unemployment is a purely theoretical concept and it can only be implemented in theoretical models. In applied economic modelling, it is not possible to identify moments in time where all prices changes have adjusted to their long-run levels. Thus, a parallel concept that can be implemented in any forecasting and/or simulation model to pin point the long-run of the labour market variables had to be sketched. This concept is the NAIRU, and it can be estimated using several alternative approaches. Here to derive the NAIRU for Portugal three alternative methods were considered in order to estimate and evaluate the robustness of the final outcomes.

The first approach is probably the simplest way of estimating the NAIRU and it relies on the strong statistical correlation between the cyclical position of the economy and the unemployment rate known in the literature as the Okun's Law. The main idea behind this approach is that the NAIRU is the rate of unemployment that is consistent with the closure of the output-gap and thus with the vanishing of the demand side pressures on prices.

A second method relies on the wage equation. In this case, the NAIRU estimate is also at times named as NAWRU (Non-accelerating wage rate of unemployment) and is estimated under the assumption that it must be consistent with a long-run growth of real wage in line with the long-run growth of labour productivity.

Finally, we use a Phillips curve to estimate the non-accelerating inflation rate of unemployment, that, in this case can be defined as the rate of unemployment that is consistent with a constant rate of inflation in the absence of supply side shocks (for instance, terms of trade or productivity shocks).

Once in the long-run not only the output-gap must close, but also prices (including nominal and real wages) must converge to their steady-state growth path. Under these conditions, the NAIRU that is consistent with the above mentioned requirements must be fairly the same. Thus, there is no reason to expect significant discrepancies between the estimates computed using the three alternative methods.

2.1. Okun's law

The Okun's Law represents an empirically observable relationship between the unemployment-gap (the deviation of the unemployment rate from its natural rate level) and the output-gap (the deviation of the output from its potential level). This empirical regularity first presented in the seminal paper by Okun (1962), became an important relationship used in macroeconomics. Assuming that inflation could be completely explained by the excess demand/supply pressures in the goods and services market, this statistical feature is probably the simplest way to get a quick estimate of the NAIRU. The Okun's Law is represented by the following equation⁽¹⁾:

$$u_t - \bar{u}_t = -\beta(y_t - \bar{y}_t) + v_t \quad (1)$$

where u_t and y_t stand respectively for the observed unemployment rate and the log of output, \bar{u}_t and \bar{y}_t stand for their corresponding unobserved sustainable long-run levels and v_t is the usual stochastic error term. The parameter β is the so-called Okun parameter. Using this relationship, it is straightforward to derive an estimate for the NAIRU, the unemployment rate consistent with output-gap closure.

However, this specification describes a long-run relationship, since it does not need to hold in every quarter. Therefore, an obvious solution to estimate this relationship is to formulate equation (1) as an autoregressive distributed lag model to include dynamic features among the two variables. This formulation incorporates in a single equation both long-run features and short-run dynamic elements of the relationship between the set of variables.

2.2. The wage equation

The wage equation approach is based on the long-run relationship between real wage growth rate $\Delta(w - p)$ and the growth rate of labour productivity, measured by the labour efficiency index $(\Delta f)^{(2)}$. Whenever the unemployment rate is below

(1) For a discussion of the theoretical foundations of the Okun's law and its derivation from a Cobb-Douglas production function, see Prachwony (1993).

NAIRU, real wages will grow faster than the labour efficiency index leading to an increase in unit labour costs that can be identified as an inflation source⁽³⁾:

$$\Delta w_t = \Delta p_t + \Delta f_t - \beta(u_t - \bar{u}_t) + v_t \quad (2)$$

In the case of the wage equation, the level of NAIRU corresponds to the level of unemployment that assures that the real wage grows in line with labour efficiency (productivity). The wage equation approach was the one most frequently used for Portugal to derive the NAIRU showing simultaneously that the sensitivity of real wages to the unemployment rate was higher in Portugal than in other European countries. This is commonly pointed out as an argument to justify the mean reversion feature of the unemployment rate (constancy of the NAIRU) for Portugal. In the present case, the NAIRU estimates were also obtained through an autoregressive distributed lag formulation reparametrized in the form of an error-correction model.

2.3. The Phillips curve

The use of the Phillips curve in the estimation of the NAIRU is widespread in the literature. Amongst others, the Phillips curve specification to estimate a time-varying NAIRU was used in Gordon (1997) and in Eller and Gordon (2003) for the United States; and in Fabiani and Mestre (2000) for the euro area⁽⁴⁾.

Following Gordon (1997), the Phillips curve model is based on the coined triangle model which is composed of three building blocks: the inertia of the inflation rate, the excess demand variable and the supply shocks. A general specification can be represented as:

$$\pi_t = A(L)\pi_{t-1} + B(L)D_t + C(L)z_t + \varepsilon_t \quad (3)$$

where $X(L)$ represents a polynomial in the lag operator, the dependent variable π is the inflation rate and the inertia is captured through the lagged term $A(L)\pi_{t-1}$. D_t represents a centered excess demand variable like the output-gap or the unemployment-gap and z_t summarizes the set of variables that account for the role of supply shocks, while ε_t is a stochastic white-noise error term.

To estimate the NAIRU, the unemployment-gap ($u_t - \bar{u}_t$) is the obvious candidate to play the role of the excess demand variable. In order to guarantee that the above specification is consistent with the existence of a well defined NAIRU, one must assure that $A(1)=1$. This ensures that in the absence of supply shocks, the inflation rate will converge to a stable level⁽⁵⁾. Therefore, in the long-run, the Phillips curve is vertical and the unemployment rate equals the NAIRU.

3. THE DATASET

This section provides a brief description of the dataset used to estimate the NAIRU for the Portuguese economy. The sample period runs from 1983 up to 2003 — the beginning of the sample period was limited to 1983, in order to allow for a direct comparison with the previous studies on the Portuguese NAIRU — and the data was based on the quarterly series presented in Castro and Esteves (2004).

Chart 1 presents both the unemployment rate and the output-gap — cyclical component of GDP. The output-gap was obtained using the Hodrick-Prescott filter (with $\lambda = 1600$). In order to minimize the end-of-sample bias, the sample was extended using the central projections for 2004-2005 from the Spring 2004 Eurosystem Forecast Exercise while a constant rate of growth — equal to the historical average of the last 10 years — was assumed for 2006-2008.

In Chart 2 the evolution of real wages follows. As an indicator of labour efficiency (Δf) the trend component of year-on-year rates of change of productivity — output per employee— was used⁽⁶⁾.

(2) Where $w - p$ represents the difference between the log of nominal wage rate and the log of price index and Δ stands for the first difference operator as usual.

(3) See, for instance, Blanchard and Katz (1999).

(4) See Ball and Mankiw (2002) for a reconciliation between the theoretical concept of the NAIRU and its empirical implementation considering the Phillips curve approach.

(5) This Phillips curve formulation ensures that inflation will converge to a stable level, but does not determine its value.

(6) A parameter of $\lambda = 1600$ was considered for the HP filter and the series were previously extended up to 2008 to reduce the end of sample problem.

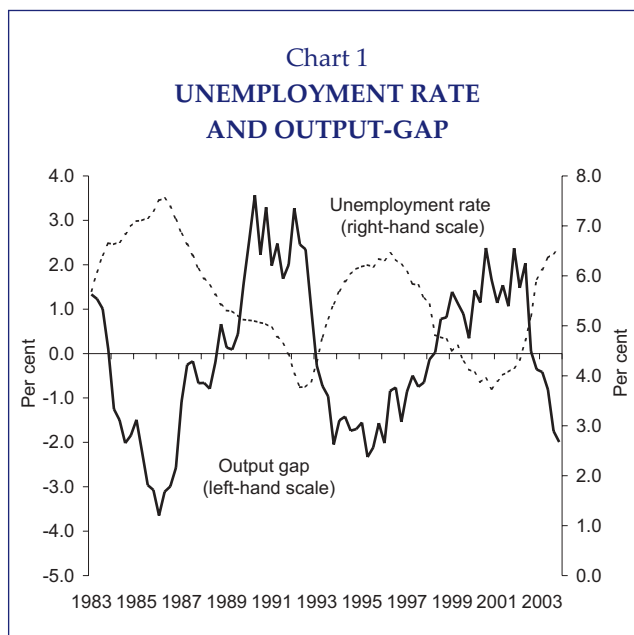


Chart 3 presents this proxy for labour efficiency (Δf) against the observed changes of output per employee $[\Delta(y-l)]$ — where l is the log of the number of employees — and changes in real wages $[\Delta(w-p)]$. This indicator is obviously much less volatile than the observed output per employee, which is traditionally extremely volatile and affected by the economic cyclical movements, and therefore its evolution cannot be directly used as a measure of long-run indicator of labour productivity.

4. EMPIRICAL RESULTS

4.1. Okun's law

4.1.1. Correlations structure

Chart 4 presents the correlation structure of the data, stressing the statistical significance of the relationship between the output-gap and the unemployment rate. The most significant coefficient of correlation between the unemployment rate and the output-gap is approximately the contemporaneous one. Considering alternative economic fluctuation indicators — GDP year-on-year growth rates or GDP chain growth rates — the usual lagged relationship between these output indicators and unemployment emerges. In this case, the correlation coefficients reach a maximum at a 9 quarter lag, in the case of the GDP year-on-year

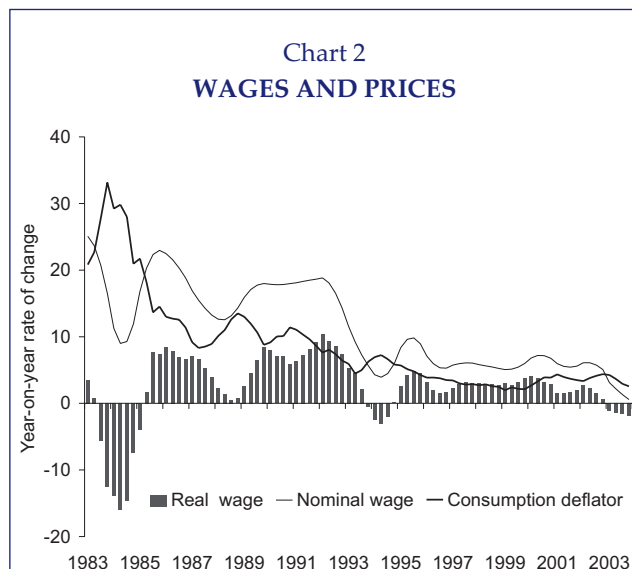
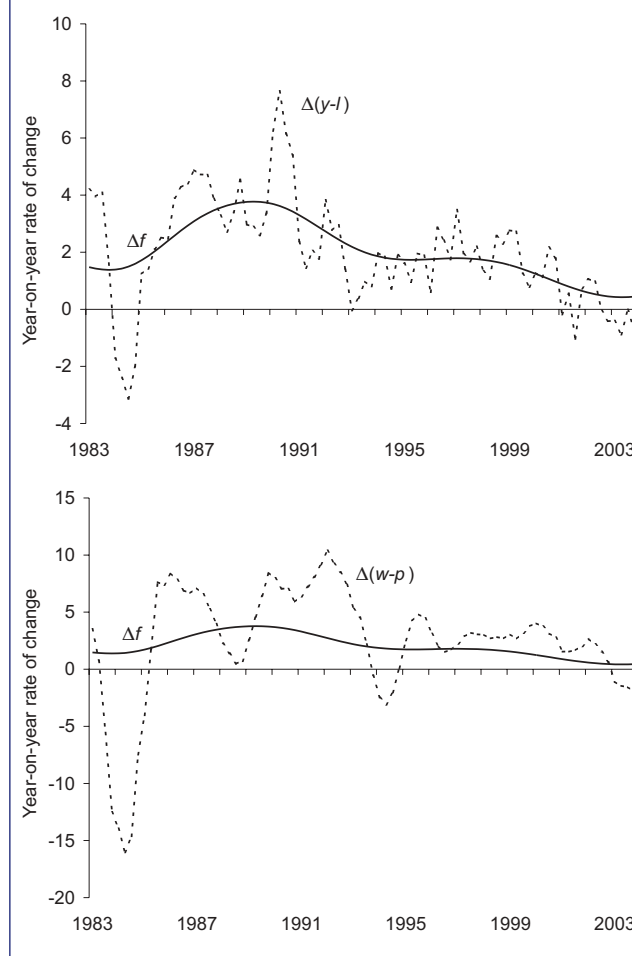
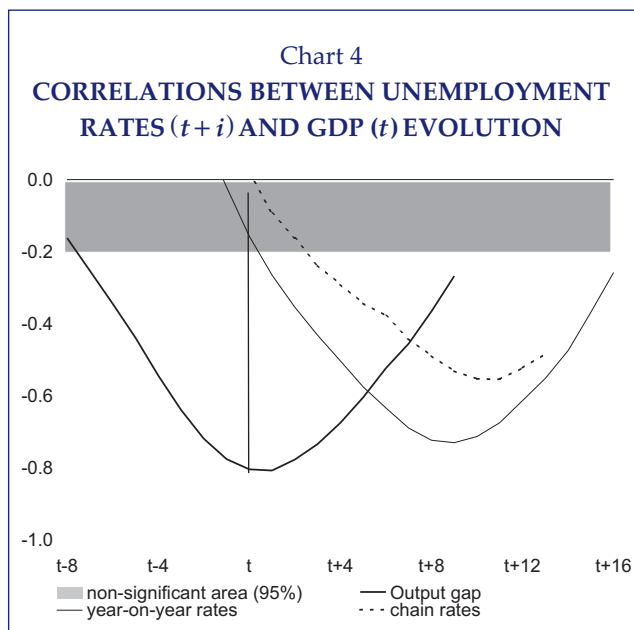


Chart 3
LABOUR EFFICIENCY INDEX AND CHANGES IN PRODUCTIVITY AND REAL WAGES



growth rates, and at a 11 quarter lag, in the case of the GDP chain growth rates. These results cling on the fact that the turning point in the output-gap



series occurs only when GDP starts to grow at a faster pace than its potential, when the economic turning point measured by GDP growth rates has already been under way several quarters before.

4.1.2. Constant NAIRU estimate

Using an autoregressive distributed lag, the Okun's Law can be specified in the form of an error-correction model, where the evolution of the unemployment rate is determined both by the short-run components and the long-run relationship between the unemployment-gap and the output-gap. In this specification, the NAIRU is restrained to be constant ($\bar{u}_t = \bar{u}$) throughout the sample period.

The estimated results for this equation are the following:

$$\Delta u_t = +0.0041 + 0.3666\Delta u_{t-1} + 0.2981\Delta u_{t-2} - 0.0455\Delta(y_t - \bar{y}_t) - 0.0583\Delta(y_{t-1} - \bar{y}_{t-1}) - 0.0762u_{t-1} - 0.0260(y_{t-1} - \bar{y}_{t-1}) \quad (4)$$

(2.79)
(3.63)
(2.97)
(1.88)
(2.40)
(2.83)
(1.49)

$$R^2 = 0.62; \quad SER = 0.0014; \quad AR(1) = 0.17[0.68]$$

where SER is the estimated standard error of the residuals and $AR(1)$ stands for the LM statistic for the test of autocorrelation of order 1 in the residuals.

The results point to the existence of a stable long-run relationship between unemployment rate and output-gap with a sensitivity parameter of

Table 1

NAIRU ESTIMATES USING ALTERNATIVE SAMPLES

1983-1993	1983-2003	1993-2003
5.6	5.4	5.3

0.34 (0.0260/0.0762), while the constant NAIRU implicit in these results is 5.4 per cent (0.0041/0.0762). These results are very similar to the ones reported in Luz and Pinheiro (1993) using a sample from 1983 to 1992 (output-gap coefficient of 0.56 and a NAIRU of 5.5), in Gaspar and Luz (1997) using a sample from 1983 to 1996 (0.56 and 6.0 per cent, respectively) and in Barbosa *et al.* (1998) using a sample from 1985 to 1997 (0.37 and 5.8 per cent, respectively), despite different datasets that were therein used.

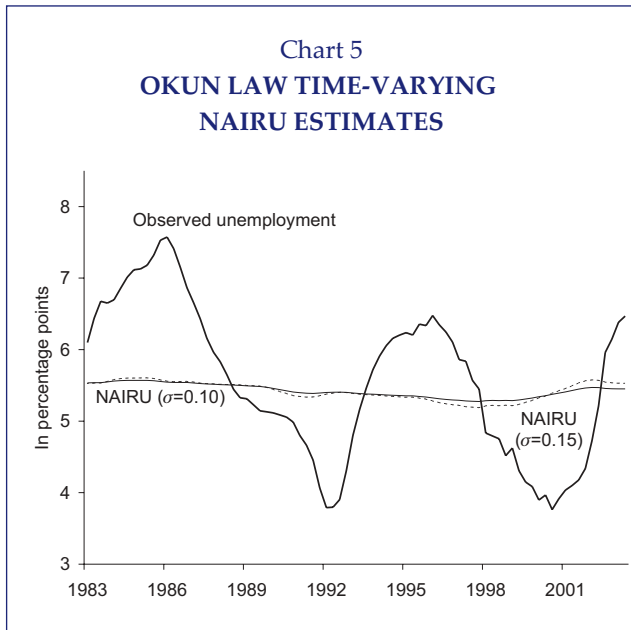
Table 1 presents evidence of the robustness of the NAIRU estimates to changes in the sample period. Despite a marginal decrease over the 90's, it is hard to reject that the Portuguese NAIRU remained fairly constant. However, a more flexible estimation technique that is able to deal with time-varying parameters models can be used to reinforce this evidence.

4.1.3. Time-varying NAIRU estimates

The estimation of a time-varying NAIRU in the context of the Okun's law is also based on equation (4), where, instead of a constant NAIRU, the possibility of the NAIRU varying over time is considered. This obliges to specify a law of motion for the NAIRU. Following a very common practice used in similar empirical applications, the NAIRU was admitted to follow a random-walk process:

$$\bar{u}_t = \bar{u}_{t-1} + \xi_t \quad (5)$$

where the disturbance error term $\xi_t \cap N(0, \sigma_\xi^2)$ is assumed to follow a white-noise process uncorrelated with the stochastic errors of the Okun's equation. In this context, the estimates of the parameters of the Okun's equation along with the unobserved NAIRU series can be obtained simultaneously using the Kalman-filtering procedure. This specification encompasses the previous constant NAIRU case, since by pinning down



$\sigma_{\xi} = 0$ we can replicate the results of the constant NAIRU case. However, on estimating the time-varying NAIRU, a constraint has to be imposed on the standard deviation σ_{ξ} of the stochastic error in the law of motion to prevent a diffuse prior from absorbing entirely the residuals of the Okun's equation, thus delivering a very erratic NAIRU along the sample period. Following a common practice used in similar empirical estimations⁽⁷⁾ we used two alternatively values for $\sigma_{\xi} = 0.10(0.15)$ to provide an idea of how sensitive the final results are to such parameter changes. This parameter pins down by how much this structural measure of unemployment – NAIRU – can change over two consecutive quarters.

Chart 5 presents the results of this exercise. The overall results show evidence of the NAIRU as having been fairly constant over the sample period presenting an average value of 5.4 per cent and a standard deviation of 0.09 and 0.13, respectively, for $\sigma_{\xi} = 0.10$ and $\sigma_{\xi} = 0.15$.

4.2. The wage equation

4.2.1. Constant NAIRU estimate

Considering a dynamic equation defined around a long-run equilibrium relationship between the deviations of real wages from the labour efficiency index (evaluated on year-on-year rates

(7) For instance see Gordon (1997).

of change) and the unemployment rate, the results are the following⁽⁸⁾:

$$\begin{aligned} \Delta\Delta_4 w_t = & +0.0093 - 0.0724(\Delta_4 w_{t-1} - \Delta_4 p_{t-1} - \Delta_4 f_{t-1}) - 0.1734u_{t-1} \\ & (2.06) \quad (5.08) \quad (2.15) \\ & + 1.1542\Delta\Delta_4 w_{t-1} - 0.4190\Delta\Delta_4 w_{t-2} + 1.4566\Delta\Delta_4 f_{t-3} \\ & (15.9) \quad (5.18) \quad (1.69) \\ & + 0.1206\Delta\Delta_4 p_t - 0.2137\Delta\Delta_4 p_{t-1} \quad (6) \\ & (2.47) \quad (5.18) \end{aligned}$$

$R^2 = 0.90; \quad SER = 0.0041; \quad AR(1) = 3.12[0.08]$

where Δ_4 represents the seasonal difference operator.

The underlying NAIRU estimates, resulting from the ratio of the constant term to the unemployment rate level coefficient, delivers an average value of 5.4 per cent. Considering alternative samples (Table 2), those estimates are once again approximately stable over the sample period, showing, however, a minor increase towards the end of the sample.

The results just presented are very similar to

Table 2

**NAIRU ESTIMATES
ALTERNATIVE SAMPLES**

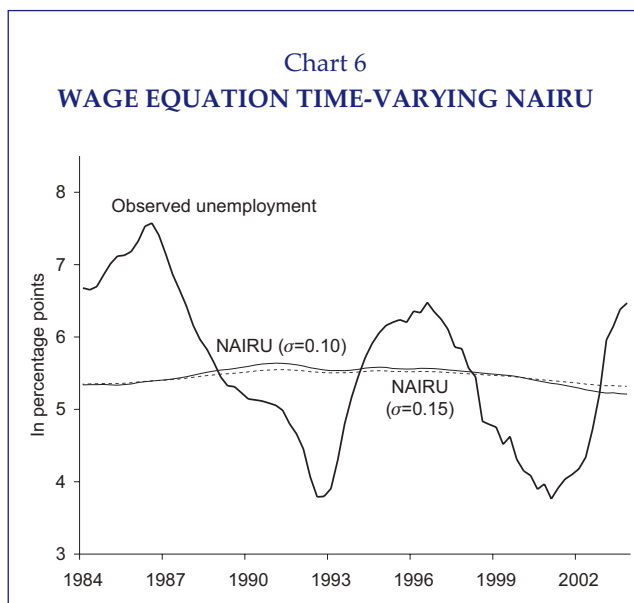
1983-1993	1983-2003	1993-2003
5.3	5.4	5.7

those in Marques and Botas (1997) that point to a NAIRU estimate of 5.4 per cent and to those of Barbosa *et al.* (1998) that point to an estimate of 5.6 per cent. Luz and Pinheiro (1993) obtained a 6 per cent NAIRU estimate using the same kind of approach.

4.2.2. Time-varying NAIRU estimates

Once again assuming a random-walk specification for the time-varying NAIRU in the wage

(8) As is implicit in this analysis, where the constant term is used to estimate the NAIRU, the deviations of real wages from the labour efficiency measure are transformed in order to assure a zero mean in the sample considered.



equation we obtain the results presented in Chart 6, which also point to a very stable pattern for the Portuguese NAIRU over the sample period.

4.3. Phillips curve

4.3.1. Constant NAIRU estimate

For the Phillips curve formulation, besides the unemployment rate, a set of supply-shock variables had to be considered. Following Gordon (1997), the variables chosen are: the deviation of the growth of productivity from its trend growth rate; the relative price changes of unprocessed food and energy goods *vis-à-vis* the remaining goods and services; and the relative import prices changes *vis-à-vis* domestic production price changes (to capture terms of trade shocks).

As in Gordon (1997), alternative inflation rate indicators were also considered, but the results obtained using the chain-weighted private consumption deflator (PCD) are the only ones reported (Table 3)⁽⁹⁾. As in the previous approaches, the results present a strong evidence that the Portuguese NAIRU has been slightly below 5.5 per cent.

Considering alternative samples, in spite of some decline of NAIRU estimates from the 80's to the 90's, the results suggest once again a fairly stable NAIRU (Table 4).

(9) The results were not significantly different using alternatively the chain-weighted GDP deflator or the consumer price index.

Table 3

NAIRU ESTIMATE USING THE PHILLIPS CURVE

	Lags	Coefficients	p-value
Constant NAIRU estimate		5.30	
Autoregressive component	1-12	1.00	
Unemployment-gap	4	-0.44	0.000
Productivity deviation	2	-0.08	0.168
Relative import prices	1-4	0.06	0.043
Relative price Food-Energy	0	0.31	0.001
R ²		0.75	
SER		0.006	
AR(1)		3.14	0.081

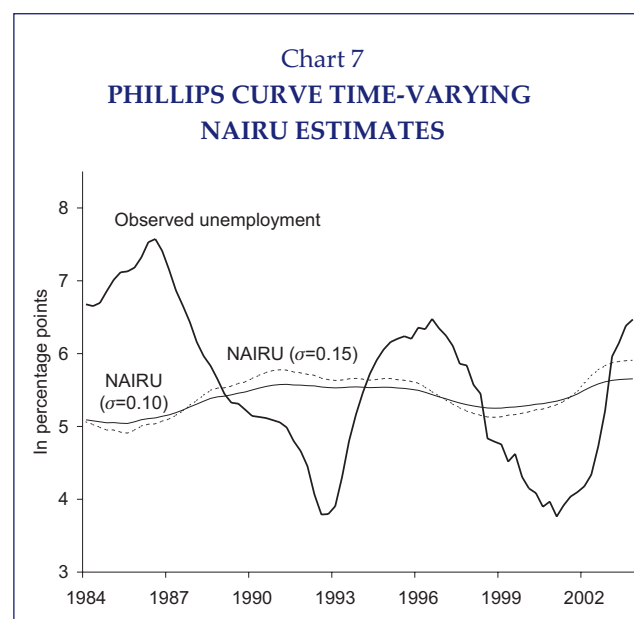
Table 4

NAIRU ESTIMATES USING ALTERNATIVE SAMPLES

1984-1993	1984-2003	1993-2003
5.8	5.3	5.3

4.3.2. Time-varying NAIRU estimates

The time-varying estimates using the Phillips curve approach delivered results that are very similar to the ones presented above in the wage equation case. As shown in Chart 7, the estimates



point to the stability of the Portuguese NAIRU, within levels between 5.0 and 5.5 per cent.

5. REAL WAGE FLEXIBILITY

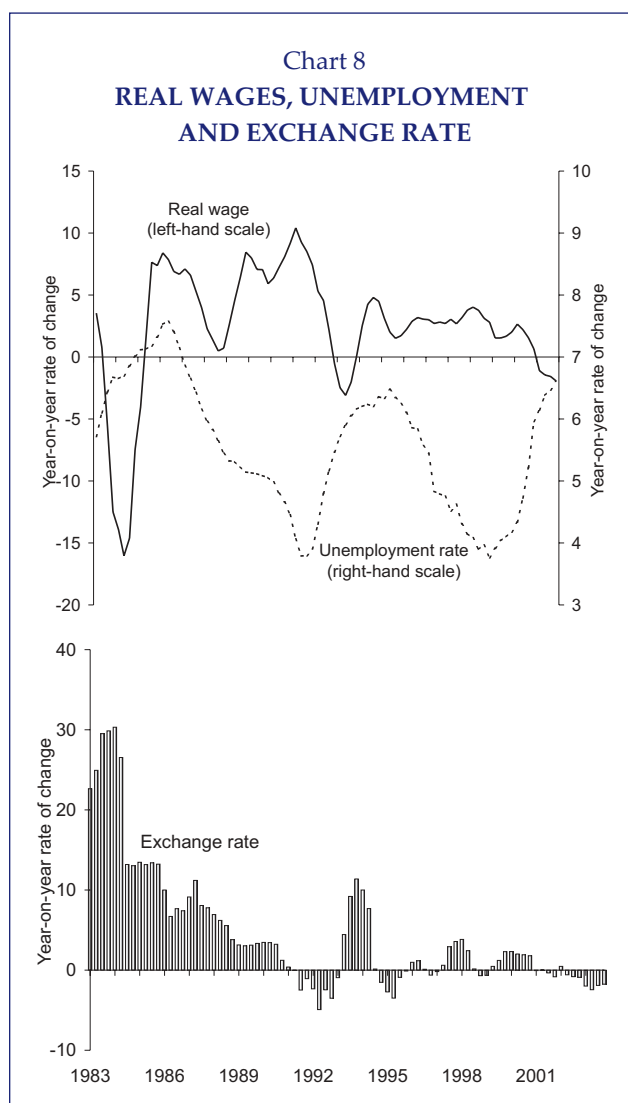
Real wages seem to have been extremely sensitive to labour market conditions, which is commonly pointed as a specific characteristic of the Portuguese economy that accounts for the constancy of the NAIRU. Using equation (7) presented above, the average real wage sensitivity to the unemployment rate in the whole sample is -2.4 (Table 5). However, these estimates also show that a continuous and significant decline of the sensitivity parameter of real wages to the unemployment rate (from a coefficient of -3.6 to -1.7), seems to have taken place along the sample period. In fact, the high average value of this parameter must have been particularly influenced by the wage-inflation behaviour that occurred during the 80's.

The decrease of the sensitivity of real wages to the unemployment rate is easily understood when the two series are confronted (Chart 8). Contrarily to the decline observed in 1984 and 1993, when the unemployment rate was increasing, in the most recent years real wages registered a more stable growth pattern, despite the fluctuations of unemployment rate within levels between 4 and 7 per cent.

Obviously, in general, real wages tend to be more volatile when inflation is higher and more unstable because changes in prices are not immediately transmitted to wages. In the Portuguese economy, a possible explanation for this wage-inflation dynamics is related with the behaviour of the exchange rate, that is strongly and quickly transmitted to prices [see, for instance, Esteves (2003)] and therefore tend to influence real wages. In the two previous episodes of real wage decline, besides the increase of the unemployment rate, the former Portuguese currency registered simultaneously significant and most probably unantic-

Table 5

REAL WAGE/UNEMPLOYMENT SENSITIVITY		
1984-1993	1984-2003	1993-2003
-3.6	-2.4	-1.7



pated depreciations following the 1984 IMF agreement and the 1993 ERM crisis). Therefore, these past exchange rate effects tend to increase the estimated sensitivity of real wages to labour market conditions.

This point can be illustrated by readdressing equation (7) and considering the Portuguese exchange rate as an additional regressor. To measure

Table 6

	EXTENDED WAGE EQUATION		
	1984-1993	1984-2003	1993-2003
NAIRU	5.3	5.4	5.7
Real wage/unemployment sensitivity.....	1.74	1.84	1.62
Number of significant exchange rate lags.....	5	5	3

their unanticipated changes, the second difference of the exchange rate was considered, and it was assumed that the wage-price dynamics can be influenced by these exchange rate surprises over the previous two years⁽¹⁰⁾. The results of this exercise are presented in Table 6.

The NAIRU estimates are not very different from the previous ones, but the introduction of the exchange rate effects allows to stabilize the relation between real wages and the unemployment rate, reducing this sensitivity for the sample periods including the eighties.

6. CONCLUSIONS

Using quarterly data from 1983 to 2003 and alternative approaches (Okun's law, wage equation and Phillips curve), this article presents alternative estimates for the Portuguese NAIRU. As in the previous studies, average estimates around 5.5 per cent are obtained assuming that the NAIRU is constant.

A time-varying NAIRU methodology that follows closely the one presented in Gordon (1997) was also used. The results obtained for a reasonable parameterization confirm that the NAIRU is likely to have been fairly stable over the sample period, thereby proving the robustness of the previous estimates.

This study also analyses the higher sensitivity of real wages in Portugal to the prevailing economic conditions, which is a feature commonly pointed out as an important explanation for the differentiated behaviour of the Portuguese unemployment rate. It is well known that a downward adjustment of the real wage rate is mainly possible when ex-post inflation records above ex-ante expected value, due to the nominal wage rate rigidity. This study presents some evidence that the adjustment of real wages have been intrinsically related with the historical behaviour of the nominal exchange rate, suggesting that sudden devaluations/depreciations generated unexpected inflation and thus allowed for real wage rate adjustment.

(10) In other words, considering e as the log of the Portuguese effective exchange rate, $\sum \alpha_i \Delta \Delta_4 e_{t-i}$ ($i=0, \dots, 8$) was initially introduced in equation (7), and then the statistically non-significant lags were sequentially dropped.

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