New evidence on unemployment hysteresis in the EU*

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January 12, 2018

Abstract

We use an unobserved components model to estimate hysteresis effects in the EU15. This includes the first estimates of their kind for Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, the Netherlands, Portugal, and Spain, and therefore constitutes a significant addition to the literature. Importantly, we use a similar dataset and estimation strategy to those used by the European Commission to estimate its NAIRU series. The European Commission NAIRUs show sharp increases for many countries over the past decade, often in the absence of major changes to labour market institutions. A simple explanation, supported by our results, is the existence of unemployment hysteresis, which has important policy implications for the EU.

Keywords: Unemployment, Hysteresis, Fiscal Compact, Demand Management.

JEL Codes: E24, E60, E61.

*We gratefully acknowledge funding from the Österreichisches Bundesministerium für Arbeit, Soziales und Konsumentenschutz, grant reference #######. The paper has benefited from the excellent research assistance of Victoria Fattinger and Benedikt G ohmann, and the advice of Christophe Planas on a number of occasions.

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1 Introduction

Unemployment has increased sharply in many EU member states since the beginning of the Global Financial Crisis in 2008. This has sparked a renewed interest in the concept of hysteresis, in which aggregate demand shocks can have permanent effects on unemployment and potential output. Blanchard et al (2015), for example, argues that the crisis has altered potential output, and the OECD argues that,

> "Fiscal support during economic downturns - both through automatic fiscal stabilisers ... and additional discretionary measures - promotes labour market resilience by stabilising aggregate demand. It also reduces the risk of hysteresis, i.e. the risk that cyclical changes in unemployment or productivity as a result of the crisis persist even after aggregate demand has recovered." (OECD 2017: 49).

These arguments are in contrast to the traditional view, in which the long run level of unemployment and potential output is independent of the history of aggregate demand shocks. The long run, supply-side driven unemployment rate is known as the NAIRU, or "Non-Accelerating Inflation Rate of Unemployment" (Layard et al 1991; Nickell 1998).

A precise definition of hysteresis - and the one we utilise in the present paper - is that the NAIRU is influenced by the history of actual unemployment levels. As a consequence, the long run unemployment rate becomes endogenous to the history of aggregate demand shocks as well as aggregate supply shocks. Initially, this hypothesis was a reaction to the sharp and persistent rise in unemployment rates in Western Europe in the 1980s (Blanchard and Summers 1986). Interest in the topic subsided in the late 1990s and the 2000s, with a small number of theoretical advances made in the academic literature during this period (e.g. Skott 2005, Stockhammer 2011). As indicated by the quotes given above, interest in hysteresis has recovered after the 2008 financial crisis.

The present study builds on this renewal of interest by presenting new evidence on the extent of hysteresis in the European Union. We use an unobserved components model which is closely related to those used in the existing literature, and flexible enough to allow gradual adjustment of the NAIRU to the actual unemployment rate. Our major contribution is to provide direct estimates of the extent of hysteresis for a number of countries that have so far been overlooked in the literature, including Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, the Netherlands, Portugal, and Spain.

Our major result in that a useful baseline degree of hysteresis for the EU15 is 80%. More precisely, on average, our results suggest that a one percentage point increase in the cyclical unemployment rate should lead to a 0.8 percentage point increase in the NAIRU one year later. This result has important policy implications for the EU. In order to maximise the policy relevance of our results, we use a dataset and modelling strategy which is very similar to those used by the European Commission to estimate its NAIRU series.

The remainder of the paper is structured as follows. Section 2 reviews the hysteresis literature, contrasting the exogenous NAIRU view and the hysteresis hypothesis and discussing the existing empirical literature. Section 3 explains the estimation methodology, and section 4 presents our empirical results for unemployment hysteresis in the EU15. Section 5 outlines the policy implications of our results, and section 6 concludes.

2 Hysteresis - a brief overview

2.1 Theory

The proposition that inflation fluctuates with the cyclical component of observed unemployment is common in macroeconomics. Under additional restrictions on lag structures, it is well known that this implies a vertical long run Phillips curve at the NAIRU, or "non-accelerating inflation rate of unemployment". The initial impetus to the development of the NAIRU concept in Phelps (1967) was the secular increase in inflation observed in the 1960s. The proposed explanation was that expansionary policies that maintained unemployment rates under the NAIRU would result in permanently increasing inflation and a breakdown in the traditional static Phillips curve. This argument was slowly formalised, and by 1980 James Tobin could state that, "The consensus view accepted the notion of a non-accelerating inflation rate of unemployment (NAIRU) as a practical constraint on policy" (cited in Espinosa-Vega and Russell 1997: 13). Subsequently, the work of Layard, Nickell, and Jackman, amongst others, explored the determination of the NAIRU in open economies and the importance of labour market institutions (Layard et al 1991).

Whilst the NAIRU concept could easily explain rising inflation rates in the late 1960s and early 1970s, it could not easily explain the apparent increases in the NAIRU itself observed in most European countries during the 1980s. One response argued that labour market institutions were, or had become, particularly rigid in European countries compared with the USA. Stephen Nickell summed up the mainstream position at the end of the 1990s as follows:

> "Here is the received wisdom. The European job market is rigid and inflexible. Result: high unemployment. The North American job market is dynamic and flexible. Result: low unemployment. So Europeans had better do something about their labor markets unless they want permanent double digit unemployment." (Nickell 1997: 55).

Nickell goes on to argue that this position is not "*totally* wrong", with generous unemployment benefits, collective and non-coordinated wage bargaining, and high payroll taxes and/or minimum wage laws leading to higher average unemployment rates. This received wisdom was well represented in major international organisations at the time, including the OECD (see e.g. OECD 1994).

The obvious problem with this argument is that, as Nickell pointed out, "in the 1960s, the unemployment rankings across countries were completely different but, roughly speaking, the labor market institutions were the same. So how can the labor market institutions have anything to do with unemployment?" (Nickell 1997: 65-66). One response, made by Nickell, is that differences in existing labour market institutions can lead to different policy responses to increases in unemployment. Our preferred response, pioneered by Blanchard and Summers (1986), is that institutional environments tend to remain relatively stable, but hysteresis effects are important in European labour markets. The basic proposition is that the NAIRU can be affected by the actual unemployment rate, and consequently aggregate demand shocks. As a result, deflationary policies or adverse shocks that raise the unemployment rate can also raise the NAIRU, which then results in a permanent increase in the unemployment rate. Specific hysteresis mechanisms include insider-outsider effects

(Blanchard and Summers 1986, 1987, 1988), skill-loss in unemployment (Pissarides 1992), and endogenous wage norms (Skott 2005, Stockhammer 2011).

2.2 Existing empirical literature

The majority of empirical studies of unemployment hysteresis utilise unit root tests, with the existence of a unit root in the unemployment rate being seen as evidence of hysteresis. This literature is extensive, and the reader can consult Stanley (2004) for a useful meta-analysis which is supportive of the hysteresis hypothesis. Stanley (2004) covers 24 studies that together report 99 separate estimates of unemployment persistence for various countries. Out of these, the simple average of persistence coefficients is found to be 0.864, and an average weighted by inverse variances (estimate precision) is found to be 0.963 (Stanley 2004: 596). This is consistent with a small sample downward bias in estimates of persistence - the existence of which is well known - and Stanley (2004) uses more sophisticated meta-regression techniques to argue that the literature taken as a whole supports the hypothesis of unemployment non-stationarity.

A drawback to the unit root approach is that the NAIRU may vary over time as labour market institutions evolve. As a result, evidence of a unit root in the unemployment rate does not constitute straightforward evidence of hysteresis. An approach which allows hysteresis effects to be estimated in the context of a time varying NAIRU is found in the unobserved components methodology, which was originally pioneered in Jaeger and Parkinson (1990, 1994). The subsequent studies using this approach include Assarsson and Jansson (1998), Logeay and Tober (2006), and Di Sanzo and Pérez-Alonso (2011). Jaeger and Parkinson (1990) examines hysteresis in the USA and Germany, and allows lagged cyclical unemployment rate shocks to affect the equilibrium rate, where the equilibrium unemployment rate is defined using a version of Okun's Law. Jaeger and Parkinson (1994) uses essentially the same methodology, but allows the lagged cyclical unemployment rate itself to affect the equilibrium rate. In addition, the analysis is extended to include Canadian, German, UK, and US data.

Assarsson and Jansson (1998) and Di Sanzo and Pérez-Alonso (2011) follow the Jaeger and Parkinson (1994) approach, again using versions of Okun's Law to define the equilibrium unemployment rate, with the latter paper incorporating non-linear threshold effects into the model. Assarsson and Jansson (1998) uses Swedish data, whilst Di Sanzo and Pérez-Alonso (2011) examines Italy, France, and the USA. Finally, Logeay and Tober (2006) uses an unobserved components model that is similar to, but not identical with, the Jaeger and Parkinson (1994) approach. In addition, they use a Phillips curve to define the equilibrium unemployment rate, using German and aggregated Euro Area data. In general, the literature using unobserved components models finds robust evidence of unemployment hysteresis, particularly in Europe, but the set of countries investigated remains quite small.

We utilise the unobserved components approach in the present paper, as it is immune to the drawback of the unit root approach noted above. As the set of countries covered by the existing literature is small, and we study the entire EU15, our results involve the first estimates of their kind for Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, the Netherlands, Portugal, and Spain.

3 Empirical approach

3.1 The model

We utilise the unobserved components method used in the literature discussed above to specify our hysteresis models. Denoting the NAIRU by u^n, the cyclical unemployment rate by u^c, the observable unemployment rate by u, the second difference of the log nominal wage by w, the second difference of the log terms of trade by tt, the second difference of log labour productivity by pr, and the second difference of the log labour share by ws, the model is as follows,

$$u_t^n = u_{t-1}^n + \alpha u_{t-1}^c + \theta_n \epsilon_t^n, \tag{1}$$

$$u_t^c = \beta_1 u_{t-1}^c + \beta_2 u_{t-2}^c + \theta_c \epsilon_t^c, \tag{2}$$

$$u_t = u_t^n + u_t^c, \tag{3}$$

$$w_t = \gamma_0 + \gamma_1 u_t^c + \gamma_2 u_{t-1}^c + \gamma_3 w_{t-1} + \gamma_4 tt_{t-1} + \gamma_5 pr_{t-1} + \gamma_6 ws_{t-1} + \theta_w \epsilon_t^w, \tag{4}$$

$$\theta_n = \lambda \theta_c, \tag{5}$$

with ϵ_t^n, ϵ_t^c, and ϵ_t^w mutually uncorrelated white noise processes with unit variance. In order to maximise the policy relevance of our results, the model is very similar to the European Commission model discussed in appendix C, but we allow for a dependency of the NAIRU on the cyclical unemployment rate. Sections 3.2 - 3.4 discuss equations (1) - (5) in detail.

3.2 The unemployment rate equations

Equation (1) is a unit root process in the NAIRU, with a hysteresis effect present when $\alpha > 0$. Equation (2) specifies the cyclical unemployment rate as a zero mean AR(2) process, allowing for complex unit roots and therefore a business cycle component in the unemployment rate. Finally, equation (3) states that the observable unemployment rate is equal to the sum of the NAIRU and cyclical unemployment rate in each period, and is observed without measurement error. By rearranging (1) and (3), we have the result that,

$$u_t^n = (1 - \alpha) u_{t-1}^n + \alpha u_{t-1} + \theta_n \epsilon_t^n, \tag{6}$$

and the NAIRU is thus an exponentially weighted average of past observed unemployment rates plus an error term representing supply-side shocks. Equation (6) is the Hargreaves-Heap (1980) specification that is commonly used in the theoretical literature on unemployment hysteresis. This suggests that α should take a value in the unit interval, although in principle α could be greater than one.

Estimating hysteresis effects using an unemployment block made up of equations (1) - (3) is a relatively direct measure of hysteresis, unlike the various unit root tests employed in the bulk of the empirical literature on unemployment hysteresis discussed in section 2.2 above. As noted above, any results indicating the presence of a unit root are open to the argument that the NAIRU is time-varying, and therefore do not constitute straightforward evidence of hysteresis. In comparison, the unobserved components method pioneered by Jaeger and Parkinson (1990, 1994) explicitly assumes that the NAIRU is time varying, and directly estimates the effect of the cyclical unemployment rate on the NAIRU.

3.3 The signal to noise ratio

The drawback of the unobserved components method is that the unemployment block made up of equations (1) - (3) is unidentified by itself, as discussed in Jaeger and Parkinson (1994, 333). To see this, consider the special case in which $\beta_1 = \beta_2 = 0$, so $u_t^c = \theta_c \epsilon_t^c$ from (2). With some rearranging, we have a reduced form IMA(2) process for the observable unemployment rate given by,

$$\Delta u_t = \theta_n \epsilon_t^n + \theta_c \epsilon_t^c - (1-\alpha)\theta_c \epsilon_{t-1}^c. \tag{7}$$

From the data we have the variance and first autocorrelation of Δu_t, which are not sufficient to identify θ_n, θ_c, and α.

The foregoing leads most users of the method, including Jaeger and Parkinson (1994), Assarsson and Jansson (1998), and Di Sanzo and Pérez-Alonso (2011), to rely on an auxiliary equation in an exogenous variable to identify the model. In our case, this role would be performed by the Phillips curve in (4). However, the fact that the model is unidentified without the Phillips curve suggests that variations in the specification of the Phillips curve might alter the estimates of α considerably, and this conjecture was borne out in preliminary investigation. Moreover, even in a situation in which the model is identified, the estimation of the variance of a non-stationary state with small true variance is biased towards zero in this type of model - see Stock (1994) for a discussion of the pile-up effect that causes this problem.

The identification problem and the pile-up problem suggest that the signal to noise ratio $\lambda^2 = \theta_n^2/\theta_c^2$ may usefully be imposed a priori, as in equation (5). Importantly for purposes of comparison, the European Commission also constrains variances a priori in the official NAIRU estimates[1]. The method is utilised in the NAIRU estimations of Staiger et al (1997), Laubach (2001), and Llaudes (2015), and it is also used in Rusticelli (2014), which estimates the effect of hysteresis on the NAIRU using the observed long term unemployment rate. As in Llaudes (2015), and to simplify replication, we set λ equal for every country.

The reported estimates below utilise a value $\lambda = 0.1$, corresponding to a signal to noise ratio of 0.01, which reflects the standpoint that supply-side shocks to the unemployment rate should be significantly less variable than demand-side shocks. It is worth noting in this context that the signal to noise ratio in the Hodrick-Prescott filter with annual data

[1]The European Commission constrains the numerical search procedure to a priori intervals for the error variance parameters in their NAIRU estimates - see the excel specification files available at https://circabc.europa.eu. When one or more of the variance estimates are corner solutions, as is often the case in the European Commission estimates, this is similar to imposing signal to noise ratios a priori.

is commonly set to around 0.01 - see Ravn and Uhlig (2002), who report values suggested in the literature between 0.0025 and 0.16 for annual data. However, as the choice of λ is relatively arbitrary, section 4.2 reports the results of a robustness analysis of the effects of changing λ on estimates of α, so our results are not dependent on a single a priori signal to noise ratio. In fact, as reported in section 4.2, the results appear to be robust to the choice of λ, so we consider this to be a useful approach to estimation.

3.4 The Phillips curve

As discussed in appendix C, the European Commission uses a variety of Phillips curve specifications in its NAIRU models, with the most important variation being the use of nominal wage inflation as the dependent variable versus the use of real unit labour costs as the dependent variable. The former is termed a traditional Keynesian Phillips curve, while the latter is termed a New Keynesian Phillips curve. At the same time, those country models that are estimated with a traditional Keynesian Phillips curve use different specifications for the exogenous regressors, including the terms of trade, labour productivity, and various transformations of the labour share of income.

In our models, we specify a relatively general form of the traditional Keynesian Phillips curve with nominal wage inflation as the dependent variable. This is mainly for reasons of simplicity and reproducibility, and we utilise an identical Phillips curve specification for each country in our sample. At the same time, as we incorporate lagged nominal wage inflation in the specification, our Phillips curve in (4) can in fact be interpreted as a New Keynesian Phillips curve with bounded rational (backwards looking) expectations. This approach is becoming more popular in the New Keynesian literature as criticisms of the strict rational expectations hypothesis have mounted in recent years - see Woodford (2013) or Dilaver et al (2017) for surveys.

In (4), the cyclical unemployment rate is the only variable that enters into the Phillips curve contemporaneously, with all other regressors entering with a lag. This reflects the fact that wage contracts tend to be updated infrequently in the EU, and thus we expect the cyclical unemployment rate to affect nominal wages within the period, but not vice versa. As we do not wish to make strong timing assumptions for the other variables, particularly given the use of annual data, all other variables enter with a lag to avoid endogeneity problems. This means that we cannot interpret the parameter estimates in a structural manner, but as the main estimates of interest are for the unemployment rate parameters we do not consider this to be a major issue.

3.5 Data and maximum likelihood estimation

All data series are identical to the series used in the European Commission NAIRU models, and are taken from the AMECO database. The unemployment rate is coded ZUTN, nominal wages (nominal compensation per employee) are coded HWCDW, the terms of trade are coded APGS, labour productivity (gross domestic product at 2010 reference levels per person employed) is coded RVGDE, and the labour share (compensation per employee as a percentage of GDP at market prices per person employed) is coded ALCD0. All data are annual, and the sample runs from 1960 to 2016 for all countries in the EU15. The only exceptions to this are Luxembourg, where the sample runs from 1975 to 2016, and Germany, where some back-casting had to be performed due to re-unification - this is detailed in appendix B. The models are estimated for each country using maximum likelihood with the de Jong diffuse Kalman filter in Stata[2].

4 Results

4.1 Estimation results

Point estimates of the hysteresis parameter α are presented for each country in table 1. Judging by these estimates, all countries with the possible exception of Spain appear to exhibit economically significant hysteresis effects. Unfortunately, due in part to the small sample size, the point estimates are relatively imprecise. As discussed above, although in principle α could be greater than one, our prior is that α should lie between zero and one and thus we interpret the five point estimates of α that are greater than one as the result of sampling uncertainty. Given this, judging from the 95% confidence intervals, 60% of the sample appears to exhibit statistically significant hysteresis effects, with the mean α equal to 0.8. As a number of the confidence intervals do not rule out $\alpha = 1$, table 1 also reports p-values from likelihood ratio tests of this null hypothesis for those countries where the confidence intervals rule out $\alpha = 0$. Note that these are likely to be more precise than relying on the confidence intervals, and indeed the result of the likelihood ratio test for Belgium contradicts the confidence interval. Judging by these results, we can state with some confidence that hysteresis effects are prevalent and in some cases strong in the EU15, with the average effect well within the reasonable range.

For those countries in which $\alpha = 1$ cannot be rejected, in particular Finland, Germany, Greece, Ireland, Italy, Sweden, and the UK, the "cyclical trend" model proposed in Harvey (1990) would appear to be a useful model of the unemployment rate. This suggests that a one percentage point increase in the cyclical unemployment rate this year is fully passed on into a one percentage point increase in the NAIRU next year, and any demand management policy is likely to be highly effective. These are higher than the point estimates found in Jaeger and Parkinson (1994), but more in line with those found in Assarsson and Jansson (1998) and Di Sanzo and Pérez-Alonso (2011). In particular, Assarsson and Jansson (1998) estimate $\alpha = 0.728$ for Sweden, which is contained in our confidence interval in table 1. Di Sanzo and Pérez-Alonso (2011) estimate a non-linear version of the model, and find values of α between 0.797 and 2.210 for Italy, France, and the USA, which contain our mean average α equal to 0.8.

The unusually low point estimate of α for Spain is of some interest, particularly as this is one of the more precisely estimated parameters in table 1. Spain might be considered an obvious contender for a country suffering from hysteresis effects, as the European Commission has estimated a large increase in its NAIRU since the mid-2000s, and the observed unemployment rate has remained persistently high over the last decade. Given this, the Spanish unemployment rate has remained stubbornly high since the early 1980s, aside from a reduction to around 10% in the early 2000s, and this has been a persistent puzzle when compared to, for example, the Portuguese unemployment experience (see e.g. Blanchard

[2]Do files and data files are available upon request.

Table 1: Hysteresis parameter estimates[a]

	α point estimate	95% confidence interval	p-value ($H_0 : \alpha = 1$)
Austria	0.64	[-0.17 1.45]	-
Belgium	1.62	[1.10 2.14]	0.14
Denmark	0.61	[0.12 1.11]	0.20
Finland	1.07	[0.45 1.69]	0.82
France	0.21	[-0.76 1.18]	-
Germany	1.00	[0.27 1.73]	0.99
Greece	0.97	[0.32 1.61]	0.92
Ireland	1.40	[0.63 2.17]	0.39
Italy	1.16	[0.70 1.63]	0.53
Luxembourg	0.31	[-0.50 1.12]	-
Netherlands	0.41	[-0.16 0.99]	-
Portugal	0.25	[-0.78 1.28]	-
Spain	0.08	[-0.09 0.24]	-
Sweden	1.28	[0.70 1.86]	0.34
UK	0.97	[0.34 1.59]	0.92
EU15 average	0.80	-	-

Notes: [a]All estimates are from the model described in equations (1) - (5) round to two decimal places. The confidence intervals correspond to the Z-distribution. The p-values from likelihood ratio tests of significance correspond to the null hypothesis, $H_0 : \alpha = 1$. Note that the LR test contradicts the confidence interval for Belgium - this is likely due to the inefficiency of the numerically approximated parameter variance-covariance matrix used to calculate the confidence intervals.

and Jimeno 1995). Like the USA, there is no obvious mean shift or drift in the Spanish unemployment rate, at least since the early 1980s, which may explain why research tends to find little or no evidence of hysteresis in these countries.

Figures 1.1 - 1.5 plot the smoothed NAIRU estimates from the model described in equations (1) - (5) alongside the observable unemployment rate and the European Commission NAIRU for each country in the sample. It is evidently the case that the greater the α estimate, the more the NAIRU follows the observable unemployment rate, becoming increasingly volatile in comparison with the European Commission NAIRU. That this should be the case is obvious from equation (6), which demonstrates that when $\alpha = 1$ the NAIRU is equal to the lagged actual unemployment rate plus an error term. Those countries with estimates of α close to one therefore have NAIRUs which follow the observable unemployment rate very closely, and those countries with the lowest estimates of α - Spain, France, and Portugal - have NAIRUs which are qualitatively similar to the European Commission NAIRUs.

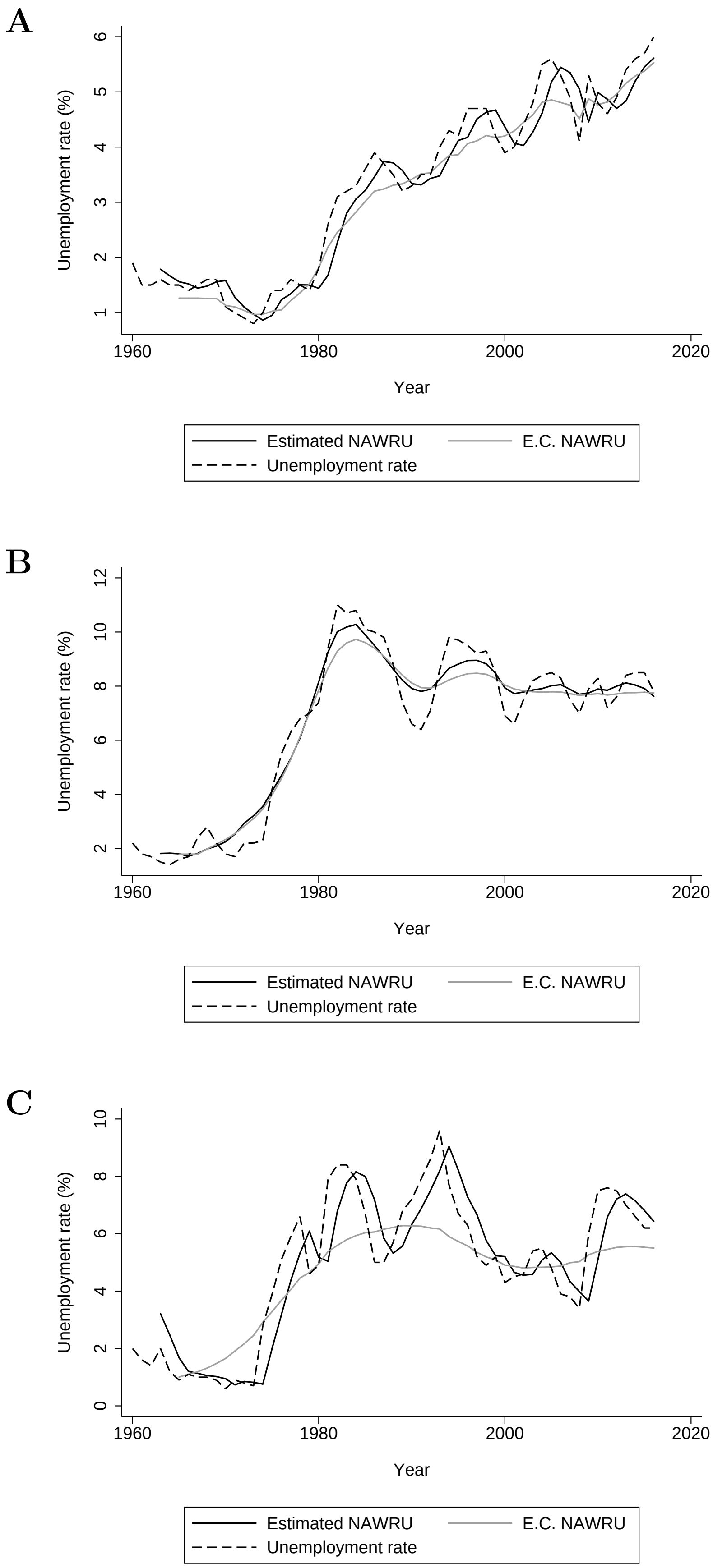
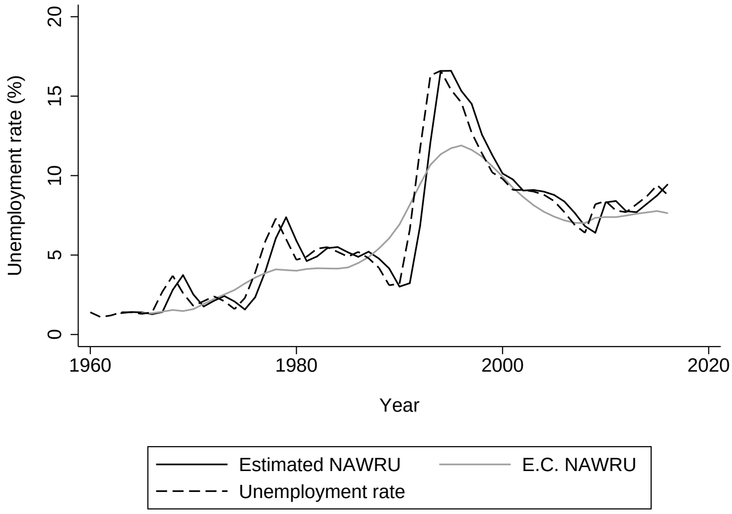


Figure 1.1: Time series of the estimated (smoothed) NAIRU from the model described in section 3, the European Commission NAIRU, and the actual unemployment rate, for Austria (panel A), Belgium (panel B), and Denmark (panel C).

D



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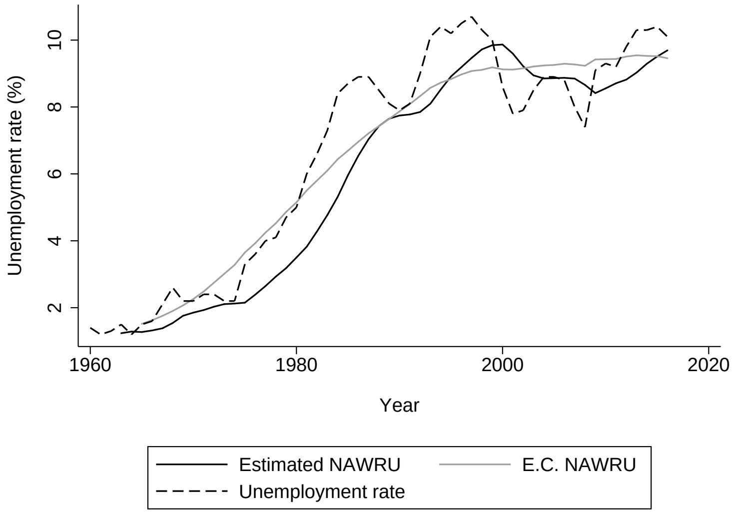


F

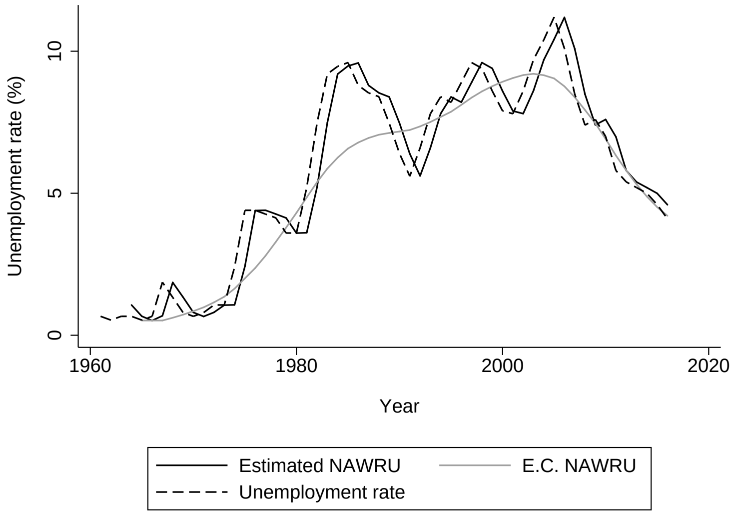


Figure 1.2: Time series of the estimated (smoothed) NAIRU from the model described in section 3, the European Commission NAIRU, and the actual unemployment rate, for Finland (panel D), France (panel E), and Germany (panel F).

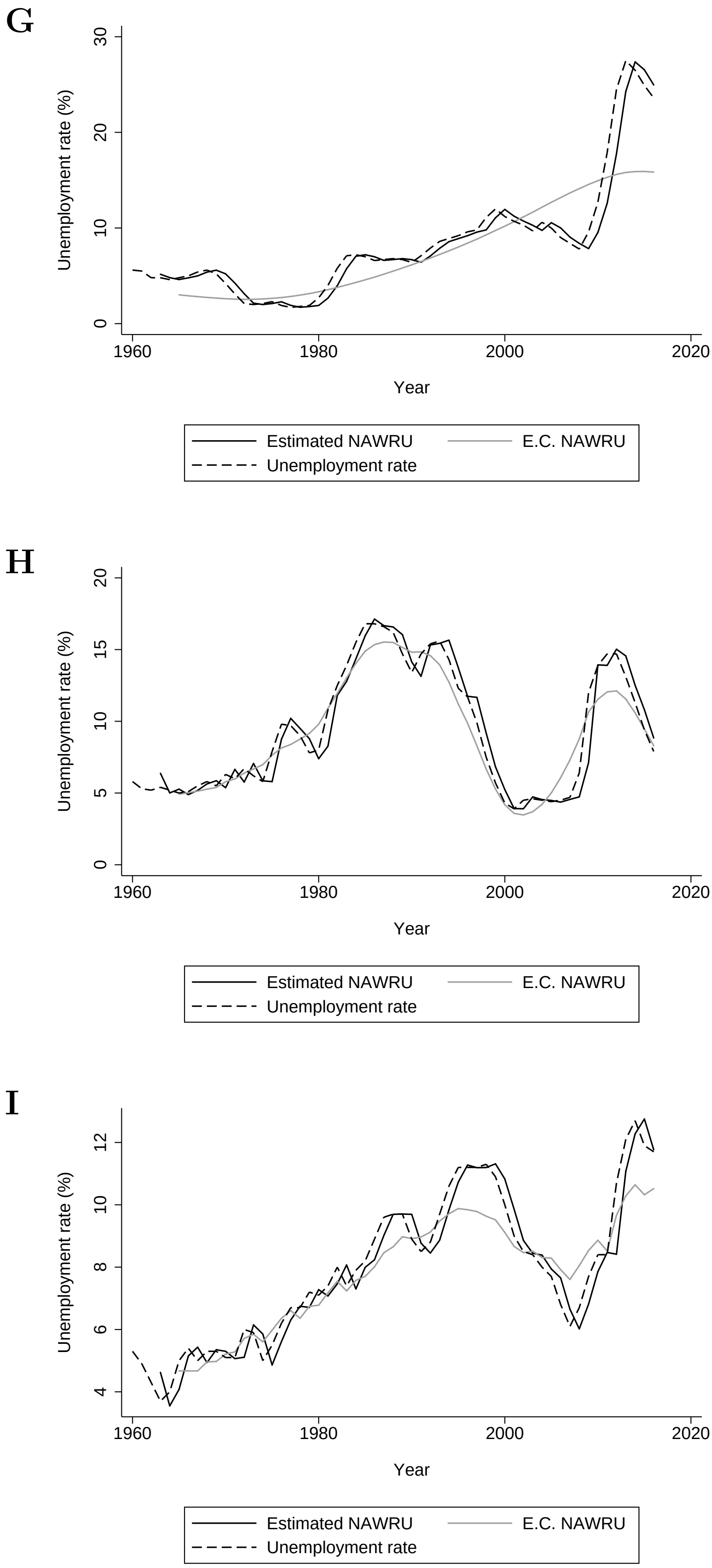


Figure 1.3: Time series of the estimated (smoothed) NAIRU from the model described in section 3, the European Commission NAIRU, and the actual unemployment rate, for Greece (panel G), Ireland (panel H), and Italy (panel I).

J

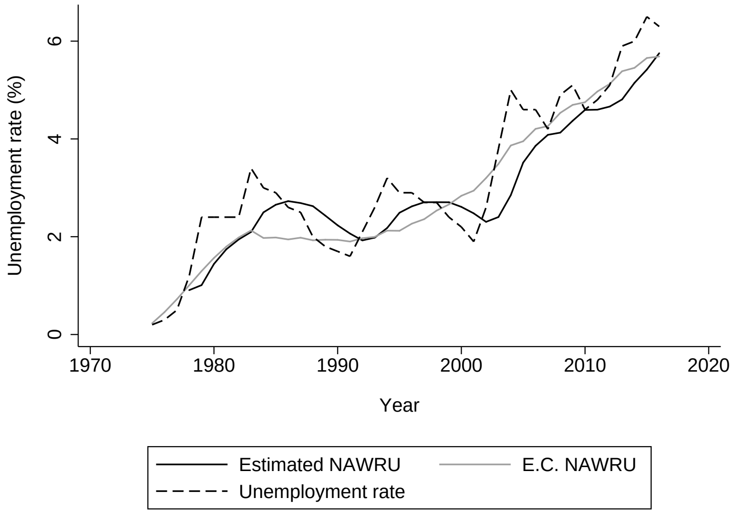
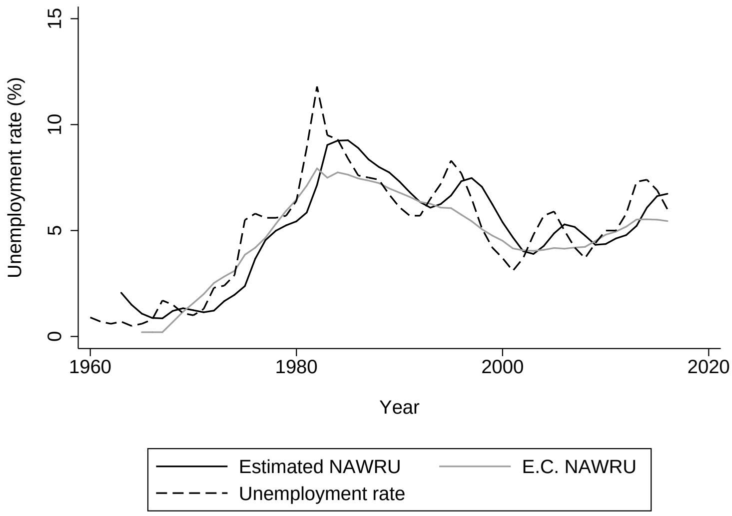
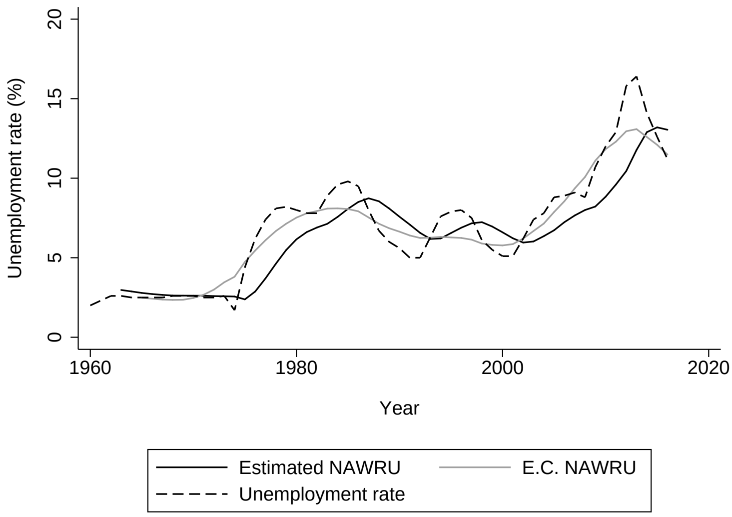


Figure 1.4: Time series of the estimated (smoothed) NAIRU from the model described in section 3, the European Commission NAIRU, and the actual unemployment rate, for Luxembourg (panel J), Netherlands (panel K), and Portugal (panel L).

K



L



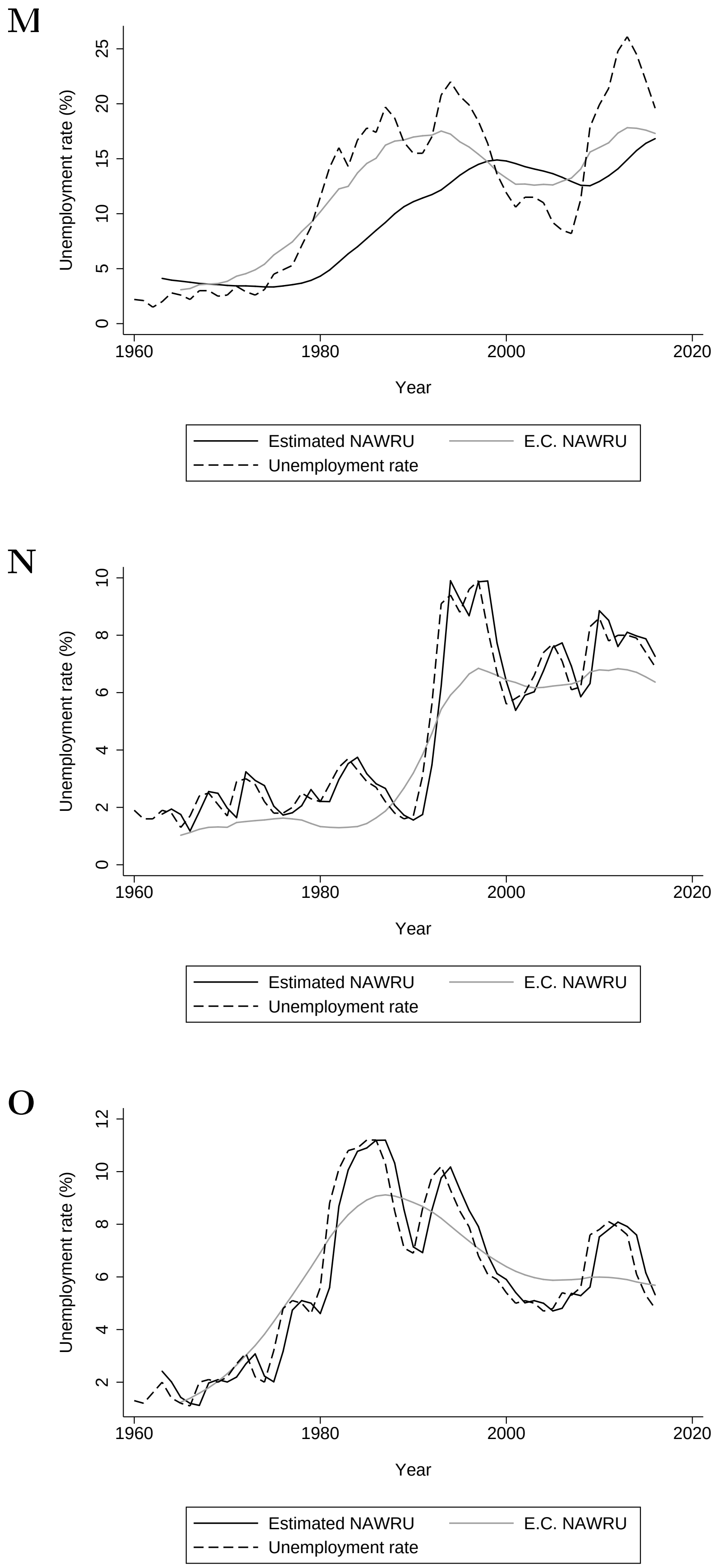


Figure 1.5: Time series of the estimated (smoothed) NAIRU from the model described in section 3, the European Commission NAIRU, and the actual unemployment rate, for Spain (panel M), Sweden (panel N), and the UK (panel O).

4.2 Specification tests and robustness checks

The estimates appear to be satisfactory from the perspective of standard specification tests. In particular, no countries exhibit autocorrelation problems. However, a third of the sample exhibits heteroskedasticity and around two thirds of the sample exhibits non-normality in the Phillips curve residuals. The latter is not particularly surprising. As discussed in appendix C, the unemployment rate is definitionally non-normal, and hence the joint distribution of wage inflation and the cyclical unemployment rate is non-normal. Any linear normal unobserved components model in the unemployment rate is therefore an approximate model, and non-normality in the Phillips curve residuals is not a pressing issue in this context. Table A1 in the appendix presents detailed results of the specification tests.

Finally, figures A1.1 - A1.5 in the appendix present the results of robustness checks on the changes in point estimates and confidence intervals of the hysteresis parameter α caused by varying the parameter λ. As is evident from the figure, the point estimates do not change significantly over the interval $\lambda \in [0, 0.3]$, with a slight tendency of the point estimates to increase as λ is increased. A possible explanation of this is that there is a moving average component in the unemployment rate process for most countries in the sample, and a decrease in θ_c relative to θ_n caused by increasing λ requires an increase in α to compensate, given equation (7). The main conclusion here, as discussed in section 3.3, is that we do not consider the use of an a priori signal to noise ratio to be a problematic approach given the robustness checks.

4.3 Alternative specifications

The estimates presented in section 4.1 are relatively well behaved, and the point estimates of the hysteresis parameter fall within the intuitive range. However, bearing in mind that the model should be considered as an approximation to the underlying data generating process, it is worth considering alternative specifications as further robustness checks. In this section, therefore, we briefly consider estimates of the hysteresis parameter α for two alternative Phillips curve specifications:

$$w_t = \gamma_0 + \gamma_1 u_t^c + \gamma_2 u_{t-1}^c + \gamma_3 w_{t-1} + \theta_w \epsilon_t^w, \tag{8}$$

$$w_t = \gamma_0 + \gamma_1 u_t^c + \gamma_2 u_{t-1}^c + \gamma_3 w_{t-1} + \gamma_4 tt_{t-1} + \gamma_5 pr_{t-1} + \gamma_6 ws_{t-1} + \gamma_7 \pi_{t-1} + \theta_w \epsilon_t^w. \tag{9}$$

Compared to (4), the first alternative Phillips curve (8) omits the exogenous variables (terms of trade, productivity, and the wage share), and the second alternative Phillips curve (9) adds the lagged second difference of log consumer prices, π_{t-1}. The first specification therefore jettisons a number of variables which are not statistically significant for the majority of countries, and the second specification brings the model closer to a standard textbook wage Phillips curve, where unions target an expected real wage (albeit with differenced wage and price inflation). To estimate the second specification we use the AMECO ZCPIN series, which for a subset countries only runs to 2015.

Table 2: Hysteresis parameter estimates for alternative Phillips curves[a]

	Model with Phillips curve (8)		Model with Phillips curve (9)	
	α point estimate[b]	95% C.I.[c]	α point estimate[d]	95% C.I.[e]
Austria	0.65	[-0.38 1.69]	0.63	[-0.23 1.50]
Belgium	1.42	[0.11 2.72]	1.62	[1.09 2.15]
Denmark	0.63	[0.05 1.20]	0.62	[0.13 1.11]
Finland	1.04	[0.46 1.62]	1.11	[0.53 1.70]
France	0.36	[-.049 1.21]	0.23	[-0.80 1.26]
Germany	1.09	[0.34 1.84]	0.92	[0.09 1.75]
Greece	0.97	[0.32 1.61]	0.96	[0.33 1.59]
Ireland	1.19	[0.53 1.85]	1.39	[-0.20 2.97]
Italy	1.10	[0.54 1.66]	1.15	[0.66 1.64]
Luxembourg[f]	0.23	[-0.67 1.12]	0.33	[-0.64 1.30]
Netherlands	0.35	[-0.13 0.83]	0.44	[-0.20 1.07]
Portugal	0.06	[-0.16 0.27]	0.43	[-0.19 1.04]
Spain	0.06	[-0.05 0.17]	0.07	[-0.09 0.23]
Sweden	1.21	[0.68 1.75]	1.25	[0.69 1.80]
UK	0.99	[0.64 1.34]	0.98	[0.36 1.61]
EU15 average	0.76	-	0.81	-

Notes: [a]The confidence intervals correspond to the Z-distribution; [b,c] These estimates correspond to the model with the alternative Phillips curve (8); [d,e] These estimates correspond to the model with the alternative Phillips curve (9); [f]The Luxembourg model with (8) drops the Phillips curve intercept (to aid convergence; the intercept is statistically insignificant).

The hysteresis parameter estimates using (8) and (9), along with 95% confidence intervals, are presented in table 2. The point estimates are not materially affected, with the exception of Portugal where the point estimates change somewhat compared with the baseline specification. In addition, the average over the point estimates does not change appreciably, with the estimates using (8) having a slightly lower average α, and the estimates using (9) having a slightly higher average α. We can therefore be confident in the accuracy of our baseline results, if not their precision, and the conclusion that hysteresis effects are prevalent in the EU15. In particular, we can be confident in the use of $\alpha = 0.8$ as a reference level of hysteresis for the EU.

5 Policy implications

There are two basic policy responses to sharp increases in unemployment: Labour market reform and active demand management. If hysteresis effects are present, then active demand management becomes considerably more important in the short run, as any increase in the unemployment rate will eventually feed through into a secular rise in joblessness. Authors adhering to this view draw attention to the fact that the compounding costs of cyclical unemployment imply that monetary policy should target both inflation and unemployment (Gali 2015, Summers 2015), with policy responses being aggressive and immediate (Blanchard et al 2015). This was not the case in the majority of continental EU countries after the 2008 crisis, at least in comparison with the UK and USA.

As well as a more aggressive role for monetary policy, the presence of hysteresis implies that fiscal policy can also aid in reducing the costs of aggregate demand shocks. Whereas some authors argue that fiscal policy is only superior to monetary policy during periods of secular stagnation, or when interest rates are close to their lower bound (DeLong and Summers 2012, Fatas and Summers 2016), others argue that fiscal policy can and should be used as an ordinary tool of demand stabilisation (Stockhammer 2011, Ball 2014, OECD 2017). Whichever point of view one takes, it is clear that the fiscal responses of EU member states to the 2008 crisis and subsequent Euro crisis were inadequate if hysteresis effects are present. As our results indicate that hysteresis effects are present in the EU, with around 80% of the cyclical unemployment rate becoming permanent within a year's time, a clear policy implication is that the responsiveness of European monetary and fiscal policy to changes in the unemployment rate should increase.

In addition to the foregoing, the existence of hysteresis is problematic for the EU Fiscal Compact, in which structural deficits must not go beyond 1% of GDP, or 0.5% of GDP if the debt-to-GDP ratio is above 60%. This is because the structural deficit is defined as the deficit that a country would have if it were operating at potential output. In turn, potential output is calculated as a Cobb-Douglas function of the actual capital stock and potential employment, where potential employment is determined by the working age population and the European Commission NAIRU estimates (Havik et al 2014). Any increase in the estimated NAIRU therefore decreases potential employment, which decreases potential output. In turn, this decrease in potential output increases the size of the structural deficit, ceteris paribus.

This leads to the possibility of a vicious cycle if hysteresis effects are present, in which a negative shock to the unemployment rate increases the NAIRU, which decreases potential output, which increases the structural deficit. At best, this gives the state less room for expansionary policy to counteract the negative demand shock, and at worst it leads the state to pursue a deflationary policy further depressing activity and increasing the unemployment rate. In the limit, a large increase in the NAIRU during a period of high unemployment - when an economy is arguably in a recession - could reduce potential output to the level of actual output. A final policy implication, echoing Lendvai et al (2015), Cottarelli (2015), Pisani-Ferry (2015), and Heimberger et al (2017), is thus a reappraisal of the EU Fiscal Compact in light of European unemployment hysteresis.

6 Concluding remarks

This paper has presented new evidence on the degree of hysteresis in EU unemployment rates. We present evidence for the entire EU15, which includes the first estimates of their kind for Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, the Netherlands, Portugal, and Spain. We demonstrate that there is considerable evidence for the existence of unemployment hysteresis in the majority of the EU15 countries. For example, we find that the degree of hysteresis is 65% in Austria, 100% in Germany, and 97% in the United Kingdom. In the EU15 as a whole, we find the average degree of hysteresis to be 80%. More precisely, on average, our results suggest that a one percentage point increase in the cyclical unemployment rate should lead to a 0.8 percentage point increase in the NAIRU one year later. These estimates are robust to changes in the specification of the Phillips curve, and robust to changes in the estimation assumptions.

Our results have two important consequences for EU policy makers. First, they indicate that a lack of government intervention in response to negative shocks has immediate effects in the form of increasing unemployment, as well as long-lasting effects on the NAIRU. If the government does not react adequately to a rise in cyclical unemployment, structural unemployment will rise significantly in the following years. This finding is consistent with the conclusions of the 2017 OECD Employment Outlook. Second, our results suggest that the EU Fiscal Compact should be revisited, as it leads to the possibility of a vicious cycle if hysteresis effects are present. As our results indicate widespread hysteresis effects in the EU15, we consider this to be a very real problem.

As noted above, the dataset and model used in the present study are similar to those used by the European Commission to estimated its NAIRU series. Various European Commission papers indicate that their NAIRU estimates are not independent of demand-side factors, and might not constitute an adequate measure of structural unemployment (Orlandi 2012, Havik et al 2014). Our findings strongly confirm this suspicion, and suggest that the European Commission could profitably consider alternative NAIRU estimation strategies. Experimenting with hysteresis effects in their model - perhaps by the construction of a “beta” version - would be a useful start to this process.

Like the European Commission models, the models used in the present paper are only semi-structural, particularly in the sense that demand pressures are modelled as reduced form AR(2) processes in the cyclical unemployment rate. As a result, these models cannot differentiate between different hysteresis mechanisms. The next step for the literature is thus to examine hysteresis using more structural specifications of the demand side, and methods which allow competing hysteresis mechanisms to be isolated on the supply side. Both of these are important from a policy perspective, as the former may shed light on the relative effectiveness of fiscal versus monetary policy when hysteresis effects are present, and the latter may shed light on the role of competitive pressures in the product and labour markets.

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A Specification tests and robustness plots

Table A1: Misspecification tests over Phillips curve residuals[a]

	Autocorrelation		Heteroskedasticity		Normality
	1 lag	4 lags	1 lag	4 lags	
Austria	0.70	0.86	0.01	0.10	0.12
Belgium	0.99	0.99	0.42	0.75	0.30
Denmark	0.89	0.90	0.99	0.93	0.01
Finland	0.86	0.99	0.01	0.11	0.28
France	0.97	0.79	0.52	0.89	0.03
Germany	0.89	1.00	0.40	0.16	0.63
Greece	0.94	0.11	0.00	0.00	0.00
Ireland	0.84	0.77	0.33	0.81	0.00
Italy	0.92	0.92	0.53	0.87	0.01
Luxembourg	0.42	0.09	0.38	0.45	0.08
Netherlands	0.85	0.94	0.00	0.01	0.00
Portugal	0.80	0.54	0.73	0.91	0.00
Spain	0.92	0.40	0.19	0.27	0.02
Sweden	0.88	1.00	0.00	0.03	0.03
UK	1.00	0.96	0.39	0.68	0.10

Notes: [a]Tests employed: Autocorrelation=Ljung–Box test on residuals; heteroskedasticity=Ljung–Box test on squared residuals; normality=Shapiro-Wilk test; all reported statistics are p-values round to two decimal places. These tests are fairly standard in the literature, and are suggested in e.g. Harvey (1994).

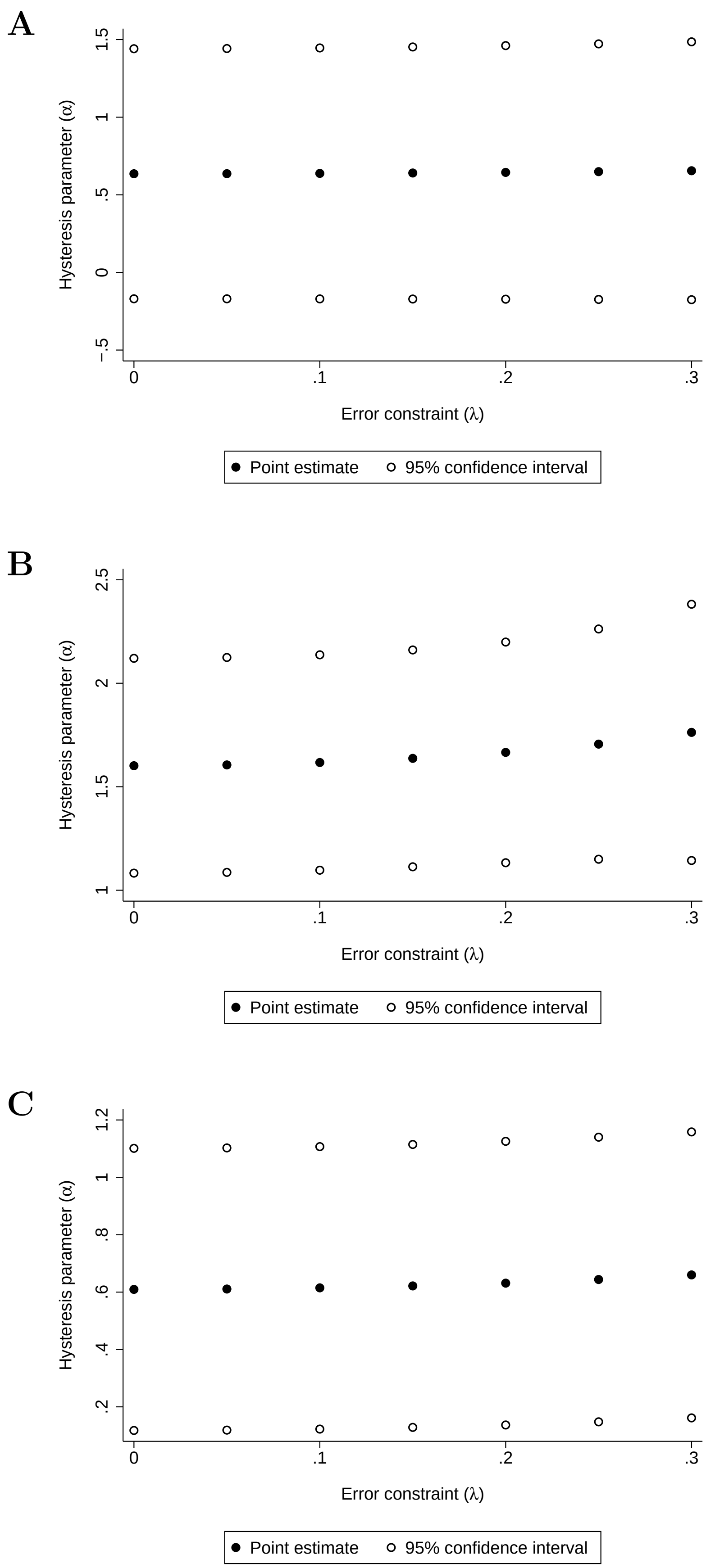


Figure A1.1: Robustness check for the estimate of the hysteresis parameter α, showing the point estimate and confidence interval plotted against the choice of error constraint λ, for Austria (panel A), Belgium (panel B), and Denmark (panel C).

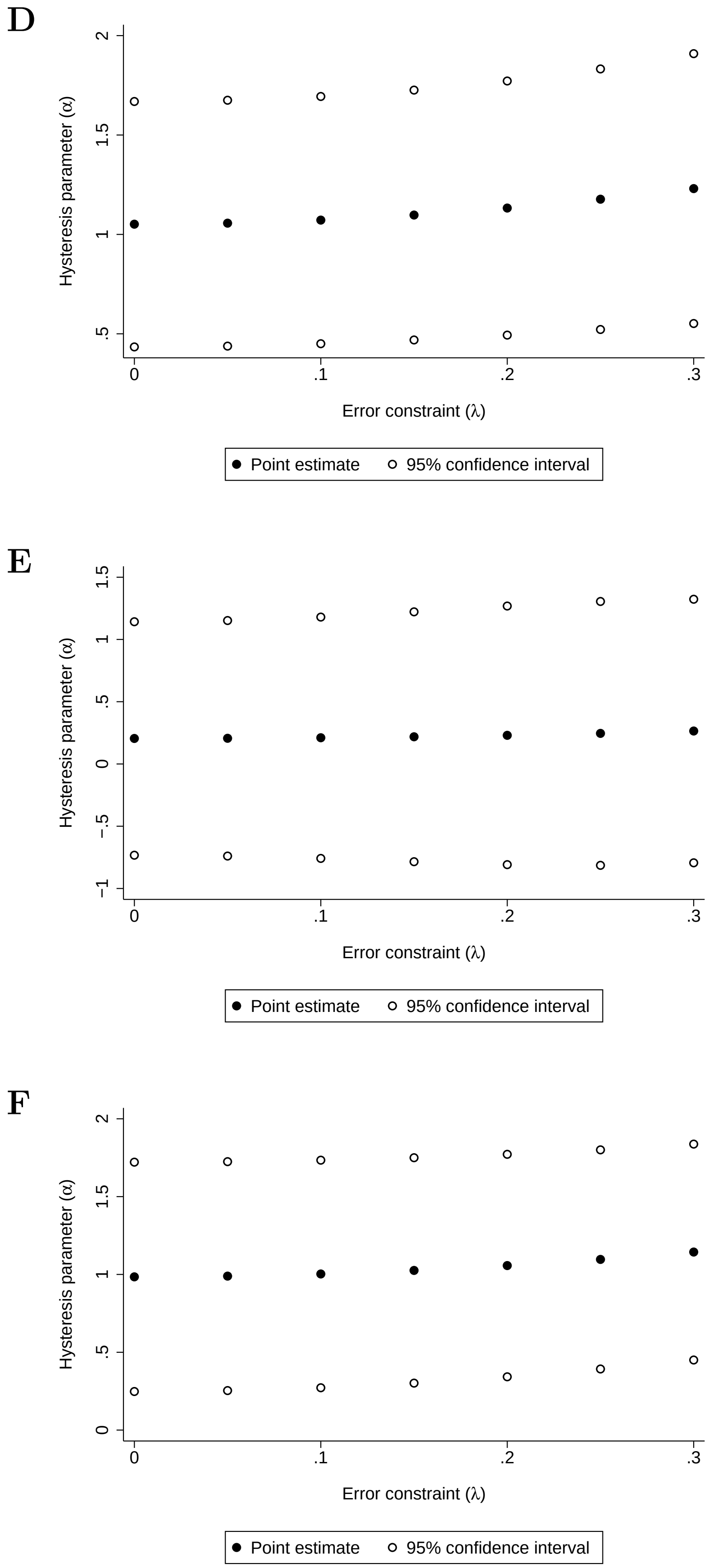
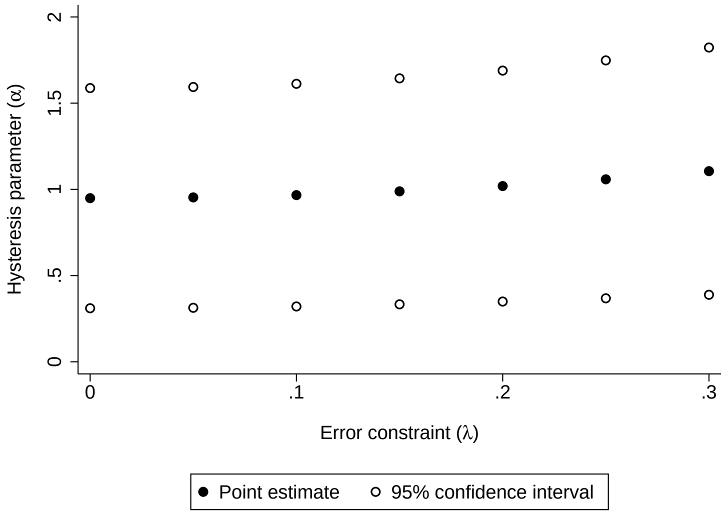


Figure A1.2: Robustness check for the estimate of the hysteresis parameter α, showing the point estimate and confidence interval plotted against the choice of error constraint λ, for Finland (panel D), France (panel E), and Germany (panel F).

G



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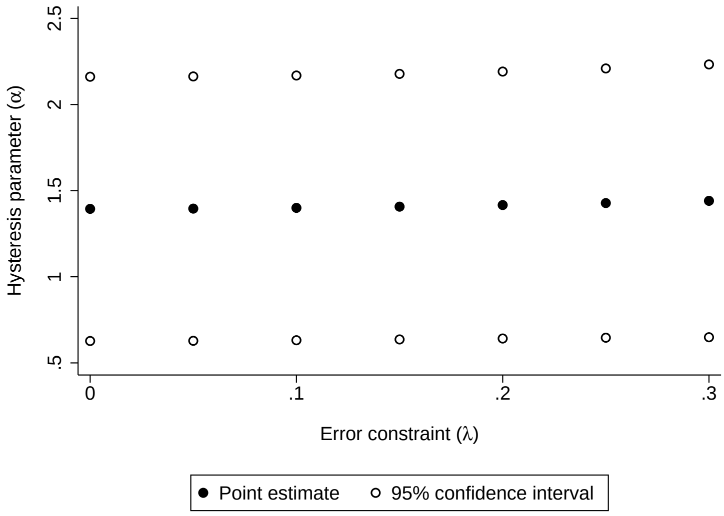


I

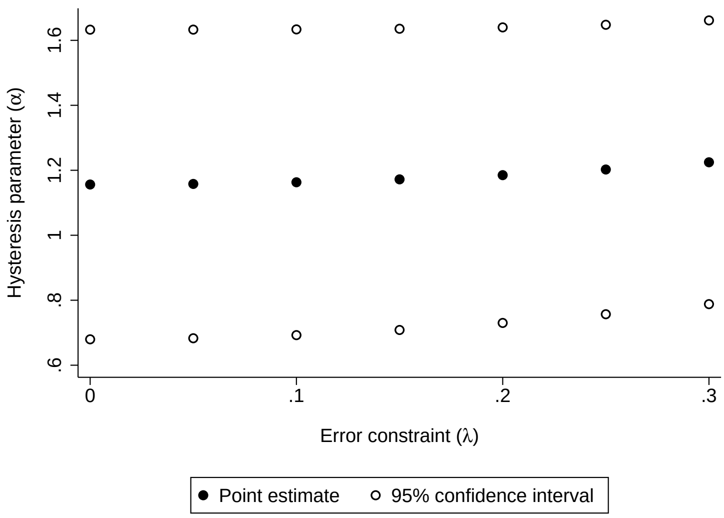


Figure A1.3: Robustness check for the estimate of the hysteresis parameter α, showing the point estimate and confidence interval plotted against the choice of error constraint λ, for Greece (panel G), Ireland (panel H), and Italy (panel I).

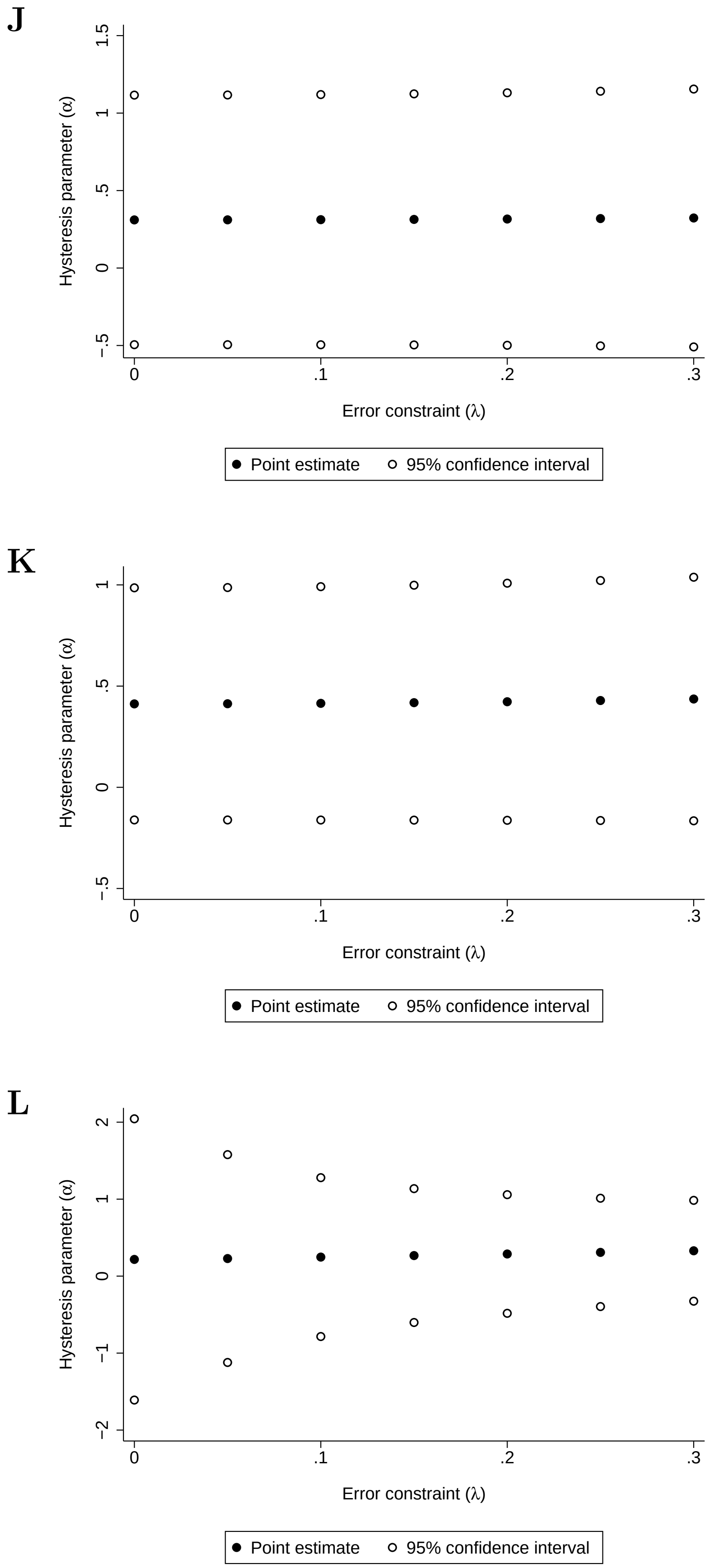
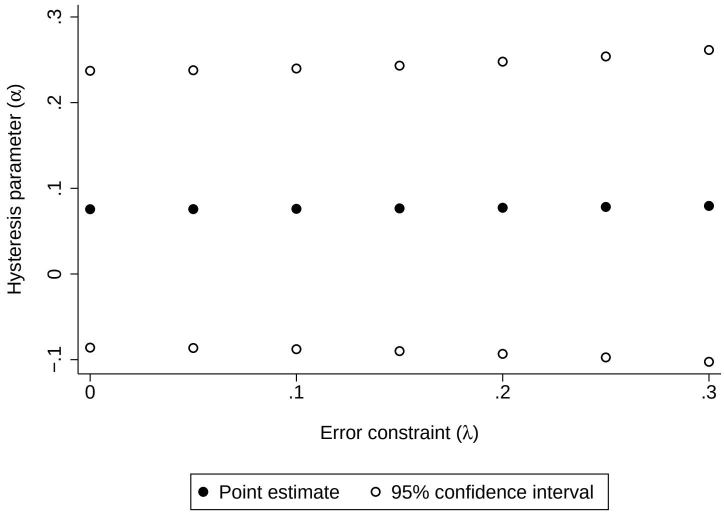


Figure A1.4: Robustness check for the estimate of the hysteresis parameter α, showing the point estimate and confidence interval plotted against the choice of error constraint λ, for Luxembourg (panel J), Netherlands (panel K), and Portugal (panel L).

M



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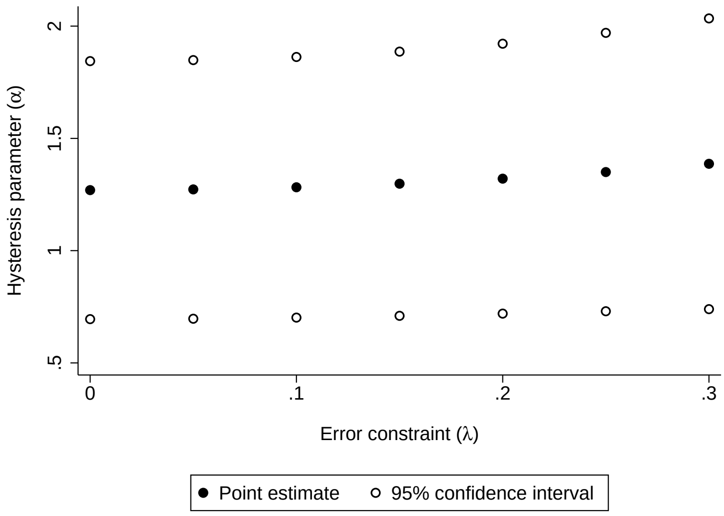

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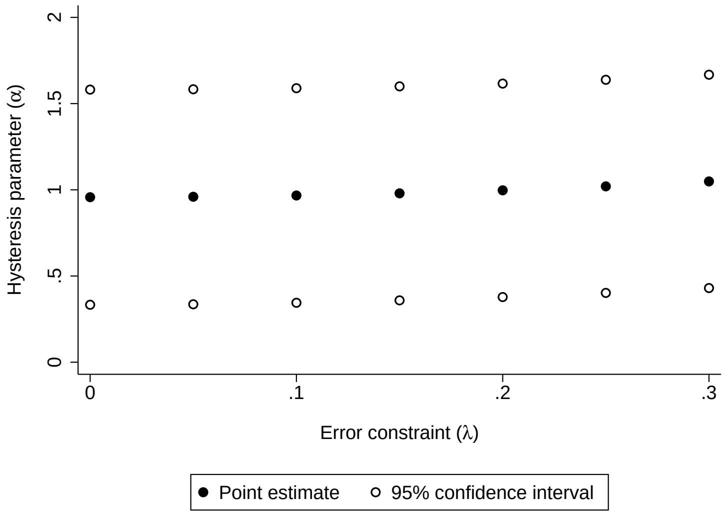


Figure A1.5: Robustness check for the estimate of the hysteresis parameter α, showing the point estimate and confidence interval plotted against the choice of error constraint λ, for Spain (panel M), Sweden (panel N), and the UK (panel O).

B Data preparation for Germany

A number of the AMECO series for Germany begin after re-unification, with West German data provided prior to this. To create unified series for Germany, therefore, the German data has to be back-cast. Suppose a West German series $\{x_t\}$ runs from $t = t_0$ to $t = t_m$, and an equivalent German series $\{y_t\}$ runs from $t = t_m$ to $t = t_n$. Denote by δ_t the West German series growth rate from $t - 1$ to t, i.e.,

$$\delta_t = \frac{x_t - x_{t-1}}{x_{t-1}}. \tag{B.1}$$

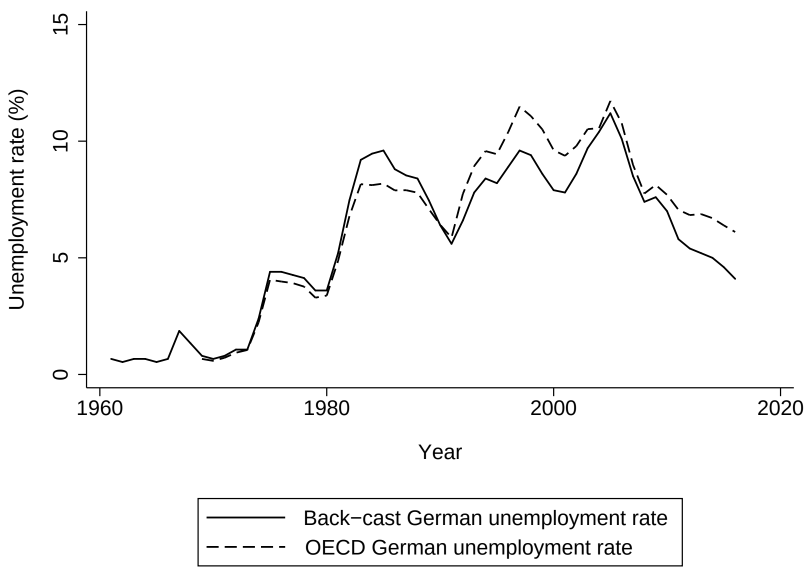
Prior to t_m - when German data is not observable but δ_t is observable - we assume that the following relation holds:

$$y_t = (1 + \delta_t) y_{t-1}. \tag{B.2}$$

Prior to t_m, we can therefore back-cast the German series by recursively calculating,

$$y_{t-1} = \frac{y_t}{1 + \delta_t}. \tag{B.3}$$

Note, however, that because we use growth rates we lose one observation from the beginning of the series, so we can only back-cast the German data to $t = t_0 + 1$, which in our case is 1961. This is a fairly common approach to back-casting, and is used (for example) by the Bank of England in its "millennium of macroeconomic data" dataset. A comparison of our back-cast series for German unemployment compared to the OECD equivalent series is shown below, where, aside from levels discrepancies, the cyclical movements of the two series are similar.



C The European Commission NAIRU approach

The European Commission's approach to estimating the NAIRU is a common one, both in the academic literature and international organisations (e.g. the OECD - see Gianella et al 2008). Note, however, that they refer to the series as a NAWRU, or "non-accelerating wage rate of unemployment", as wage inflation rather than price inflation is used in the Phillips curve. To avoid confusion, the main body of the present paper retains the usual NAIRU terminology. The European Commission approach involves an unobserved components model of the following form,

$$u_t^n = \mu_{t-1} + u_{t-1}^n + \theta_n \epsilon_t^n,$$

$$\mu_t = \mu_{t-1} + \theta_\mu \epsilon_t^\mu,$$

$$u_t^c = \beta_1 u_{t-1}^c + \beta_2 u_{t-2}^c + \theta_c \epsilon_t^c,$$

$$u_t = u_t^n + u_t^c,$$

$$w_t = f(u_t^c, z_t),$$

where the NAIRU is denoted by u^n, the cyclical unemployment rate is denoted by u^c, the observable unemployment rate is denoted by u, and μ is a time varying drift term in the NAIRU. The error terms ϵ_t^n, ϵ_t^c, and ϵ_t^μ are mutually uncorrelated white noise processes with unit variance. Generally, if θ_μ is small, this model will behave in a similar manner to an integrated random walk, and will therefore yield relatively smooth NAIRU estimates. The model is completed with a Phillips curve in w_t, the second difference in log wages, which is a function of the cyclical unemployment rate and a vector z_t of control variables.

The wage Phillips curve in the European Commission models is specified differently for each of the EU15 countries[3]. The major difference is in the use of nominal wage inflation versus real unit labour costs as the dependent variable, where the former is termed a traditional Keynesian Phillips curve, and the latter is termed a New Keynesian Phillips curve. This choice, and the rationale behind it, is detailed in Havik et al (2014). Havik et al report that the use of real unit labour costs results in slightly less volatile NAIRU estimates, but for most countries the difference between the two methods appears to be minor.

Alongside the differences in the dependent variable, those country models that are estimated with a traditional Keynesian Phillips curve use different specifications for the exogenous regressors, including the terms of trade, labour productivity, and various transformations of the labour share of income. General ARMA errors can also be incorporated, and upper and lower bounds on the parameter estimates are imposed on the estimation procedure. As at least some of these constraints are usually binding, this implies the imposition of signal-to-noise ratios in the European Commission models (see section 3.3 in the main body of the text, and particularly footnote 1, for further discussion). The interested reader can

[3]Given data availability, the European Commission uses different NAIRU estimation methods for the newer EU countries.

refer to the excel specification files available at https://circabc.europa.eu. These estimates are relatively straightforward to reproduce with Stata or Matlab.

Estimation is undertaken using maximum likelihood with the Kalman filter, with smoothed state estimates of u^n providing the basis of the final reported NAIRUs (i.e. the AMECO ZNAWRU series). Clearly, as the unemployment rate is limited to the unit interval (or the $[0, 100]$ interval), it cannot be normally distributed, and hence the joint distribution of the cyclical unemployment rate, NAIRU, observable unemployment rate, and wage inflation is non-normal. Any linear normal unobserved components model in the unemployment rate is therefore an approximation.

The European Commission NAIRU method does not allow for hysteresis effects running from the cyclical unemployment rate to the NAIRU. However, secondary estimates in Orlandi (2012), also discussed in Havik et al (2014), acknowledge that the European Commission NAIRU estimates do not correspond to structural unemployment - i.e. the European Commission NAIRUs can be affected by demand-side factors. These include, but are not limited to, housing boom-bust episodes and the real interest rate. Havik et al (2014) argues that,

> "Recent increases in the euro-area's NAWRU should therefore not be interpreted as a sign of big structural change at the current juncture. Rather, in most countries, the increases reflect the effects of shocks that, in the presence of various rigidities, have a long-lasting impact on unemployment rates. Note that, despite uncertainties, the NAWRU remains a useful policy indicator. It is a well-defined concept that provides useful information on the nature of unemployment rate developments." (Havik et al, 2014, 28).

These observations are confirmed by the results presented in the present paper, and provide support to our proposal in the concluding remarks that the European Commission could profitably consider alternative NAIRU estimation strategies.