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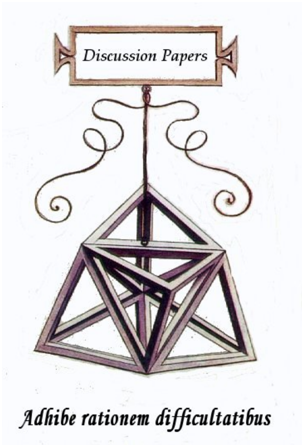

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The Role of Endogenous NAWRU in Reducing the "Space of Forgiveness": a Theoretical and Empirical Appraisal of the European Fiscal Framework

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Keywords: National Budget; Aggregate Production Function; Fiscal Policy

JEL CLassification: H610; E23; E620

The Role of Endogenous NAWRU in Reducing the "Space of Forgiveness": a Theoretical and Empirical Appraisal of the European Fiscal Framework.

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The European Union's fiscal policy framework imposes constraints on individual countries' fiscal policies to ensure long-term financial sustainability. However, it is also designed to provide flexibility through the operation of "off-balance" automatic stabilisers. In practice, these rules have led to pro-cyclical measures in EU peripheral countries due to the way European institutions estimate the Non-Accelerating Wage Rate of Unemployment (NAWRU). The paper demonstrates the procyclical nature of the current mechanism by combining empirical evidence covering the period 2002-2023 with a semi-analytical model of the potential output and NAWRU dynamics to estimate the change in the Cyclical Component due to the endogenisation of the variables relevant to the business cycle. Since the recent reform of the Stability and Growth Pact has maintained the core of this mechanism, the challenges identified for the period 2002-2023 are likely to persist in the upcoming years as well.

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1 Introduction

This paper addresses three interrelated topics or research questions.

Firstly, we introduce the theoretical framework of the European Union fiscal system. Within this framework, we develop a mathematical model to study the responsiveness of the Cyclical Component of the budget balance to changes in output using two different methods of modeling the Non-Accelerating Wage Rate of Unemployment (NAWRU).

Secondly, we evaluate the stability of the NAWRU through a panel analysis spanning the period from 2002 to 2023 and covering the European countries that have been part of the European Monetary Union (EMU) since its inception. Contrary to the notion of NAWRU as a slowly varying anchor value tied to changing labor market structural characteristics, our findings reveal its high sensitivity to fluctuations in the actual GDP growth rate.

Thirdly, we incorporate these results into our mathematical model. This integration reveals substantial disparities in the fiscal operating space afforded by the two different conceptions of the NAWRU (exogenous vs. endogenous). The endogenous bias of actual NAWRU calculated in accordance with the official methodology implies, during economic recessions and particularly for peripheral European countries, a significant reduction in fiscal space, potentially triggering a vicious cycle involving restrictive fiscal policies, a decline in GDP, and a subsequent increase in NAWRU.

The remainder of the paper is organised as follows. Section 2 provides a theoretical overview of the European fiscal framework. More specifically, subsection 2.1 deals with the concept of potential output within an “economic” approach as opposed to a “statistical” approach. Subsection 2.2 introduces the notion of the Cyclical Component of the budget balance as a space for intervention during recessionary phases. It also presents the mathematical model used to study the responsiveness of the Cyclical Component to the business cycle. Section 3 details the data and methodology used for estimating the sensitivity of NAWRU to changes in actual GDP growth rates (subsections 3.1 and 3.2). Subsection 3.3 presents the results of the empirical estimation. Section 4 integrates the insights from the previous sections into the mathematical model, emphasising how the endogeneity of NAWRU within the European Commission’s methodology significantly constrains fiscal maneuvering space. Finally, Section 5 provides the conclusion.

2 The European Union fiscal framework

2.1 The Production Function

The concept of *potential output* plays a central role in the EU fiscal framework. Potential output can be defined as the level of production/income an economic system would achieve "on the basis of available production factors without creating inflationary pressures" (European Central Bank, 2011, p. 51).

While the actual output, represented by a country's Gross Domestic Product, is easily observable and quantifiable through regularly published figures by national statistical organisations, potential output remains an unobservable variable. Therefore, estimating potential output is inherently accompanied by uncertainty.

Different methodologies have been developed to estimate potential output. Broadly speaking, they follow either a "statistical" approach or an "economic" approach. The former consists of the extraction of a trend component from observed economic data; the latter is primarily based on economic theory. The EU fiscal framework favors the economic approach because it facilitates the examination of the fundamental economic factors influencing any observed shifts in the potential output indicator. This, in turn, allows for the establishment of a meaningful link between policy reform measures with actual outcomes (Havik et al., 2014).

The model used by the EU fiscal framework is based on a Cobb-Douglas production function (equation 1), where potential output (Y_t^*) is determined by a combination of labour input (potential labour, L_t^*, as further explained below) and capital (K_t). Labour is measured in terms of hours worked, while capital is defined in relation to investments in structures and equipment. Total factor productivity (TFP_t) captures the technological level of a production system, as the same combination of labour and capital factors can result in varying output levels depending on the technology employed in the production process. For each year t, potential output is equal to:

$$Y_t^* = L_t^{*\alpha}\, K_t^{1-\alpha}\, TFP_t \tag{1}$$

The choice of the Cobb-Douglas production function with constant returns to scale (as indicated by the fact that the sum of the output elasticities of labour and capital, denoted as α and $(1-\alpha)$ respectively, equals one) is justified by its simplicity: it allows for an easy interpretation of the applied coefficients. Indeed, assuming a high average degree of competition in the goods market, the output elasticities of the two factors are equivalent to the factors' income shares. These values are directly observable and relatively stable. Consequently, α is equal to the labour share (with a value of 0.63 for all EU Member states in the EU fiscal framework model), and $(1-\alpha)$ is equal to the profit share (0.37 for all EU Member states, Havik et al. (2014)).

The *TFP* variables is estimated from the Solow residual through a bivariate Kalman filter.

Capital (K_t) is straightforwardly determined as the capital of the previous period (K_{t-1}), adjusted for depreciation at the rate of σ, plus investment (I_t):

$$K_t = K_{t-1}\,(1-\delta) + I_t\,. \tag{2}$$

The potential labour is given by the following formula:

$$L_t^* = Popw_t\ Parts_t\ (1 - NAWRU_t)\,h_t\,, \tag{3}$$

where $Popw_t$ represents the working-age population, h_t is the trend of hours worked per worker, and $Parts_t$ denotes the participation rate. The latter variable can be influenced by cyclical fluctuations, as participation rates often decline during recessions when discouraged workers exit the labour force. Therefore, the model employs a "structural" value for $Parts_t$ by detrending its time series using a Hodrick-Prescott filter.

The variable $NAWRU_t$ represents the Non-Accelerating Wage Rate of Unemployment, which is a direct descendant of the concept of the NAIRU (Non-Accelerating Inflation Rate of Unemployment) developed in New Keynesian literature (Carlin & Soskice, 1990; Layard et al., 1991). The NAIRU, in turn, has its origins in Milton Friedman's concept of the "natural unemployment rate" (Friedman, 1968). Although, as Friedman pointed out, there is nothing inherently "natural" about the natural rate of unemployment, given that "many of the market characteristics that determine its level are man-made and policy-driven" (Friedman, 1968, p. 9), its value is expected to reflect the "structural characteristics" of the labour market. These include factors such as the legal minimum wage rate, the unemployment benefit replacement ratio, the trade union density, and the legislative framework for worker protection within a country. Evidently, this encompasses a complex framework of social norms that tend to remain relatively stable in the short to medium term, unless there are significant labour market reforms.

The final endogenous variable to determine is Investment (I_t), as specified by the following formula:

$$I_t = Y_t^*\ IYPOT_t \tag{4}$$

where the $IYPOT_t$ (Investment to potential GDP ratio) is an exogenous, estimated variable (whose value is approximately 0.20 for EU members).

2.2 The Cyclical Component of the Budget as a "space of forgiveness"

Within the EU fiscal framework, the Budget Balance (BB), expressed as a percentage of GDP, can be deconstructed into two distinct components: the Cyclically Adjusted Balance (CAB) and the Cyclical Component (CC). The former, in turn, comprises the Structural Balance (SB) alongside one-off and temporary measures (OO). Typically, these temporary measures have negligible significance from a public finance perspective, and for the sake of convenience, we can assume that $OO = 0$, entailing $CAB = SB$. The Cyclical Component primarily arises from reduced revenue and increased expenditures when a country's actual output falls below its potential output. It represents a "space of forgiveness" that a country can rely on during a recession, when public finances deteriorate due to factors beyond the control of policymakers.

In the event of a GDP decline, automatic stabilisers such as unemployment benefits come into effect, leading to an increased level of public deficit. If the country had a balanced Budget Balance and Structural Balance before the recession – when the productive system was operating at full potential –, it will run a deficit during a recession. However, in the absence of discretionary fiscal policy intervention, the entire deficit amount will be attributed to the Cyclical Component. No corrective, contractionary measures will be imposed on the country to ensure compliance with the rules of the EU fiscal framework. Indeed, automatic stabilisers are considered the most appropriate tools for mitigating the negative phase of the economic cycle. This dynamic can be summarised by the following implications:

$$Y_t = Y_t^* \Rightarrow BB_t = CAB_t = SB_t = 0, \tag{5a}$$

$$Y_t < Y_t^* \Rightarrow BB_t = SB_t + CC_t = 0 + CC_t. \tag{5b}$$

The necessity of a "space of forgiveness" during times of crisis is to be contextualised in relation to the principle of maintaining a zero-budget deficit "in the medium term", as outlined in the *Stability and Growth Pact* (SGP), signed in 1997 by the European Union members and amended in 2005. In 2012, a new intergovernmental *Treaty on Stability, Coordination and Governance in the Economic and Monetary Union* was signed. This treaty incorporated the so-called *Fiscal compact*, that committed signatory members to introduce the zero-structural deficit rule in their legislation. Italy has even included the principle in its Constitution (art. 81[1]). For a brief, but detailed

[1]It is important to emphasize that constitutional norms in Italy are hierarchically

history of the evolution of European fiscal rules in the last three decades see Estella (2023).

Under the official "interpretation" of the zero-budget deficit fiscal rule offered by the Fiscal Compact, compliance was deemed if the *SB* aligned with the country-specific Medium-Term Budgetary Objective (MTO) and did not exceed a structural deficit of 0.5% of GDP (European Central Bank, 2012).

A seemingly slightly less stringent limit has been introduced through the so-called "deficit safeguard" in the recent reform of the SGP, approved by European institutions in April 2024 (Council of the European Union, 2024a,b; European Parliament and Council of the European Union, 2024). European countries not in compliance with the deficit and debt limits of the Maastricht Treaty (as reinterpreted by the reformed SGP), and that have agreed with the European Commission on a medium-term structural fiscal plan, should aim for a structural deficit target (common resilience margin) of 1.5% of GDP. Until the target is met, annual improvements in the structural primary balance should amount to 0.4% of GDP for countries with a "standard" plan of 4 or 5 years, and 0.25% for countries with an "extended plan" of 7 years. When the deficit exceeds the 3% threshold, the minimum annual structural adjustment should be at least 0.5% of GDP.

The debt criterion of the Maastricht Treaty is considered breached if the debt-to-GDP ratio is over 60%, the budget position is not close to balance or in surplus, and the deviation from the "net expenditure" trajectory agreed with the European Commission either exceeds 0.3% of GDP annually or 0.6% of GDP cumulatively. In addition, the "debt sustainability safeguard" requires a minimal annual average adjustment of the debt-to-GDP ratio of 1% for countries with a ratio that exceeds 90% (0.5% for countries with a ratio between 60% and 90%[2]).

As evident from this brief summary, the reform of European economic governance still centers on the core principle of the structural balance as calculated within the European fiscal framework. The question of whether the reformed Pact is, on the whole, more "permissive" than the previous version remains a subject of debate.

If the *SB* is to be kept anchored to a value close to zero, only the *CC* can change due to output falling below its potential. According to the methodology outlined in the EU fiscal framework, the *CC* can be calculated as a

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more important than standard primary legislation. They require a qualified majority in parliament to be amended. This new article of the Italian Constitution, obviously, has not been affected by the recent reform of the Growth and Stability Pact.

[2]Note that the average decrease by 1% or 0.5% should be computed from the year in which the country is expected to exit the excessive deficit procedure.

function of the output gap (OG_t):

$$CC_t = \epsilon\, OG_t = \epsilon\, \frac{Y_t - Y_t^*}{Y_t^*} = \epsilon\, \frac{Y_t}{Y_t^*} - \epsilon, \tag{6}$$

where ϵ is a country-specific cyclical-adjustment budgetary parameter estimated using the concept of semi-elasticity (for more information about the current methodology applied for the estimates of ϵ, see Mourre et al. (2019)).

If investment and NAWRU are treated as exogenous variables (thus, if they are supposed to be independent of the output Y_t), then we call the corresponding Cyclical Component as exogenous Cyclical Component. In what follows, we denote the exogenous Cyclical Component as $CC_t^{(\mathrm{ex})}$.

However, the hypothesis of an exogenous NAWRU openly conflicts with the empirical evidence that suggests its dependence on variations in actual unemployment, and hence on changes in the output. Indeed, the procyclicality of the European Commission's NAWRU estimates has been acknowledged in Havik et al. (2014). Attempts to address this issue have been made through approaches incorporating structural indicators of the labour market (Lendvai et al., 2015; Hristov et al., 2017). Despite the highly technical nature of the debate on the procyclicality of potential output (the direct consequence of the procyclicality of NAWRU), it has also spilled over into interventions by renowned commentators aimed at informing the wider public (see, for instance, Cottarelli (2015); Pisani-Ferry (2015)). Nevertheless, the European fiscal framework still predominantly relies on the "commonly agreed" methodology presented in Havik et al. (2014).

A simple and effective way to capture the procyclicality dynamics, is to express the NAWRU as an explicit function of the rate of change of output:

$$NAWRU_t = a\, NAWRU_{t-1} + b\, \frac{Y_t - Y_{t-1}}{Y_t}. \tag{7}$$

Further arguments supporting the use of equation 7 will be presented in section 3.

If $NAWRU_t$ and I_t are treated as endogenous variables and hence are allowed to depend on Y_t, then we call the corresponding Cyclical Component as endogenous Cyclical Component and denote it as $CC_t^{(\mathrm{en})}$. Its mathematical expression is given by (6), where the potential output Y_t^* at the denominator is written in terms of (1), (2) and (3),

$$\begin{aligned} Y_t^* \equiv Y_t^*(Y_t) = {} & [Popw_t\, Parts_t\, (1 - NAWRU_t)\, h_t]^\alpha \times \\ & [(1-\delta)\, K_{t-1} + I_t]^{(1-\alpha)}\ \ TFP_t^*\,, \end{aligned} \tag{8}$$

and, in turn, the investment $I_t \equiv I_t(Y_t)$ depends on Y_t via (4), and the Non-Accelerating Wage Rate of Unemployment $NAWRU_t \equiv NAWRU_t(Y_t)$ depends on Y_t via (7). In this case, it is convenient to introduce the three auxiliary parameters, η_1, η_2, and η_3:

$$\eta_1 = Popw_t \; Parts_t \, h_t \,, \qquad \eta_2 = (1-\delta)\, K_{t-1} \,, \qquad \eta_3 = \frac{IYPOT_t}{(1-\delta)\, K_{t-1}} \,, \tag{9a}$$

and the further two auxiliary parameters η_4 and η_5:

$$\eta_4 = 1 - a\, NAWRU_{t-1} - b \,, \qquad \eta_5 = b\, Y_{t-1} \,. \tag{9b}$$

so that equation (7) for the endogenous NAWRU reads:

$$NAWRU_t \equiv NAWRU_t(Y_t) = 1 - \eta_4 - \frac{\eta_5}{Y_t} \,. \tag{10}$$

Then, assuming all η_j's to be constant with respect to a variation of Y_t, at a given time t, the endogenous Cyclical Component $CC_t^{(\mathrm{en})}$ with endogenous NAWRU and investment is given by (6) ,

$$CC_t^{(\mathrm{en})} \equiv CC_t^{(\mathrm{en})}\,(Y_t) = \epsilon\, \frac{Y_t}{Y_t^*} - \epsilon \,, \tag{11a}$$

where the endogenous investment (4), once plugged into (1) with (2), (3) and (10), entails that the potential output $Y_t^* \equiv Y_t^*(Y_t)$ satisfies the equation

$$Y_t^* = \eta_1^{\alpha}\, \eta_2^{1-\alpha} \left(\eta_4 + \frac{\eta_5}{Y_t} \right)^{\alpha} (1 + \eta_3\, Y_t^*)^{1-\alpha} \; TFP_t^* \,. \tag{11b}$$

Observe that the potential output Y_t^* as a function of the actual output Y_t is implicitly defined as the solution to equation (11b), for it appears on either side of the equal sign. In practice, the potential output Y_t^* can be computed by numerically solving (11b) via Newton's method, once Y_t and the η_j's have been fixed. In the present work, numerical values of Y_t^* have been computed in this way, with a tolerance of 10^{-6} to ensure the desired accuracy.

Let ΔCC_t be the difference between the endogenous Cyclical Component $CC_t^{(\mathrm{en})}$ and the exogenous Cyclical Component $CC_t^{(\mathrm{ex})}$,

$$\Delta CC_t = CC_t^{(\mathrm{en})} - CC_t^{(\mathrm{ex})} \,. \tag{12}$$

The sign of ΔCC_t captures the effects of the two methods used to calculate the Cyclical Component on a country's fiscal space, and it directly depends on the business cycle. Figure 1 provides a scheme that clearly illustrates this dynamic. During a recession (the red area in the figure), real output decreases. When potential output is assumed to be unaffected by the slump (exogenous potential output), a significant (negative) output gap materialises (the distance between the blue line and the dashed black line on the right-hand side of the figure). In contrast, if potential output decreases along with real output, the (negative) output gap would be smaller (in absolute terms). Therefore, ΔCC_t would result in a positive value (a negative value minus an even more negative value). The opposite occurs when actual output exceeds potential output. If potential output is assumed to be exogenous, the (positive) output gap will be larger than it would be under the assumption that potential output is "pulled up" by the economic expansion. In this case, the negative ΔCC_t arises from subtracting a greater positive value from a smaller positive value.

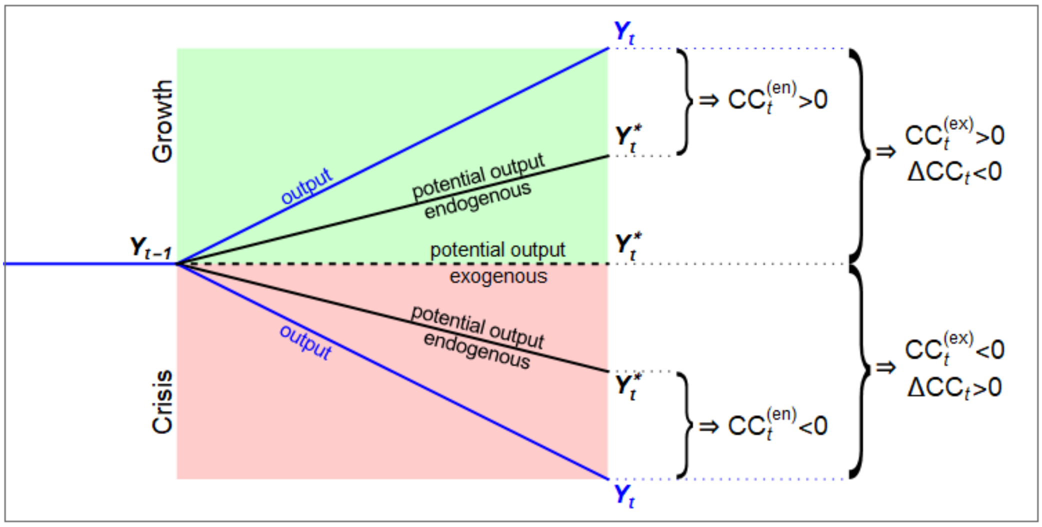

Figure 1: Illustration of two different economical scenarios (growth and crisis), and corresponding dynamics of the output (blue) and of the potential output (black), in the exogenous (dashed line) and endogenous (continuous line) assumption.

For the sake of simplicity, in what follows, we will model the exogenous Cyclical Component as

$$CC_t^{(\mathrm{ex})} = \epsilon \frac{Y_t}{Y_{t-1}^*} - \epsilon \,, \tag{13}$$

namely, we will assume that, in a given year t, in the exogenous case (as investment and NAWRU do not depend on the output Y_t and are supposed to remain constant) the potential output showing in the denominator of formula (6), Y_t^*, coincides with the one obtained (endogenously) from (11b) in the previous year, Y_{t-1}^*.

Other methods to model Y_t^* could have been devised. For instance, an alternative measure of exogenous output could combine annual data from the production function with a fixed level of the NAWRU. A reasonable assumption could have been to use the real time 2007 NAWRU data for all countries, insulating potential output from the effects of the increase in actual unemployment following the financial crisis of 2007-2008 and the European sovereign debt crisis. Fortunately, the specific way in which exogenous potential output is calculated does not affect the model's results, as long as the measure retains a degree of "stickiness" or "fixity". In figure 4 in the appendix, we provide numerical evidence that the assumption in our model leading to formula (13) is reasonably sound and justified. The figure shows a comparison between the exogenous Cyclical Component calculated using formula (13) and one calculated using the aforementioned example of alternative potential output, where the NAWRU is fixed at its 2007 level[3]. The difference between the two is negligible.

Using expression (13) for the exogenous Cyclical Component, we can rewrite ΔCC_t as

$$\Delta CC_t = CC_t^{(\mathrm{en})} - CC_t^{(\mathrm{ex})} = \epsilon \left(\frac{Y_t}{Y_t^*} - \frac{Y_t}{Y_{t-1}^*} \right) , \tag{14}$$

where Y_t^* and Y_{t-1}^* are solutions to the implicit equation (11b) at times t and $t-1$, respectively.

In the case of small variations of the output Y_t over one year, from (14) an approximate formula can be derived for ΔCC_t. Expanding $CC_t \equiv CC_t^{(\mathrm{en})}(Y_t)$ in Taylor series around Y_{t-1} we have:

$$CC_t^{(\mathrm{en})}(Y_t) = CC_t^{(\mathrm{en})}(Y_{t-1}) + \frac{\mathrm{d}CC_{t-1}^{(\mathrm{en})}}{\mathrm{d}Y_{t-1}} (Y_t - Y_{t-1}) + O\left((Y_t - Y_{t-1})^2\right) = \tag{15a}$$

$$= \epsilon \left(\frac{Y_t}{Y_{t-1}^*} - 1 \right) - \epsilon \frac{Y_{t-1}\,(Y_t - Y_{t-1})}{\left(Y_{t-1}^*\right)^2} \dot{Y}_{t-1}^* + O\left((Y_t - Y_{t-1})^2\right) = \tag{15b}$$

$$= CC_t^{(\mathrm{ex})} - \epsilon \frac{Y_{t-1}\,(Y_t - Y_{t-1})}{\left(Y_{t-1}^*\right)^2} \dot{Y}_{t-1}^* + O\left((Y_t - Y_{t-1})^2\right) , \tag{15c}$$

where

$$\dot{Y}_t^* = \frac{\mathrm{d}Y_t^*}{\mathrm{d}Y_t} = \frac{\alpha\, \eta_1^{\alpha}\, \eta_2^{1-\alpha}\, \eta_5\, \left(1 + \eta_3\, Y_t^*\right)\ TFP_t}{\left(\eta_4\, Y_t + \eta_5\right)^{1-\alpha}\ Y_t^{*2}\ \Theta} , \tag{15d}$$

[3] All the other variables of the production function take the values from the expost data set.

with

$$\Theta = (1-\alpha)\, TFP_t\, \eta_1^{\alpha}\, \eta_2^{1-\alpha}\, \eta_3\, Y_t\, (\eta_4\, Y_t + \eta_5)^{\alpha} - Y_t^{1+\alpha}\, (1 + \eta_3\, Y_t^*)^{\alpha} \ , \qquad (15e)$$

and Y_t^* satisfies equation (11b). Substituting this expression into (14), we have

$$\Delta CC_t = -\epsilon\, \frac{Y_{t-1}\, (Y_t - Y_{t-1})}{\left(Y_{t-1}^*\right)^2}\, \dot{Y}_{t-1}^* + O\left((Y_t - Y_{t-1})^2\right) . \qquad (16)$$

If $\dot{Y}_{t-1}^* > 0$, then, for small variations of Y_t, the first order term on the right-hand side of (16) is positive if $Y_t < Y_{t-1}$ and negative if $Y_t > Y_{t-1}$. In other words, equations 15d and 16 illustrate the dynamics represented in figure 1. When potential output is assumed to be affected by actual output and moves in the same direction ($\dot{Y}_{t-1}^* > 0$), ΔCC_t is positive during periods of crisis ($Y_t < Y_{t-1}$) and negative during periods of expansion ($Y_t > Y_{t-1}$). Equation 15d shows that the $CC^{(\mathrm{en})}$ can be understood as the $CC_t^{(\mathrm{ee})}$ plus a term that represents their difference. Again, the sign of the term depends on the phase of the business cycle.

Unfortunately, the higher order terms in $O\left((Y_t - Y_{t-1})^2\right)$ cannot be neglected in real case scenarios, and we will generically resort to the exact formula (14) in the following computational exercises.

3 The cyclically of the NAWRU: an empirical approach

3.1 Theoretical framework: The (in)stability of the NAWRU

As we have seen in the previous section, the NAWRU plays a crucial role in estimating potential GDP, as it is a key factor in determining potential labour input, denoted by L^*. Ideally, the NAWRU should be inferred from wage inflation data and empirically identified as the unemployment rate that maintains stable wage inflation[4]; however, due to the unstable relationship between wage and unemployment in empirical studies, the estimated NAWRU is in fact derived as the trend component of the actual unemployment rate series (Carnazza et al., 2020). In essence, this process entails a ba-

[4] Broadly speaking, this concept postulates that it is impossible to permanently reduce (increase) the actual unemployment rate below (above) its natural level (Pesaran & Smith, 1995).

sic interpolation of the observed unemployment data, making the estimated NAWRU significantly dependent on the actual unemployment rate[5].

Ultimately, the degree of closeness between the estimated NAWRU and the actual unemployment rate, and thus the variability of the NAWRU, depends largely on discretionary assumptions about the model specification. Far from being an anchor that is essentially stable over time, the NAWRU becomes a highly volatile indicator. This element introduces an endogenous relationship of the potential contribution of labour (L^*), and hence of potential GDP (Y^*), relative to the actual realisations of GDP.

Given these premises, we decide to model the change in the NAWRU over time via (7), namely as an explicit function of the rate of change in real GDP (Y):

$$NAWRU_t = \alpha\, NAWRU_{t-1} + \beta \frac{Y_t - Y_{t-1}}{Y_t} = \alpha\, NAWRU_{t-1} + \beta\, growth_t \tag{17}$$

where the parameter α represents the persistence of the NAWRU over time, while β represents its sensitivity to changes in the actual GDP growth rate ($growth_t$). Note that here α and β represent the numerical values of the coefficients a and b in (7), respectively. Since the NAWRU is empirically affected by the actual realisations of the unemployment rates, it is reasonable to theorise that the same influence is played by GDP growth. Our general objective is to demonstrate the endogenous relationship between the latter variable and the NAWRU and to empirically estimate a proper value of the coefficient β.

From a theoretical point of view, the NAWRU stability would imply a coefficient α that is statistically significant and very close to 1 and a coefficient β that should be very close to zero[6]. In this way, the consistency of the anchor

[5]This dependence is sometimes theoretically justified by the concept of hysteresis, suggesting that the equilibrium level of unemployment is influenced by its past realisations. The basic idea behind hysteresis is that the persistent under-utilisation of resources can have an impact on their effectiveness (or even exhaust their reserves). For example, prolonged unemployment leads to a decline in human capital, resulting in an irreversible rise in the NAWRU. For more information on the concept of hysteresis in the labour market, one can refer to the influential research conducted by Blanchard & Summers (1986) and Ball (2009). However, one could question the consistency of this explanation with the European fiscal policy framework and its skepticism towards the use of discretionary fiscal policy to avoid prolonged recessions that could cause a scarring/hysteresis effect on unemployment. Furthermore, it seems difficult to reconcile the concept of hysteresis with the sudden and significant fluctuations in the estimated values of the NAWRU.

[6]According to Gordon (1997), the NAWRU should shift slowly since, paraphrasing Friedman (1968), it is *ground out* by the microeconomic structure and behaviour of the

indicator over time would be ensured. This is reflected in the methodological position of the main international institutions, whose estimation of potential GDP is based on the assumption that potential output mostly fluctuates only in response to medium-run (i.e., either permanent or highly persistent) structural shocks (Havik et al., 2014; Chalaux & Guillemette, 2019). The empirical consequences of violating these assumptions in the European fiscal framework constitute the core of our analysis.

3.2 Empirical framework: Data and methodology

We consider the countries that first joined the Eurozone (Austria, Belgium, Finland, France, Germany, Greece[7], Ireland, Italy, the Netherlands, Portugal and Spain) excluding Luxembourg due to the scarce reliability of the data for this country[8]. Overall, the sample is made of 11 countries observed over the years 2002-2023[9].

We then examine whether and how the level of the NAWRU is explained by GDP growth. The baseline specification is a dynamic panel data model that can be expressed as follows:

$$NAWRU_{i,t} = \gamma + \alpha\, NAWRU_{i,t-1} + \beta\, growth_{i,t} + \mathbf{u_{i,t}} \tag{18}$$

The sign of the coefficient associated with growth captures the cyclical reaction of the NAWRU. If $\beta < 0$, a positive growth rate results in a reduction of the NAWRU (in statistical terms, this qualifies as a counter-cyclical reaction), while the opposite happens when $\beta > 0$ (i.e., a pro-cyclical reaction). Since our dependent variable is positively influenced by the actual realisations of the unemployment rates, our hypothesis is that β turns out to be significant and negative. This would represent a first clue to the endogeneity issue within the European Commission methodology. Finally, γ is the constant term and the vector $\mathbf{u_{i,t}}$ includes country fixed-effects γ_i (to control for unobserved time-invariant country characteristics), time fixed-effects γ_t

economy. In other terms, its theoretical foundation allows the possibility for the natural rate of unemployment to change in accordance with a host of market and non-market factors (Pesaran and Smith, 1995), but these shifts should occur gradually over time.

[7]Greece is conventionally considered among the twelve founding members, although it formally joined the club on 1 January 2001.

[8]In contrast to other European countries, Luxembourg's data for the various variables of the production function do not align with the potential GDP values provided by the European Commission.

[9]2002 marks the year when the European Commission began estimating the output gap twice a year, and consequently publishing the real-time NARWU values used in our econometric estimates (see figures 2, 5 and 6).

(to deal with possible exogenous shocks common to all countries in a specific year) and the error component $\epsilon_{i,t}$.

The presence of the lagged dependent variable as a regressor – as well as the possible endogenous relationship between the dependent and the independent variables – can make standard estimators inconsistent due to the Nickell-bias in a dynamic panel setting (Nickell, 1981). The Nickell bias would not be a concern for panels with a large time and cross-section dimension like ours (see also Gootjes & de Haan (2022)). In any case, we address this issue adopting the Arellano-Bond (AB) model, which uses the conventionally derived variance estimator for Generalised Method of Moments (GMM) estimation (Arellano & Bond, 1991). The AB framework solves the endogeneity issue by instrumenting *growth* with its own lags[10].

Following the idea behind Carnazza et al. (2023), we consider both the ex-post and real-time frameworks, by examining past forecasts implemented by the European Commission. Since Autumn 2002, the European Commission has been recalculating the NAWRU — along with all variables related to the estimation of potential GDP — twice a year (i.e., Spring and Autumn forecasts). Consequently, numerous time series exist due to these revisions, that cover not only forecasts *strictu sensu* but also past values of the NAWRU. This would not be problematic, had the estimated NAWRU been stable over time; however, given its high variability, the choice of which forecast to consider could influence and bias our results. In this regard, we split our estimates, emphasising the distinctions between the ex-post (*NAWRU*_expost) and the real-time outcome (*NAWRU*_realtime). The real time framework is based on the values provided by the autumn forecasts[11]. In discussing the results, we will distinguish between real-time and ex-post coefficient estimation (i.e., $\alpha^{real-time}$, $\alpha^{ex-post}$, $\beta^{real-time}$ and $\beta^{ex-post}$).

The real-time framework is expected to better capture the procyclical behavior of the NAWRU in relation to actual unemployment rates, implying a more sensitive coefficient (β) to changes in actual GDP[12]. This coefficient would provide a more accurate assessment of the effects of constant revisions to the NAWRU compared to the last ex-post evaluation of the NAWRU. Real-time data are also the ones used to inform recommendations by the

[10]We use a maximum of three lags as instruments. The results do not differ when growth is not considered endogenous and are available upon request.

[11]The results with the spring forecasts are robust and are available upon request. Descriptive statistics are reported in figure 7 in the Appendix.

[12]Operationally, for each country we build a matrix as shown in figure 6 in the Appendix, which reports an example for Italy. Our real-time variable is then built by taking — from the data in each column — only the values of the rows at the corresponding year. In this way, we get a sequence of values highlighted in the grey diagonal of the matrix.

European Union to individual countries regarding their fiscal policy stance; therefore, they are more relevant from an economic policy perspective.

After estimating the overall β, we consider a potential differentiation between peripheral (i.e., Portugal, Ireland, Italy, Greece and Spain) and core countries (i.e., Austria, Belgium, Finland, France, Germany and the Netherlands). This idea is based on the observation that peripheral countries have experienced greater increases in NAWRU over time and may have suffered from a greater endogeneity of the NAWRU itself (e.g., the dependence of the NAWRU on the growth rate of GDP). Formula 18 can then be rewritten as follows:

$$\begin{aligned} NAWRU_{i,t} = \gamma \, + \, \alpha \, NAWRU_{i,t-1} \, + \, \beta_1 \, growth_{i,t}^{(\mathrm{PIIGS})} \\ + \, \beta_2 \, growth_{i,t}^{(\mathrm{noPIIGS})} \, + \, \mathbf{u_{i,t}} \end{aligned} \tag{19}$$

where β_1 is the coefficient associated with growth of the peripheral countries ($growth_{i,t}^{(\mathrm{PIIGS})}$), while β_2 is the coefficient associated with growth of the core countries ($growth_{i,t}^{(\mathrm{noPIIGS})}$). In this respect, our hypothesis is that $\mid \beta_1 \mid > \mid \beta_2 \mid$. We then introduce another possible distinction from a temporal perspective, taking as a watershed the year when the Covid-19 pandemic started and the European fiscal framework was temporarily suspended (i.e., 2020):

$$\begin{aligned} NAWRU_{i,t} = \gamma \, + \, \alpha \, NAWRU_{i,t-1} \, + \, \beta_3 \, growth_{i,t}^{(2002-2019)} \\ + \, \beta_4 \, growth_{i,t}^{(2020-2022)} \, + \, \mathbf{u_{i,t}} \end{aligned} \tag{20}$$

where β_3 is the coefficient for the growth up to 2019 ($growth_{i,t}^{(2002-2019)}$), while β_4 refers to the remaining years ($growth_{i,t}^{(2020-2022)}$)[13]. Our idea is that the pro-cyclical outcome of fiscal policy was probably influenced by an estimate of potential GDP that was affected by actual GDP realisations: the increase in the unemployment rate resulting from a cyclical downturn led to an increase in the NAWRU, which in turn pushed down potential GDP. The resulting absolute reduction in the amplitude of the business cycle implied a reduction in the room for manoeuvre of the automatic stabilisers granted by the European Commission; hence, the need to implement restrictive fiscal policies in a recessionary phase in order to comply with the European fiscal framework

[13] Autumn forecasts range from 2002 to 2022, while Spring forecasts – whose results are robust and are available upon request – go from 2003 to 2023.

(Carnazza et al., 2023). Given these premises, β_3 should be greater than β_4 since the last few years have not been affected by its application. Finally, we combine the reasoning behind the two previous equations by disaggregating the estimate of β between country groups (PIIGS vs noPIIGS) and periods (2002-2019 vs 2020-2022): β_5 and β_6 identify peripheral and core countries respectively between 2002 and 2019, while β_7 and β_8 represent the coefficients associated with peripheral and core countries between 2020 and 2022. From this perspective, the feedback effect of the GDP growth rate on the NAWRU should be concentrated in the peripheral countries in the first sub-period.

3.3 The sensitivity of the NAWRU to changes in the GDP growth rates

Figure 2 displays the results comparing the real-time and ex-post frameworks, while figure 5 simplifies the interpretation of the results, showing in graphical terms the estimated coefficients (*i.e.*, α and β coefficients. The letter "b" after each kind of model denotes the AB approach).

On the one hand, the persistence of the NAWRU – measured by the lag of the dependent variable (*i.e.*, the α parameter) – is stronger when the ex-post framework is taken into consideration ($\alpha^{ex-post} = 0.924$, while $\alpha^{real-time} = 0.858$)); hence, the ex-post NAWRU at time t will be the same as the NAWRU at time $t-1$ for approximately 92%. This characterisation of the α coefficient tends to be the same regardless of the decomposition of the β parameter. On the other hand, the impact of changes in the actual GDP growth rate on the NAWRU (β) is much more relevant in the real-time framework ($\beta^{real-time} = -0.131$, while $\beta^{ex-post} = -0.072$); the real-time approach then implies that a 1% increase in the GDP growth rate leads to a 0.131% decrease in the NAWRU. Therefore, by omitting to consider the real-time framework – and all the progressive variations that have been implemented over time – one risks underestimating the magnitude of the endogeneity of NAWRU relative to actual GDP growth rate.

The importance of using the real-time framework as a reference becomes even more significant when introducing the distinction of the β coefficient between peripheral (β_1) and core (β_2) countries and between sub-periods. Firstly, the ex-post scenario weakly highlights the greater sensitivity of peripheral countries to NAWRU corrections as a result of changes in *growth* ($\beta_1^{ex-post} = -0.075$, while $\beta_2^{ex-post} = -0.054$); on the contrary, considering the real-time interpretation of the NAWRU allows us to appreciate the sharp difference between the two groups of countries ($\beta_1^{real-time} = -0.133$, while $\beta_2^{ex-post}$ is statistically not significant).

Figure 2: The cyclicality of the NAWRU: real-time vs ex post approach (autumn forecasts).

Autumn forecasts								
Dependent variable	***NAWRU_realtime***							
Model	**(1a)**	**(1b)**	**(2a)**	**(2b)**	**(3a)**	**(3b)**	**(4a)**	**(4b)**
Estimator	**FE**	**AB**	**FE**	**AB**	**FE**	**AB**	**FE**	**AB**
l.NAWRU_realtime	0.873 ***	0.858 ***	0.869 ***	0.860 ***	0.880 ***	0.866 ***	0.875 ***	0.867 ***
growth	-0.130 ***	-0.131 ***						
growth_PIIGS			-0.133 ***	-0.133 ***				
growth_noPIIGS			-0.036	-0.032				
growth_2002-2019					-0.165 ***	-0.168 ***		
growth_2020-2022					-0.026	-0.030		
growth_noPIIGS_2002-2019							-0.066	-0.059
growth_PIIGS_2002-2019							-0.172 ***	-0.174 ***
growth_noPIIGS_2020-2022							0.101 *	0.100
growth_PIIGS_2020-2022							-0.018	-0.018
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Endogenous relationship	No	Yes	No	Yes	No	Yes	No	Yes
Variance estimator	Robust	GMM	Robust	GMM	Robust	GMM	Robust	GMM
Number of observations	220	209	220	209	220	209	220	209
Number of countries	11	11	11	11	11	11	11	11
Time period	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022
Wald chi^2		***		***		***		***

Autumn forecasts								
Dependent variable	***NAWRU_expost***							
Model	**(5a)**	**(5b)**	**(6a)**	**(6b)**	**(7a)**	**(7b)**	**(8a)**	**(8b)**
Estimator	**FE**	**AB**	**FE**	**AB**	**FE**	**AB**	**FE**	**AB**
l.NAWRU_expost	0.936 ***	0.924 ***	0.935 ***	0.931 ***	0.941 ***	0.931 ***	0.940 ***	0.935 ***
growth	-0.072 **	-0.072 ***						
growth_PIIGS			-0.073 **	-0.075 ***				
growth_noPIIGS			-0.053 ***	-0.054 ***				
growth_2002-2019					-0.081 **	-0.081 ***		
growth_2020-2022					-0.046 *	-0.048 ***		
growth_noPIIGS_2002-2019							-0.046 **	-0.045 ***
growth_PIIGS_2002-2019							-0.084 **	-0.087 ***
growth_noPIIGS_2020-2022							-0.043	-0.045 **
growth_PIIGS_2020-2022							-0.048 *	-0.050 ***
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Endogenous relationship	No	Yes	No	Yes	No	Yes	No	Yes
Variance estimator	Robust	GMM	Robust	GMM	Robust	GMM	Robust	GMM
Number of observations	220	209	220	209	220	209	220	209
Number of countries	11	11	11	11	11	11	11	11
Time period	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022	2002 - 2022
Wald chi^2		***		***		***		***

Note (i): ***,**,* denote significance at 1%, 5% and 10% level, respectively.
Note (ii): FE = Fixed Effects (robust standard errors); AB = Arellano-Bond (using the conventionally derived variance estimator for Generalised Method of Moments estimation). The AB estimator implies the presence of the lag of the dependent variable within regressors; growth has been considered endogenous in this kind of framework with a maximum of three lags as instruments. Results do not differ if growth is not considered endogenous and are available upon request.
Note (iii): the real-time approach is based on all past autumn forecasts (see also Table A1 in the Appendix for a graphical explanation). Results do not differ if spring forecasts are taken into consideration (see Table A2 in the Appendix).
Note (iv): to strengthen the results in relation to the endogeneity problem, we also consider the lag of the independent variable 'growth' with a FE estimator. Results are robust and can be found in Table A3 in the Appendix.
Source: own elaborations on AMECO.

In this regard, core countries do not seem to have been significantly affected by the endogeneity of the NAWRU, relegating this issue to dynamics that occurred mainly in peripheral countries.

Secondly, the real-time approach shows that the impact on NAWRU of changes in the GDP growth rate is concentrated when the European fiscal rules were in force ($\beta_3^{real-time} = -0.168$, while $\beta_4^{real-time}$ is once again statistically not significant). Conversely, the ex-post framework is unable to identify a significant difference between the two sub-periods ($\beta_3^{ex-post} = -0.081$, while $\beta_4^{ex-post} = -0.048$).

Finally, we take into account both scenarios, distinguishing between peripheral and core countries in the first and second sub-period. According to the ex-post approach, there exist no significant differences between the four coefficients. The picture is very different in the real-time approach, where only the coefficient associated with the peripheral countries is significant and very high between 2002 and 2019 ($\beta_5^{real-time} = -0.174$).

4 The restriction of the "space of forgiveness"

As we have seen in section 2.2, the rationale for using the structural balance as a benchmark, rather than a nominal deficit measure, is to allow automatic stabilisers to operate during a recession. Additional government spending on unemployment benefits and reduced revenues due to a GDP contraction increase the nominal deficit. This portion of the deficit is classified as *Cyclical* and should be "forgiven" within the European fiscal framework. In other words, national governments are not expected to implement contractionary measures to offset the nominal deficit that results directly from cyclical economic downturns.

However, the actual dynamics of the entire mechanism clearly depend on how much the measure of the CC responds to changes in actual GDP. The sensitivity of the CC with respect to Y_t is influenced by how potential output is determined. In section 2.2 two different formulas for defining the CC_t were presented through equations 11a and 13, corresponding to two different approaches to calculating Y_t^*.

We can now use this theoretical method to compare different levels of the "space of forgiveness" on an individual country basis. Figure 3 shows ΔCC_t, the difference between the two Cyclical Components (as in equation 14), that is to say the difference between the Cyclical Component derived from an endogenous potential output ($CC_t^{(\text{en})}$) and the one derived from an exogenous potential output ($CC_t^{(\mathrm{ex})}$), as functions of the year t (horizontal axis) ranging from 2004[14] to 2019, for real-time data. The NAWRU is modelled as in equation 17 with parametres α and β from the overall sample[15] (red circles), or from the model that disaggregates the estimate of β between country groups (PIIGS vs noPIIGS) (blue diamonds)[16].

As it is evident in figure 3 for countries such as Portugal, Italy, Greece, and Spain[17] display positive values throughout the period of the European sovereign debt crisis (i.e., 2011-2015). This indicates that the Cyclical Component calculated using an endogenous measure of potential output – the one practically applied by European Union institutions to set country-specific consolidation targets and fiscal policy recommendations – was higher than it would have been if a measure of potential output less sensitive to the contingent deterioration of the labor market had been used. This difference precisely measures the reduction of the "space of forgiveness" entirely attributable to the exogeneity of potential output.

Interestingly, the reduction of the "space of forgiveness" does not materialise in the core countries. From a theoretical perspective, this aligns with the scheme displayed in figure 1. As all these countries experienced positive growth rates even during the years of the European sovereign debt crisis[18], we would expect a negative value for ΔCC_t. From an empirical perspective, these results are consistent with those obtained in section 3.3, where it was shown that changes in GDP have no significant effect on the NAWRU of core countries. Therefore, even during a recession year (2009), some countries, such as Austria, Belgium, and France, show negative values for ΔCC_t (blue diamonds). However, it is worth noting that a moderate reduction in the "space of forgiveness" did occur for Germany in 2009, its only recession year prior to the COVID-19 pandemic[19].

[14]The difference ΔCC_t, via equation 13, requires the computation of Y_{t-1}^*, the potential output at time $t-1$, from equation 11b; in turn, the potential output Y_{t-1}^* in equation 11b depends on the actual output Y_{t-1} via the NAWRU modelled by formula 7, which requires input of Y_{t-2} to be computed; therefore, if data start in 2002, the first value of ΔCC_t can be given for 2004.

[15]See figure 2 (model 3b): $\alpha = 0.866$ and $\beta = -0.168$.

[16]See figure 2 (model 4b): $\alpha = 0.867$, and $\beta = -0.059$ for core countries and $\beta = -0.174$ for peripheral countries.

[17]Ireland is not considered in this analysis due to the well-known substantial fluctuations in its GDP recorded during those years, which result in out-of-scale computations of the corresponding Cyclical Components.

[18]with the exception of Finland from 2012 to 2014 and the Netherlands from 2012 to 2013, which both recorded a very mild recession

[19]Core countries' NAWRU is not affected by the recession. For Germany this result can be explained by the fact that the endogenous potential output includes variables that are exogenous but not fixed. These variables are gathered annually and can, in

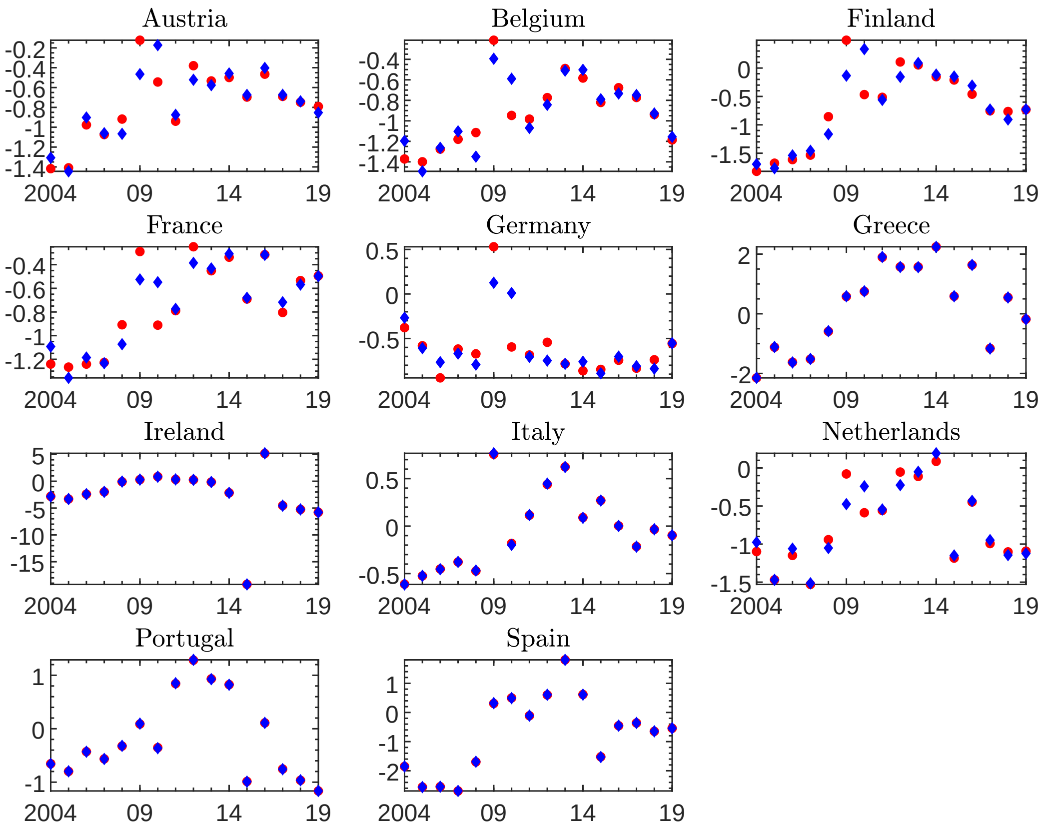

Figure 3: ΔCC_t, the difference between the endogenous $CC_t^{(\mathrm{en})}$ and the exogenous $CC_t^{(\mathrm{ex})}$ Cyclical Components, as a function of the time t (years from 2004 to 2019). The NAWRU is modeled using data from the overall sample (red circles) or differentiated between country groups (PIIGS vs noPIIGS, blue diamonds).

By multiplying the difference between the two measures of the Cyclical Component in each year and the nominal GDP, it is possible to obtain an explicit "money estimate" of the reduction of the "space of forgiveness": how many billions of euros of deficit should have fallen into the Cyclical Component "pot" – and therefore should have been "forgiven" – but were not. This could also be considered a measure of the "undue" contractionary correction that was imposed on member states during the sovereign debt crisis.

For countries like Greece, these amounts can be very significant, reaching €3.8 billion in 2011, €2.9 billion in 2012, €2.8 billion in 2013, and €3.9

practice, be affected by a recession, even though they are intended to capture the structural characteristics of the economy (e.g., participation rate, hours worked per worker). The exogenous potential output, being the potential output of the previous year, is by definition not immediately affected by the outbreak of an economic recession.

billion in 2014 (which correspond to 1.9%, 1.6%, 1.6% and 2.2% of GDP, respectively).

However, even larger countries like Spain and Italy have been affected by a serious reduction in the "space of forgiveness" during those years. In Italy, for instance, the amounts were €7.2 billion in 2012, €10 billion in 2013, €1.4 billion in 2014, €4.5 billion in 2015 (which correspond to 0.4%, 0.6%, 0.1% and 0.3% of GDP, respectively). In Spain, the amounts were €6.2 billion in 2012, €18.4 billion in 2013, and €6.3 billion in 2014 (which correspond to 0.6%, 1.8%, and 0.6% of GDP respectively).

5 Conclusions

In this paper, we presented an appraisal of the European Union fiscal framework and investigated some of the problems related to the theoretical principles and empirical estimation methodologies on which it is grounded.

The notion of potential output, along with the associated measure of the output gap, is crucial for identifying the Cyclical Component of a country's budget balance. Consequently, it plays a key role in calculating the structural balance. The structural balance is fundamental for assessing a country's compliance with the European fiscal rules. The recent reform of the SGP has reiterated the centrality of this indicator. Both the final deficit target in the country-specific medium-term fiscal plan and the adjustment pace are now expressed in structural terms.

By proposing a theoretical mathematical model, we described the difference in the impact that a change in actual output could have on the Cyclical Component. Firstly, we assumed an exogenous measure of potential output and the NAWRU. Then, we assumed a NAWRU dependent on actual output. The latter case, in a time of economic crisis, would arbitrarily reduce the Cyclical Component – what we called the "space of forgiveness" granted to policymakers with respect to fiscal rules inspired by a principle of a balanced budget.

The empirical analysis we conducted on the countries that first joined the Eurozone found solid evidence of the dependence of the NAWRU on the actual output rate of growth. Interestingly, the level of this dependence was significantly higher for countries on the periphery of the Eurozone than for core countries. In addition, real-time estimates of the NAWRU, those used to inform recommendations by the European Union to individual countries regarding their fiscal policy stance, suffered from a stronger effect of changes in actual output than ex-post estimates.

In the final part of the paper, we integrated our empirical findings into our mathematical model to derive country-specific measures reflecting the reduction of the “space of forgiveness”.

The heterogeneity of the results presented in sections 3 and 4 across countries or groups of countries (i.e., core vs periphery) can help explain why it has been so difficult in recent years to find common ground on the assessment, application, and reform of the fiscal framework within the European Union.

Given that the new version of the SGP, approved by the European Parliament and the European Commission in April 2024, has retained the core mechanisms of the previous version – particularly the key role of the structural balance – the challenges identified during the period 2002-2023 are likely to persist in the coming years.

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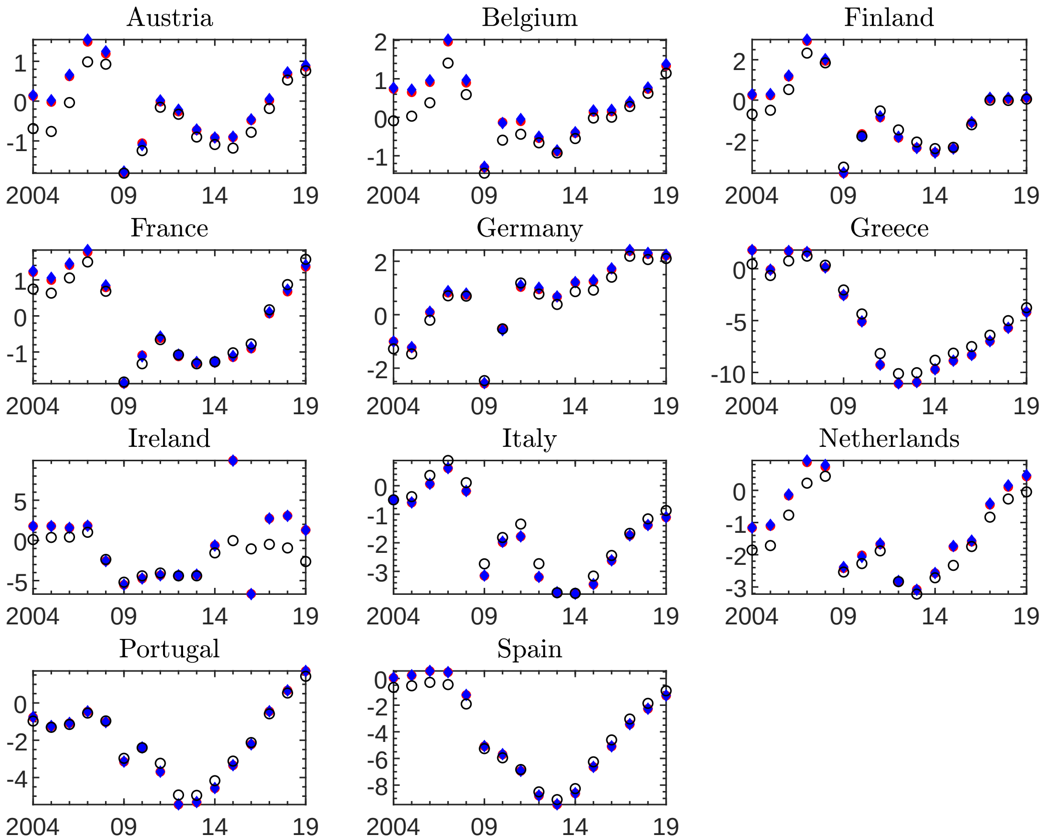
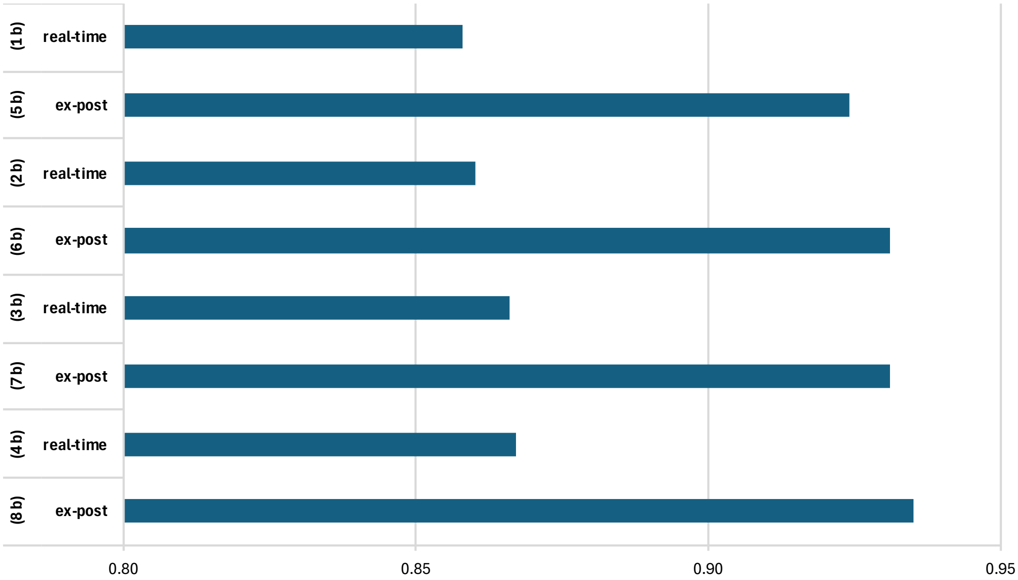
6 Appendix: Figures and Tables

Figure 4: Exogenous Cyclical Components: 2007 NAWRU vs Previous Year Potential Output.

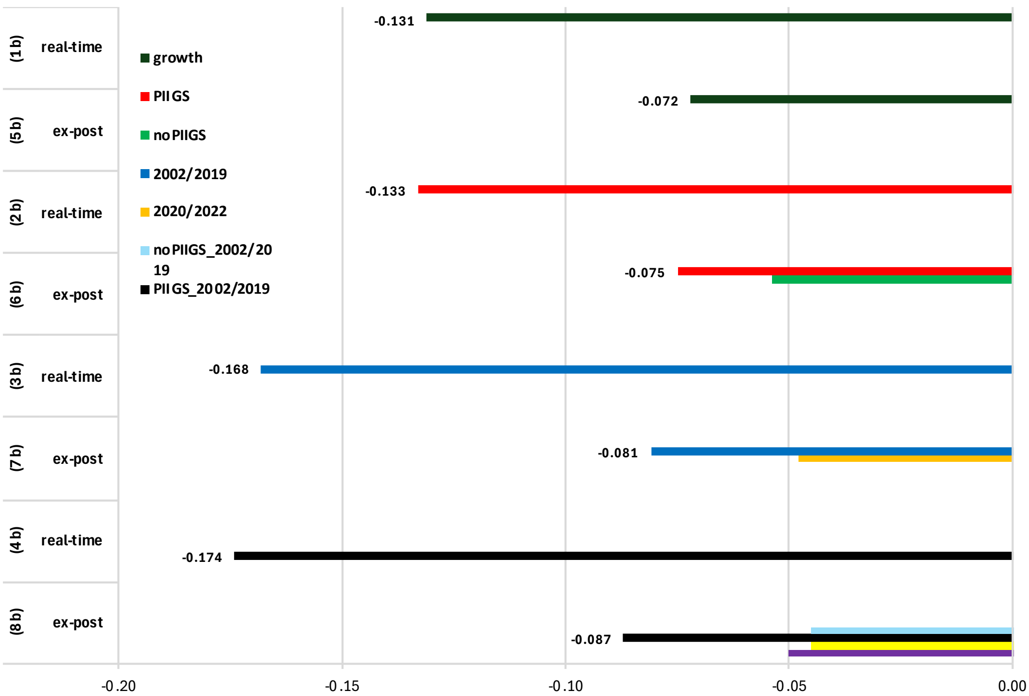


Note: The Cyclical Component CC_t as a function of time in the period 2004-2019, computed by assuming the NAWRU constant at the value attained in 2007 (black circle). This is plotted against the exogenous Cyclical Component $CC_t^{(\mathrm{ex})}$ from formula (13), where the potential output Y^* was obtained numerically by solving (11b) with all the η_j's taking values from real-time data and the NAWRU parameters a and b in (7) taking values from the Overall Sample (red circles) and the *PIIGS vs NO PIIGS* (blue diamonds) data sets, respectively.

Figure 5: The cyclicality of the NAWRU: real-time vs ex post approach.



(a) Estimates of the α coefficient



(b) Estimates of the β coefficient

Note (i): we present the α and β coefficients of equation 18. in the AB framework, accounting for the potential endogeneity between the NAWRU and GDP growth. We consider the autumn forecasts displayed in figure 2.
Source: own elaborations on AMECO (current – Spring 2023 forecast – and all past Spring and Autumn forecasts) data.

Figure 6: Revisions in the Italian NAWRU estimates (autumn forecasts).

	Autumn forecasts																					
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Δ
2002	9.2	9.4	9.1	8.9	8.9	8.8	8.6	8.7	8.6	8.6	8.2	8.4	8.3	8.4	8.5	8.5	8.6	8.6	8.8	8.9	9.1	-0.1
2003		9.1	8.7	8.6	8.6	8.5	8.4	8.7	8.6	8.5	8.2	8.3	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.2	0.1
2004			8.4	8.2	8.3	7.9	8.1	8.5	8.4	8.2	7.9	8.1	8.1	8.1	8.3	8.4	8.6	8.7	8.7	8.8	9.0	0.7
2005				7.9	7.9	7.5	7.9	8.4	8.3	8.1	7.9	8.0	8.0	8.0	8.2	8.4	8.7	8.8	8.8	8.9	9.1	1.3
2006					7.5	6.8	7.5	8.2	8.0	7.8	7.6	7.7	7.7	7.7	7.9	8.0	8.4	8.6	8.5	8.7	8.9	1.4
2007						6.2	7.2	7.9	7.7	7.5	7.3	7.4	7.4	7.4	7.6	7.7	8.1	8.3	8.3	8.4	8.6	2.4
2008							7.2	7.9	7.7	7.6	7.7	7.8	7.8	7.8	8.0	8.1	8.5	8.6	8.6	8.7	8.9	1.6
2009								7.9	7.7	7.6	8.2	8.3	8.4	8.3	8.5	8.6	8.8	8.9	8.9	9.0	9.2	1.3
2010									7.7	7.6	8.6	8.6	8.7	8.7	8.9	8.9	9.0	9.1	9.0	9.1	9.2	1.5
2011										7.5	8.5	8.5	8.5	8.4	8.5	8.5	8.5	8.6	8.6	8.6	8.7	1.3
2012											9.7	9.6	9.7	9.6	9.7	9.5	9.4	9.4	9.4	9.3	9.5	-0.2
2013												10.3	10.4	10.2	10.3	10.1	9.8	9.8	9.8	9.7	9.8	-0.5
2014													10.7	10.7	10.7	10.4	9.9	10.0	9.9	9.8	9.9	-0.8
2015														10.7	10.4	10.0	9.6	9.6	9.6	9.4	9.5	-1.2
2016															10.5	10.2	9.8	9.8	9.8	9.5	9.5	-1.0
2017																10.3	9.7	9.9	9.8	9.5	9.6	-0.7
2018																	9.8	9.9	9.8	9.5	9.5	-0.3
2019																		9.8	9.6	9.5	9.4	-0.4
2020																			9.5	9.3	9.4	-0.1
2021																				9.7	9.6	-0.1
2022																					9.1	0.0

Note: grey areas summarise the estimation of the *NAWRU*_realtime variable; on the contrary, column concerning 2023 defines the variable *NAWRU*_expost. Last column (Δ) reports the difference between the two variables. The same procedure has been applied to derive the real-time values of the NAWRU from the Autumn forecasts.
Source: authors' elaborations on AMECO (current – Spring 2023 forecast – and all past Spring forecasts) data.

Figure 7: Descriptive statistics (The cyclicality of the NAWRU).

	Obs	Period	Mean	Std. Dev.	Skewness	Kurtosis	Source
			Autumn forecasts				
growth	231	2002-2022	1.462	3.744	0.445	10.102	AMECO (2023 spring forecast)
NAWRU_expost	231	2002-2022	8.325	2.979	0.763	3.273	AMECO (2023 spring forecast)
NAWRU_realtime	231	2002-2022	8.286	3.715	1.276	5.075	AMECO (all vintage autumn forecasts)