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Structural unemployment and its determinants in the EU countries

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Fabrice ORLANDI*

Abstract

Variables commonly used, in a panel setting, to explain unemployment rate developments (e.g. Bassanini and Duval (2006a, 2006b)) provide similarly good fit for *structural* unemployment rate, as measured by the Commission services (i.e. the so-called NAWRU). Those variables include labour market structural indicators, thus confirming the impact of labour market structural reforms on the NAWRU. In addition, we find that persistent demand shocks also have a bearing on the NAWRU. Such shocks are related to crisis events (i.e. unwinding of unsustainable developments). In particular, housing boom-bust episodes have statistically significant impacts on the NAWRU. Real interest rate and TFP growth, which controls more generally for the presence of such shocks, also matter. Put together, the explanatory variables account for 90% of the variance of NAWRU, in a 13 EU countries panel covering the period 1985-2009. The tight fit leaves no scope for statistically significant linear trend or period-effects. The paper also presents a new measure of the degree of generosity of unemployment benefit schemes, which has superior explanatory power compared to alternative measures commonly used to account for the role of this variable in similar studies.

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COUNTRY CODE ABBREVIATIONS

BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
EL	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
UK	United Kingdom
EA	Euro area
EU27	European Union
CN	China
JP	Japan
US	United States

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1 Introduction

This paper identifies factors driving structural unemployment across 13 EU countries in a panel setting covering the period 1985-2009. The so-called NAWRU estimate, as produced by Commission services, is used to proxy for structural unemployment. Similar studies include, among others, Nickell (1997), Blanchard and Wolfers (2000) and Bassanini and Duval (2006a and 2006b).

The results show that variables commonly used in the literature to explain unemployment rate developments (e.g. Bassanini and Duval (2006a, 2006b)) provide similarly good fit for the NAWRU. Those explanatory variables include labour market structural indicators, thus confirming the impact of labour market structural reforms on the NAWRU. In addition, we find that persistent demand shocks also have a bearing on the NAWRU. Such shocks are related to crisis episodes (i.e. unwinding of unsustainable developments). In particular, housing boom-bust episodes have a statistically significant impact on NAWRU developments. Real interest rate and TFP growth, which controls more generally for the presence of such shocks, also matter. Put together, the explanatory variables (including fixed-effects) account for 90% of the variance of the NAWRU in our panel. The tight fit leaves no scope for statistically significant linear trend or period effects.

On a more technical note, the paper also presents a new measure of the degree of generosity of unemployment benefit schemes, which combines information regarding the level and the duration of the schemes in a novel way. In a nutshell, the measure computes a weighted average of replacement rates at different spell horizons, allowing weights to vary across countries depending on the level of the unemployment exit rate (i.e. job finding rates). The measure has superior explanatory power compared to the alternative variables commonly used to account for the role of unemployment benefits (i.e. replacement rate at different spell horizons and ratio of replacement rate at different spell horizons) in similar studies.

The remainder of this paper is organised as follows. Section 2 describes NAWRU estimation. Section 3 explains the link between NAWRU and its determinants. Section 4 describes the data used in the empirical part, reporting stylised facts. Section 5 describes the econometric analysis. Section 6 stresses the policy relevant results. Section 7 concludes.

2 Measuring structural unemployment

Structural unemployment is the 'natural' rate of unemployment that the economy would settle at in the long run in the absence of shocks. Its level is determined by institutional factors and fiscal measures (unemployment benefits, tax rates) which influence the reservation wage. Empirically structural unemployment cannot be observed. Instead, it is estimated through methods that rely on pinning-down its statistical and/or theoretical properties.

The approach used by ECFIN, relies on a so-called unobserved component model. Intuitively, the method seeks to identify structural unemployment by removing short term fluctuations. In particular, the filtering assumes that short term unemployment fluctuations (i.e. cyclical unemployment) affect wage inflation while trend unemployment (i.e. structural unemployment) does not – i.e. the trend component is the non-accelerating wage rate of unemployment (NAWRU).

Importantly, this method provides only a proxy for structural unemployment that might not remove fully the impact of all temporary shocks. In particular, persistent shocks are likely to contaminate the trend. This point will be further discussed in the empirical part.

More specifically, ECFIN's approach for NAWRU estimation relies on the use of the Kalman Filter to disentangle trend from cycle in the unemployment rate series. A large literature describes such methodologies, which have been applied to the estimation of structural unemployment or potential output series. A seminal contribution, using the Kalman Filter to estimate US potential output is Kuttner (1994). Gerlach and Smets (1999) have applied a variant of the Kuttner model to obtain estimates for the euro area. A prominent reference for structural unemployment estimation is Gordon (1997). In a series of papers Apel and Jansson (1999a, 1999b) have applied this methodology to Sweden, the UK, the US and Canada, while the OECD (2000) used it to produce structural unemployment estimates for OECD countries.

The ECFIN approach does not rely on economic information to model the trend component of the unemployment rate series (i.e. the NAWRUs). These factors are regarded as unobservable and only a time series model is specified to capture general statistical properties of the unemployment trend (e.g. non-stationarity). Economic information is however used to model the cyclical component of the unemployment rate. This is done by allowing for a wage-Phillips curve type relationship whereby changes in wage inflation affect cyclical unemployment. In other words, this relationship is used to assist in the identification of the cyclical component of the unemployment rate.

Formally, unemployment rate U_t is decomposed into a trend (T_t) and a cycle (C_t):

$$U_t = T_t + C_t \qquad (1)$$

The below wage-Phillips curve is added to the system,[1] allowing for a link between changes in wage inflation ($\Delta\pi_t^w$) and the cyclical component of the unemployment rate (C_t). Moreover, the relationship controls for the impact of a number of exogenous/predetermined variables such as lagged changes in the unemployment rate or terms of trade, captured by X_t. Remaining unobserved shocks are captured by the error term (u_t) which can be autocorrelated.

$$\Delta\pi_t^w = \mu^w + \gamma X_t + \beta C_t + u_t \qquad (2)$$

where: $u_t = \sum_i \theta_i \, \epsilon_{t-i}$

Besides having predictive power for wage inflation, the cyclical component of unemployment must obey certain business cycle restrictions:

- It should be an AR process, preferably with cyclical properties (e.g. cyclical AR(2)).

- It should be stationary.

- It should have a sample mean of zero.

Formally the cycle is modelled as an AR(2) process (note that stationarity requires $\emptyset_1 + \emptyset_2 < 1$):

$$C_t = \emptyset_1 C_{t-1} + \emptyset_2 C_{t-2} + v_t \qquad (3)$$

The trend is modelled as a random walk with drift (where the drift itself can be a random walk), with error terms (z_t and a_t) both IID.[2]

$$T_t = \mu_t + T_{t-1} + z_t$$

where: $\mu_t = \mu_{t-1} + a_t$

[1] Note that, as will be shown in the next section, such wage Phillips curves are not imposed in an ad-hoc way. Instead, the relationship is consistent with the underlying model used to underpin the structural unemployment derivation.

[2] For further details on the approach used by ECFIN for the estimation of structural unemployment see Denis et al. (2002), Denis et al. (2006) and D'Auria et al. (2010).

3 Determinants of structural unemployment

This section discusses the theoretical link between structural unemployment and its determinants. Two types of determinants can be distinguished, namely structural and non-structural. Structural determinants, discussed in the first sub-section, are features of the labour market that have a bearing on its functioning. The second sub-section discusses the non-structural determinants, which include changes in the real interest rate, variations in the level of technological progress and housing boom-bust effects.

3.1 Labour market structural indicators

In this section, we present the model used to characterise structural unemployment. This model follows closely the setting used in ECFIN to theoretically underpin structural unemployment derivations in the context of the NAWRU estimation framework (see D'Auria et al (2010); see Blanchard and Katz (1999) for additional reference). For the purpose of the present analysis the framework was however extended to incorporate links to the labour market structural indicators which will be considered in the empirical part.

First a labour demand schedule is defined:[3]

$$w_t - \emptyset\, almp_t - p_t = c + y_t - l_t \qquad (4)$$

where: $almp_t$ is active labour market policies. This variable takes the role of a shock to the labour demand schedule. Intuitively, an increase in $almp_t$ is equivalent to a decline in non-wage cost for the firm as active labour market polices is perceived to represent workers' training cost borne by the government. More generally, the firm perceives that an increase in $almp_t$ improves matching and performance in the jab. The effect is then to increase demand for labour. However (as shown below in eq (6)) the worker is allowed to internalise part of the shock (i.e. the change in non-wage cost), potentially mitigating the benefit of an improvement or a reduction in $almp_t$.

On the supply side, alternative theories are encompassed by the following wage rule:

$$w_t - tax_t - p_t^e = a_0\, ud_t + (1-\mu) b_t^e - \mu\, pr_t^e - \beta\, u_t + a_t^w \qquad (5)$$

where: p_t^e stands for expected price, b_t^e stands for expected reservation wage, pr_t^e stands for expected productivity, u_t stands for unemployment rate, a_t^w is a shock to the wage rule and ud_t stands for union density.

Note that μ is of particular importance, as it determines the relative weight of alternative theories. When μ is equal to zero, the wage curve collapses to the neoclassical case, while $\mu = 1$ implies a bargaining model framework.

In the neoclassical model, the worker sets its labour supply so as to be indifferent between additional work and additional leisure. At that optimum wage equals the so-called reservation wage (i.e. b_t, according to our notation). Importantly, an increase in the tax rate or an increase in the unemployment benefit will have similar effects in the neoclassical case (i.e. when $\mu = 0$). Both will lower labour supply by the same amount for a given wage level. Or, equivalently, they will raise the reservation wage by the same amount, which implies that workers would demand a higher wage to maintain a given level of labour supply.

In the bargaining model, unions aim at ensuring that the wage share (after taxes) in GDP is appropriate. The latter objective is represented by a productivity indexation rule. By enforcing a link between net wage and productivity, unions shift tax costs onto firms. Firms would thus react to an increase in taxes by lowering labour demand. While unions internalise risk of unemployment and aim

[3] The demand schedule is derived from a typical firm maximisation problem.

for an optimal trade-off between more wage and lower unemployment risks, they however tend to generate an insider-outsider situation as they tend to cater to the needs of the employed rather than the unemployed. In this setting, the unemployment benefit plays a small role.

Values of μ between 0 and 1 represent intermediary situations. Such an intermediary situation could, for instance, be the result of the fact that segments of the labour market are best modelled as behaving according to the neoclassical predictions while others rather follow a bargaining model framework type of behaviour.

As discussed above, we further assume that the worker internalises part of the labour demand shock related to $almp_t$:

$$pr_t = y_t - l_t + \psi_{almp} almp_t \quad (6)$$

Then, the below equation determines the worker's reservation wage (b_t). The latter is set in proportion to productivity (corrected for the portion of the labour demand shock internalised by the worker). The proportion is the *unemployment benefit replacement rate* (b_t^0). In addition, reservation wage is affected by the level of labour tax, to an extent which is controlled by $\kappa \in [0\,;1]$. The latter elasticity parameter measures whether the reservation wage is indexed to the net or the gross wage:

$$b_t = b_t^0 + pr_t - \kappa\, tax_t \quad (7)$$

To account for duration of benefits entitlements, the replacement rate (b_t^0) is further defined as the average expected replacement rate that the worker would receive while unemployed. To compute this expected replacement rate, the worker uses unemployment exit rate probabilities (i.e. job finding rate). Intuitively, this approach is similar to a permanent income approach whereby the worker computes expected permanent income during a (typical) spell of unemployment. In particular, this approach allows accounting for the duration of unemployment benefits entitlement. An economy with a low unemployment exit rate features longer typical spell of unemployment. In our computation of the replacement rate level, replacement rate received over longer spell of unemployment will feature more prominently than in a country with higher unemployment exit rate probabilities.

Formally, this can be expressed as follows, where α stands for the monthly unemployment exit rate probability and $b_t^{0,i}$ stands for the replacement rate after i months of unemployment:

$$b_t^0 = \sum_{i=0}^{\infty} b_t^{0,i} \alpha (1-\alpha)^i \quad (8)$$

Finally, we close the model by assuming static expectation, as is commonly done in this type of framework:[4]

$$\pi_t^e = \pi_{t-1}$$

$$\Delta pr_t^e = \Delta pr_{t-1}$$

The steady state unemployment rate consistent with the above setting is as follows:

$$u_t^* = \frac{-c + a_0\, ud_t + (1-\mu) b_t^0 + (\psi_{almp} - \phi) almp_t + (1-\kappa(1-\mu)) tax_t}{\beta} \quad (9)$$

Moreover, the wage-Phillips-curve consistent with the above is shown below.[5] Note it features the $almp_t$ variable, reflecting the fact that the latter was assumed to affect (non-wage) labour costs.

$$\Delta \pi_t^w = (\phi - \psi_{almp}) \Delta^2 almp_t - \beta (u_t - u_t^*) + a_t^w \quad (10)$$

Equation (9) is the key result, describing the link between structural unemployment and the labour market structural indicators. This equation will be estimated in a panel presented below in the

[4] We plan further extension to the case of rational expectation.
[5] See Blanchard and Katz (1999) or D'Auria et al (2010), especially annex 2, for details of such derivations.

empirical part. However, the regression will also feature non-structural variables which need to be controlled for, as discussed in the next sub-section.

3.2 Other (non-structural) factors

In addition to the structural factors considered in the previous section evidence gathered in the literature suggests that, in the presence of labour market rigidities,[6] other factors can also affect the NAWRU. Indeed, a link between demand conditions and the NAWRU (i.e. demand shocks affecting the NAWRU) can be found in models featuring labour market rigidities (e.g. a hybrid New Keynesian Phillips curve (see Vogel (2008)). Discussion along those lines is provided in Blanchard and Wolfers (2000), with the authors mentioning real interest rate, TFP growth rate and shifts in labour demand as shocks likely to have affected NAWRU developments in the EU countries over the past decades. Intuitively, rigidities influence speed of adjustment to shock causing long-lasting effect on labour market developments. Such developments can contaminate trend component estimation in method such as the one used by Commission services (described in section 2 above).

While it is unclear whether a change in TFP would permanently affect the level of the NAWRU, it is straightforward to show that it can have persistent effects on unemployment. In particular, a decline in trend TFP growth would increase unemployment so long as workers and firms do not fully adjust to this new environment (i.e. in particular adjusting expectations in respect of wage claims), entailing a negative link between TFP growth and unemployment.[7] Alternatively, a positive link could result from the fact that technological progress may increase the need for reallocation. The present study reports a negative empirical link, in line with other studies (e.g. Blanchard and Wolfers (2000) and Bassanini and Duval (2006a and 2006b)).

As regards the real interest rate, the link with the NAWRU is negative. The impact runs through the investment variable. That is, a rise in the real interest rate triggers a decline in capital accumulation. Employment then has to decrease to restore the equilibrium capital-labour ratio. Moreover, prolonged periods of low real interest rates are susceptible to increased risks of unsustainable developments (e.g. boom-bust patterns in the housing sector). Such unsustainable developments can have a bearing on the NAWRU as well, as further discussed below.

Shocks affecting the economy can also influence the NAWRU through hysteresis effects, namely rises in unemployment can become entrenched (see e.g. Ball (2009)). Proponents of this theory argue that long periods of high unemployment can increase the proportion of long-term unemployed. As those, it is argued tend to have less impact on labour market adjustment, this can alter labour market dynamics adversely. More precisely, a long spell of unemployment can make the unemployed less appealing to potential employers. The unemployed then exerts less downward pressure on wages and rises in unemployment tend to become entrenched.

Ball (2009) ascribes a large portion of the evolution of the NAWRU since the 80s in OECD countries to such hysteresis phenomena. Indeed, it can be noted that countries that have witnessed important economic shocks (e.g. financial crisis or housing market boom-bust episodes) typically tend to have experienced large corresponding variation in their NAWRU. A case in point is the large increase in structural unemployment observed in Sweden and Finland in the 90s at the time of their financial crises. Yet, the overall empirical resultsremains mixed. On the basis of unit root tests, Leon-Ledesma (2002) does not find support for the hysteresis effect claim for the EU. Jaeger and Parkinson (1994) however find supporting evidence for Germany and the UK, relying on Kalman-filter techniques, while Logeay and Tober (2006) find similar results for the Euro Area.

[6] Note that the existence of labour market rigidities has been documented empirically for the EU in a recent study which finds that wages are revised on average only every 15 months (see results in Druant et al. (2009) reported within the Eurosystem Wage Dynamics Network project).

[7] A negative link between TFP growth and unemployment has also been rationalised in terms of relative prevalence of disembodied (rather than embodied) technological change (see Pissarides and Vallanti (2007)).

Other researchers also mention the potential impact of housing boom-bust effects on structural unemployment. Findings for the US reported in Estevao and Tsounta (2011) show that States hit more severely by the collapse of a housing bubble experienced a larger increase in the unemployment rate, even after controlling for the cycle. Intuitively, a bursting of a housing bubble triggers a need for a sectoral reallocation in the labour market that may prove cumbersome. Sluggish adjustment of wages in the face of rising skill mismatch, due to sharp increases in the unemployed with a similar low-skill profile, yields a long-lasting rise in the level of unemployment.[8] Similar results on the impact of reallocation are reported in Phelan and Trejos (2000) and in Chen et al. (2011).

To sum up, the above discussion provides explanations for potential movements in the NAWRU unrelated to changes in the structural features discussed in the previous sub-section. Such unemployment patterns are likely driven by persistent demand shocks which, in combination with labour market rigidities, translate in long-lasting rise in unemployment. Note that in a number of countries the recent movement in the NAWRU, in the midst of the Great Recession, is likely to be related, to a substantial extent, to such large persistent demand shocks. Importantly, such phenomena do not affect structural unemployment as such (i.e. the long term equilibrium). Convergence back to a little affected structural unemployment level determined by structural features can still be expected, once the effects of persistent shocks disappear. Bearing this point in mind is of particular importance in attempting to forecast NAWRU developments over the long run.

The next section turns to the empirical analysis. It presents the data that will be used in the econometric analysis to regress the NAWRU on its determinants.

4 Data

This section describes the data used in the empirical part (panel estimation period: 1985-2009). Stylised facts are gathered while presenting the data. The dependent variable, namely the NAWRU, is first described. Then, structural labour market indicators are presented (i.e. union density; labour tax wedge; unemployment benefits; active labour market policies) followed by the variables used to account for impact of non-structural variables on the NAWRU (i.e. real interest rate, TFP growth and a variable controlling for housing boom-bust patterns).

4.1 NAWRUs

Graph 1 below shows the evolution of the NAWRU, as estimated by ECFIN.[9] The series shows a broad increase in the 70s and the 80s in most countries. Since then, most countries have witnessed a stabilisation or even a decline in the NAWRU (i.e. exceptions are Spain, Ireland and Portugal). Those general tendencies confirm the existence of common shocks across countries.

Another important stylised fact is that some countries witnessed more volatile NAWRU developments than others. Interestingly, those countries turn out to be those affected by large economic shocks related to major crises – e.g. Finland and Sweden in the 90s or, more recently, Spain, Ireland and Portugal. This strongly suggests that, as discussed in the previous section, important economic shocks can have a bearing on structural unemployment developments.

4.2 Labour market structural indicators

We now turn to the data that will be used to control for the structural features of the labour market in the different countries. To account for differences in NAWRU developments across countries, empirical studies have typically relied on such labour market institutional features.[10] In the econometric analysis, the below list of structural labour market indicators have been used. Note that

[8] On evidence of increased relevance of labour mismatch see European Commission (2011).
[9] Data refers to NAWRUs computed for the Autumn 2011 EC forecast.
[10] For an extensive discussion see Blanchard and Wolfers (2000).

the country and indicator coverage is dictated by data limitations, as sufficient time-span is required for panel estimation. Moreover, while other indicators have been tested, the below set of indicators provided the most significant and robust econometric link with the NAWRU variable:

- the unemployment benefits replacement rate
- the labour tax wedge[11]
- the degree of union density
- the expenditure on active labour market policies

More precisely, for the *unemployment benefits replacement rate* the series is a proxy for expected average replacement rates (i.e. the definition provided in equation (8) above). To proxy that rate, a weighted average of the rate received during the 1st year of unemployment and the average rate beyond that horizon is computed. Formally, the replacement rate is computed as follows:

$$b_t^0 = \theta b_t^{0,<12} + (1-\theta) b_t^{0,>12}$$

$$\theta = \sum_{i=0}^{11} \alpha (1-\alpha)^i$$

where α is the monthly unemployment exit probability (or job finding probability) and $b_t^{0,<12}$ is the average replacement rate received for a spell of unemployment of up to 12 months, while $b_t^{0,>12}$ and the average replacement rate received beyond 12 months. Note that the above formulation is in line with equation (8), under the assumption of constant replacement rate level beyond the 1st year of unemployment. To calibrate α we rely on monthly unemployment exit probabilities reported by the OECD (i.e. Economic Outlook n.89), as shown in the table below. Those are computed using a method pioneered by Shimer (2007) and recently applied (and adapted) to a number of EU countries by Elsby et al. (2009) and Arpaia and Curci (2010). In our analysis we use the rates reported in the first row, representing more accurately the situation in "normal" times.[12]

Importantly, our measure of unemployment benefit generosity could generate problems of colinearity and endogeneity. That is, exit rates levels may co-move with the NAWRU or with explanatory variables such as the degree of ALMP spending. To circumvent those issues, fixed (average) exit probabilities per country are used, as reported in the table, rather than time varying measures. While cross country variation could also generate similar issues, in practice this did not affect our results substantially. More precisely, using average exit rate for the group as a whole yielded a similar coefficient on the unemployment benefit variable, affecting only precision of the estimation (i.e. t-statistics lower). In view of that result our preferred measure is the unemployment benefit measure based on average unemployment exit probabilities per country.

Table 1. Probability to exit unemployment (monthly probabilities, in %)

	AT	BE	DE	DK	ES	FI	FR	IE	IT	NL	PT	SE	UK
2005-2007*	14.9	8.5	8.1	20.4	15.1	19.0	11.5	6.2	7.2	11.0	6.5	19.2	14.8
2008-last	14.6	8.3	8.7	17.8	9.8	19.1	11.1	4.2	6.3	11.0	6.0	17.4	12.3

Note: The table reports the average probabilities (over the two periods) of exiting unemployment within a month.
* For Ireland and Turkey the period is 2006-2007.
Source: OECD (Economic Outlook n.89).

The replacement rate series used in the computation (i.e. $b_t^{0,<12}$ and $b_t^{0,>12}$) are, for the recent years (covering 2001-2009), net replacement rates, available from the OECD. More precisely, replacement rate series express unemployment benefit levels as a percentage of previous earnings while working. The OECD reports average replacement rate across two income situations and 3 family situations.[13]

[11] For empirical evidence on the role of the labour tax wedge see for instance OECD (2006).
[12] Using the average of the two rows was also tested. It did not affect econometric results significantly.
[13] Recipients use to earn 100% or 67% of average wage income. Recipient has no children and is either single, married with a partner that has no income or with a partner that has an income.

For $b_t^{0,<12}$ we use the average rate received for an unemployment spell of up to a year. For $b_t^{0,>12}$ we rely on a series reporting the average rate received over an up to 5 year unemployment spell.[14]

To increase time span, corresponding gross replacement rate series are used over history. The splicing of the net and the gross series imposes matching of the net level.[15] This reflects the fact that information content of the net indicator is more valuable as it measures more accurately the effect of the unemployment benefit scheme on workers incentives (i.e. on the reservation wage).[16]

The replacement rate series used are shown in Graph 2 below. The higher series is the rate received during the first year and the lower series is the average rate received over a 5 year unemployment spell. Note that a large gap between the highest (initial rate) and the lowest (5 years average) replacement rate series is indicative of a sharp decline in the profile of the replacement rate level over the unemployment spell horizon. A case in point is Italy, where replacement rate indeed quickly decline over the unemployment spell (see Graph A3, appendix E).

The circled line is the weighted average of the two other series – i.e. the measure of unemployment benefit generosity used in our analysis. The circled line stands closer to either of the two series depending on the level of the exit rate (i.e. rates reported in Table 1 above). That is, in a country with high probability of exiting unemployment quickly, worker's expected replacement rate while unemployed is mainly determined by the 1st year replacement rate (i.e. the higher series). Instead, in a country where longer spells of unemployment are likely (i.e. lower unemployment exit rate), workers use a more balanced weighted average across the different replacement rate received over the time (i.e the initial 1st year rate and the rate received beyond that horizon).

Graph 2 shows that our measure of unemployment benefit generosity (the circled line) is on average, across time and countries, close to the 60% mark. Scandinavian countries however tend to have a higher rate, though there has been some tendency to converge down towards the average. Noteworthy is also the fact that Spain has a relatively high replacement rate. Italy also stands out as having a substantially less generous unemployment benefit scheme than the average, despite some recent increases in the replacement rate series.

The *labour tax wedge* measures the proportional difference between the costs of a worker to their employer (wage and social security contributions, i.e. the total labour cost) and the amount of net earnings that the worker receives (wages minus personal income tax and social security contributions, plus any available family benefits). The situation considered is that of a single person without children, earning average wage. Before 2000, the series is spliced with an alternative series that considers the situation of a single-earner couple with two children earning average wage.

The labour tax wedge series are depicted in Graph 3 below. It shows that the level of the labour tax wedge varies substantially across countries, ranging from an average rate of below 30% in Ireland to up to 55% in Belgium. The Netherlands appears to be the only country that achieved any reduction in the level of the labour tax wedge over the period. In Finland, the decline since the mid-90s represents a compensation for an earlier notable increase. A trend increase is noticeable in Austria and France, though in the latter case a flattening out is discernable recently. The other countries show broadly stable levels over the period, with varying degrees of volatility.

Turning to *union density*, the series used is the proportion of union membership, based either on surveys data or calculated on the basis of administrative data.

The union density series are depicted in Graph 4 below. It shows significant level differences across countries, ranging from a recent level of less than 10% in France to up to around 75% across the Scandinavian countries. No country has witnessed a durable increase in the level of union density over

[14] In the computation of the weighted average, the 5 year series is transformed into a more than 1 year by removing the effect of the up to 1 year series.

[15] In the case of Italy this implied negative replacement rates for the early part of the sample for the 5 year average replacement rate series. To correct for this, negative rates were substituted by zeroes. More generally, note that the replacement rate series for Italy is atypical. For instance, the 1st year rate series and the 5 years average rates series cross each other occasionally. This is also the case for the UK series.

[16] See Howell and Rehm (2009) for a detailed discussion on the usefulness of net replacement rates.

the period, except for Finland, although most of the increase seen in that country took place in the early 70s. Instead, a number of countries witnessed a significant drop in the level of union density, most notably Austria, Germany, France, Ireland, Netherlands, Portugal and the UK.

The *active labour market policies* (ALMP, see Graph 5) series measures the expenditure on seven sub-items,[17] except for Italy, where the sub-item "public employment services" (PES) had to be excluded to increase time span. Note that this sub-item increased the ALMP variable by 0.2 pp. on average in the other countries. Also, the series including the PES sub-item and the ones excluding it tended to have the same profile (except in the case of the UK, where the temporary rise in ALMP is exclusively related to a rise in the PES sub-item).[18]

To allow cross-country comparison, the variable is transformed into the following ratio: (Share of ALMP expenditure in GDP / Share of unemployed in the population). This controls for the size of the country as well as the fact that expenditure tends to go up with the number of unemployed. In other words, this ratio measures the intensity of ALMP for controlling for the size of the country and number of unemployed.

Those series are depicted in Graph 5 below. It shows that some countries witnessed stable developments while others occasionally engaged in a substantial increase in ALMP (e.g. DK, NL and SE). Interestingly, those increases tended to be temporary. Tentatively, this suggests that such policies were conducted in response to specific challenges, to support the adjustment.

4.3 Other (non-structural) factors

As discussed in section 3, our empirical analysis will also control for the effect of non-structural factors – i.e. factors not related to the structural features of the labour markets. Three such factors will be considered, namely the growth rate of total factor productivity (TFP), the real interest rate and a variable (i.e. employment share in construction) controlling for boom-bust patterns in the construction sector.[19]

As explained in section 3, a decline in the *TFP growth* can yield a rise in unemployment, as expectations (i.e. in particular wages) might not adjust swiftly. Graph 6 below reports the evolution of the TFP growth rate. It shows that most countries have witnessed a trend decline in their TFP growth rate over time. This could explain partly the trend increase in NAWRU observed across the board since the early 60s in most countries. Note also that trend TFP growth has recently been especially weak in a number of countries (e.g. ES, IT and PT).

Moreover, in times of crisis, TFP growth can decelerate sharply. Unless wage claims adjust swiftly and substantially downwards this tends to cause increases in the NAWRU. A sharp drop in TFP growth has been observed recently in a number of countries in the midst of the crisis. While measures have been put in place to mitigate its impact (e.g. employment-hours reduction schemes) it has contributed to the recent rise in the NAWRU seen in a number of countries.

As explained in the previous section, an increase in the *real interest rate* is prone to increase the NAWRU. In addition, prolonged periods of low real interest rate can spark episodes of housing market boom-bust patterns.

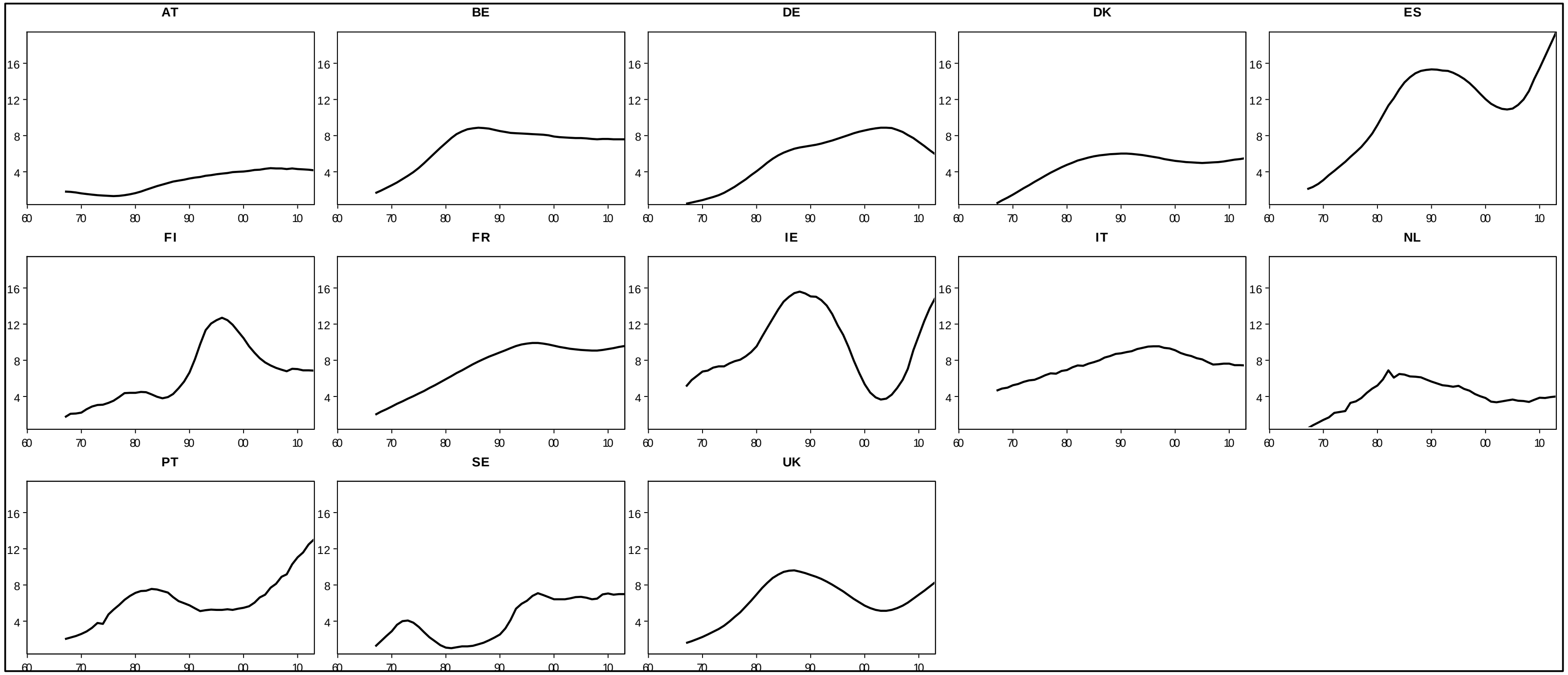
Graph 7 below shows the real interest rate, measured as the difference between the nominal long term interest rate and the average of the past 5-years of GDP deflator based inflation rate. This variable has displayed substantial cross-country diversity across the 13 EU countries considered over the past decades. Noteworthy are recent patterns of persistently low real interest rates, followed by sharp increases, seen in some countries (i.e. ES, IE, PT and, to a lesser extent, also IT).

[17] See appendix A for further details.
[18] Moreover, the ratio was kept constant for Italy over the period 1985-1990 to increase time span.
[19] Note that, to account for possible other common factors, the significance of a trend variable or period-effects will also be tested.

A so-called *"construction"* variable (see Graph 8) will also be used in the panel analysis to control specifically for boom-bust patterns in the construction sector. The variable is the deviation from the mean of the proportion of persons working in the construction sector. Intuitively, countries with high or low value for that variable are expected to be undergoing severe housing boom-bust effects.

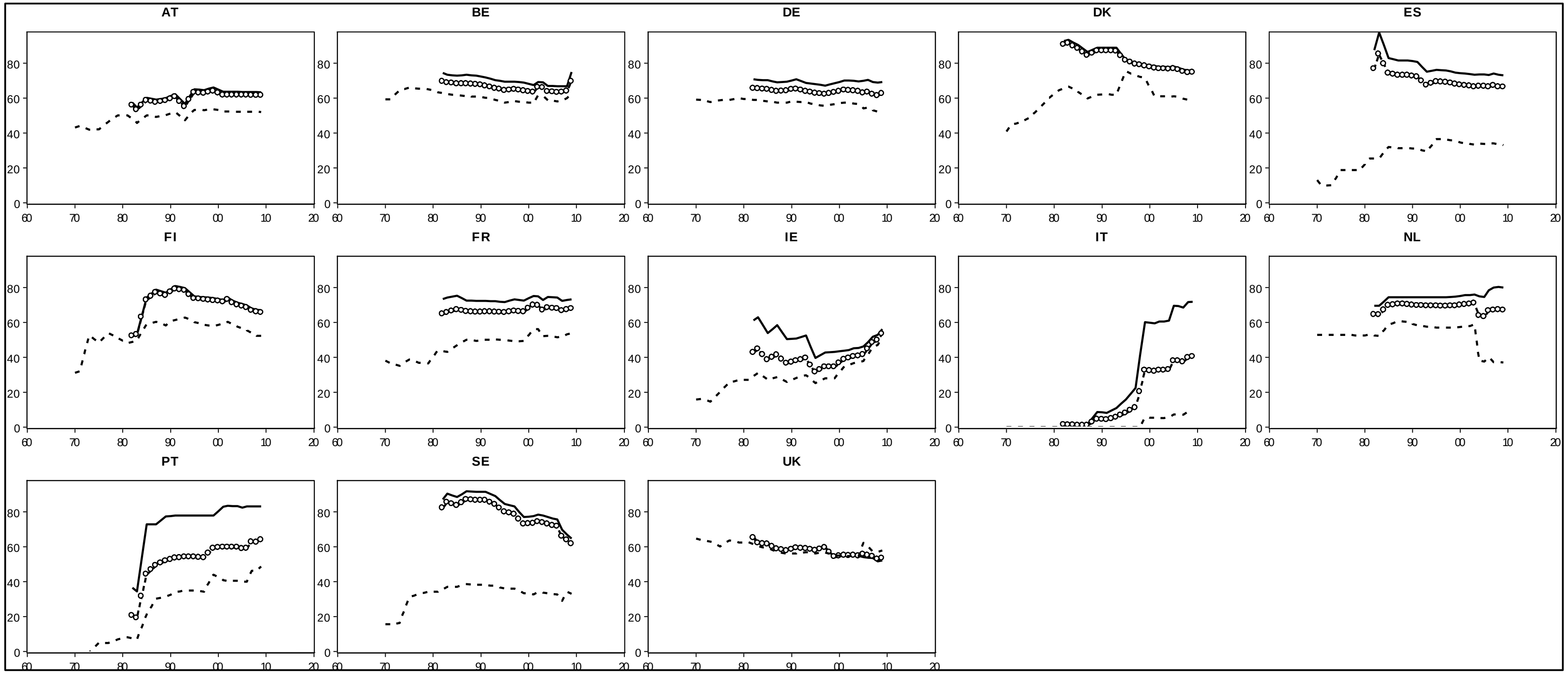
Graph 8 below shows the evolution of this variable. A sudden and large increase in the volatility for that variable signals a possible episode of housing market boom-bust pattern. Such episodes are discernable in a number of countries, namely Germany in the early 90s and, most notably, Spain and Ireland over the recent past.

Graph 1 – NAWRUs across the EU13 countries (1967-2013)



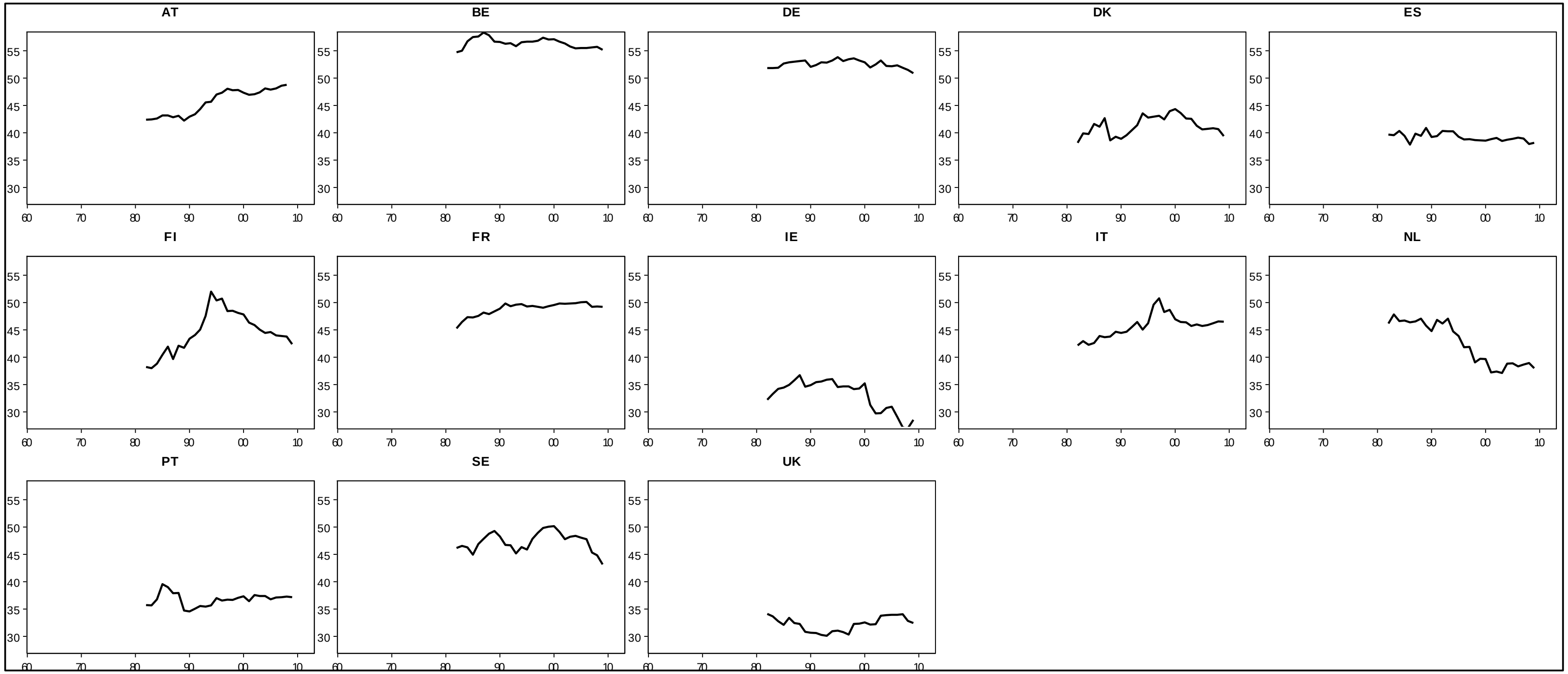
Source: Commission services

Graph 2. Unemployment benefits replacement rate across the EU13 countries



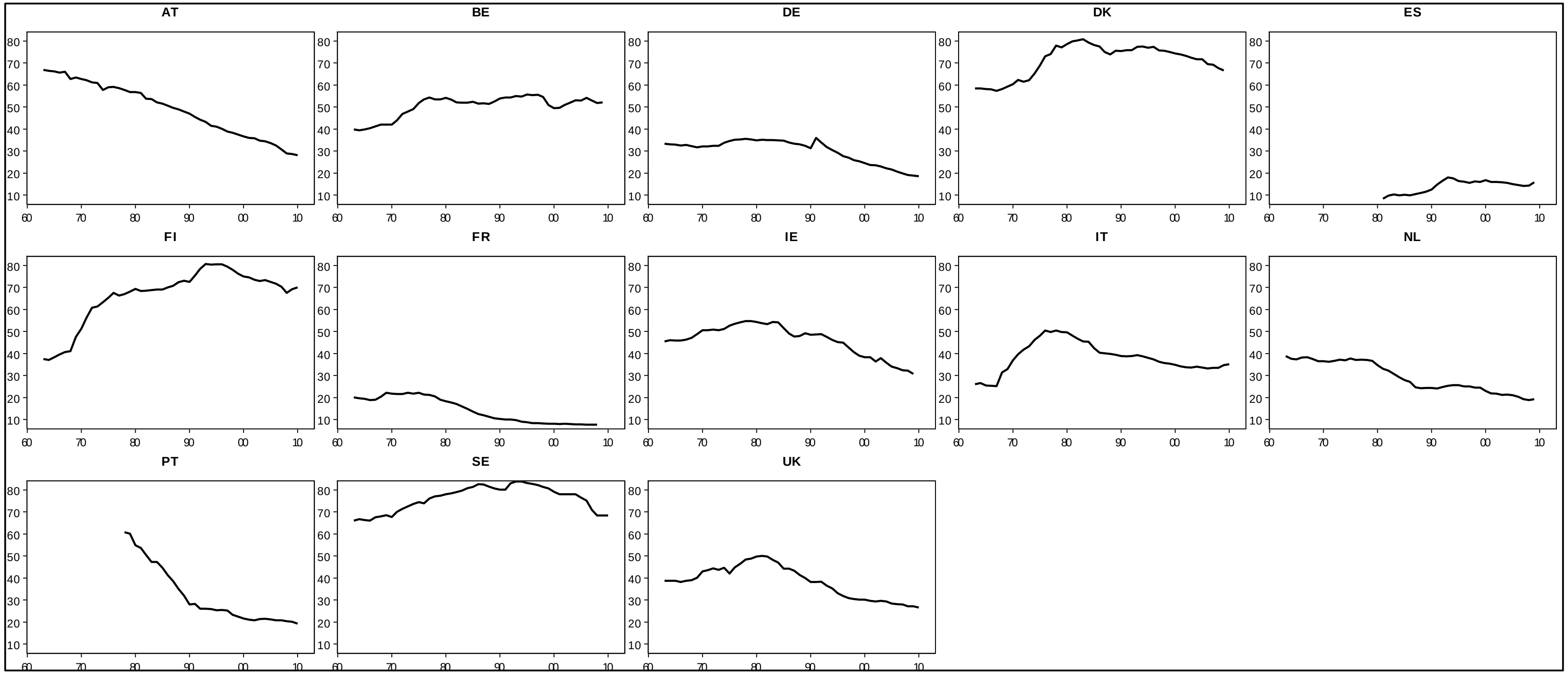
Note: The circled line is the weighted average of the two other series and is the series used in our analysis. The highest series is the replacement rate received during the 1st year and the lowest series is the average rate received over a 5 year unemployment spell.
Source: Commission services

Graph 3. Labour tax wedge across the EU13 countries



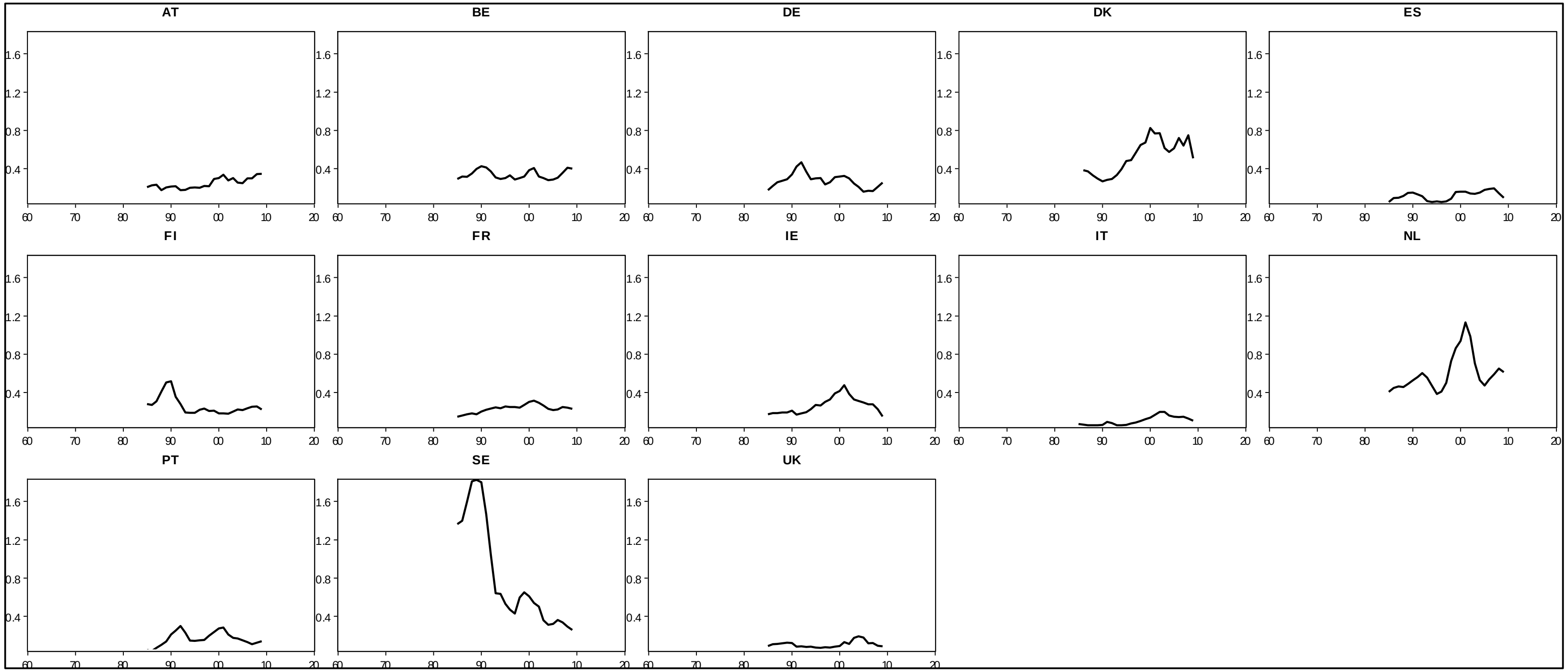
Source: OECD

Graph 4. Union density across the EU13 countries



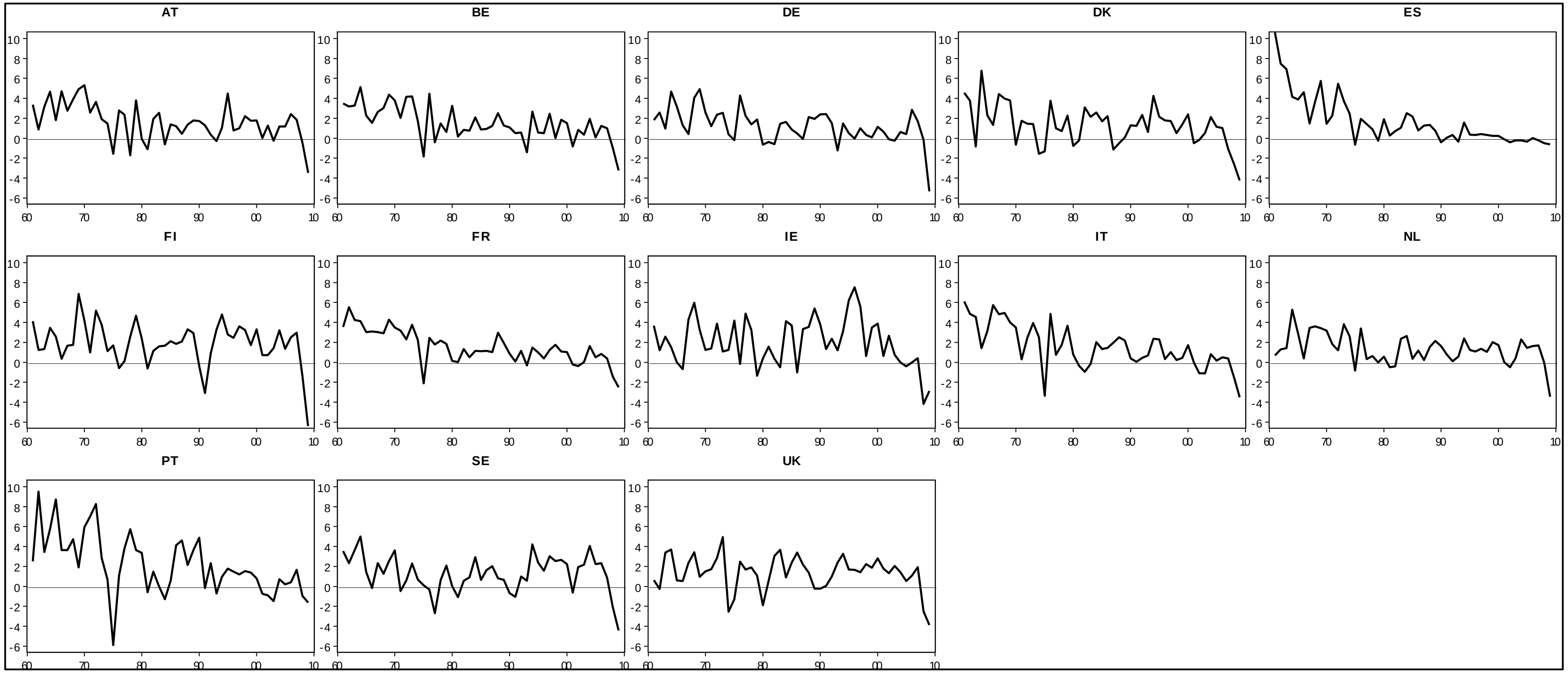
Source: OECD

Graph 5. Active labour market policies across the EU13 countries



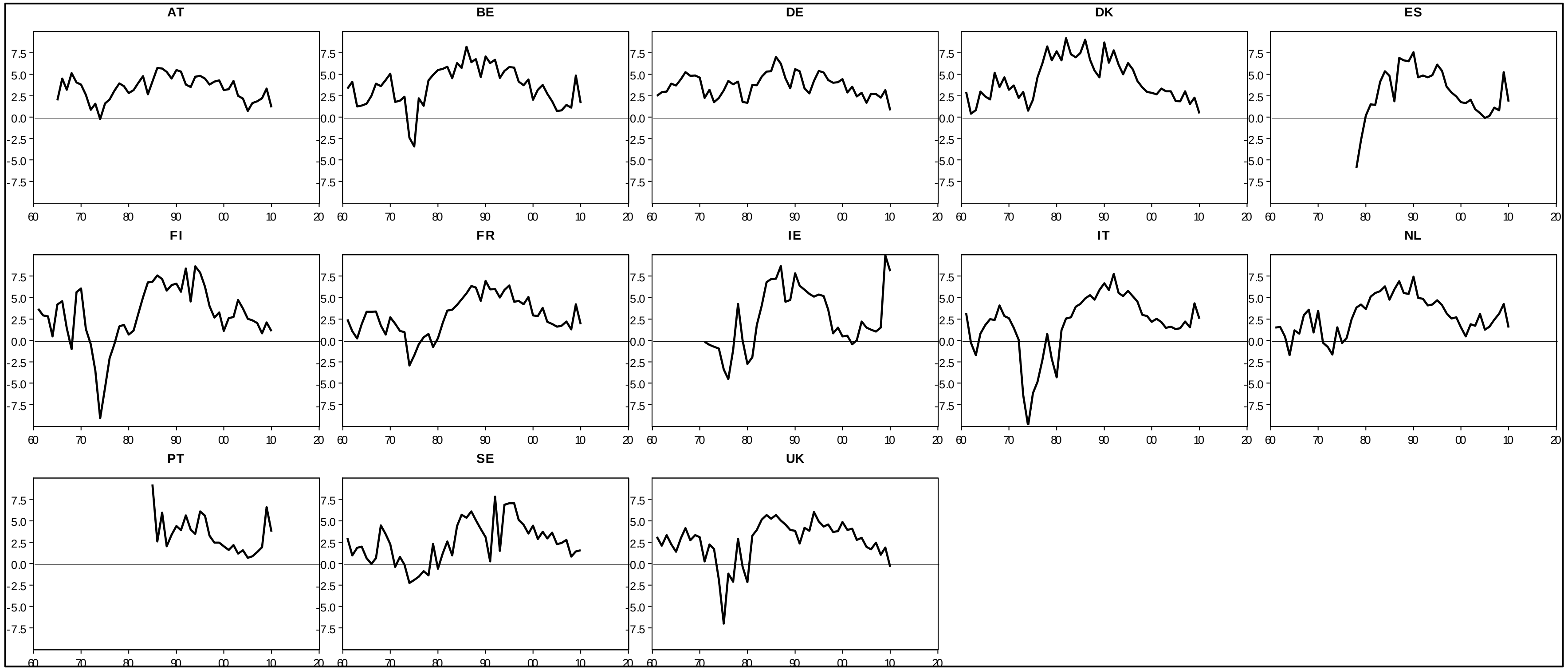
Note: Depicted is the ratio (Share of ALMP expenditure in GDP / Share of unemployed in the population).
Source: Commission services

Graph 6. TFP growth rate across the EU13 countries



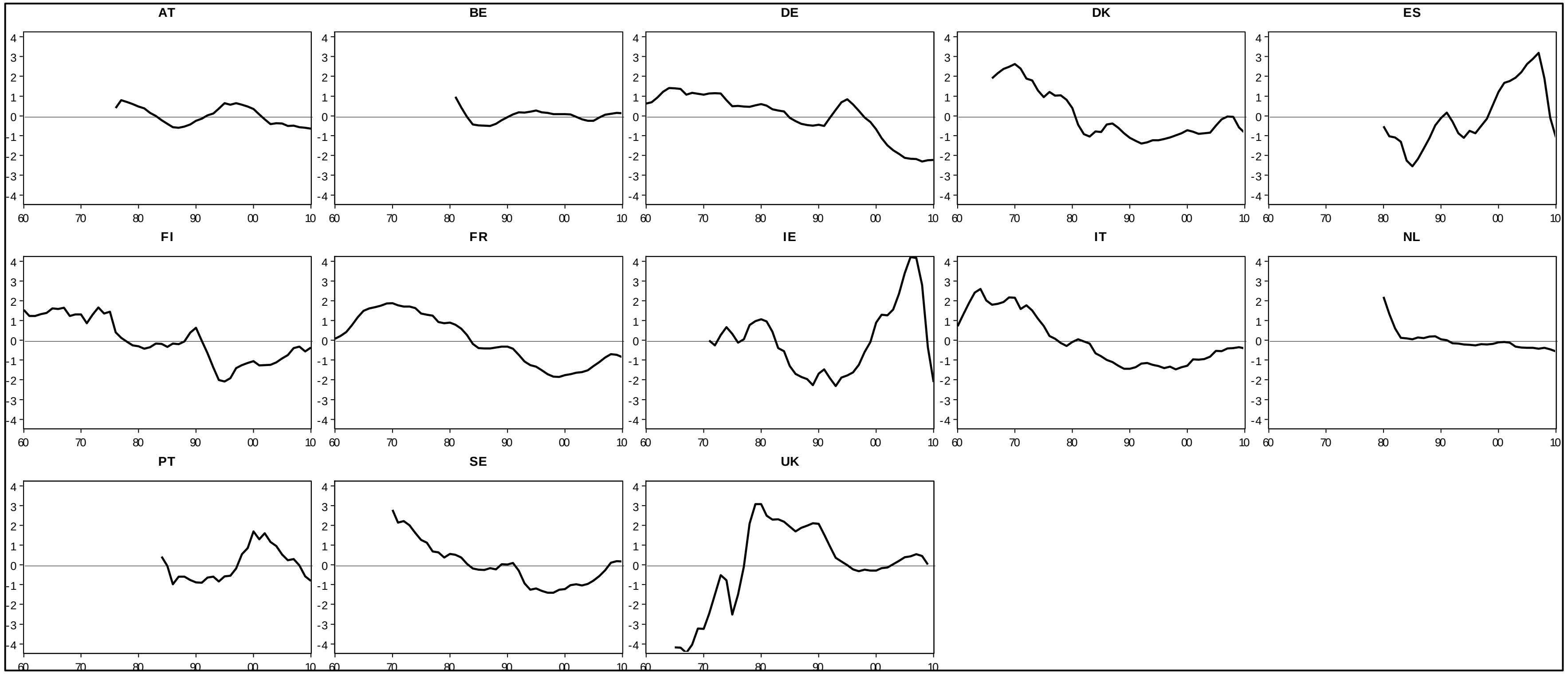
Source: Commission services

Graph 7. Real interest rate across the EU13 countries



Note: Depicted is the real interest rate, computed as the difference between the nominal rate and the 5-year (backward-looking) average (GDP deflator based) inflation rate.
Source: Commission services

Graph 8. Deviation from the mean for the employment share in the construction across the EU13 countries



Source: Commission services

5 ECONOMETRIC ANALYSIS

In this section we present estimation results for the panel featuring the NAWRU as the dependent variable and the variables presented in the previous section as the explanatory variables. In addition, wage-Phillips curve estimation results are presented. Finally, we compare our results to other similar studies.

5.1 NAWRU and its determinant - Panel estimation results

This section reports the results of the panel regression analysis. The NAWRU is regressed against the set of four labour market structural indicators and the three non-structural variables described in the previous section. The panel covers 13 EU countries (for which data were available) over the period 1985-2009, using annual data. A linear trend is added to the regression to account for unidentified common shocks with similar pass-through across countries (period-effects are also tested) but is ultimately found to be statistically insignificant. Country fixed-effects instead are found to be necessary. The details of the econometric analysis are provided in Table 2 below.

Column (1) show the result of a simple regression in which all variables mentioned in the previous section feature in the equation along with a linear trend and cross-country fixed-effects. All variables (and country fixed-effects) are significant and correctly signed. The R2 indicates that the regression accounts for 88% of the variance in the NAWRU across the 13 countries.[20] Residuals (plotted in the appendix C) point to some cross-country heteroscedasticity and substantial autocorrelation. Column (2) and (3) address those two issues.

Column (2) implements the panel-corrected standard errors (PCSE) procedure[21] that accounts for cross-section heteroschedastic (i.e. PCSE cross-section). Inference is little affected by this correction, confirming that heteroscedasticity is somewhat limited, as residual plots suggested. In fact, for a number of coefficients, significance improves.

Column (3) implements the PCSE procedure that accounts for autocorrelation in the residuals (i.e. PCSE period). In this case, inference is more substantially affected. This suggests that residual autocorrelation is a more significant feature in the analysis. Intuitively, this points to unaccounted dynamics in the relationship between the dependent variable and the explanatory variable, which seems plausible. Yet, as the focus is to uncover the long term relationship among the data, moving to a dynamic specification is beyond the scope of the present analysis. Instead the strategy is to rely on the more stringent PCSE period procedure for the remainder of the analysis, to account for the significant residual autocorrelation. Note that similar studies (e.g. Nickell (1997) and Bassanini and Duval (2006a and 2006b)) typically do not account for residual autocorrelation, reporting instead results that are more comparable to those shown in column (1) or (2).

An important change in the result, once accounting for residual autocorrelation, is the loss of significance of the unemployment benefit replacement rate variable. In addition, the significance of the linear trend also disappears. The next step is to address the issue of the loss of significance of the unemployment benefit variable.

It is important to recall that the unemployment benefit replacement rate variable is a splice between a gross replacement rate series and a net replacement rate series. As explained in the previous section, the net replacement rate would be the preferred measure but was unavailable before 2001. In other words, the coefficient on the net replacement rate portion of the sample could be different from the

[20] The panel without fixed-effects shows an R2 at about 0.4. The same is true for the panel featuring only fixed-effects (i.e. no explanatory variables).

[21] See Beck and Katz (1995).

coefficient on the portion of the sample that relies on the gross replacement rate. To account for this, a dummy used to distinguish the two periods. Results are shown in column (4).

The dummy variable is strongly significant confirming that gross and net replacement rate are not substitute for each other when measuring the impact of unemployment benefit generosity on the NAWRU. The coefficient on the portion of the sample featuring the net replacement rate is strongly statistically significant, confirming the good signal provided by the series in net terms. Distinguishing the two sub-periods also recovers significance of the coefficient on the portion relying on the gross series. The dummy implies that the coefficient on the net replacement rate is 0.10 higher than the coefficient on the gross series. That is, the coefficient on the gross replacement rate is 0.07, while the coefficient on the net replacement rate is 0.17. Note also that the linear trend remained insignificant and was thus removed from the specification. Column (4) is our preferred specification, robust to sensitivity analysis, as will be shown further below. Moreover, note that the specification does not appear to suffer from problems of colinearity (see appendix D).

Table 2. Panel regression results (1985-2009)

				Preferred equation	Robustness checks		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	NAWRU	NAWRU	NAWRU	NAWRU	NAWRU	NAWRU (tsls)	Unemp. rate
UB replacement rate	0.02 (2.17)**	0.02 (2.49)**	0.02 (0.67)	0.07 (2.08)**	0.07 (2.01)**	0.10 (2.43)**	0.09 (2.27)**
Labour tax wedge	0.28 (8.17)**	0.28 (8.17)**	0.28 (2.84)**	0.29 (3.52)**	0.29 (3.19)**	0.33 (3.70)**	0.26 (2.49)**
Union density	0.13 (6.18)**	0.13 (6.17)**	0.13 (1.99)**	0.08 (1.71)*	0.11 (1.91)*	0.09 (1.70)*	0.13 (2.28)**
ALMP	-0.04 (-9.45)**	-0.04 (-10.5)**	-0.04 (-3.03)**	-0.04 (-4.09)**	-0.04 (-3.70)**	-0.04 (-4.68)**	-0.06 (-4.94)**
TFP growth rate	-0.15 (-3.45)**	-0.15 (-3.03)**	-0.15 (-2.76)**	-0.16 (-3.06)**	-0.17 (-2.22)**	-0.18 (-3.27)**	-0.17 (-2.23)**
Real interest rate	0.22 (5.43)**	0.22 (4.91)**	0.22 (3.69)**	0.19 (3.15)**	0.17 (1.99)**	0.18 (2.46)**	0.04 (0.52)
Construction	-0.74 (-9.82)**	-0.74 (-7.90)**	-0.74 (-3.38)**	-0.66 (-3.74)**	-0.71 (-3.49)**	-0.61 (-3.68)**	-1.16 (-4.74)**
Linear trend	0.05 (3.25)**	0.05 (3.79)**	0.05 (1.12)	-	-	-	-
UB replacement rate dummy for 2001-09	-	-	-	0.10 (3.31)**	0.09 (3.12)**	0.14 (2.45)**	0.07 (1.87)*
Fixed-effect	yes**	yes**	yes**	yes**	yes**	yes**	yes**
Period-effect	no	no	no	no	yes	no	no
PCSE cross-section	no	yes	no	no	no	no	no
PCSE period	no	no	yes	yes	yes	yes	yes
R2	0.88	0.88	0.88	0.89	0.90	0.89	0.89

Note: Coefficients, t-stat in parentheses. * p-value < 0.1, ** p-value < 0.05. For the coefficients, the p-values relate to significance test, while for fixed and period-effects they relate to the redundancy test. PCSE cross-section controls for panel heteroscedasticity and PCSE period controls for common serially correlated errors, as defined in Beck and Katz (1995). Number of observations: 324.

Columns (5) to (7) perform some sensitivity analysis. First, column (5) tests adding period-effects. This leaves both coefficients and inference little affected and a redundancy test does not reject the redundancy of such period-effects (i.e. period-effects are not statistically significant). Second, column (6) checks possible problems of endogeneity that could bias coefficients estimation. To do that, two-stage least square estimation is performed using lagged variables as instruments for all labour market structural indicators. Results are little affected. Finally, column (7) checks the impact of substituting the unemployment rate for the NAWRU. The overall result is unaffected, with coefficients remaining correctly signed and significant. This indicates that the generality of our results goes beyond the specific use of the NAWRUs as computed by ECFIN. Interestingly, some coefficients (i.e. on the unemployment benefits and the construction variables) are larger when using the unemployment rate as the dependent variable, suggesting that those variables affect not only structural unemployment but the unemployment gap as well, to some extent.

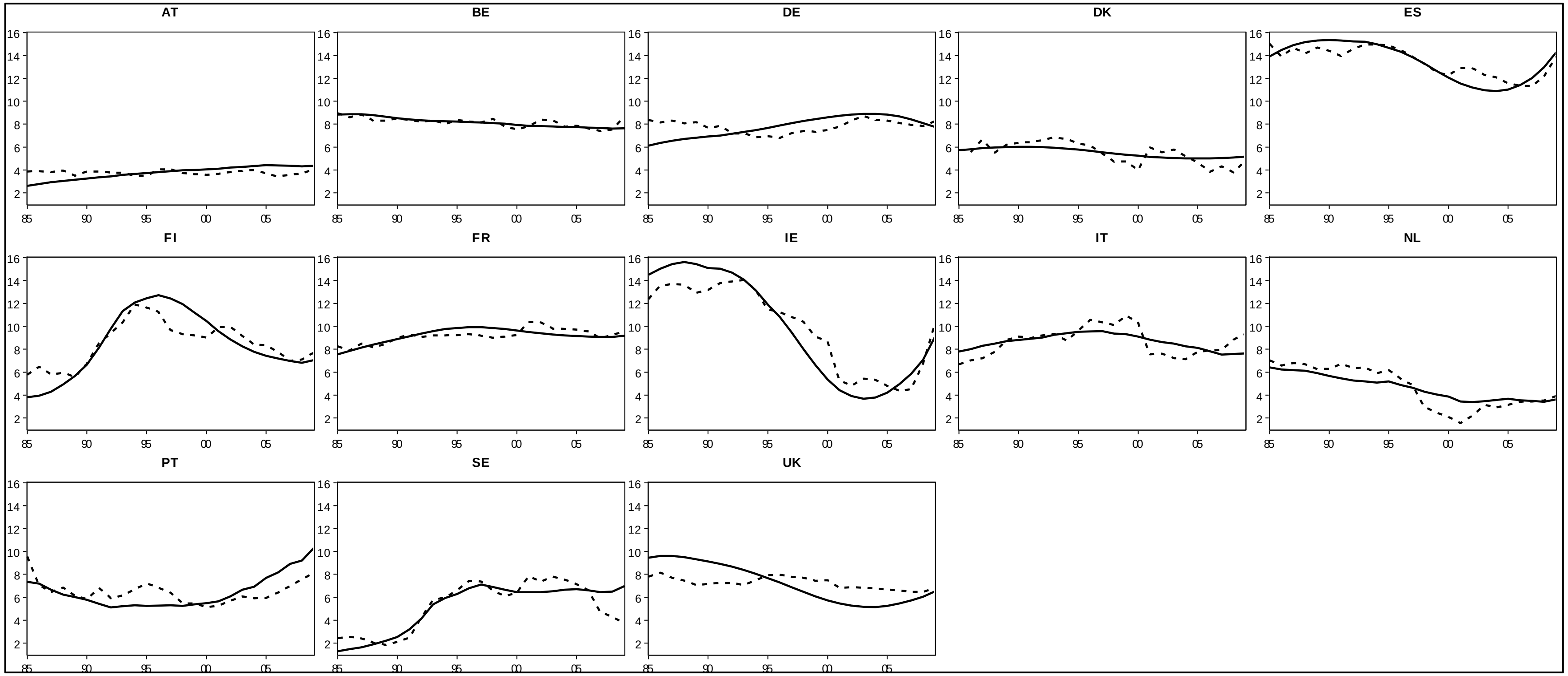
Relying on more commonly used unemployment benefit measures yielded weaker results (see Table A3, appendix F for details). A measure of the average unemployment benefit replacement rate received over a 5 year spell yields insignificant results. A measure focusing on the initial 1st year replacement rate yielded insignificant results as well, when relying on the OLS/PCSE-period estimation procedure. Relying on the simple OLS estimation procedure yielded significant results which were however weaker than those obtained for our measure of unemployment benefit generosity. This can be related to the fact that, contrary to our measure, simpler replacement rate variables do not account for the duration of the unemployment benefit entitlements. The ratio of the initial 1st year rates to the 5 year average replacement rate is sometimes used as a proxy for duration of benefits entitlements. Intuitively, a sharp decline from the initial rate to the average 5 year rate indicating short duration. Adding this ratio variable to the equation however yielded wrongly signed and insignificant results in the OLS/PCSE-period case.

Therefore, only our measure of unemployment benefit generosity (i.e. weighted average of different rates at different spell horizon, with weights dependent on unemployment exit rates) is strongly significant in all case, including the more stringent OLS/PCSE-period estimation approach. We interpret this result as evidence that our measure has superior explanatory power.

Turning to the fit of the panel, Graph 9 below reports the fit of our preferred equation (i.e. Table 1, column (4)). Overall, the fit tracks remarkably well the diversified patterns seen across countries. Important events, such as the recent upswing in some countries (e.g. ES, IE and PT) or episodes of crises - e.g. Finland and Sweden in the 90s - are captured reasonably well by the fit.

Conversely, for some countries the fit occasionally points to developments that are at odds with those shown by the NAWRU as computed by the Commission services. This is the case recently for Sweden and throughout for Austria and the UK. This could be due to a number of causes such as the need to account for more explanatory variables. Allowing for dynamics (e.g. dynamic or cointegrated panel) could help tracking more tightly occasional deviations from the long run relationship (and account for residual autocorrelation). Analysing those occasional failures is however beyond the scope of this paper. Overall, the main message remains that the panel fits well the diversified patterns observed across countries.

Graph 9. NAWRU (solid) and panel regression fit (dashed) (1985-2009)



Note: Charts show the fit of the panel as specified in Table 2, columns (4).
Source: Commission services

5.2 Wage-Phillips curve estimation

The equation below reproduces equation (10) above, namely the wage Phillips curve consistent with our framework.

$$\Delta\pi_t^w = (\phi - \psi_{almp})\Delta^2 almp_t - \beta(u_t - u_t^*) + a_t^w$$

Table 3 provides an estimate for that equation. Two alternative measures for the unemployment gap are considered. In the first column, the unemployment gap is computed as the difference between the unemployment rate and the fit of the panel, removing also the impact of the non-structural variables. This represents an unemployment gap vis-à-vis a "stripped down" NAWRU, which contains only movements related to movements in the structural features of the labour market. In the second column, the more common unemployment gap is used – i.e. unemployment minus NAWRU.

The unemployment gap computed as a difference to the "stripped down" NAWRU has explanatory power for the change in wage inflation (i.e. $\beta = 0.18$, and significant). Its coefficient is lower than the coefficient on the more traditional unemployment gap (i.e. $\beta = 0.37$), which is consistent with the fact that this latter unemployment gap tends to be smaller on average than the gap computed with respect to the "stripped down" NAWRU. In other words, the two columns indicate broadly similar impact magnitudes on wages.

Importantly, however, the more common unemployment gap yields a more significant coefficient. This suggests that an unemployment gap computed on the basis of a NAWRU that features effects of persistent demand shocks (i.e. the common NAWRU) is a better measure of wage inflation stemming from market developments. In other words, results in Table 3 tend to indicate that effects related to persistent demand shocks belong to the NAWRU, in the sense that removing them from the unemployment gap provides a better cyclical measure.

Table 3. Wage-Phillips curve panel regression (1985-2009)

Double difference of ALMP	0.03 (2.11)**	0.04 (2.52)**
Unemployment gap based on fitted NAWRU (also excluding effect of non-structural variables)	-0.18 (-2.94)**	-
Unemployment gap based on NAWRU	-	-0.37 (-4.08)**

Note: Coefficients, t-statistics in parentheses. The panel regressions include country fixed-effects. * p-value < 0.1, ** p-value < 0.05, relating to significance test.

5.3 Comparing results with other studies

In this section we compare the results presented in the previous sub-section with results reported in other similar studies, both for the NAWRU panel estimation and for the wage-Phillips curve estimation.

Starting with the NAWRU panel estimate, our results are close to those reported in other similar studies. The most directly comparable results are those reported in Bassanini and Duval (2006a, 2006b). Those authors estimate a series of specifications in which labour market structural indicators affect the level of the unemployment rate (occasionally controlling for the output gap). Another benchmark study is Nickell (1997), although the panel set-up is less comparable as it features only two periods for the time dimension. Moreover, those two studies rely on the unemployment rate rather than the NAWRU as the dependent variable. Yet, as explained above, our results are little affected by this change. In addition, both Nickell and Bassanini-Duval account for the role of the business cycle in their specifications.

Table 3 compares our results, which (for simplicity) is taken to be the one reported in column (4) of Table 1, to Bassanini and Duval (2006b). Those authors run a panel regression for the unemployment rate in 21 OECD countries, controlling for the cycle (in most specifications). Their panel features a set of labour market structural indicators, including those used in our analysis. The panel covers the period 1982-2003.

Results of Bassanini-Duval are close to ours. Starting with the labour tax wedge, they obtain an elasticity of 0.25, close to our 0.29. In addition, they estimate various specifications featuring a total tax wedge variable (i.e. non labour specific) for which they obtain an impact ranging from 0.15 to 0.31. In particular, the specifications yielding the lower estimates feature two tax variables, namely tax and tax interacted with another variable (i.e. indirect impact). The duplication of the tax effect is likely to lower the magnitude on the direct impact, which we report here in the table. Thus, the upper part of the range is more comparable to our results.

Similarly close results are obtained for the unemployment benefit replacement rate variable. Bassanini and Duval test in one specification estimate the impact of the 1st year replacement rate at 0.09, in the range we report (i.e. 0.07 to 0.16). The impact of the average replacement rate is also similar with a range of 0.04 to 0.13. Note again that the lower range is characterised by the presence of two variables accounting for the replacement rate impact (i.e. direct impact and interacted impact) and the table below report on one of those (i.e. the direct impact).

The impact of ALMP is significant only in one of Bassanini-Duval's specification and yield in that regression a coefficient value of -0.03, very close to our -0.04.[22]

Finally, Bassanini and Duval find a significant impact for union density in one specification putting the impact at 0.06, comparable to the 0.09 reported in our analysis. Moreover, Bassanini-Duval account for other features related to the impact of unions such as union coverage and the degree of cooperation in the wage formation mechanism. This again could dampen the coefficient on the union density variable explaining the somewhat lower magnitude compared to our result.

Table 4. Comparing our NAWRU panel results with Bassanini-Duval (2006b)

	Our results	Bassanini-Duval (2006b)			
		Significant coefficients	All coefficients	Number of specifications	
				Nbr. of specifications with significant coef.	Total nbr.
Labour tax wedge	0.29	0.25	0.25	1	1
Total tax wedge	-	0.15 to 0.31	0.15 to 0.31	24	24
UB replacement	0.07 to 0.16	0.04 to 0.13	0.04 to 0.13	24	24
UB 1st year repl.	-	0.09	0.09	1	1
ALMP	-0.04	-0.03	-0.03 to -0.003	1	3
Training	-	-0.19 to -0.05	-0.19 to -0.05	7	7
Union density	0.09	0.06	-0.05 to 0.06	1	25

Note: The table compares the results of our preferred equation (i.e. Table 1, column (4)) with those of Bassanini and Duval (2006b).

Turning to Nickell (1997), this author reports on three panels distinguishing between total, long-term and short-term unemployment as the dependent variable. The panels cover 20 OECD countries over two periods (averages): 1983-88 and 1989-94. Importantly, Nickell relies on a log-linear specification. Thus, to allow comparison, our specification was recast in that form. Table 4 below compares the

[22] In addition, the authors test the impact of a sub-item of ALMP, namely "training", finding a range of -0.19 to -0.05. Using this sub-item, we find a (significant) coefficient estimate at -0.10.

magnitudes between Nickell and ours, focusing on the Nickell's results for long term unemployment (closest to our NAWRU concept).[23]

Magnitudes reported by Nickell are comparable to ours (in log-linear form). The largest difference pertains to the tax variable. However, the variable used by Nickell it is not comparable to ours, as it comprises both income and consumption taxes. To the extent that the decision to take up a job is more directly affected by the labour tax wedge than by more general tax measure, finding a higher coefficient on the former seems plausible.

Table 5. Comparing our NAWRU panel results with Nickell (1997)

	Our results (in log-linear form)	Nickell (1997)
Tax variable	0.05	0.03
UB replacement rate	0.01 to 0.02	0.01
ALMP	-0.01	-0.02
Union density	0.01	0.01

Note: The table compares the results of our preferred equation (i.e. Table 1, column (4), re-estimated in log-linear form) with those of Nickell (1997) for the case of long term unemployment in that study.

Comparing to other studies, it should also be mentioned that robust results for a number of indicators, reported as being significant by others, could not be obtained. Product market regulation indicators failed yielded wrongly signed coefficients. Results reported in other studies however suggest that identifying such effects could require allowing for interaction among variables – i.e. allowing (pairs of) features of the labour market to reinforcing each other (see Fiori et al. (2012) for a recent application along those lines) – which was not considered in the present paper. Felbermayr and Prat (2011) also stress the need to rely on detailed measures of product market regulations to identify such effects. Such measures are available only for limited time span at the country level. We also failed to identify robust effects for employment protection legislation and degree of centralisation of the wage bargaining framework indicators, including, for the latter, when considering non-linear effects, as suggested in Calmfors and Driffill (1988).

Turning to the wage-Phillips curve, in Table 4 below, we compare our results to those reported in Planas et al. (2007), which report estimates for a wage-Phillips curve in a panel for 12 EU countries running over the period 1970-2004. Interestingly, their estimate for the impact of the unemployment gap on wages developments is at -0.37,[24] identical to ours when using the same unemployment gap measure, namely the simple difference between the unemployment rate and the NAWRU (see Table 6 below). Instead, as explained above, a lower absolute magnitude is found if an alternative unemployment gap is computed (i.e. difference with respect to the fit of our panel removing, in addition, the effects of non-structural variables).

Table 6. Comparing Wage-Phillips curve results. (dependent variable: Change in wage inflation)

	Our results	Planas et al. (2007)
Unemployment gap based on fitted NAWRU (also excluding effect of non-structural variables)	-0.18 (-2.79)**	-
Unemployment gap based on the NAWRU	-0.37 (-4.08)**	-0.37 (-1.9)*

Note: The table compares the results of our wage-Phillips curve estimate with those reported in Planas et al. (2007).

[23] Note that re-estimating our own panel regression in log-linear form does not affect the results substantially. All coefficients remain significant and the R2 remains practically unchanged.
[24] We refer to the specification in Planas et al (2007) that accounts for the effect of the labour tax wedge.

6 POLICY ANALYSIS - INTERPRETATION OF THE RESULTS

The significance in the panel regression of the labour market structural indicators coefficients confirms their role in shaping NAWRU developments. In that regression, labour market indicators are all expressed in percentage term. Thus, the coefficient represents the impact on the NAWRU of a 1.0 pp. change in those indicators. This analysis thus indicates the relative impact of different features (and of different structural reforms) on the NAWRU.

It should be also borne in mind that our analysis also indicated that other variables impacted the NAWRU. That is, the non-structural variables: real interest rate, TFP growth and the so-called "construction" variable. Those, as discussed in the previous section are expected to have temporary (though potentially highly persistent) effect on the level of the NAWRU. Occasionally those effects can even be the main drivers of NAWRU developments – e.g. in periods of crises and in times of build-up and unwinding of unsustainable economic positions. Note that distinguishing among all the different types of effects (i.e. structural variables, non-structural variables, fixed-effects) is particularly important when attempting to anticipate future NAWRU developments.

More fundamental insight can also be gained from relating the empirical results to the underlying model that was introduced in section 2.2. The results reported in Table 2 (section 5.1) is an empirical estimate of equation (9) (in section 2.2). The fact that the coefficient on the unemployment benefit replacement rate variable is smaller than the one on the tax variable carries a particular meaning, as was stressed in section 2.2. It implies that μ is close to 1, meaning that the wage bargaining framework rather than a neoclassical framework appears to fit better the data for this set of countries.[25] Caution is however warranted in interpreting this result as the fact that the coefficient on the replacement rate variable is low could, alternatively, reflect econometric issues (e.g. quality of the indicators). Evidence pointing to the relevance of the bargaining model suggests that, while addressing workers' incentives is not to be overlooked, paying attention to the functioning of the wage negotiation framework is particularly important in order to improve labour market outcomes in Europe.

7 CONCLUSIONS

The work presented in this paper has yielded a number of insights on the dynamics of the NAWRU. First, it confirmed that NAWRU developments are related to labour market structural developments. Second, other variables causing persistent demand shock play also a role. Distinguishing between those two types of effects can provide valuable policy insight. In particular, it provides a framework that helps anticipating likely future NAWRU developments. This empirical analysis on the drivers of NAWRU developments also provides a useful tool for policy analysis (e.g. tracking impact of structural reforms) and monitoring (e.g. identifying source of underperformance). However, limitations of the analysis should be borne in mind, namely results can only reflect the information that could be taken into account. Yet, the fact that the panel is able to account for 90% of the variance of the NAWRU in our panel (including fixed-effects) unambiguously confirms the usefulness of such approaches.

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[25] See also Howell and Rehm (2009) for further evidence of limited role of unemployment benefits.

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9 Appendix A: Detailed description of the ALMP variable

The ALMP variable includes the following sub-items:

10: PES and administration
- 11: Placement and related services
- 12: Benefit administration

20: Training
- 21: Institutional training
- 22: Workplace training
- 23: Integrated training
- 24: Special support for apprenticeship

30: Job rotation and job sharing

40: Employment incentives
- 41: Recruitment incentives
- 42: Employment maintenance incentives

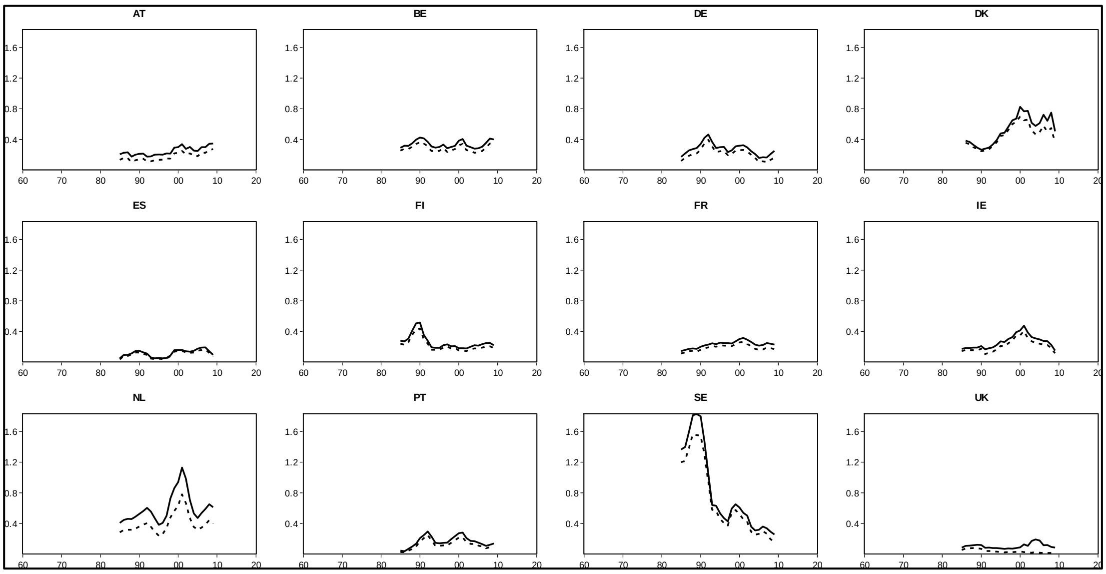
50: Supported employment and rehabilitation
- 51: Supported employment
- 52: Rehabilitation

60: Direct job creation

70: Start-up incentives

In the case of Italy, sub-item 10 could not be included. On average, this Item increases the ALMP variable by 0.2 pp. Moreover, excluding the item 10 does not affect the profile of the ALMP variable except for the case of the UK (see Graph below).

Graph A1. ALMP variable with (solid) and without (dashed) PES (i.e. sub item 10)



Source: OECD

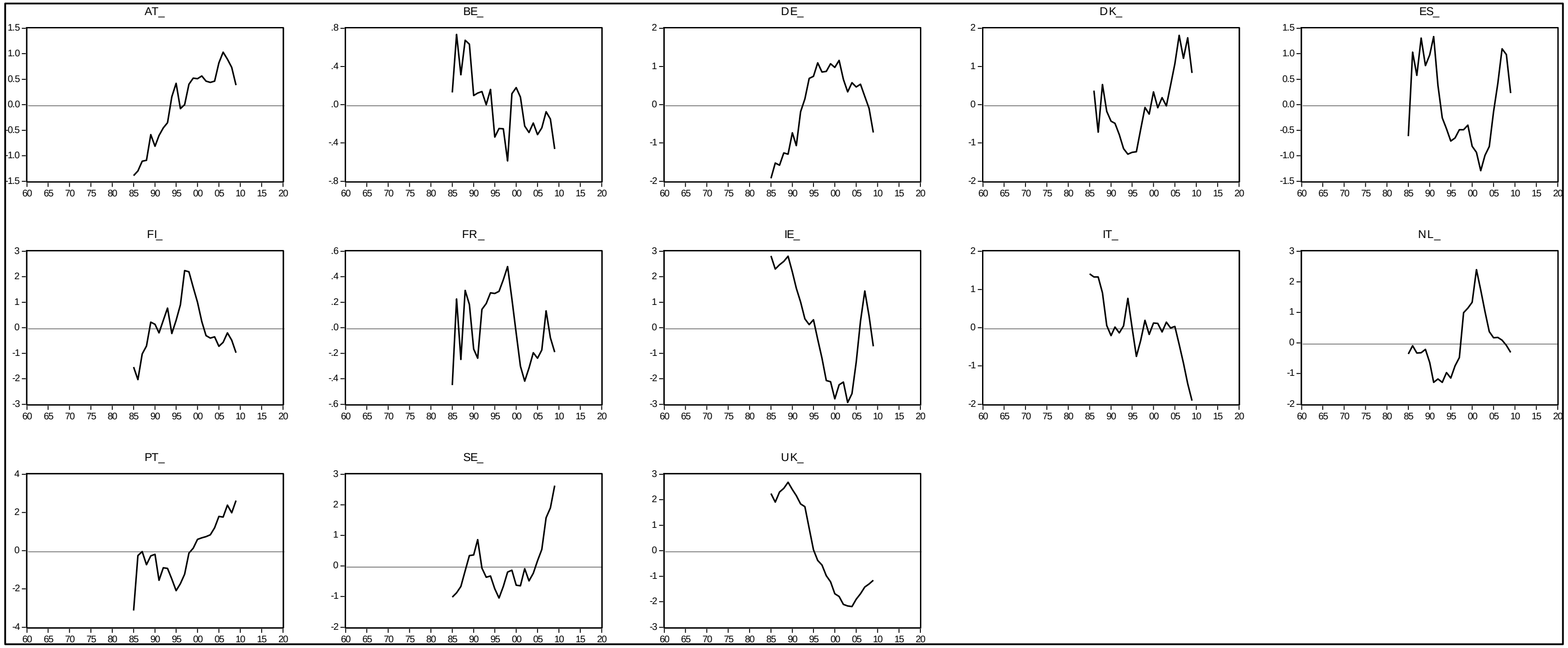
10 Appendix B: Dataset descriptive statistics

Table A1. Dataset descriptive statistics

	NAWRU	Construction employment share (de-meaned)	Real interest rate	TFP growth	Union density	Labour tax wedge	ALMP	UB replacement rate
Mean	7.6	-0.4	3.4	1.0	40.9	43.7	31.1	61.9
Median	7.4	-0.4	3.4	1.0	35.9	44.3	24.7	64.4
Maximum	15.6	4.2	8.5	7.5	83.9	58.3	182.8	87.9
Minimum	1.3	-2.5	-5.9	-6.5	7.6	27.0	4.1	0.9
Std. Dev.	3.1	1.1	2.0	1.7	22.4	7.2	26.7	16.7
Observations	324	324	324	324	324	324	324	324

11 Appendix C: Plot of the residuals

Graph A2. Residuals of the preferred regression (i.e. Table 2, Column (4))



12 Appendix D: Colinearity diagnostics

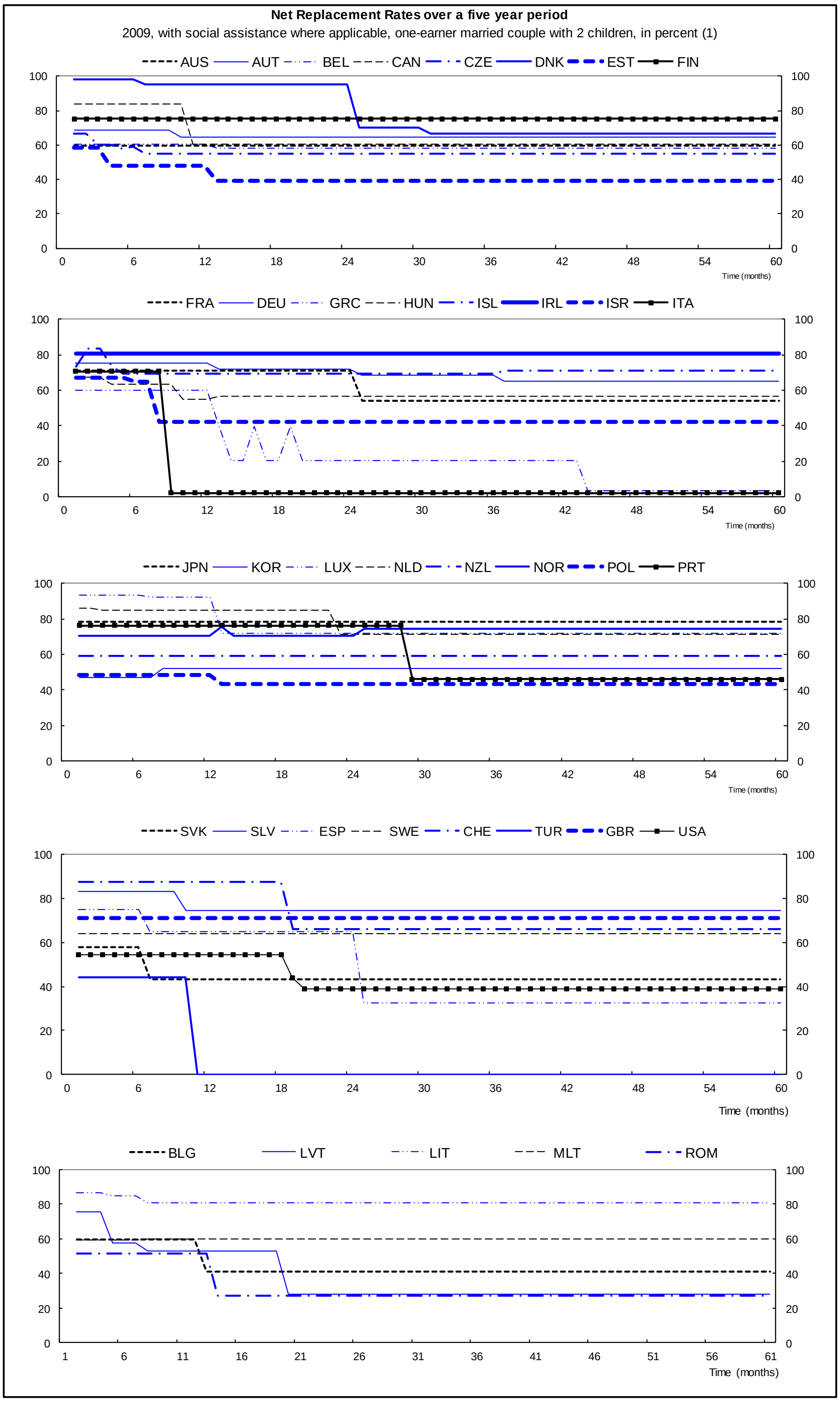
Table A2. Colinearity diagnostic for preferred regression (i.e. Table 2, Column (4))

Variance Inflation Factors	Coefficient Variance	Uncentered VIF	Centered VIF
Constant	20.99808	544296.1	-
Construction employment share	0.031746	45306.19	1.224595
Real interest rate	0.00485	1428.202	1.131308
TFP growth	0.002756	69.95422	1.354959
Union density	0.001728	75039.68	1.461365
Labour tax wedge	0.007033	347960.5	1.313944
ALMP	9.50E-05	2361.115	1.125609
UB replacement rate	0.001147	114064	1.41041
(Dummy 2001-09) x (UB replacement rate)	0.000844	1.405346	1.392947

Number of observations: 324.

13 Appendix E: Unemployment benefits replacement rates by spell

Graph A3. Replacement rate profile over 5 years across OECD countries



Source: OECD, Tax-Benefit Models.

14 Appendix F: Regressions results with alternative replacement rate variables

Table A3. Panel regression results (1985-2009). Dependent variable: NAWRU

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UB replacement rate, 1st year initial rate	0.01 (0.79)	-	0.02 (0.69)	0.01 (1.92)*	-	0.02 (1.90)*	0.02 (2.02)**	-	0.02 (2.01)**
UB replacement rate, 5 year average rate	-	0.01 (0.20)	0.02 (0.72)	-	0.01 (0.42)	0.02 (1.49)	-	0.00 (0.29)	-0.00 (-0.19)
Labour tax wedge	0.31 (4.03)**	0.31 (3.15)**	0.30 (3.85)**	0.31 (10.1)**	0.31 (8.73)**	0.30 (9.51)**	0.31 (8.86)**	0.31 (8.81)**	0.31 (8.70)**
Union density	0.07 (1.48)	0.10 (1.88)*	0.07 (1.56)	0.07 (4.06)**	0.10 (5.47)**	0.07 (4.34)**	0.08 (5.16)**	0.08 (4.94)**	0.08 (5.02)**
ALMP	-0.04 (-4.16)**	-0.04 (-2.98)**	-0.04 (-3.93)**	-0.04 (-10.6)**	-0.04 (-9.14)**	-0.04 (-10.4)**	-0.04 (-9.86)**	-0.04 (-9.55)**	-0.04 (-9.80)**
TFP growth rate	-0.17 (-3.25)**	-0.16 (-3.07)**	-0.16 (-3.14)**	-0.17 (-4.21)**	-0.16 (-3.52)**	-0.16 (-3.98)**	-0.18 (-3.98)**	-0.18 (-4.13)**	-0.18 (-3.97)**
Real interest rate	0.18 (3.08)**	0.22 (3.31)**	0.17 (2.78)**	0.18 (4.71)**	0.22 (5.13)**	0.17 (4.34)**	0.17 (4.65)**	0.18 (4.54)**	0.18 (4.58)**
Construction	-0.63 (-4.11)**	-0.74 (-3.30)**	-0.63 (-3.36)**	-0.63 (-9.15)**	-0.74 (-8.58)**	-0.63 (-7.68)**	-0.72 (-9.45)**	-0.73 (-8.87)**	-0.72 (-8.67)**
UB replacement rate dummy for 2001-09, 1st year initial rate	0.11 (5.26)**	-	0.11 (5.04)**	0.11 (8.77)**	-	0.11 (8.93)**	-	-	-
UB replacement rate dummy for 2001-09, 5 year average rate	-	-0.00 (-0.01)	0.01 (0.64)	-	-0.00 (-0.04)	0.01 (1.27)	-	-	-
Fixed-effect	yes**	yes**	yes**	yes**	yes**	yes**	yes**	yes**	yes**
PCSE period	yes	yes	yes	no	no	no	no	no	no
R2	0.90	0.87	0.90	0.90	0.87	0.90	0.87	0.87	0.87

Note: Coefficients, t-stat in parentheses. * p-value < 0.1, ** p-value < 0.05. For the coefficients, the p-values relate to significance test, while for fixed and period-effects they relate to the redundancy test. PCSE cross-section controls for panel heteroscedasticity and PCSE period controls for common serially correlated errors, as defined in Beck and Katz (1995). Number of observations: 324.