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Rescuing the Phillips curve: Making use of long-term unemployment in the measurement of the NAIRU

by
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Despite the increased importance of cyclically-adjusted measures of labour market slack for policymaking, estimates of the NAIRU have become increasingly fragile. Particularly for euro area countries, NAIRU estimates represent a crucial input to compute cyclically-adjusted budget balances adopted to formulate medium-term fiscal objectives under the EU fiscal surveillance framework. However, the apparent reduced sensitivity of inflation to labour market dynamics and unemployment gaps seriously undermines the use of Phillips curve equations in estimating the NAIRU. Estimates of the NAIRU are particularly problematic when changes in unemployment are both very large and rapid as in the aftermath of the global crisis. This paper proposes a refinement to the standard OECD approach of using a Kalman filter to estimate the NAIRU in the context of the Phillips curve. The proposed refinement strengthens the relationship between inflation and labour market developments by considering the risk of hysteresis effects associated with changes in long-term unemployment. Testing the revised methodology on a broad selection of OECD countries gives mixed results. For a group of countries in the euro area periphery (Greece, Ireland, Italy, Portugal and Spain) there is an increase in the magnitude and statistical significance of the unemployment gap, with the NAIRU revised upward by on average 1¾ percentage points. However, the revised methodology provides less improvement to the standard OECD methodology for a second set of countries considered, namely the G7 excluding Italy. The United States is an interesting intermediate case as the statistical evidence for the proposed methodology is marginal, but the policy implications of the revised point estimate of the NAIRU are major.

JEL classification: C32, E24, E31, E32, J64.

Keywords: Long-term unemployment, flattening Phillips curve, NAIRU, euro area periphery, Kalman filter.

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1. Introduction

Unemployment in many OECD countries has soared and estimates of the NAIRU (Non-Accelerating Inflation Rate of Unemployment) appear increasingly fragile, while at the same time such estimates have become more important to policymaking: most notably, because of their formal incorporation in fiscal frameworks, but also because they provide a basis for assessing future deflation risks. The fragility of NAIRU estimates stems from the reduced ability of such estimates (specified as the gap with actual unemployment) in explaining inflation dynamics in Phillips curves equations. NAIRU estimates have critical implications for fiscal adjustment strategies which, in many countries, are set in terms of the cyclically-adjusted budget balances, with structural unemployment being an input to the cyclical adjustment. In case of the euro area countries, the cyclically-adjusted balance (CAB) has become the key indicator in the EU fiscal surveillance framework as it is adopted to assess country-specific medium-term fiscal objectives (MTO) as well as the corrective fiscal adjustment required for member states experiencing excessive deficit situations. Moreover, since the *European Fiscal Compact* entered into force in March 2012, EU member states are obliged to transfer their MTO into national binding laws and to pay financial sanctions in case of a repeated failure to comply with the set fiscal objectives.

At the same time, inflation seems to have become less sensitive to labour market dynamics and unemployment gaps, with such variables losing explanatory power in Phillips curves equations. Different factors have been recognised as playing a crucial role in this "flattening" of the Phillips curve, although their impact varies across different OECD countries. Rising unemployment levels and duration have contributed to exacerbate nominal wage stickiness, which associated with rigid labour market institutions, tend to curb inflation adjustments to macroeconomic dynamics. At the same time, the recent increase in labour mobility and migration, especially in Europe, contributes to reducing inflation due to existing differences in wage settings as well as consumption propensities between natives and immigrants. In addition, inflation expectations which are well anchored to central banks' inflation targets have weakened the relationship between inflation and labour market imbalances. However, previous attempts to include central bank inflation targets in the Phillips curve estimation did not produce satisfactory results (Guichard and Rusticelli, 2011). Finally, greater economic integration may have shifted the drivers of the inflation process away from domestic pressure towards more global drivers.

The purpose of this paper is to strengthen the relationship between inflation and the unemployment gap by considering the impact that hysteresis effects have on the NAIRU. The estimation here focuses on a selection of OECD countries: those of the European periphery, where risks of recent hysteresis dynamics are the highest, and the G7 which form a control group to verify whether the proposed methodology can be applied more generally. More specifically, the inclusion of long-term unemployment to model the NAIRU allows an upward shift in the structural component of actual unemployment associated with a tighter relationship between inflation and the unemployment gap. More specifically,

this modification helps increasing the size and the statistical significance of the unemployment gap coefficient in the Phillips curve estimated for the European peripheral countries, while it leaves the results for the G7 economies mostly little changed.

The next section briefly reviews the standard OECD method of estimating the NAIRU by means of a Kalman filter within a Phillips curve framework. Section 3 provides evidence of the reduced sensitivity of inflation to unemployment. The following section describes recent developments in aggregate and long-term unemployment, discussing the role of the latter in hysteresis dynamics and as a predictor of the NAIRU. Section 5 presents the proposed innovation to the existing standard estimation methodology which considers the inclusion of the change in long-term unemployment in modelling the NAIRU. The final section analyses the results and conclusions are drawn.

2. The current OECD approach to estimating the NAIRU

The standard state-space framework introduced in Gianella et al. (2008) and adopted to regularly update the NAIRU estimates for all OECD member states (most recently in Guichard and Rusticelli, 2011) can be summarised as:

$$\Delta\pi_t = \beta\left(u_t - u_t^*\right) + \sum_{j=1}^{A}\alpha_j \Delta\pi_{t-j} + \sum_{j=1}^{L}\lambda_j \Delta\pi_{t-j}^{imp} + \sum_{j=1}^{G}\gamma_j \Delta\pi_{t-j}^{oil} + \varepsilon_t \quad [1]$$

$$u_t = u_t^* + u_t^{gap} \quad [2]$$

$$u_t^{gap} = \phi_1 u_{t-1}^{gap} + \phi_2 u_{t-2}^{gap} + \eta_t \quad [3]$$

$$u_t^* = u_{t-1}^* + \nu_t \quad [4a]$$

The first equation represents the measurement equation of the state space model, i.e. the Phillips curve which relates changes in core consumer price inflation ($\Delta\pi_t$) to the unemployment gap (u_t^{gap}), lags of the change in inflation and control variables.[1] The control variables consist of two types of short-term supply shocks: changes in real import price inflation weighted by import penetration ($\Delta\pi^{imp}$) and changes in real oil price inflation ($\Delta\pi^{oil}$) weighted by oil intensity of production. The number of lags is determined on the basis of their statistical significance and to yield a parsimonious model. The second equation is an identity and specifies actual unemployment u_t as the sum of a structural component, i.e. the NAIRU u_t^*, and a cyclical one, i.e. the unemployment gap u_t^{gap}. The third and fourth equations are the transition equations of the state space describing the law of motion of the two unobserved components of unemployment and are consistent with the idea that both variables can be inferred on the basis of the inflationary pressure in the economy. For this purpose, equation [3] specifies the unemployment gap as a stationary second-order autoregressive process (Jaeger and Parkinson, 1994; Laubach, 2001).[2] The three error terms of the model $\varepsilon_t, \eta_t, \nu_t$ are all assumed to be i.i.d. normally distributed with mean zero and uncorrelated variances $\sigma_\varepsilon^2, \sigma_\eta^2, \sigma_\nu^2$, respectively.[3]

3. Evidence of reduced sensitivity of inflation to unemployment gaps

The reduced sensitivity of the inflation process to the economic activity has become a stylised fact which has generated a plethora of studies trying to assess whether the Phillips curve still remains a reliable tool to express the link between the evolution of prices and wages and labour market dynamics (Smets and Wouters, 2007; Borio and Filardo, 2007; Kuttner and Robinson, 2010; Williams, 2006; Benkovskis et al., 2011). A small or

insignificant slope coefficient β on the unemployment gap term in the Phillips curve in equation [1] implies high unemployment in excess of the NAIRU has little or no disinflationary effect. However, the source of this "flattening" of the Phillips curve is still a widely debated issue.

Many of these studies focus on the change that the reduced volatility implies for the properties of the inflation process, as well as the parameters of the Phillips curve (Roberts, 2006; Sargent, Williams and Zha, 2006; Smets and Wouters, 2007; Kuttner and Robinson, 2010). These latter conclude that changes in monetary policy affect the volatility of inflation and are the main reason for large declines in the Phillips curve slope when all other parameters underlying the inflation behaviour are held fixed. Changes in monetary policy, such as those associated with the introduction of inflation targeting or with euro area monetary integration, create both a mean and a persistence break in the inflation series which can undermine the stability of its relationship with labour market indicators (Bataa et al., 2014). Relatedly, the decline in inflation persistence observed in the last decade with respect to the two preceding ones is also the result of better-anchored inflation expectations around a clear long-run inflation objective which contributes to reduce the uncertainty inherent in estimated econometric models. As a consequence, both lower inflation persistence and a flatter slope in the Phillips curve imply a larger sacrifice ratio, i.e. a larger unemployment or negative output gap that the economy has to bear in order to achieve a given disinflation.

Alternatively, rather than being the result of effective monetary policies, some authors argue that the flattening of the Phillips curve is due to structural changes in the labour market that, when specifically accounted for, would leave the link between inflation and unemployment unchanged. Razin and Binyamini (2007) and Borio and Filardo (2007) explore the effect that an increased openness in labour markets has on domestic marginal costs and inflationary mechanisms and conclude that global factors exert a higher explanatory power on domestic inflation than those from domestic measures of economic slack, such as output or unemployment gaps. Blanchard and Galí (2010) and Elsby et al. (2010) show that the degree of labour market tightness, captured by increasing hiring costs and real wage rigidities, increases marginal costs, with "sclerotic" labour markets, such as those in Europe, displaying higher inflation persistency to productivity shocks than more flexible labour markets.

The reduced sensitivity of inflation to unemployment gaps is confirmed by re-estimating the OECD Phillips curves over sub-samples, comparing the most recent period 2000Q1-2012Q4 with a sub sample of similar length 1987Q1-1999Q4 (Table 1). For all countries examined, the coefficient on the unemployment gap estimated over the most recent period is smaller and less statistically significant when compared with the results obtained over the entire sample. In particular, when the estimates are carried out using two datasets of similar size, the relationship between unemployment and inflation seems to have especially weakened in the cases of Canada, Germany, Greece, and the United Kingdom.

The loss of responsiveness of inflation dynamics to cyclical unemployment is not a recent phenomenon generated by the global financial crisis, nor is it completely unrelated to future expectations on prices and wages developments. Since the late 1990s, the success of central banks in holding inflation stable and low, while anchoring inflation expectations to explicit target levels, contributes to explain the quite modest declines in inflation in the

Table 1. **Estimated coefficients of the unemployment gap in the Phillips curve**

	Whole data sample	1987Q1-1999Q4	2000Q1-2012Q4
Canada	-0.103***	-0.129***	0.037
France	-0.112***	-0.065*	-0.065
Germany	-0.062***	-0.106*	-0.007
Greece	-0.046*	-0.167***	-0.006
Ireland	-0.035**	-0.051*	-0.005
Italy	-0.048*	-0.034	-0.034
Japan	-0.232***	-0.005	-0.004
Portugal	-0.092**	-0.052	-0.017
Spain	-0.028**	-0.015	-0.001
United Kingdom	-0.149***	-0.131**	-0.039
United States	-0.036***	-0.044**	-0.006

Notes: The Phillips curve specification and the exact period to which the estimation over "the whole data sample" refers are reported in Table 3. *, **, *** indicate statistically significant at 10%, 5% and 1%, respectively.

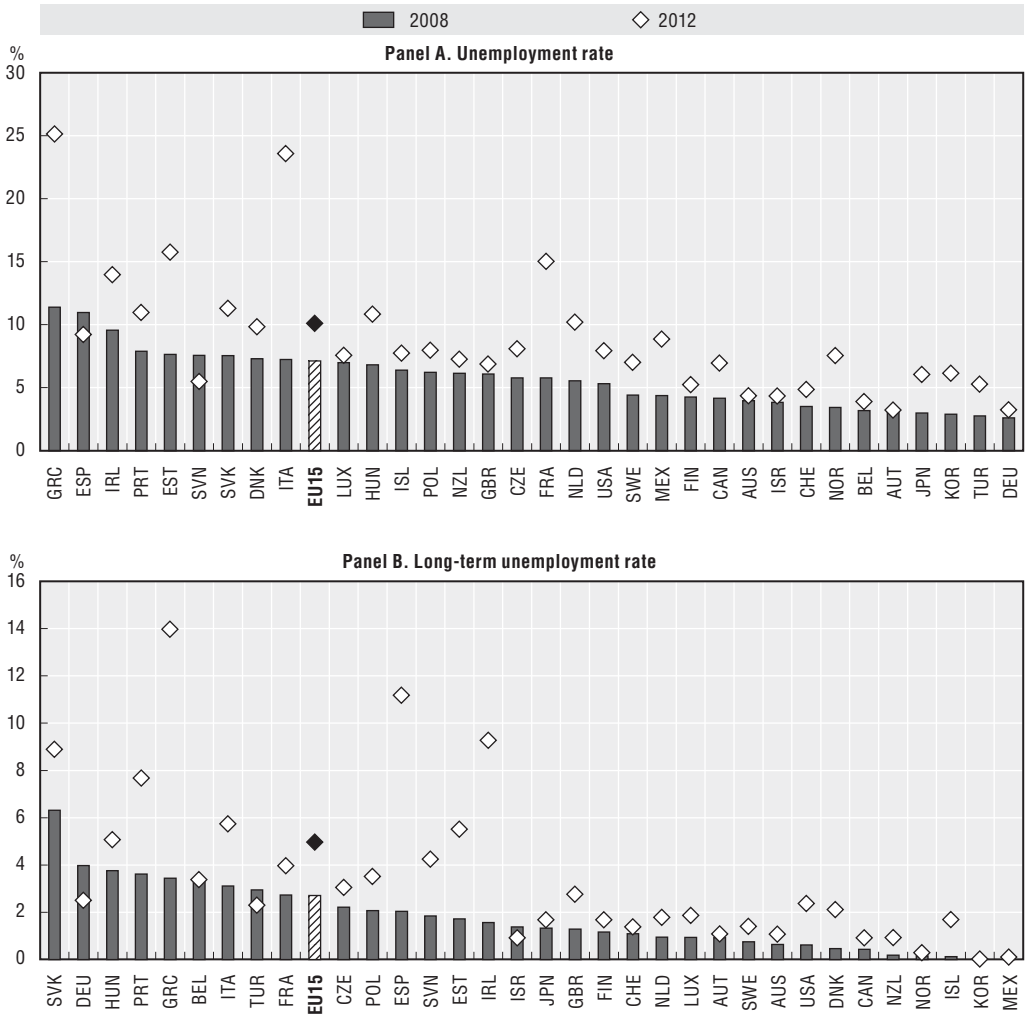
aftermath of the global crisis, despite the existence of a great economic slack (IMF, 2013). As empirical evidence, the OECD Phillips curves estimated over the sub-sample covering the pre-crisis period, i.e. 2000Q1-2007Q4, return a not statistically significant coefficient of the unemployment gap for all the countries considered in the present exercise. These results suggest that the flattening of the Phillips curve began much earlier than the global crisis, and most likely around the time when inflation-targeting regimes were adopted across advanced economies (Rusticelli et al., 2014).

The observed flattening of the Phillips curve at low levels of inflation is also consistent with the existence of downward nominal wage rigidities (Yellen, 2012). The relevance of nominal downward wage rigidities has risen considerably since the beginning of the crisis, accompanied by an increased incidence of nominal wage freezes across the OECD as a whole (*OECD Employment Outlook*, 2014). As proof, recent regression-based estimates of wage-Phillips curves, which control for price developments, indicate that the slope of the Phillips curve has flattened during the course of the global financial crisis as nominal wage growth has slowed (*OECD Employment Outlook*, 2014). Moreover, the adjustment of nominal wages to the persistent labour market slack tends to be higher in good times rather than in bad times, introducing therefore an asymmetric responsiveness of nominal wage growth over the cycle.[4]

4. Recent developments in long-term unemployment and risks of hysteresis

The global financial crisis has had alarming repercussions on OECD unemployment rates, with particularly severe increases being experienced by the European peripheral countries (Figure 1, panel A). In the five-year period following the crisis, unemployment has increased on average by 3¾ percentage points in the euro area as a whole and by 12 percentage points on average in the peripheral countries of Greece, Ireland, Spain and Portugal. In these countries, unemployment continues to rise with average unemployment rates equal to about 20% in 2013. Beyond Europe, the effects of the economic recession on labour markets have been less extreme in the United States and Japan, where the unemployment rate has increased by about 2½ and ½ percentage points, respectively, since the beginning of the financial crisis.

Figure 1. **Developments in unemployment rates**



Note: The long-term unemployment rate refers to the unemployment rate for those unemployed for more than 12 months.
Source: Eurostat, OECD *Labour Force Statistics Database*.

From the mid-1980s until the beginning of the sovereign debt turmoil in 2010, euro area long-term unemployment remained fairly stable at around 4%. Indeed, the boom in the real estate sector in both Spain and Ireland contributed to reduce long-term unemployment in the European peripheral countries, which reached the average lowest rate of 2.7% at the onset of the global financial crisis in 2007. But, as unemployment started to rise, as a consequence of the economic recession generated from both the global financial and the sovereign debt crisis, the share of long-term unemployment (the percentage of the active population having been unemployed for 12 months or more) first declined due to the increase in inflows with short duration, then it increased given the decline in both the exit probabilities and the outflows from unemployment. The latter are more extreme in Europe than the United States and Japan (*OECD Employment Outlook*, 2011) and in part explain the quite heterogeneous behaviour of unemployment indicators across the OECD. It follows that the

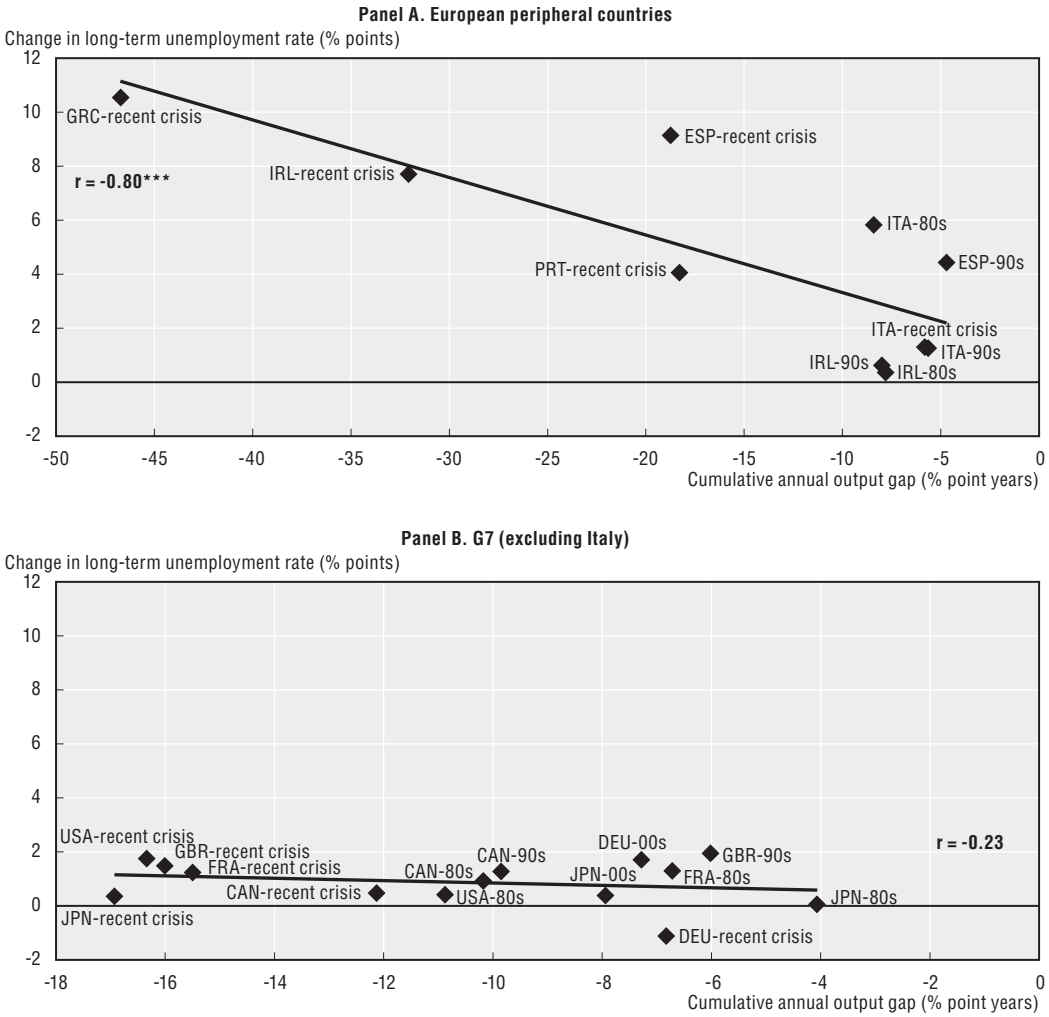
average duration of unemployment is much longer in the euro area than elsewhere, and as consequence long-term unemployment in the euro area is at present more than double that of the United States (Figure 1, panel B), at 5% and 2.4%, respectively. In the European peripheral countries (notably Greece, Ireland, Spain and Portugal), the rate of long-term unemployment in 2012 is on average twice as large as that of the entire euro area, i.e. 10%, with an average rise by about 8 percentage points since the beginning of the crisis.

The rise in aggregate unemployment caused by economic downturns is more likely to degenerate into an increase in long-term unemployment depending on the setting of labour and product-market structural policies (Llaudes 2005; Guichard and Rusticelli, 2010). More precisely, in those countries where product-market regulations (PMR) are tighter both the level of long-term unemployment and its response to a shock on the actual unemployment rate are higher (by about 0.1 to 0.25 percentage points per unit of PMR). Likewise, where long-term unemployment benefits are generous, the response of long-term unemployment to a shock on aggregate unemployment will tend to increase by 0.1 percentage points for each percentage point shock. Conversely, active labour market policies and the level of protection on regular contracts contribute to reducing both the level of long-term unemployment and its response to aggregate unemployment.

Moreover, this increase in long-term unemployment seems to be proportional to the severity of recessions in European peripheral countries (Figure 2, panel A). In these countries, prolonged downturns, represented here by episodes in which negative output gaps are at least 2% and last for at least eight quarters, are significantly associated with a rise in long-term unemployment, and it is particularly evident for the recent economic crisis.[5] Conversely, this relationship does not seem to hold for the other large economies considered here, where against the backdrop of adverse economic conditions the risk of unemployment persistence is lower (Figure 2, panel B). At the same time, Figure 2 also highlights that the large dispersion of unemployment rates across both groups of countries in the aftermath of economic downturns is due not only to different institutional settings, but also to the different magnitude of the shock experienced.

A major risk associated with protracted unemployment spells is that they lead to long-term unemployment, which can cause a deterioration of human capital, with the long-term unemployed detaching progressively from the labour market. A consequent reduction in wage bargaining pressure exerted by the long-term unemployed prevents real wages from adjusting to the adverse shock, with a consequent decline of total labour demand (Phelps, 1972; Blanchard and Summer, 1986; Layard and Nickell, 1987; Lindbeck and Snower, 1988). Under the effect of these dynamics, the NAIRU can rise permanently through a so-called *hysteresis* effect. In this respect, hysteresis can be regarded as an extreme case of high persistence of unemployment which does not return to any specific value and depends on the history of shocks (Blanchard, 2006).

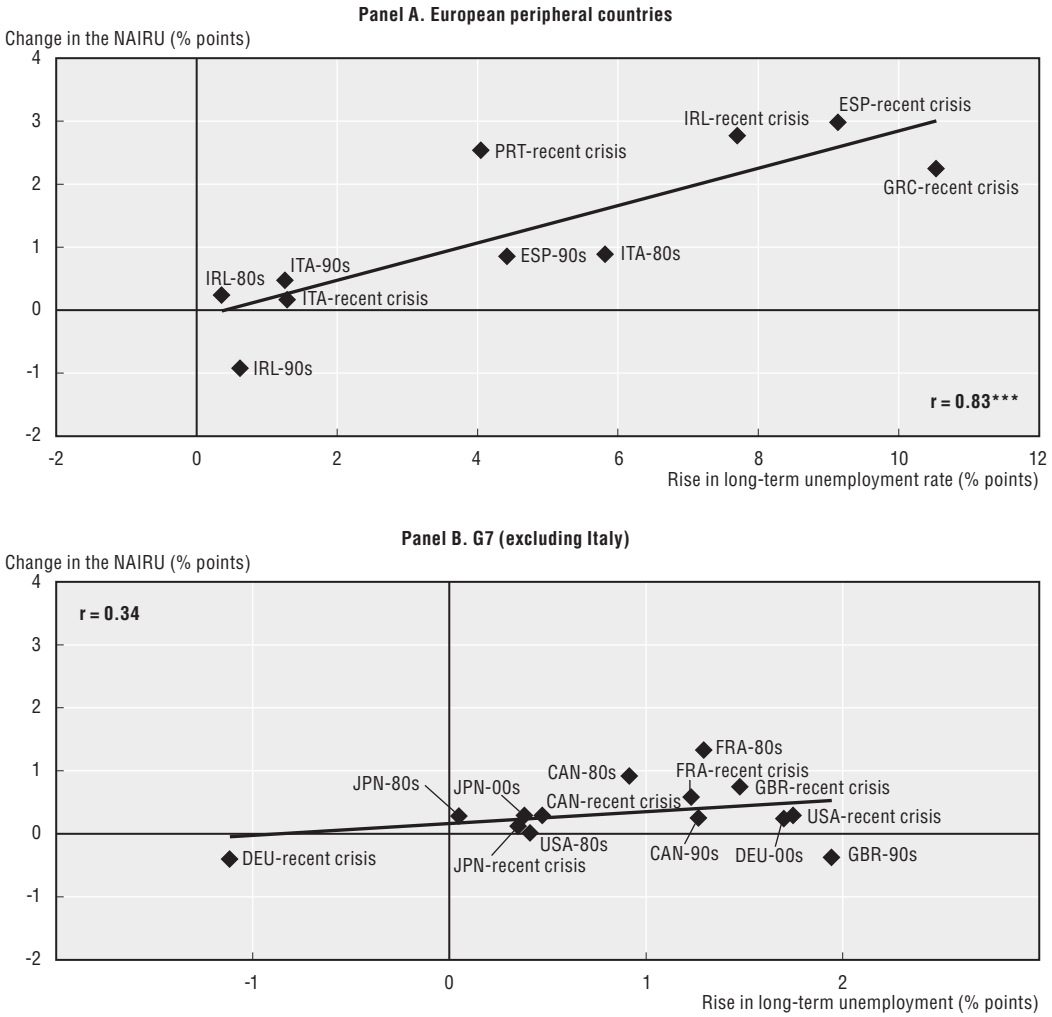
Figure 2. **Changes to long-term unemployment following economic downturns**



Notes: The scatterplot illustrates the rise in the long-term unemployment rate between the year prior to an episode of severe economic downturn to the year after the end of the episode. The episodes selected correspond to periods of negative annual output gap exceeding 2% and lasting for at least two consecutive years. *** indicates that the correlation index *r* is statistically significant at 1%.
Source: OECD *Economic Outlook 90 Database*, Eurostat, OECD *Labour Force Statistics Database*, OECD calculations.

The risk of hysteresis associated with protracted unemployment spells increases proportionally with the rise in long-term unemployment rates. In particular, during severe recessions as labour-market conditions worsen, the NAIRU increases significantly in line with the increase in long-term unemployment in the European periphery (Figure 3, panel A). Following the recent economic crisis, the average rise in the long-term unemployment rate was about 8 percentage points in Ireland, Greece, Spain and Portugal, while the NAIRU increased on average by 2¾ percentage points at the end of 2012 (*OECD Economic Outlook, 2012/2*). Among G7 countries (excluding Italy) this relationship is weaker and not statistically significant. More specifically, excluding Germany, the average rise in long-term unemployment following the recent economic downturn equals 1 percentage point and it is associated with an average increase in the NAIRU by only ½ percentage point (Figure 3, panel B).[6]

Figure 3. **Relationship between long-term unemployment and the NAIRU**



Notes: The scatterplot shows the change in the NAIRU associated with a rise in the long-term unemployment rate in correspondence of severe recession episodes. The episodes selected correspond to periods of negative annual output gap exceeding 2% and lasting for at least two consecutive years. *** indicates that the correlation index *r* is statistically significant at 1%.
Source: OECD *Economic Outlook 92 Database*, Eurostat, OECD *Labour Force Statistics Database*, OECD calculations.

5. A modified methodology for estimating the OECD NAIRU using long-term unemployment

In order to take into account the most recent developments in OECD labour markets and the risk of hysteresis,[7] long-term unemployment has been included in the NAIRU modelling equation. This may be particularly important when changes in unemployment are large and rapid because the smoothness parameters underlying filtering methods, which may be appropriate in "normal" times, may be too restrictive. In the post-crisis period, this could lead to the under-estimation of the NAIRU and contribute to explaining the reduced statistical significance of unemployment gaps in explaining inflation.[8] This methodological modification helps increasing both the size and the statistical significance of the coefficient on the unemployment gap in the estimated Phillips curve, while improving its goodness-of-fit. However, in line with the very few studies previously considering the inclusion of long-term unemployment to model the unemployment gap

(Box 1), the change in long-term unemployment which translates into a rise of structural unemployment differs across countries and is statistically significant only in the case of the European peripheral countries.

The change in the lagged long-term unemployment rate has been added to the first-order random walk process modelling the NAIRU in equation [4a]. More precisely, the additional variable in equation [4b] takes the form of a stochastic non-stationary time-varying drift:[9]

$$u_t^* = u_{t-1}^* + \rho \Delta u_{t-1}^{ltu} + v_t \qquad [4b]$$

The coefficient ρ represents the proportion of the change in long-term unemployment that translates into an increase in structural unemployment, so capturing hysteresis effects. It is estimated by applying the Kalman filter to the same state-space model presented in Section 2 and using the same Phillips curve specification which is regularly estimated to derive the NAIRU series used by the OECD.

Box 1. **Previous studies considering long-term unemployment in Phillips curve estimation**

To the author's knowledge, only a few empirical studies have considered the inclusion of long-term unemployment in modelling the NAIRU. They mainly focus on European labour markets, which are traditionally more prone to hysteresis phenomena. A frequent limitation to the use of long-term unemployment in such applications is the short time span over which time series for long-term unemployment is available.

Llaudes (2005) constructs an unemployment index in which the weight of both the short-term and the long-term unemployment rate on the unemployment gap is estimated within a Phillips curve cast into a state-space framework by applying Kalman filter techniques. The results confirm that the long-term unemployed have a smaller weight than the short-term unemployed in the determination of prices and wages. The new index is employed to estimate the NAIRU and the unemployment gap entering the Phillips curve. The author finds that the relative impact of long-term unemployment on inflation varies across countries, with the difference between short- and long-term unemployment being less marked in non-European economies than European ones, suggesting that the share of long-term unemployment which is translated into structural unemployment might be higher in Europe than elsewhere.

Following Llaudes's findings, Guichard and Rusticelli (2010) assume that one-third of the increase in long-term unemployment translates into increases in the NAIRU in the United States, the United Kingdom and other non-European OECD countries, whereas a share of two-thirds is assumed for the rest of Europe. This calibration was proposed as a means of accounting for hysteresis effects in the immediate aftermath of the financial crisis. It is consistent with the rationale that the long-term unemployed exert significantly less pressure on wages than the short-term unemployed and that the relative impact of the long-term unemployed on wages and prices varies across countries.

Applying Kalman filter techniques to a similar modelling formulation adopted by the OECD, Logeay and Tober (2006) focus on the euro area as a whole and find that the lagged unemployment rate for the euro area plays a significant role in supporting the importance of hysteresis effects. More precisely, the coefficient of the lagged unemployment rate in the NAIRU estimating equation is significant and equals 0.26, suggesting the presence of hysteresis at the aggregate euro area level (similar results were found in Jaeger and Parkinson, 1994). Due to the limited availability of long series on long-term unemployment of individual European countries, Germany is the only country for which hysteresis effects have been investigated through the inclusion of long-term unemployment in the NAIRU equation. The authors estimate a long-term unemployment coefficient of 0.82,

Box 1. **Previous studies considering long-term unemployment in Phillips curve estimation** *(cont.)*

which multiplied by one-third, i.e. the share of long-term unemployment in total unemployment in Germany, gives a corresponding coefficient of 0.25 for lagged unemployment and it is therefore consistent with the coefficient of 0.26 previously estimated for the euro area lagged unemployment rate.

Using a similar framework to the standard Phillips curve set-up estimated by the OECD, Kajuth (2010) adds the long-term unemployment rate to the second-order random walk process with time varying drift modelling the NAIRU for Germany. The author estimates a significant coefficient equal to 0.28 capturing the impact of long-term unemployment on the NAIRU, which reaches 8% in 2009, the end of the estimation period. This result is similar to the OECD estimate of 7.6% (Guichard and Rusticelli, 2011) which was obtained applying a similar methodology, but without the adjustment for hysteresis made by including long-term unemployment.

6. Empirical results from applying the modified methodology for the NAIRU estimation

Both the standard and the modified modelling procedures have been applied and compared on a common data sample, which has been shortened given that data on long-term unemployment are not available over the full sample. The results are, however, mixed: the inclusion of long-term unemployment in modelling the NAIRU appears to improve the fit of the Phillips curve equation for some countries, but not all.

More specifically, the estimation results imply two groups of countries, and it is only for the first of these that the new methodology demonstrates an effective improvement to the standard OECD method for estimating the NAIRU (Table 2).

For the first group of countries – Greece, Ireland, Italy, Portugal and Spain (see upper half of Table 2) – where long-term has typically risen the most while capturing hysteresis effects in the labour market, the new methodology demonstrates an effective

Table 2. **Estimated coefficients from the standard and modified methodology to NAIRU modelling**

	Change in lagged long-term unemployment (ρ)	*Standard methodology*	*Modified methodology*	Difference in NAIRU estimates in 2012 (% pts)
		Unemployment gap (β)	Unemployment gap (β)	
Greece	0.43***	-0.035	-0.049**	1.64
Ireland	0.75***	-0.014	-0.034*	3.71
Italy	0.72***	-0.022*	-0.064***	0.68
Portugal	0.78***	-0.059*	-0.065*	0.15
Spain	0.73***	-0.017	-0.020*	-1.07
Canada	1.53	-0.116***	-0.143***	0.21
France	0.74	-0.084***	-0.097***	-0.03
Germany	0.47	-0.054**	-0.067**	-0.42
Japan	1.65	-0.176*	-0.131*	0.34
United Kingdom	0.58	-0.098**	-0.101**	0.23
United States	0.74	-0.031***	-0.045***	1.40

Notes: The NAIRU estimation with both the standard and the modified methodologies has been performed on the same observations sample according to the availability of data on long-term unemployment. *, **, *** indicate statistically significant at 10%, 5% and 1%, respectively.

improvement to the standard OECD method for estimating the NAIRU in a number of respects:

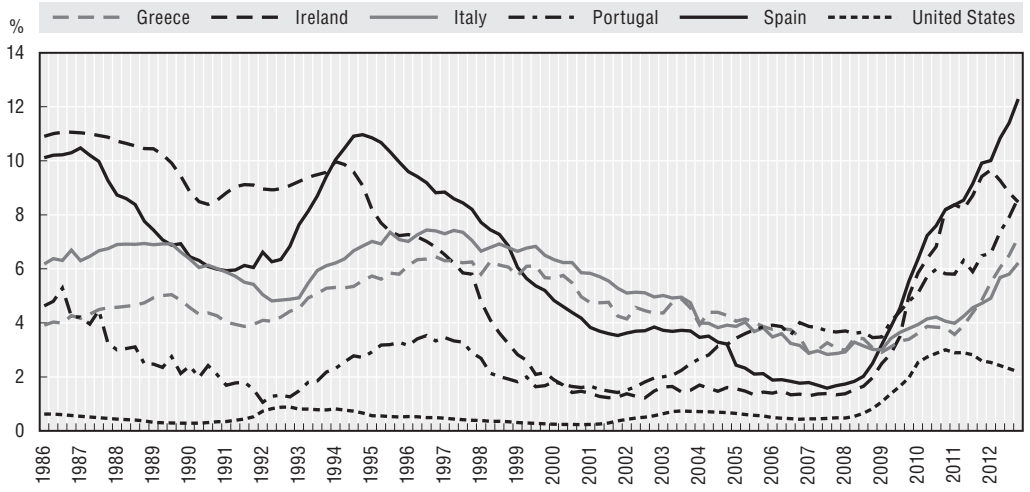
- The estimated coefficient ρ on the change in lagged long-term unemployment is statistically significant and of a plausible magnitude. It varies from 0.43 to 0.78 with an average value of 0.68, this latter in line with Guichard and Rusticelli (2010), who assume that the share of the change in long-term unemployment which is translated into a rise of structural unemployment equals two-thirds for the Continental European countries.
- The fit of the Phillips curve is improved as indicated by the increased magnitude and statistical significance of the slope coefficient β on the unemployment gap; notably for Greece, Ireland and Spain, this coefficient is statistically significant only when long-term unemployment is included in the new estimation technique and becomes much larger in the case of Italy and, to a lesser extent, for Portugal.
- Differences in the NAIRU estimates are meaningfully different from an economic perspective; for 2012 they increase by a minimum of 0.2 percentage points in the case of Portugal to a maximum of 3.7 percentage points for Ireland, while the estimate for Spain is revised downward by 1 percentage point when long-term unemployment is included in the modelling equation.

For the second group of countries – Canada, France, Germany, Japan, the United Kingdom and the United States (see lower half of Table 2) – there is a less compelling case that the new methodology provides an improvement to the standard OECD methodology:

- The coefficient of long-term unemployment is either not significant or takes implausible values (as in case of Canada and Japan) indicating that this latter does not play any relevant role in explaining the NAIRU increase following the financial crisis.
- The new methodology does not improve the fit of the Phillips curve when compared with the standard approach. The Wald test, performed on the unemployment gap coefficients β, does not reject the null hypothesis of equality of the estimated coefficients from the application of the standard and the new approach for any country. These findings seem to cast some doubt on whether the new methodology should be applied mechanically in the same way across all countries. For this reason, more results are shown only for those countries where the new approach is successful.
- NAIRU point estimates for 2012 are revised upward only marginally, by 0.2 percentage points on average for all countries except Germany and the United States, for which the size of the revision is larger. In particular, the NAIRU is estimated to decrease by ½ percentage point for Germany, while for the United States the upwards revision is nearly 1½ percentage points.
- The United States is an interesting intermediate case as the statistical evidence for the proposed methodology is marginal, but the economic relevance of the revised NAIRU is major. The statistical significance of the coefficient associated with the change in long-term unemployment is very low, although the coefficient of the unemployment gap is larger and more significant when hysteresis effects on the NAIRU are taken into consideration in the new specification (Table 2). The revised NAIRU for the final quarter of 2012 is 8%, which is significantly higher than both the point estimate obtained by applying the standard OECD methodology and the latest CBO estimate,[10] by 1.4 and 2.0 percentage points, respectively. The higher estimate would imply that that the unemployment gap was already closed by the end of 2012. These results can be considered in light of the recent debate on the role played by the prolonged high rate of

long-term unemployment generated by the recent economic crisis in determining the level of inflation and affecting monetary policy strategies in the United States. More specifically, despite the large and relatively new persistence of long-term unemployment compared with the euro area periphery (Figure 4), most recent studies conclude that long-term unemployment only exerts a limited pressure if any on inflation and has a negligible effect in holding down wages (Gordon, 2013; Watson, 2014; Krueger et al., 2014). Thus to the extent that there has been an increase in US long-term unemployment which is unprecedented in the post-war period, some increase in the NAIRU seems likely but not as large as the one estimated by the new methodology.

Figure 4. **Long-term unemployment developments in the euro area periphery and the United States**

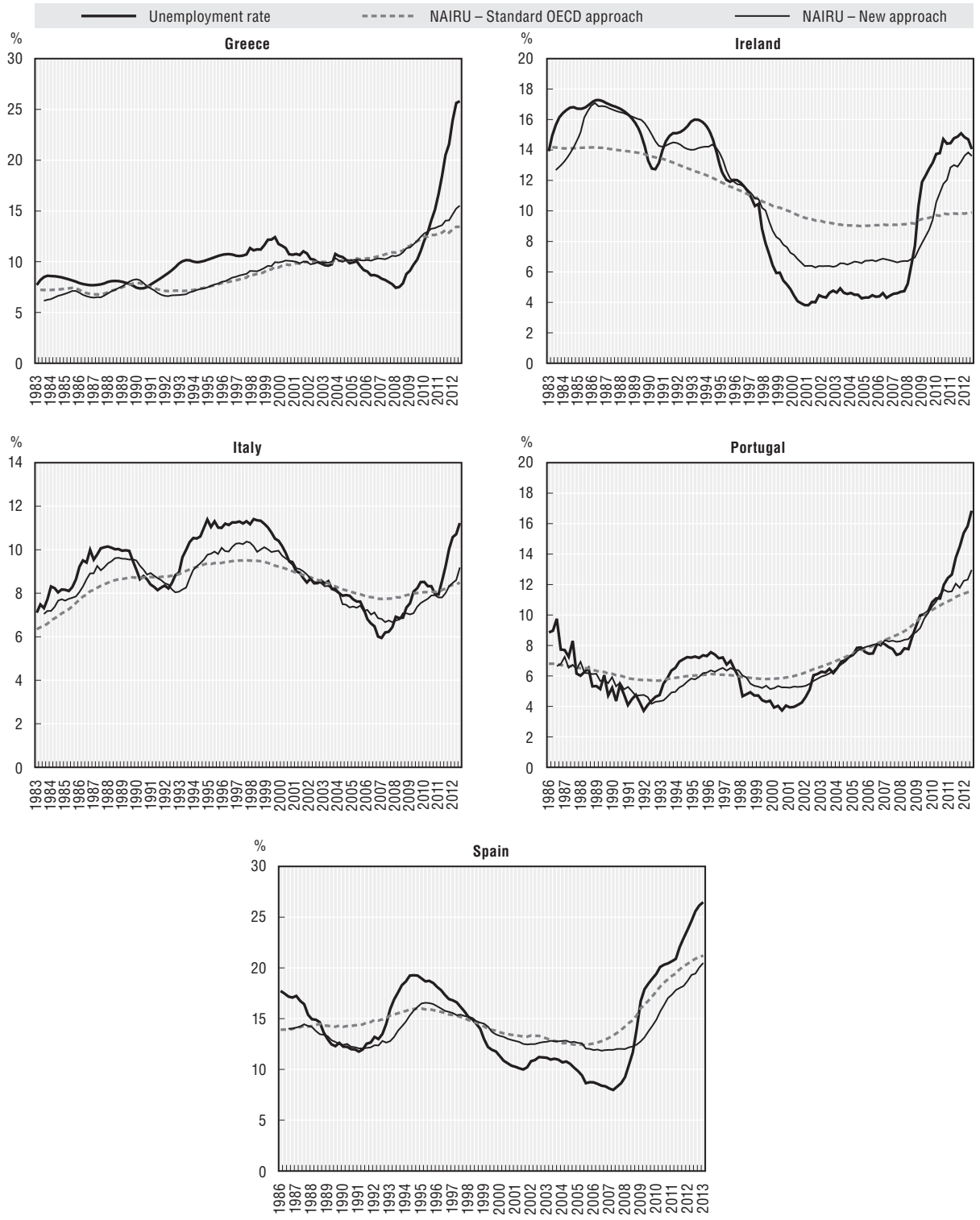


Source: OECD *Labour Force Statistics Database*.

The increase in the estimated NAIRU since the start of the financial crisis is the largest for Spain, followed by Portugal and Greece (Figure 5). In these countries, the NAIRU has risen by 6 percentage points for Spain and 2½ percentage points for Greece and Portugal when applying the standard OECD approach. The modified estimation technique provides an even larger rise in the NAIRU estimate in the aftermath of the crisis. More precisely, in the period 2008-12, the average increase in the NAIRU equals 5 percentage points, from a minimum rise of 2 percentage points in case of Italy to a maximum of 7 percentage points for Spain. On the other hand, the revised methodology also implies revised NAIRU estimates in the pre-crisis period as a consequence of unusually low long-term unemployment rates. On average, for the first group of countries, the new NAIRU is 0.7 percentage points lower than the estimate obtained through the standard methodology over the period 2005-08, with the largest downward correction by 1¼ percentage points for Ireland and Spain.

The new Phillips curve better explains changes in inflation (Table 3). In the case of Spain, Ireland and Greece, the Phillips curve estimated on a dataset starting from mid-1980s, i.e. shorter than that considered for the regular *Economic Outlook* updates, shows a weaker relationship between inflation and the unemployment gap (as indicated by the unemployment gap coefficient no longer being statistically significant), with unemployment rising and core inflation close to zero (second column in Table 3). However,

Figure 5. **NAIRU estimates following the standard and the new approach**



Source: OECD Economic Outlook 93 Database, OECD estimates.

Table 3. **Phillips curve estimation results**

	Greece			Ireland		
Sample period	**1975Q1-2013Q1**	**1983Q3-2012Q4**	**1983Q3-2012Q4**	**1978Q3-2013Q1**	**1986Q2-2012Q4**	**1986Q2-2012Q4**
Specification	**Standard**	**Standard**	**New**	**Standard**	**Standard**	**New**
constant						
$\Delta\pi_{t-1}$	-0.51***	-0.36***	-0.38***	-0.62***	-0.28***	-0.29***
$\Delta\pi_{t-2}$	-0.35***	-0.39***	-0.39***	-0.25***	-0.24***	-0.25***
$\Delta\pi_{t-3}$	-0.15**	-0.25***	-0.25***	0.30***		
$\Delta\pi_{t-4}$	-0.19***	-0.27***	-0.29***			
u_t-u_t^*	-0.05*	-0.04	-0.05**	-0.03**	-0.01	-0.03*
$\Delta\pi_{t-1}^{imp}$				0.20***	0.13***	0.14***
$\Delta\pi_{t-4}^{imp}$						
$\Delta\pi_{t-1}^{oil}$						
Dummy				2009Q1, 2009Q4	2009Q1, 2009Q4	2009Q1, 2009Q4
Sacrifice ratio	2.8	4.0	2.9	3.3	6.6	2.8
Adj. R^2	0.26	0.17	0.18	0.58	0.39	0.39
	Italy			**Portugal**		
Sample period	**1968Q4-2013Q1**	**1983Q3-2012Q4**	**1983Q3-2012Q4**	**1980Q1-2013Q1**	**1986Q2-2012Q4**	**1986Q2-2012Q4**
Specification	**Standard**	**Standard**	**New**	**Standard**	**Standard**	**New**
constant						
$\Delta\pi_{t-1}$	-0.15**	-0.47***	-0.49***	-0.50***	-0.38***	-0.39***
$\Delta\pi_{t-2}$	-0.16**	-0.28***	-0.36***	-0.26***	-0.34***	-0.35***
$\Delta\pi_{t-3}$						
$\Delta\pi_{t-4}$						
u_t-u_t^*	-0.05*	-0.02*	-0.06***	-0.09**	-0.06*	-0.06*
$\Delta\pi_{t-1}^{imp}$	0.18***	0.12***	0.13***	0.29***	0.19***	0.20***
$\Delta\pi_{t-4}^{imp}$						
$\Delta\pi_{t-1}^{oil}$						
Dummy	1975Q1, 1976Q1			1983Q2-Q3		
Sacrifice ratio	1.6	4.9	1.8	1.2	1.8	1.7
Adj. R^2	0.29	0.18	0.22	0.25	0.22	0.20
	Spain					
Sample period	**1978Q1-2013Q1**	**1986Q2-2012Q4**	**1986Q2-2012Q4**			
Specification	**Standard**	**Standard**	**New**			
constant	-0.05*	-0.02				
$\Delta\pi_{t-1}$	-0.67***	-0.71***	-0.71***			
$\Delta\pi_{t-2}$	-0.17***	-0.17***	-0.17***			
$\Delta\pi_{t-3}$						
$\Delta\pi_{t-4}$						
u_t-u_t^*	-0.03**	-0.02	-0.02*			
$\Delta\pi_{t-1}^{imp}$						
$\Delta\pi_{t-4}^{imp}$						
$\Delta\pi_{t-1}^{oil}$	0.06*	0.07**	0.07*			
Dummy	1986Q1, 2002Q1	2002Q1	2002Q1			
Sacrifice ratio	3.8	7.0	5.9			
Adj. R^2	0.58	0.64	0.63			

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1%, respectively.

the new approach seems to strengthen this relationship and to improve the goodness-of-fit of the estimated equation for all countries (third column in Table 3). Moreover, the stability of the parameters estimated in the new Phillips curve has been tested against two alternative hypotheses of a structural change in the relationship between inflation and the unemployment gap occurring a) in 1998, assumed as starting period for the explicit inflation-targeting pursued by the European Central bank in the euro area; b) in 2009, at the onset of the global crisis blow to labour markets. The Chow test fails to reject the null hypothesis of absence of a structural break for all European peripheral countries considered, thus confirming the robustness of the estimated Phillips curve specification when long-term unemployment is included to account for hysteresis risks.

7. Conclusions

This paper presents a modification of the existing OECD approach to estimate the NAIRU in the context of a flattening Phillips curve, where the reduced sensitivity of the inflation process to the economic activity is translated into a loss of statistical significance of the unemployment gap. The proposed alternative aims at strengthening the relationship between inflation and labour market developments by considering the impact on aggregate unemployment associated with hysteresis effects, which are particularly important in the latest economic downturn. For this purpose, recent changes in long-term unemployment have been taken as an indication of possible risks of permanent rises in the structural unemployment and included directly in the NAIRU modelling equation. Only a selection of OECD countries has been examined: the European peripheral ones, where risks of recent hysteresis dynamics are the highest, and the G7 economies which form a control group to verify whether the proposed methodology can be applied more generally.

This methodological modification helps increasing both the size and the statistical significance of the coefficient on the unemployment gap in the estimated Phillips curve, while improving its goodness-of-fit and warranting the stability of the estimated parameters. However, the change in long-term unemployment which translates into a rise of structural unemployment differs across countries and is statistically significant only in the case of the European peripheral countries. On average for these countries – namely Greece, Ireland, Italy, Portugal and Spain – the new NAIRU is between 0.2 and 3.7 percentage points higher than the standard OECD NAIRU in 2012, while the estimated coefficient on the change in lagged long-term unemployment is statistically significant and of a plausible magnitude. For the second group of countries – Canada, France, Germany, Japan, the United Kingdom and the United States – there is a less compelling case that the new methodology provides an improvement to the standard OECD methodology.

Following these encouraging results and the need to improve both the macroeconomic and statistical explanatory power of a flattening Phillips curve, these modifications could be extended to a broader set of OECD countries. Similarly, new research could explore whether different lengths of unemployment duration have a different influence on the unemployment gap estimate, by considering an index as in Llaudes (2005) for instance, where the pressure on wage and prices is disentangled by short- and long-term unemployment. An alternative hypothesis for understanding the flattening of the Phillips curve would be to examine the existence of structural breaks directly affecting the inflation process arising from the establishment of explicit inflation targeting and its role in anchoring inflation expectations (Rusticelli et al., 2014).

Notes

1. Due to the longer span of data, headline CPI inflation is used for Canada, Greece, Portugal and the United Kingdom.
2. The sum of the autoregressive parameters is constrained to vary between 0.7 and 0.9 in order to ensure the stationarity of the unemployment gap.
3. Following the approach of Staiger et al. (1997), Laubach (2001) and Llaudes (2005), these parameters are empirically selected on an individual country basis and fixed throughout the estimated state space model in order to preserve good distributive properties for the unobserved components. The estimation of the signal-to-noise ratio can lead to very flat NAIRUs due to the so-called pile-up problem (Stock, 1994): pure maximum likelihood estimation methods of the variance of non-stationary processes yield estimates which are downward biased towards zero when the true unknown parameter is small, as in the case of the standard deviation of the innovation process in the random walk describing the NAIRU model. More details on the initialisation procedure for the state parameters and the selection of the variances of the error terms can be found in Guichard and Rusticelli (2011).
4. It should be noted that the unemployment gap is computed as difference to constant trend unemployment, calculated as historical mean over the estimation period. Therefore, the slope of the Phillips curve and the size of the estimated unemployment gap may be biased by unaccounted movements in the unobserved structural unemployment.
5. The episodes of large negative output gaps associated with the recent financial crisis differ from all other episodes considered since they are not concluded and aggregate unemployment is not back to its natural rate.
6. When the episodes of economic recession associated with the recent crisis are removed from the observation sample, the correlation index r is reduced but still equals 0.72 for the European peripheral countries and -0.10 instead of 0.34 for the G7 economies (excluding Italy).
7. The Perron test of stationarity in the presence of structural breaks has been performed and does not reject the null hypothesis of the existence of a unit root for any of the countries considered when a drift and a trend are also included. This result further suggests that hysteresis is an intrinsic characteristic of the European labour market even when changes in labour market institutions and policies are taken into consideration.
8. This can only be a partial explanation, as the reduced significance of gap terms in explaining inflation is a well-documented effect over the pre-crisis period.
9. The augmented Dickey-Fuller test of stationarity performed on the level of long-term unemployment confirms the presence of a unit root for all countries. As a consequence, the NAIRU model follows instead a second-order random walk process (see Laubach, 2001 or Llaudes, 2005 for references on I(2) models for NAIRU specifications).
10. United States Congressional Budget Office's February 2014 report: *The Budget and Economic Outlook: 2014 to 2024*.

References

Bataa, E., D.R. Osborn, M. Sensier and D. van Dijk (2014), "Identifying Changes in Mean, Seasonality, Persistence and Volatility for G7 and Euro Area Inflation", *Oxford Bulletin of Economics and Statistics*, Vol. 76, Issue 3, pp. 360-388.

Benkovskis, K., et al. (2011), "Assessing the Sensitivity of Inflation to Economic Activity", *European Central Bank Working Paper Series*, No. 1357.

Blanchard, O.J. (2006), "European Unemployment: The Evolution of Facts and Ideas", *Economic Policy,* CEPR, CES, MSH, Vol. 21(45), pp. 5-59.

Blanchard, O.J. and L.H. Summers (1986), "Hysteresis and the European Unemployment Problem", *NBER Macroeconomic Annual*, MIT Press, Cambridge, MA.

Blanchard, O.J. and J. Galí (2010), "Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment", *American Economic Journal: Macroeconomics*, 2 (2), pp. 1-33.

Borio, C. and A. Filardo (2007), "Globalisation and Inflation: New Cross-country Evidence on the Global Determinants of Domestic Inflation", *Bank for International Settlements Working Papers*, No. 227.

Elsby, M., B. Hobijn and A. Sahin (2010), "The Labor Market in the Great Recession", *NBER Working Paper*, No. 15979.

Gianella, C., et al. (2008), "What Drives the NAIRU? Evidence from a Panel of OECD Countries", *OECD Economics Department Working Papers*, No. 649, OECD Publishing, *http://dx.doi.org/10.1787/231764364351*.

Gordon, R.J. (2013), "The Phillips Curve is Alive and Well: Inflation and the NAIRU during the Slow Recovery", *NBER Working Paper*, No. 19390.

Guichard, S. and E. Rusticelli (2010), "Assessing the Impact of the Financial Crisis on Structural Unemployment in OECD Countries", *OECD Economics Department Working Papers*, No. 767, OECD Publishing, *http://dx.doi.org/10.1787/5kmftp8khfjg-en*.

Guichard, S. and E. Rusticelli (2011), "Reassessing the NAIRUs after the Crisis", *OECD Economics Department Working Papers*, No. 918, OECD Publishing, *http://dx.doi.org/10.1787/5kg0kp712f6l-en*.

IMF (2013), "The Dog that didn't Bark: Has Inflation been Muzzled or was it Just Sleeping", *World Economic Outlook*, April.

Jaeger, A. and M. Parkinson (1994), "Some Evidence on Hysteresis in Unemployment Rates", *European Economic Review*, No. 38, pp. 329-342.

Kajuth, F. (2010), "NAIRU Estimates for Germany: New Evidence on the Inflation-unemployment Trade-off", *Discussion Paper Series 1: Economic Studies*, No. 19, Deutsche Bundesbank, Research Centre.

Krueger, A.B., J. Cramer and D. Cho (2014), "Are the Long-Term Unemployed on the Margins of the Labor Market?", *Brookings Papers on Economic Activity*, Spring.

Kuttner, K. and T. Robinson (2010), "Understanding the Flattening Phillips Curve", *The North American Journal of Economics and Finance*, Elsevier, Vol. 21(2), pp. 110-125.

Laubach, T. (2001), "Measuring the NAIRU: Evidence From Seven Economies", *The Review of Economics and Statistics*, MIT Press, Vol. 83(2), pp. 218-231.

Layard, R. and S. Nickell (1987), "The Labour Market", in: Dornbusch, Rudiger and Layard, Richard, (eds.), *The Performance of the British Economy*, Clarendon, Oxford, UK.

Lindbeck, A. and D.J. Snower (1988), *The Insider-Outsider Theory of Employment and Unemployment, Cambridge: Mass*, MIT Press.

Llaudes, R. (2005), "The Phillips Curve and Long-Term Unemployment", *European Central Bank Working Paper* Series, No. 441.

Logeay, C. and S. Tober (2006), "Hysteresis and the NAIRU in the Euro Area", *Scottish Journal of Political Economy*, Vol. 53, No. 4, pp. 409-429.

OECD (2011), *OECD Employment Outlook,* Vol. 2011, OECD Publishing, *http://dx.doi.org/10.1787/empl_outlook-2011-en*.

OECD (2012), *OECD Economic Outlook*, Vol. 2012/2, OECD Publishing, *http://dx.doi.org/10.1787/eco_outlook-v2012-2-en*.

OECD (2014), *OECD Employment Outlook*, Vol. 2014, OECD Publishing, *http://dx.doi.org/10.1787/empl_outlook-2014-en*.

Phelps, E.S. (1972), *Inflation Policy and Unemployment Theory: The Cost-Benefit Approach to Monetary Planning*, Macmillan, London.

Razin, A. and A. Binyamini (2007), "Flattening of the Short-run Trade-off between Inflation and Domestic Activity: The Analytics of the Effects of Globalization", *Kiel Working Papers,* No. 1363, Kiel Institute for the World Economy.

Roberts, J. (2006), "Monetary Policy and Inflation Dynamics", *International Journal of Central Banking 2,* pp. 193-230.

Rusticelli, E., D. Turner and M.C. Cavalleri (2014), "Incorporating Anchored Inflation Expectations in the Phillips Curve and in the Derivation of Measures of OECD Equilibrium Unemployment", *OECD Economics Department Working Papers*.

Sargent, T., N. Williams and T. Zha (2009), "The Conquest of South American Inflation", *Journal of Political Economy, University of Chicago Press*, Vol. 117(2), pp. 211-256.

Smets, F. and R. Wouters (2007), "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach", *American Economic Review*, Vol. 97(3), pp. 586-606.

Staiger, D., J. Stock and M. Watson (1997), "How Precise are Estimates of the Natural Rate of Unemployment?", in C. Romer and D. Romer (eds), *Reducing Inflation: Motivation and Strategy*, Chicago, Chicago University Press and NBER.

Stock, J.H. (1994), "Unit Roots, Structural Breaks and Trends", in R. Engle and D. MacFadden (eds), *Handbook of Econometrics*, Vol. 4, Amsterdam, Elsevier, pp. 2739-2841.

Watson, M.W. (2014), "Inflation Persistence, the NAIRU, and the Great Recession", *American Economic Review*, Vol. 104, No. 5 (May).

Williams, J.C. (2006), "Inflation Persistence in an Era of Well-anchored Inflation Expectations", *Federal Reserve Bank of San Francisco Economic Letter,* October 13 issue.

Yellen, J.L. (2012), "Perspectives on Monetary Policy", speech delivered at the Boston Economic Club dinner, Boston, 6 June.