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Labour market institutions, shocks and the employment rate

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Abstract:
The average employment rate for the OECD countries was close to 63 percent in the period 2000-2015 but there is considerable variation within and between countries. We find that a dynamic model for employment, derived from a multiple equation macro model with institutional and population variables, can explain much of the development. The estimated models capture the dynamics well and they imply interpretable estimates of the normal employment rate level, conditional on the state of the institutional variables in 2015. The estimated normal employment rate is 2 percentage points higher when shocks are included in the model, implying that shocks have persistent effects. Regulations of the labour market are important for the effect of shocks. Regulated labour markets amplify positive shocks while negative shocks are dampened compared to less regulated labour markets. In the estimation of the models, we use standard panel data estimators, as well as a version of the within-group estimator which is robust to structural breaks in the means. Empirically we find that some of the estimated coefficients of the institutional variables are robust with respect to the breaks, while others are not. We find that the interaction effect between benefit replacement ratio and benefit duration is robust, and that is can significantly affect the employment rate. This result implies that changes in replacement ratios (or duration) may be expected to have larger impacts in countries where duration (or replacement ratio) is long compared to countries characterized by short duration (or replacement ratio).

Keywords: Employment share, Labor market institutions, Macro shocks, Panel data model

JEL classification: E21, E22, E24, E25 and J08

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Sammendrag

I denne studien modelleres sysselsettingsandelen i OECD-området ved hjelp av indikatorer for arbeidsmarkedsreguleringer, demografivariabler og makroøkonomiske sjokk. Sysselsettingsandelen er en viktig indikator på økonomisk fremgang både i et historisk og komparativt perspektiv, og utviklingen av moderne velferdsstater er avhengig av høy yrkesdeltagelse. Vi estimerer også realistiske likevektsnivåer for sysselsettingen, noe som er særlig viktig for finanspolitisk planlegging og spesielt for å bestemme størrelsen på fremtidige skatteinntekter.

Datasettet er et paneldatasett for 20 OECD medlemsland og viser at det har vært store variasjoner over tid og mellom land. For eksempel var sysselsettingsraten 50 prosent i Italia og 74 prosent i Sveits i 2015. Finland har noen av de største svingningene over tid, og andelen falt fra 70 prosent i 1960 og til 52 prosent i 1994. Det store fallet må ses i sammenheng med oppløsningen av Sovjetunionen og den nasjonale bankkrisen, men andelen i Finland per i dag fortsatt er på et relativt lavt nivå (60 prosent i 2015).

De estimerte modellene fanger sysselsettingsdynamikken godt. De arbeidsmarkedsreguleringene som får mest støtte fra våre resultater er at en høyere arbeidsledighetstrygd kombinert med lang varighet på stønaden er knyttet til lavere sysselsettingsrate. Dersom arbeidsledighetstrygden øker med 10 prosentpoeng i et gjennomsnittlig stønadsland som Tyskland, reduseres sysselsettingsraten med 0,2 prosentpoeng på lang sikt. Effekten av endringer i trygden er større i land med lavt stønadsnivå, som Portugal eller USA, der en tilsvarende økning reduserer sysselsettingsraten med 2,5 prosentpoeng. Det er imidlertid relativt få signifikante effekter av arbeidsmarkedsreguleringer, og den økonomiske tolkningen ville stått sterkere dersom presisjonen av estimatene hadde vært høyere. Vår undersøkelse støtter imidlertid også opp om oppfatningen om at den pågående aldringen i befolkningene representerer en utfordring for sysselsettingsraten. Denne effekten kan motvirkes med nye reformer, politikk eller institusjonelle endringer for å forhindre en permanent nedgang i sysselsettingsraten.

Vi finner empirisk at makroøkonomiske sjokk påvirker sysselsettingsraten. Den simulerte sysselsettingsraten som ikke tar hensyn til sjokk er om lag 2 prosentpoeng lavere enn i den simuleringen som nettopp tar hensyn til slike sjokk. Positive sjokk har øker også sysselsettingsraten mer i økonomier som er regulerte sammenlignet med mindre regulerte arbeidsmarkeder. Videre dempes effekten av negative sjokk når arbeidsmarkedet er regulert, mens effekten av disse sjokkene blir større i mindre regulerte arbeidsmarkeder. Det betyr at konjunkturpolitikk er viktig også for sysselsettingsgraden. Studien, indikerer derfor at finans- og pengepolitikk kan redusere kostnadene av negative sjokk i form av både redusert arbeidsledighet og inaktivitet.

1 Introduction

The employment share, defined as the employment to population rate in the age group 15 to 74 year, was 63 percent for an average of 20 OECD countries over the period 2000-2015. There is considerable variation across countries and within any country. For example, in 2015, the employment rate ranged from 50 percent in Italy to 74 percent in Switzerland. Finland illustrates some of the largest fluctuations in the employment rate within one country, the employment rate was above 70 percent in 1960, then it declined to 52 percent in 1994 after the dissolution of the Soviet union and the national banking crisis. The current employment rate in Finland is still at a fairly low level, 60 percent in 2015.

The share of the adult population working as wage earners is an important indicator of economic performance both in a historical and comparative perspective. The evolution of modern welfare states depended on the tax revenues from a large working population. An increased labour marked participation of married women represents one trend towards a secular increase in the employment rate in many countries, during the last decades of the previous millennium. The tendency of young adults to engage in higher education is a factor in the other direction, although in many countries students hold part time jobs.

In addition to the secular development of the employment rate, there is also an important business cycle element. The employment rate typically falls in an economic downturn as a result of lay-offs, at the same time as the rate of unemployment increases. However, when the effect of the set-back is over, it is not always that the employment rate starts to increase at the same time as the official (recorded) unemployment rate begins to fall. There are several reason for this. For example, persons who have been unsuccessfully seeking work for a long time may become discouraged and withdraw from the workforce (Dagsvik et al. (2013)). As a result, official unemployment rates can begin to fall, while employment rates might stay below their pre-crisis levels. The recent development in employment rate in US due to the financial crisis is one example, where the employment rate declined from nearly 66 percent in 2007 to 60 percent and is still below 62 percent in 2015, while the unemployment rate is nearly at the pre crisis historical level.

The system of labour market institutions can play a role for both the secular evolution of the employment rate, and for the variation in employment over the business-cycle. Bertola et al. (2007) found that unionization reduced employment using data from 17 OECD countries over the period 1960 to 1996. They focus on groups that are characterized by relatively elastic labour supply, as the hypothesis is that a "union (wage) premium" is negative for the job prospects of these groups. Kahn (2000) finds that greater union coverage, collective bargaining and coordinated wage setting lead to lower relative employment of low-skilled and young, using data from 15 OECD countries for the period 1985 to 1994. A related paper is Neumark and Wascher (2007) where the literature on the employment effects of minimum wages is reviewed. The overall conclusion is that there is no evidence of positive employment effects, and strong evidence of stronger disemployment effects for low-skilled groups of regulations. On the other hand, Messina (2005) finds that unions and coordinated wage-setting increase employment in the service sector. Employment protection legislation (EPL) is one of the institutional factors that has been most studied theoretically and empirically. Bertola et al. (2000) concludes theoretically that there is clear negative effect of EPL on employment, but argues that more precise measures of EPL is needed for empirical analysis. OECD (2004) states that EPL reduces inflow into unemployment and inflow into employment and hence has an ambiguous effect on employment rates. However the effect is negative for youth and prime-aged women. Heckman and Pages (2000) find a negative and significant effect of EPL on overall employment rates. Two other important studies are Nickell et al. (2005) and Nickell et al. (2000). They find strong effects of all the above variables and shocks on unemployment.

In this paper, we include a relatively large number of measured labour market institutions in an econometric investigation of the employment rate, with the aim of testing whether there are effects of the these institutions. We use a panel data set of OECD countries with a relatively long time dimension, from 1960 to 2015 so that we include a number of years after the financial crises of 2008 and 2009. In order to control for the business cycle element mentioned above, the econometric model equations are dynamic with reference to a macro economic framework where aggregate demand affects the labour marked situation in the short term.

The data for several of the countries also display trends and business cycle shocks over long parts of the sample period. Whether these trends are genuinely related to labour market institution, or to other social developments is difficult to determine empirically. In order to robustify the empirical results, we use time dummies to control and capture the effects of common and national shocks by using impulse indicator saturation (IIS) from the dynamic time series methodology, see Hendry (1999) and Castle et al. (2014). We use the new method together with country specific dummies to give a within-group IIS estimation (WG-IIS), cf. Nymoen and Sparrman (2015).

WG-IIS is relevant to use when the distributions of all the variables are not the same at all points in time, which is a realistic characterization of OECD economies over the last half-century spanned by the time dimension of our data set. As a description of the data generating process of employment rates over a long period of time, an empirical model with indicators is incomplete, as the causes of the shifts in model parameters are left unexplained. An important question in our research is therefore whether variation in institutional factors can account for the non-stationarity in the observed employment rates. One possible empirical result is that when the full set of institutional variables is included, no impulse dummies are significant, in which case we would have an full institutional explanation of also the secular development of the employment rates. However, it may be more realistic to expect that some of the indicators are retained as significant, and in this case the interpretation is that the coefficients of the retained institutional variables are robustly estimated.

The paper is organised as follows. In Section 2 the data set are presented. The hypothesis about the relationship between employment and unemployment and labour market regulations are formulated in Section 3. The econometric framework and estimation methods are outlined in Section 4. Finally the results and conclusion are found in Section 5 and 6.

2 Data

As already noted, the data set is a macro panel data set for OECD countries. The employment rate is estimated on annual data from OECD (2016f) for 20 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. The sample is 1960 to 2015, except for Germany, where the data starts in 1991. See the Data Appendix 2 for the detailed documentation of all variables.

2.1 OECD employment rates

The employment rate is calculated as total employment from employment surveys divided by the population in age 15 to 74. The employment rates from surveys are more consistent with the population rates as they do not include e.g. short term immigrants. Although we model the employment rate data in this paper, it is a useful reference to compare with the unemployment rates. There are a high correlation between unemployment and

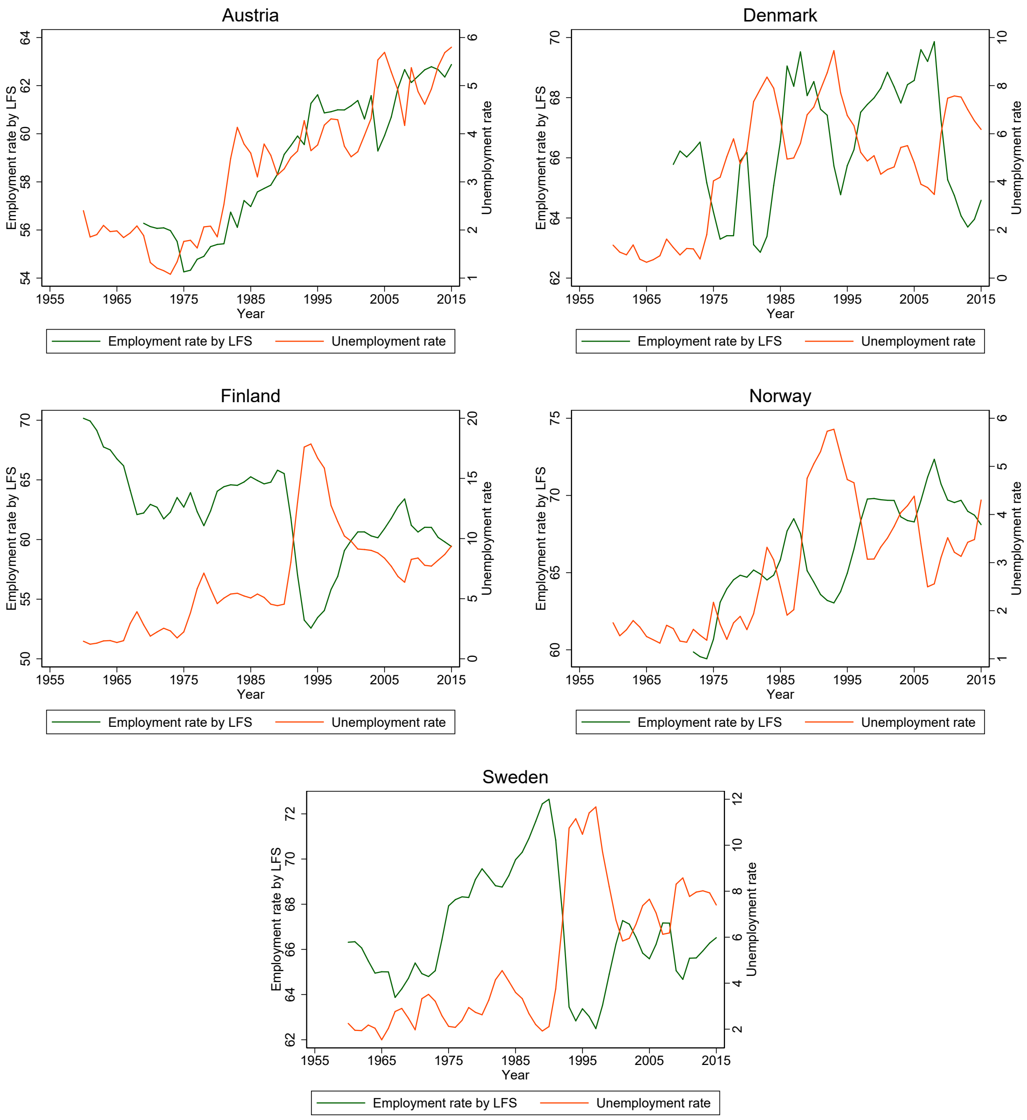

Figure 1: Employment and unemployment rates in Nordic countries and Austria. Per cent

employment rates, see graphs in figures 1 to 3. However, there might also be a discrepancy in the development as described in Section 3.

2.2 Changes in population

Over time, all countries in the sample has experienced an aging of the population. Cohorts for different age groups have different participation rates. If the institutional variables are correlated with the development in the cohort effects, estimation can lead to biased estimates of institutional variables if cohort effects are not accounted for in the regression. We have therefore included the share of population with age 60 to 64 years (share6064), 65 to 69 (share6569) and 70 to 74 (share7074), i.e. the number of workers in age 60 to 64 divided by total population. Data are collected from OECD (2016e). Due to a change in the education enrollment, one could argue that the empirical analysis should control for young cohorts. However, many of the students have hold part time jobs at all times, hence changes in education enrollment will probably not affect the results to the same extent as the ageing of the population.

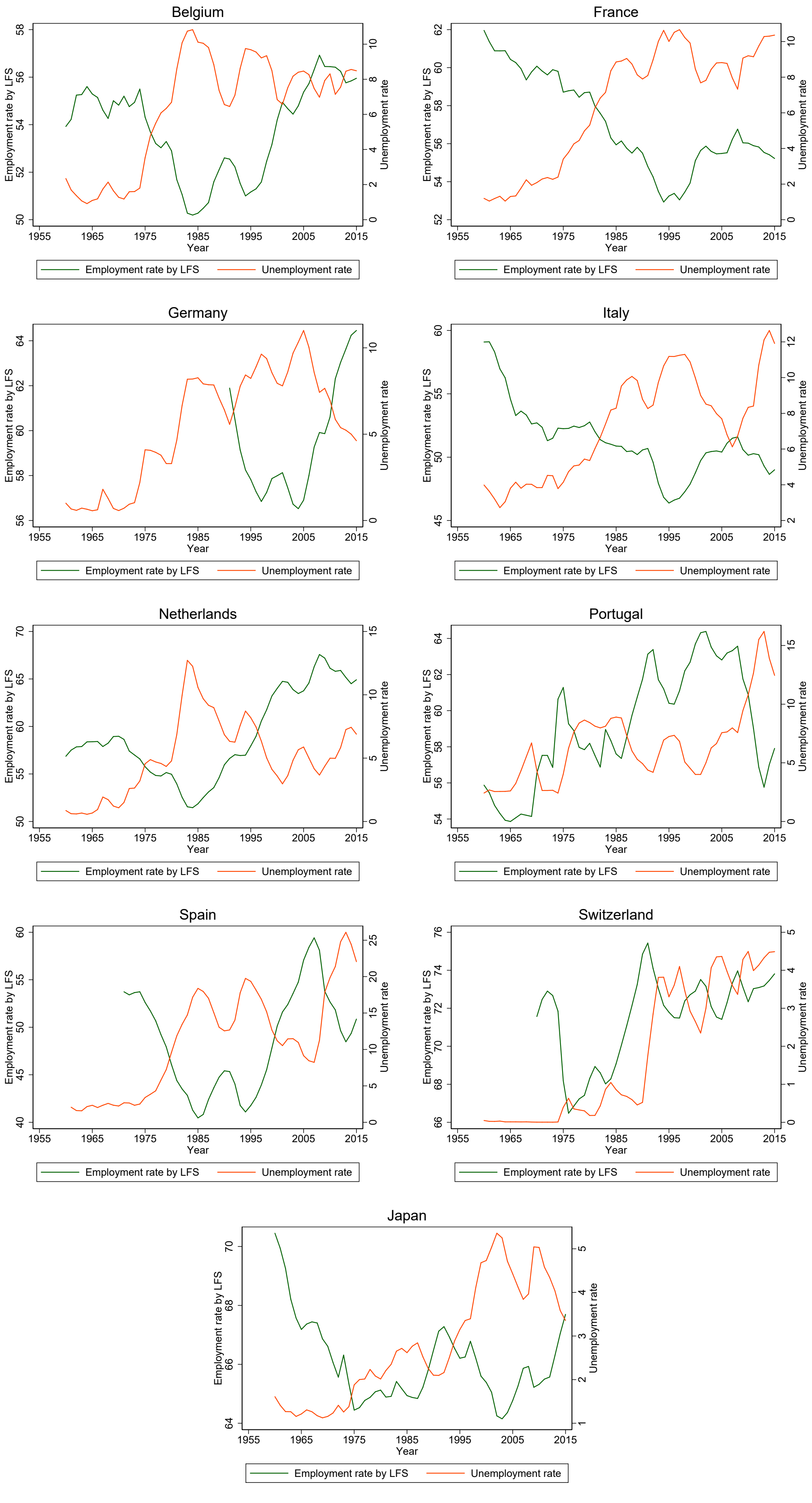

Figure 2: Employment and unemployment rates in European countries and Japan. Per cent

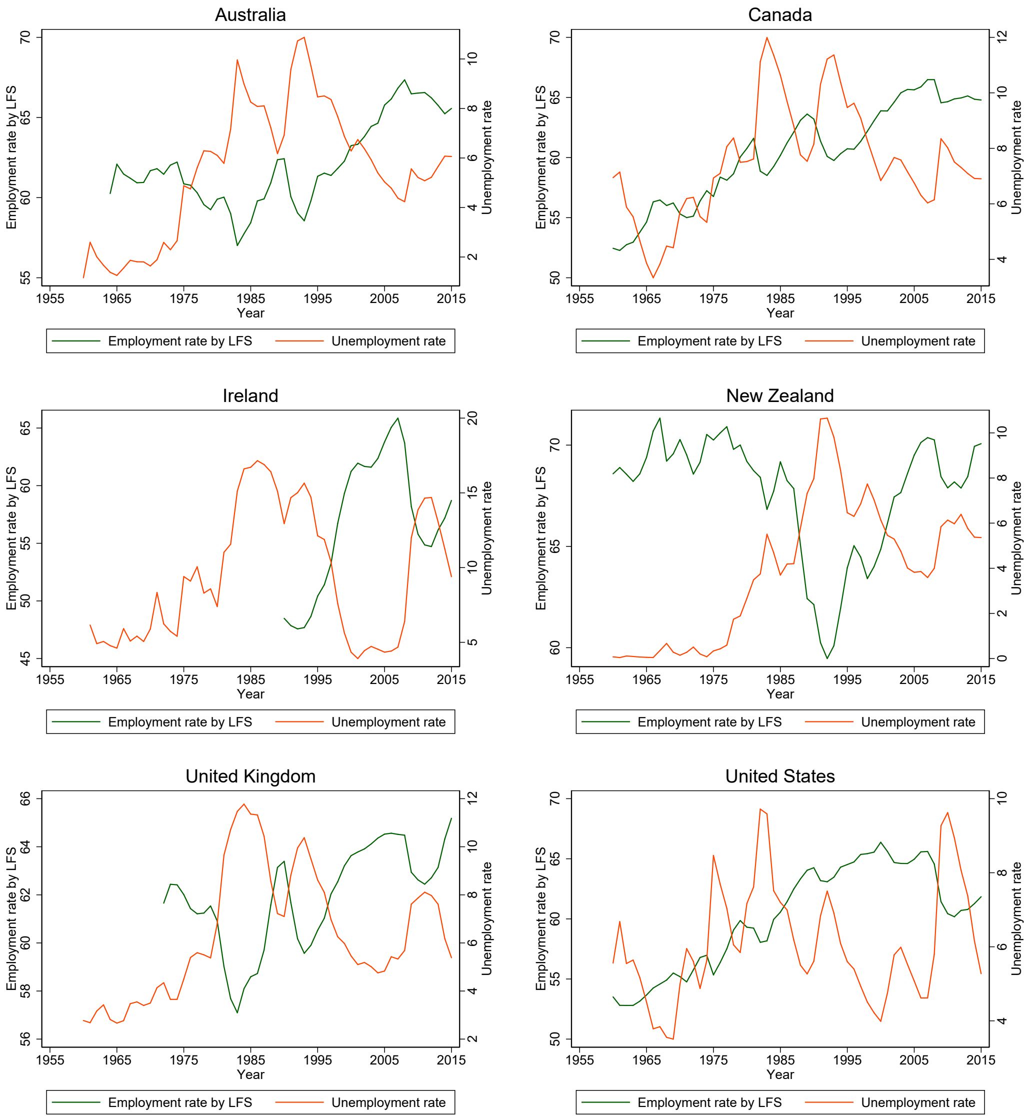

Figure 3: Employment and unemployment rates in Anglo-Saxon countries. Per cent

2.3 The institutional variables

Labour market institutions are measured by indicators constructed by the OECD for employment protection (EPL), the benefit replacement ratio (BRR), benefit duration (BD), union density ($UDNET$), the tax wedge (TW) and the degree of co-ordination in wage setting (CO), see Nymoen and Sparrman (2015) for further calculations and discussion. We also include several interaction terms between three pairs of institutional variables: benefit duration and the benefit replacement ratio; co-ordination in wage setting and union density; and co-ordination and the tax wedge, measured as the deviations from country-specific means.

We have data for indicators constructed by the OECD for employment protection (EPL), the benefit replacement ratio (BRR), benefit duration (BD),
union density ($UDNET$), the tax wedge (TW) and the degree of co-ordination in wage setting (CO).

As noted above, following standard procedures, we also include several interaction terms between three pairs of institutional variables: benefit duration and the benefit replacement ratio; co-ordination in wage setting and union density; and co-ordination and the tax wedge, measured as the deviations from country-specific means.

2.4 Second wage earner

There may also be different tax systems depending on whether or not there are one or two tax earners in the family, see OECD (2011b). The total extra tax for the second wage earner is derived by calculating the extra income tax and social security tax (both employer and employee) the family will have to pay as a result of the second earner entering employment. The tax rate is then this amount divided by the second earners total income plus the employers social security contribution. This is a more correct measure of the tax rate that the second wage earner is facing, see Jaumotte (2003). This rate should also capture differences in tax system depending on if the tax system is based on the individual level or household income, which in turn may affect the participation rate of the person who earns least.

3 Theoretical framework

In this section, we clarify the relationship between the two main indicators of overall labour market performance, the unemployment and employment rate. Based on this, we briefly review a dynamic framework that places the employment rate in a macro dynamic context.

3.1 Unemployment and employment rates

As noted in the introduction, there is a relationship between the unemployment rate and the employment rate. But there is no identity, and the two variables represent different indicators of macroeconomic performance, and they may have different dynamics as they may react differently to variation in institutional factors.

We denote the population in working age, 15-74 years for example, by POP and note that POP can be divided into those who are labour market active (labour force) and those who are inactive:

$$POP = N_A + N_{IA}$$

N_A denotes the number who participate actively in the labour market, as employees or as self-employed, and unemployed who are actively seeking work. N_{IA} is the number of inactive, those who are not actively seeking work (including part time of course).

Next consider the employment rate:

$$e = \frac{E}{N_A + N_{IA}}$$

where E denotes the total number of employed persons. Since, by definition, $N_A = E + U$ where U is the number who are unemployed (and seeking job):

$$\begin{aligned} e &= \frac{E}{E + U + N_{IA}} = \frac{E + U - U}{E + U + N_{IA}} \\ &= \frac{1 - \frac{U}{E+U}}{1 + \frac{N_{IA}}{E+U}} = \frac{1 - u}{1 + \frac{N_{IA}}{E+U}} \end{aligned}$$

where u denotes the unemployment rate, and $\frac{N_{IA}}{E+U}$ is the *inactivity rate.*

To aid interpretation:

$$\ln(e) = \ln(1 - u) - \ln(1 + \frac{N_{IA}}{E + U}) \approx -u - \frac{N_{IA}}{E + U}$$

so that:

$$\ln(e) \approx -(u + IA^{rate}) \tag{1}$$

where $IA^{rate} = \frac{N_{IA}}{E+U}$ is used to denote the *inactivity rate.*

Consequently, changes in $\ln e$ are equal to changes in the unemployment rate u if the inactivity rate is constant. However, between countries, and across decades of economic development, the inactivity rate is most probably not constant.

In particular, the inactivity rate can depend on the business-cycle, and therefore be correlated with u. Discouraged worker effects for example, implies that the inactivity rate, IA^{rate} can increase if unemployment grows to a new level, and stays there for a period of time.

We indicate that IA^{rate} is a sum of a cyclical component that depends on u_t and a mainly institutional determined component $Z_{ia,t}$,

$$IA_t^{rate} = bu_t + Z_{ia,t},\ b \geq 0 \tag{2}$$

Collecting terms, we get

$$\ln e_t = -(u + IA^{rate}) = -(1 + b)u_t - Z_{ia,t}. \tag{3}$$

Hence, the relationship between the unemployment rate and the employment rate may be affected by discouraged worker effects, represented by $b > 0$ and the many other factors that affect the inactivity rate of the population. In the long-run, the equilibrium rate of unemployment, is in its turn influenced by institutional developments, as also Nymoen and Sparrman (2015) has found evidence of. In this steady-state perspective, the implication of (3) is that institutional factors may have long-run influence on the secular development of the employment rate both directly (through $Z_{ia,t}$) and indirectly through the institutionally determined part of steady-state unemployment.

As a background to the more detailed modelling, we tested whether the data support a simple relationship like (3). In order to be robust to non-stationarity to non-stationary behaviour of the rates, we applied cointegration tests to our 20 pairs of $\ln(e_t), u_t$ time series. The maximum length of the sample is 1960-2015.

We made use of three standard tests due to Pedroni (1999), Kao (1999), which are variants of residual-based Engle-Granger tests, and the Johansen-type test proposed by

Maddala and Wu (1999). [1] Since we only have two variables, multiple long-run relationships is not an issue, but the Johansen-test may still be useful since it is robust to the endogenity of u_t in the long-run relationship, see Pesaran (2015, Ch. 31.8.2-3). The results show the Pedroni tests do not reject the null of no-relationship, while the Kao (Augmented Dickey-Fuller) test, and the Johansen (Trace) test do give support of the expected relationship. The power of the Pedroni test may suffer from the individually estimated slope coefficients in the Engle-Granger regressions, so the results of the two other tests seems to more in accordance with how we think about the relationship: With country specific intercepts that can capture differences in the approximation as well as levels of ia_t^{inst}, but with homogenous $(1+b)$ coefficient.

Conditional on cointegration, we can obtain a direct estimate of the b parameter linking inactivity to unemployment from the conditional equilibrium correction model:

$$\Delta \ln(e_t) = \underset{(0.0308)}{0.3068}\Delta \ln(e_{t-1}) - \underset{(0.0421)}{1.267}\,\Delta u_t + \underset{(0.0607)}{0.2338}\Delta u_{t-1} - \underset{(0.00722)}{0.0426}\,\ln(e_{t-1}) + \underset{(0.0189)}{0.0653}u_{t-1} \tag{4}$$

for 952 observations, and using the within-transformation and time dummies (which we omitted to save space). Mis-specification tests for first and second order residual autocorrelation do not reject the hypothesis of no autocorrelation. The empirical counterpart to (1) therefore becomes:

$$\ln(e_t) = -(1 + \underset{(0.332)}{0.53})u_t - ia_t^{ins} \tag{5}$$

i.e., $\hat{b} = 0.53$. The exogeneity of u_t is not rejected when we estimate the marginal equation for Δu_t, the joint test of weak exogeneity with respect to (5) and non Granger causality between $\Delta \ln(e_t)$ and Δu_t, gives $\chi^2(2) = 1.86[0.40]$.

As an example, if the initial employment rate is 65 percent the estimated effect of a permanent increase in u by one percentage point is that the employment rate is reduced by one percentage point. However, if the initial e is as high as 0.75 the estimated long-term reduction in the employment rate is 1.14 percentage points.

3.2 Macro economic dynamics and the employment rate

The literature on the relationship between institutions and equilibrium unemployment and employment performance focus on how wage and prices adjustment depend on product market competition and the labour market regulations, see Nickell and Layard (1999), Nickell et al. (2005). One hypothesis is that institutions can influence the relationship between wages and the rate of unemployment, the slope of the so called wage curve. A second idea is that the institutional set-up is of importance for how high wage ambitions become for a given level of unemployment (the intercept of the wage curve). The second point is of course important to encompass cost-push inflation and wage-price spirals.

Nymoen and Sparrman (2015) formulated a dynamic version of this approach to motivate their dynamic econometric model of equilibrium unemployment, as a function of both institutional factors and macroeconomic shocks. One step in the derivation was the reduced form model of unemployment, the real exchange rate and the productivity-corrected real wage (or wage-share). With reference to (1), the rate of employment can be used in place of the rate of unemployment, with the implied sign changes of coefficients, the logic of the derivation is unaffected and the result is an open VAR (i.e.,VAR-X):

$$\boldsymbol{y}_t = \boldsymbol{R}\boldsymbol{y}_{t-1} + \mathbf{P}\boldsymbol{x}_{t-1} + \boldsymbol{\epsilon}_t \tag{6}$$

where the vector $\mathbf{y}$ contains the three variables: log of the real exchange rate, log of the wage-share and the employment rate, which was denoted by e_t above. The vector

[1] As implemented in Eviews 9.5, see EViews (2016, Ch. 46).

$\mathbf{x}_t$ represent indicators of institutional development. The disturbance vector $\boldsymbol{\epsilon}_t$ is widely interpreted, as containing for example the exogenous growth rate of import prices and of labor productivity. Since the VAR is derived as the reduced form of a simultaneous equations model, the three disturbances $\boldsymbol{\epsilon}_t$ are generally correlated. However, the research question in this paper does not involve the identification of impulse responses to random shocks to the VAR. Instead, (6) is used to motivate a dynamic model equation for e_t, one of the variables in the $\boldsymbol{y}_t$ vector, that include the institution indications in $\boldsymbol{x}_t$ as observable explanatory variables, cf. section 4 below.

4 Econometric framework and estimation methods

Above, we introduced (6) as a reduced form model for the employment rate of a vector of macroeconomic variables that includes the employment rate. The elements of the autoregressive matrix $\boldsymbol{R}$ in (6) are complicated expressions of the parameters of the underlying structural dynamic model of wage and price adjustment, and of the parameters of the postulated theoretical relationship between for example the real exchange rate and unemployment.

It is of interest whether an econometric model of the employment rate is stable or not, and for that purpose it may seem to be necessary to estimate $\boldsymbol{R}$ in order to estimate the eigenvalues. However, we note that, in principle, the eigenvalues of $\boldsymbol{R}$ are the same as the characteristic roots of the homogenous part of the final equation for e_t associated with (6), Wallis (1977). Based on the same assumptions as in Nymoen and Sparrman (2015), and using (1), it can be shown that the homogenous final equation for the rate of employment has third order dynamics.

In summary, the model equations estimate are of the following basic type:

$$e_{it} = \beta_1 e_{it-1} + \beta_2 e_{it-2} + \beta_3 e_{it-3} + \boldsymbol{\gamma} \boldsymbol{x}_{it-1} + \alpha_i + \varepsilon_{it} \tag{7}$$

where e_{it} is the employment rate in country i in year t.

As noted above, it is reasonable to allow interaction effects between institutional variables in the model, see e.g., Belot and van Ours (2001), Nickell et al. (2005). For example, existing studies have shown that it is not only the level of unemployment benefits that are important for the outcome of the labour market, but also for how long your receive the benefits, see Nickell et al. (2005). We therefore interpret $\boldsymbol{x}_{it-1}$ as including interacting institutional variables.[2]

The number of cross-section units is 20, and the initial sample length is from 1960 to 2015; hence, $i = 1, 2, ... 20$ and $t = 1960, 1961, ..., 2015$. Because it does not exist consistent operational definitions of all the institutional variables, the sample used in the estimations is unbalanced and we lose a few annual observations. Typically, the longest time series is **55** observations, and the shortest is **23** observations. **932** observations in total.

We follow the studies of OECD unemployment by Nickell et al. (2005) and Nymoen and Sparrman (2015) and use the within-group (WG) estimator, also known as the least squares dummy variable method, as the reference estimator. This reflects the fact that our main purpose is to estimate regression coefficients, and the equilibrium employment rate as a derived coefficient, free from unobserved heterogeneity bias. As the time dimension is relatively large, the sample realizations of the individual effects α_i may be treated as parameters that are jointly determined with the common parameters in (7). In this setting, the WG bias will be small if the disturbances not are autocorrelated see, Judson and Owen (1999), which is usually a weak assumption for dynamic models like (7).

[2]Formally, there is an implied lag distribution of $\boldsymbol{x}_{it-1}$ in the final equation, which is not indicated in (7). This is to reduce the dimension of the model, and can be defensible since the chance of estimating a significant coefficient of a relevant institutional variable, does not depend on solving the more ambitious specification problem, namely of estimating the correct distributed lag of that variable.

We investigate the robustness of the WG estimator by using several other panel data estimators. First, we use standard modifications of the WG estimator that allow for heteroscedasticity and autocorrelation, which may also be relevant since the model equation has been derived from multiple equation structural model in several steps. It might be noted that all our estimated models are augmented by time dummies in the same way as in Nymoen and Sparrman (2015) for example. In the present context, those dummies are interpretable as common location shifts in the employment rate, and location shifts that are identified from *Autometrics* represent heterogeneity in the location shifts. Of course, it is possible that no such dummies will be found to be significant and that the conventional times dummies are sufficient in terms of the robustness of the WG estimator of the regression coefficients.

As noted above, we extend the use of WG estimation to IIS estimation, denoted WG-IIS. One motivation for this method is that it may account for wide-sense non-stationarity of the employment rates, in the event that location breaks, or the mode secular trends that we saw in the data section, are not well captured by the institutional variables. The WG-IIS has been shown to improve the size and the precision of the estimated coefficients of explanatory variables in econometric time series models; cf. Johansen and Nielsen (2009).

We used the indicator saturation algorithm in *Autometrics*, see Doornik (2009a). It divides the sample into two sets and saturates first one set, and then the other set, with zero–one indicators for the observation. The indicators are tested for significance, taking the estimated indicator coefficients from the other half of the sample as given, and observations are deleted if the t-ratios are significant. In this way, the indicators are selected, and the number of indicators retained are often relatively few and interpretable (among others, see Hendry (1999) and Castle et al. (2014)). When the model is augmented by the selected individual-specific location-shift indicators and estimated by OLS, we obtain the IIS estimators of the original regression coefficients. When the error distribution is symmetric, and under the null hypothesis that there are no location shifts, the IIS estimator is centred around the same value as the OLS estimator; however, there is an efficiency loss because irrelevant explanatory variables are included in the model. Against that loss, there is the potential of gains both in the centring and in the efficiency under the alternative of breaks and/or outliers, which is empirically highly relevant for the actual employment rates, as we have seen.

Johansen and Nielsen (2009) extend the IIS estimator to stationary autoregressive distributed lags, but the literature still lacks a formalization of the panel data version of the IIS estimator. We propose to use the method to add robustness to the WG estimator. The IIS algorithm is not pre-programmed for panel data models, but we have worked around this by using the within-transformation on all the data in equation (7). Impulse indicator saturation (IIS) was then applied to the transformed data set, stacked into a matrix, The set of institutional variables, and the three lags of the unemployment rate are not selected over. Concretely, the WG-IIS estimator is obtained by first applying within-group transformation of the data set, and second, by impulse saturating the transformed data set, as explained in the previous paragraph. In the algorithm for indicator saturation that we use, the original regressors (the autoregressive part and the institutional variables) are not selected over, see Doornik (2009a), Doornik (2009b, Ch 14.8), Castle et al. (2012). Step-dummies are relevant for persistent breaks in location parameters, and by also proxy secular trends that are present in parts of the sample period, unless they are well accounted for by the institutional variables in our data set. However, the rich dynamic in the model, including several lags of the endogenous variable, the IIS-variables result in having persistent effects. The effect of IIS might therefor also be interpreted as labour market regulations that are not included in our analysis.

A second motivation for using WG-IIS is that we are interested in the equilibrium rate of employment. As noted above, dynamic stability stationarity require that:

$$1 - \beta_1 - \beta_2 - \beta_3 > 0 \tag{8}$$

The equilibrium (steady-sate) rate of employment e^{ast} is a parameter which is derived from the other parameters of our model. Specifically, the equilibrium rate of unemployment is determined uniquely as

$$e^* = \frac{\alpha_0 + \boldsymbol{\gamma x}}{1 - \beta_1 - \beta_2 - \beta_3} \tag{9}$$

for the case where the disturbances are set to their expected value of zero, and where the vector of institutional variables is assumed to be in stationary situation.

For OECD unemployment data, Nymoen and Sparrman (2015) found empirically that $1 - \beta_1 - \beta_2 - \beta_3 < 0$ is supported by the evidence, when controlling for institutional indicators and shocks that are estimated by the IIS method, Doornik (2009a). In other words, the empirical results for the stability condition can be sensible to whether indicators of structural breaks have been included in the model or not.

5 Empirical results

Our first set of results of the relationship for employment is shown in Table 1. The WG estimation results allowing the residuals to be heteroscedastic and autocorrelated are reported in the second column of the table, the autoregressive coefficients sum to 0.89 which is consistent with the results of the panel unit-root and cointegration tests of above. The third autoregressive coefficient is not significant. However, we keep it as third order dynamics is implied by the macro economic model that we use as our framework. As we shall some of the robust estimators also give more precise estimates for this parameter. For the time being, we note that the WG estimation results correspond to two sizeable real roots (0.74 and 0.64), and a third one which is small (0.04). Hence, though the point estimates are well inside the unit circle, they also imply that the employment rate will show intermediate run response to shocks, and that there is a potential for permanent effects of institutional changes,

The WG results show that two of the institutional variables are statistically significant, judged by the t-ratios. The tax variable is significant with a sign implying that an increase in the tax rate reduces the employment rate. In addition, one of the interaction terms stand out: the interaction term of the levels of benefit replacement BRR and benefit duration BD, and interaction between coordination and tax. The results indicate that an increase in either one of them tend to reduce the level of the employment rate. These institutional variables (interactions) are also relatively significant in the two other columns in Table 1, where we allow for heteroscedasticity and autocorrelation. The population share variable for age group 60-64 is also estimated to have a negative coefficient by all the three estimators used in Table 1.

However, before attempting to draw substantive conclusions, we investigate whether the results are robust towards non-stationarity of the form that can be represented in a model equation by the inclusion of impulse indicators, i.e., the method we dubbed WG-IIS above. The approach is analogous to the analysis of the IIS estimator for dynamic regression models in time series, where Hendry et al. (2008) and Johansen and Nielsen (2009) have shown that exclusion of shocks might bias the estimators.

We used a *target size* of 2.5 per cent for IIS. Hence, for example if there are no breaks in the data generating process the algorithm returns 23 indicators on average. Although 2.5 percent may appear as liberal in a situation with several tests, it only implies loosing 23 observations out of 932 even if the process was completely stationary. Hence the cost is not very large, in the form of data points lost that could be used for the estimation

Table 1: WG estimation results

	WG		WG, robust[a]		WG autocorr. [b]	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Employment previous period e_{it-1}	1.42***	0.03	1.42***	0.07	1.41***	0.03
Employment two years ago e_{it-2}	-0.53***	0.06	-0.53***	0.11	-0.58***	0.05
Employment three years ago e_{it-3}	0.02	0.03	0.02	0.05	0.08***	0.03
EPL_{it-1}	0.10	0.08	0.10	0.10	0.17**	0.08
BRR_{it-1}	-0.44	0.31	-0.44	0.33	-0.40	0.29
BD_{it-1}	0.18	0.21	0.18	0.20	0.20	0.20
UDNET_{it-1}	0.27	0.35	0.27	0.46	0.31	0.34
CO_{it-1}	-0.04	0.03	-0.04	0.04	-0.04	0.03
TW_{it-1}	-2.05***	0.76	-2.05**	0.90	-2.17***	0.71
SEAWTW_{it-1}	-1.55	1.29	-1.55	1.37	-0.35	1.33
Interaction-BRR and BD_{it-1}	-1.45*	0.74	-1.45*	0.76	-1.93***	0.74
Interaction-CO and UDNET_{it-1}	-0.03	0.17	-0.03	0.16	-0.11	0.16
Interaction-CO and TW_{it-1}	-0.60**	0.29	-0.60***	0.22	-0.67**	0.27
share6064_{it-1}	-0.10	0.06	-0.10	0.07	-0.10*	0.06
share6569_{it-1}	0.12	0.08	0.12	0.09	0.15**	0.07
share7074_{it-1}	0.08	0.08	0.08	0.11	-0.03	0.08
Tot. obs and countries	932	20	932	20	932	20
Standard errors of residuals	0.9		0.7		0.7	
χ^2 of all explanatory variables [c]	1.93	(0.02)	55.94	(0.00)	38.44	(0.00)
χ^2 of institutional variables (level).[c]	2.04	(0.03)	35.92	(0.00)	31.10	(0.00)
χ^2 of institutional variables (interaction).[c]	3.36	(0.02)	11.38	(0.01)	17.65	(0.00)
χ^2 of the share of self employed and demographic effects.[c]	2.41	(0.07)	4.45	(0.22)	5.64	(0.13)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Employment to population rate in age group 15 to 74 (e_{it}). Percent.

Generalised least squares. Each equation contains country and time dummies.

a) Estimation method: Within country estimate with heteroscedastic and within country autocorrelated robust standard errors, see Stock and Watson (2008).

b) Generalised least squares within group allowing for autocorrelated country specific error terms.

c) Numbers in parenthesis are p-values for the relevant null.

Variables:

The benefit replacement ratio (BRR), union density (UDNET) and employment tax wedge (TW) are proportions (range 0-1),

benefit duration (BD) range (0-1), employment protection (EPL) range (0-5), coordination (CO) range (1-5),

Tax, second wage earner (SEAWTW) range (0-1), share self employed (shareself) range (0-100),

and the demographic age group 60-64, 65-69 and 70-74 are measured by variables share6064, share6569 and share7074 respectively, range (0-100).

All variables in the interaction terms are expressed as deviations from the sample mean.

of the coefficients of the dynamic terms and of the institutions. Moreover, real world data generation processes are not likely to be without location shifts, so the Type-II error problem is very relevant. "Loosing" too many indicators for breaks that are in fact in the data will not give the robust estimation for the parameters of interest that we are looking for when we use the WG-ISS estimation method.

Table 2 shows the indicators found by the procedure described above. There are 90 indicators is total, 4.5 per country on overage. However, there is an uneven distribution. For Denmark the method finds 13 indicators and Spain has 10. At the other end of the spectrum we find France and Germany with no breaks, and Belgium, Italy and Japan with a single break dummy for each of these countries.[3]

The time series for Denmark shows considerable variation around a stable level, and ISS is likely to pick up large deviation from the mean in this case, in particular since the institutional variables typically evolve gradually as noted. The time series for Finland show the large change in employment rate after the dissolution of the Soviet union and the national banking crisis. For Germany we only have post unification data after 1990, so several years are "unavailable for breaks", while the French employment rate is dominated by a smooth negative trend for most of the time period which leaves little scope for the IIS algorithm to return anything.

We note that there is a clustering of indicators in 1975 and 1976, in the late 1980s and early 1990s, which were crisis years in many European countries. For USA, IIS identifies breaks in 1975, 1976 and 1982, which is not unreasonable given how much the US economy was impacted by the oil-price shocks of that epoch and the near doubling of the interest rate in 1980 ("Volker shock"). In the UK, the employment rate decreased sharply with

[3] As there is no natural ordering of the countries, and there is a chance that IIS will deliver slightly different results depending on what one chooses. In principle it can be randomized, but we ordered by the alphabet.

Table 2: Year with location shifts in the form of impulses (IIS). 2.5 percent target size (overall significance level)

	IIS (indicator years)
Australia	1975 1983 1984 1991 1994
Austria	1975 1983 1984 1985 1994 2003 2004 2005
Belgium	1975
Canada	1976 1977 1982 1983 1991 2009 2010
Denmark	1974 1979 1982 1984 1986 1987 1988 1989 1990 1991 1993 1995 2009
Finland	1979 1991 1992 1993 1999 2009
France	
Germany	
Ireland	1998 2008 2009
Italy	2009
Japan	1974
Netherlands	1981 1982 2007
New Zealand	1988 1989 1991 1997 2009
Norway	1976 1986 1988 1989 2006 2009
Portugal	1975 1976 1993 2009 2011 2012
Spain	1980 1984 1992 1993 1999 2005 2008 2009 2010 2012
Sweden	1974 1991 1992 1993 1994 2009
Switzerland	1992 2009
United Kingdom	1981 1988 1991 2009
United States	1975 1976 1982

Thatcher in 1981. Another cluster is for the years 2008 and 2009, as the employment rate was (unusually) high in many countries when the financial crisis hit, and later developed into an international job and income crisis.

Table 3 shows that the autoregressive coefficients are not greatly affected by the use of WG-IIS. However, for the institutional variables there are several interesting results compared to Table 1. First, the coefficient of the tax variable is reduced in magnitude from -2.07 in WG to -0.30 in WG-IIS (and the t-value is no longer significant). Hence, the result in Table 1 that tax reductions are strongly associated with higher employment rates was not robust to the estimation methods that takes location shifts into account (WG-IIS). On the other hand, the estimated coefficient of the interaction term between benefit replacement BRR and duration BD does not change very much when we compare WG (Table 1) and WG-IIS (Table 3). The coefficient estimate is robust and is statistically significant in both tables. It is interesting to note that also the numerical estimates of the linear effects of BRR and BD are robust to the location shifts, although they are not statistically significant different from zero. We also note that the coefficients of the population variables do not change by a great deal between Table 1 and Table 3 , and they are estimated with lower standard errors when WG-IIS is used.

Table 4 shows the WG-based estimated coefficients of the institutional determinants of the equilibrium employment rate e^*. The standard WG estimation results are to the left of the table, and the WG-IIS estimates with standard errors are in the two columns to the right. With the exception of CO the signs of the WG estimated coefficients are robust to the use of the IIS method. As can be expected from Table 3, one coefficient that change notably, is the coefficient for TW.

As the table shows, most of coefficients are statistically insignificant, because the standard errors are relatively large. In the column with the WG estimated coefficients, TW stands out as the most statistically significant. The effect of an increase in TW by 0.1 implies a reduction in e by 2.5 percentage point. However, as the WG-IIS estimates for the same coefficient shows, this estimate is not robust, and is reduced to 0.5 percentage point when that estimate is used. The WG-ISS result for $SEATW$ implies that the numerical significance of a change in the tax rate of the secondary wage earner ($SEATW$is numerically larger (-1.5) than for TW, but again that effect is statistically insignificant.

As noted above, several of the linear coefficients robust to estimation method, even though they are insignificantly different from zero. If we focus on the WG-ISS estimated coefficients absolute values of t-values larger than one, we see that a 0.1 increases in BRR

and BD reduces the employment rate by -0.55 and -0.39 percentage points.[4]

Turning to the statistically significant interaction effects, the interaction of BRR and BD is statically significant in the WG-IIS column. The averages in the first decennial of the new millennium of the two variables are close to 0.5 for both variables. Hence a permanent increase in BRR by 0.1 implies that e is reduced by 1.1 percentage points. An increase in the duration of benefits by 0.1 gets an estimated effect of the same size (because the average values of the two variables are practically equal).

Since the estimated effect of a change in the benefit replacement ratio (BRR) depends on the duration of benefits (BD), it is interesting to note that a 0.1 change in an average duration country, like Germany, reduces the employment rate by 0.2 percentage points in the long run (coefficients in second column of Table 4). Changes in benefit duration are more severe in countries with (high initial duration level, like Portugal, where the same size of change decreases the employment rate by 2.5 percent.

It is of interest to try to investigate further whether the effects of negative or positive large shocks (location shifts) depend on the institutional variables. This is similar to the question about possible institutional dependency of fiscal polity effects on GDP in the existing literature. For example, Holden and Sparrman (2018) showed empirically that the effect of government purchases are different depending on the nature of labour market institutions. In order to investigate, we constructed a summary index of the predicted effect of the labour-market institutions. The index is country-year specific, equal to the product of the estimated coefficients from Table 3, column 2 and the country-year specific values of the institutional variables. We computed the deviation of the index from its sample mean to obtain an index with a zero mean. The result in Table 3, column 3, Interaction shock and LMI (labour market institutions), show that the interaction term significant affect the employment rate. The estimated coefficient is positive, meaning that positive shocks have a larger effect on the employment rate in economies with highly regulated labour markets. While less regulated labour markets are less affected by positive shocks. Negative shocks on the other hand, have a dampening effect on the employment rate when labour market are more regulated and a larger effect when the labour markets are less regulated.

5.1 Model simulations

Since there are multiple variables included in the model, and with some differences in the coefficient estimates depending on estimation methods, it is not easy to see from the tables with estimation results, what is the implied equilibrium (natural) employment rate. However it is easy to get an impression by using standard dynamic simulation, based on the hypothetical situation that each institutional variable is prolonged into the simulation period by their end-of-estimation sample values.

In Figure 4, we show the results (for the average OECD country) of two dynamic simulations, for using the estimated coefficients WG and WG-IIS (robust standard errors). In principle the simulations (i.e., the solution of the difference equations) start in 1975, although for some countries is has to starter later due to the ragged edge of the data matrix. As noted above, the end of the sample period is 2014, but the simulations continue until 2030, based on the assumption of unchanged end-of-sample institutions as noted above. Within sample, the two simulation paths are almost identical, while there is a difference of around 2 percentage points between to two simulated employment rates in the post-estimation period. From the estimation results in the previous section, the effect is larger for regulated than less regulated labour markets.

The graphs show that the version of the WG-IIS estimate provide some more grounds

[4] EPL also has a t-vaue larger than one, but is not a continuous variable, so a 0.1 change in this variable is now comparable to a 0.1 change in a tax-rate, or in the replacement ratio.

Table 3: WG-IIS estimation results

	WG SIS-IIS		WG SIS-IIS, robust[a]		WG SIS-IIS, robust[a]		WG SIS-IIS autocorr. [c]	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
e_{it-1}	1.41***	0.03	1.41***	0.06	1.41***	0.06	1.41***	0.03
e_{it-2}	-0.53***	0.05	-0.53***	0.07	-0.53***	0.07	-0.57***	0.05
e_{it-3}	0.06*	0.03	0.06**	0.03	0.06**	0.03	0.09***	0.03
EPL_{it-1}	0.08	0.07	0.08	0.10	0.08	0.10	0.10*	0.06
BRR_{it-1}	-0.33	0.26	-0.33	0.24	-0.33	0.24	-0.35*	0.21
BD_{it-1}	0.23	0.17	0.23	0.16	0.23	0.16	0.18	0.14
UDNET_{it-1}	0.00	0.29	0.00	0.36	0.00	0.36	-0.29	0.24
CO_{it-1}	0.01	0.03	0.01	0.04	0.01	0.04	0.03	0.03
TW_{it-1}	-0.30	0.62	-0.30	0.99	-0.30	0.99	-0.09	0.52
SEAWTW_{it-1}	-0.90	1.05	-0.90	0.80	-0.90	0.80	-0.95	0.99
Interaction-BRR and BD_{it-1}	-1.32**	0.61	-1.32*	0.72	-1.32*	0.72	-1.63***	0.51
Interaction-CO and UDNET_{it-1}	-0.09	0.15	-0.09	0.18	-0.09	0.18	-0.18	0.14
Interaction-CO and TW_{it-1}	-0.06	0.25	-0.06	0.23	-0.06	0.23	-0.00	0.22
share6064_{it-1}	-0.12**	0.05	-0.12***	0.04	-0.12***	0.04	-0.09**	0.05
share6569_{it-1}	0.04	0.07	0.04	0.07	0.04	0.07	0.00	0.06
share7074_{it-1}	0.12*	0.07	0.12*	0.07	0.12*	0.07	0.10	0.06
Interaction shock and LMI_{it}					0.07***	0.01		
Tot. obs and countries	932	20	932	20	932	20	932	20
Standard errors of residuals	0.6		0.5		0.5		0.5	
χ^2 of all explanatory variables [d]	1.29	(0.21)	51.26	(0.00)	51.26	(0.00)	24.71	(0.03)
χ^2 of institutional variables (level).[d]	0.87	(0.57)	29.21	(0.00)	29.21	(0.00)	18.57	(0.05)
χ^2 of institutional variables (interaction).[d]	1.76	(0.15)	3.39	(0.34)	3.39	(0.34)	12.44	(0.01)
χ^2 of the share of self employed and demographic effects.[d]	3.16	(0.02)	7.84	(0.05)	7.84	(0.05)	7.09	(0.07)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Employment rate (e_{it}). Percent

Generalised least squares. Each equation contains country and time dummies.

a) Estimation method: Within country estimate with heteroscedastic and within country autocorrelated robust standard errors, see Stock and Watson (2008).

b) Generalised least squares within group allowing for autocorrelated country specific error terms.

c) Numbers in parenthesis are p-values for the relevant null.

Variables:

The benefit replacement ratio (BRR), union density (UDNET) and employment tax wedge (TW) are proportions (range 0-1), benefit duration (BD) range (0-1), employment protection (EPL) range (0-5), coordination (CO) range (1-5), Tax, second wage earner (SEAWTW) range (0-1), share self employed (shareself) range (0-100), and the demographic age group 60-64, 65-69 and 70-74 are measured by variables share6064, share6569 and share7074 respectively, range (0-100).

All variables in the interaction terms are expressed as deviations from the sample mean.

Table 4: Estimated long-run coefficients of the institutional variables, using the WG robust and WG IIS robust estimation results

	WG (Tab. 2)		WG-IIS (Tab. 3)	
	Coeff.	St.err.	Coeff.	St.err
EPL	1.21	0.98	1.39	1.11
BRR	-5.41	3.81	-5.48	4.39
BD	2.24	2.64	3.87	3.03
UDNET	3.30	4.37	0.03	4.92
CO	-0.52	0.42	0.16	0.48
TW	-24.89	8.94	-4.97	10.31
SEATW	-18.90	15.49	-15.12	17.34
BRR, BD interaction	-17.60	8.90	-22.06	10.18
CO, UDNET interaction	-0.43	2.10	-1.45	2.43
CO, TW interaction	-7.34	3.68	-0.95	4.18
share6064	-1.17	0.75	-1.99	0.90
share6569	1.43	0.99	0.64	1.11
share7074	0.98	0.99	2.00	1.15

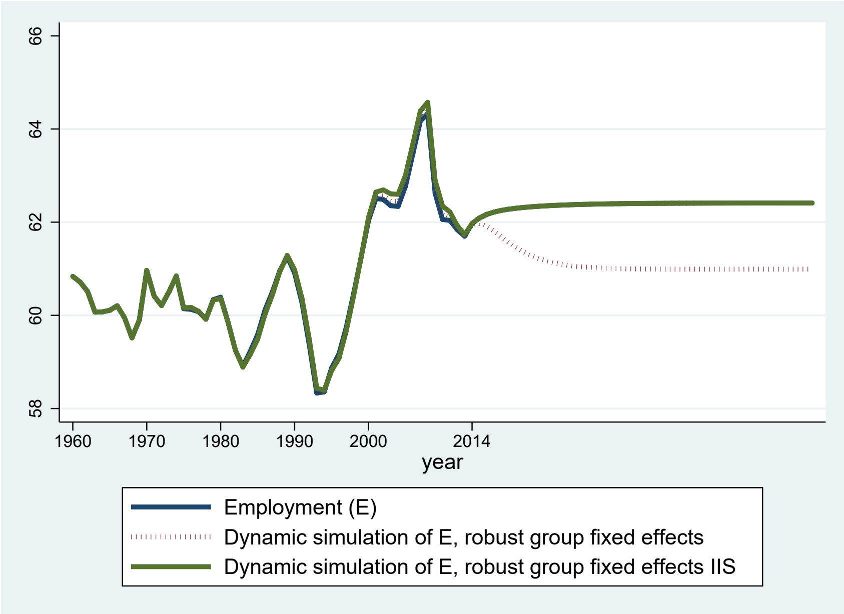

Figure 4: Average simulated employment rate for the sample of OECD countries. WG and WG-IIS estimators. Per cent

for optimism about the level of the equilibrium rate conditioned by the no change in institutions situation. It may be reasonable to place most emphasis on the more optimistic simulation, as the coefficients of the underlying drivers in the employment rate model equation has been robustly estimated in that simulation.

The simulations for the individual countries are found in Figure 5-8. It is clear that for individual countries the within sample correspondence between simulations and actuals are not always too impressive. And there are also quite large differences for the simulation with and without ISS estimation. Looking at the post-sample period: For a majority of the countries the difference between the two simulated equilibrium rates goes in the same direction as in the aggregate. For a few of the countries (Canada, Denmark, Norway, UK) the choice of estimation method difference played very little role for the simulated steady-state value of the employment rate.

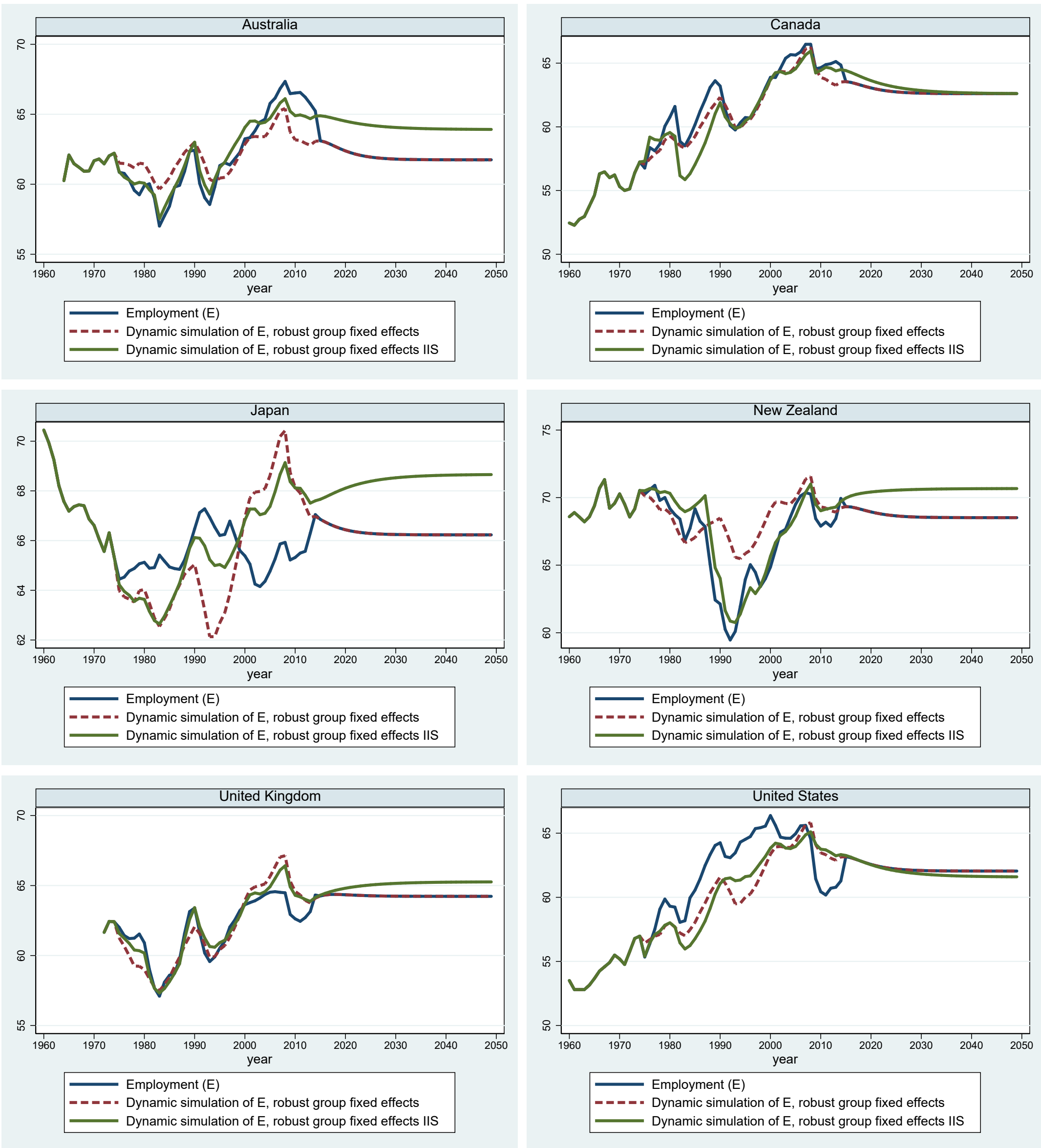

Figure 5: US, UK and some selected countries. Country specific simulated employment rates, based on WG-, WG-IIS- estimation. Actual unemployment rates shown for comparison.

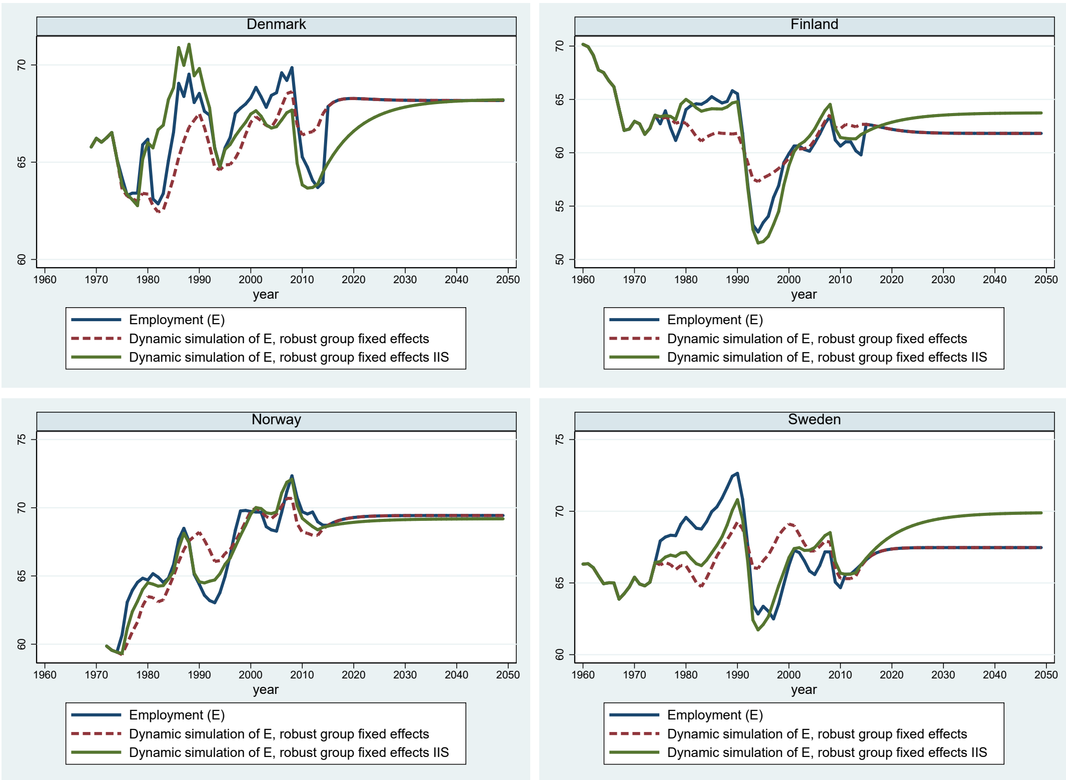

Figure 6: Nordic countries. Country specific simulated employment rates, based on WG-, WG-IIS- estimation. Actual unemployment rates shown for comparison.

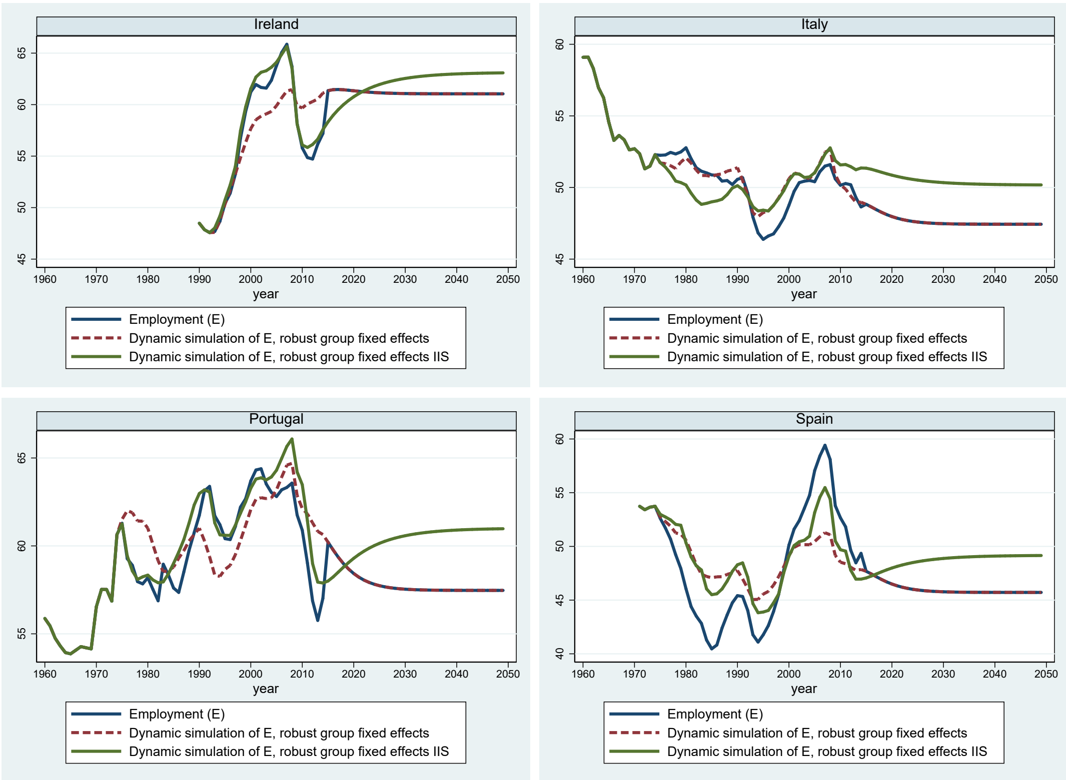

Figure 7: PIIGS countries. Country specific simulated employment rates, based on WG-, WG-IIS- estimation. Actual unemployment rates shown for comparison.

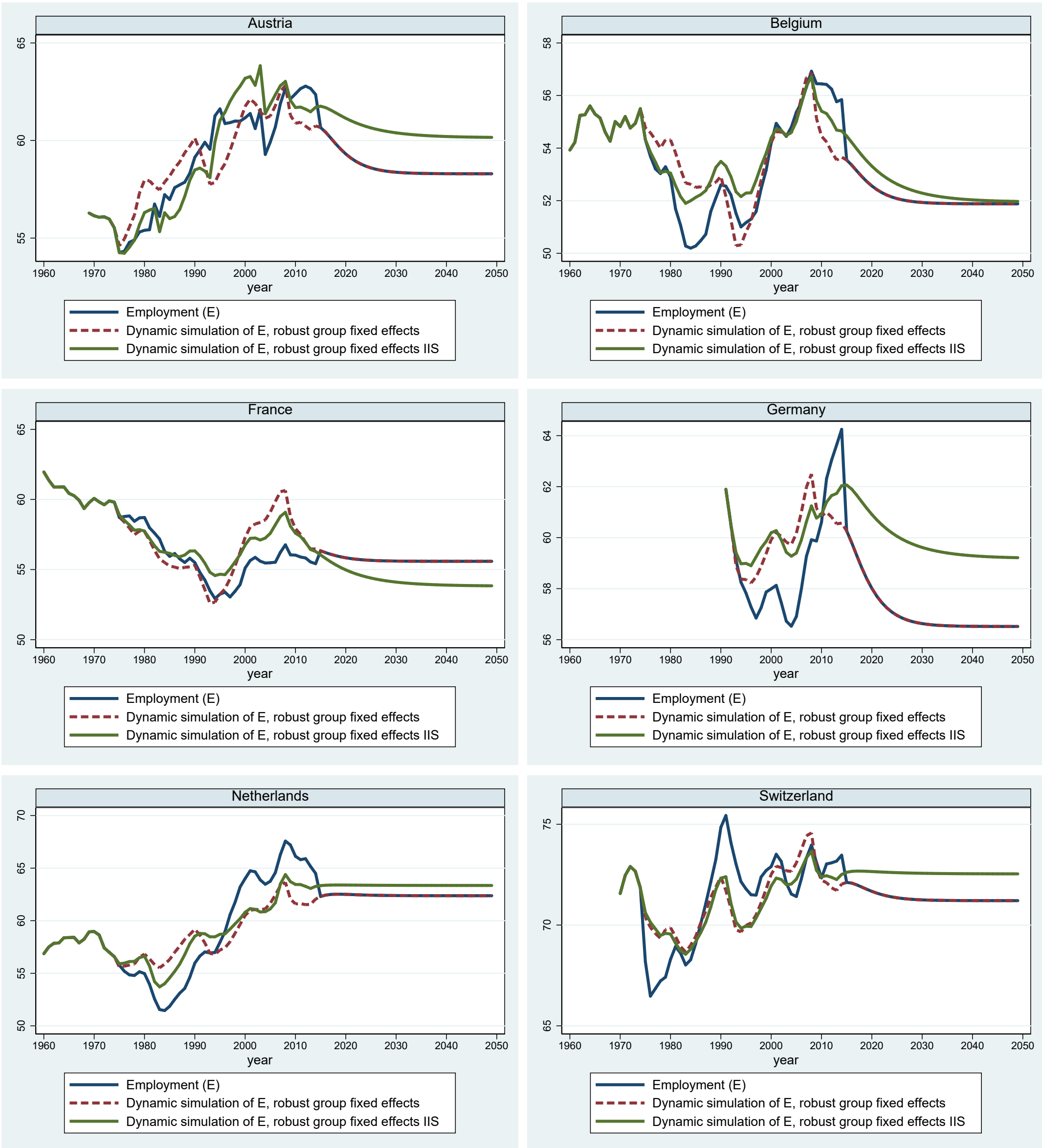

Figure 8: Other European countries. Country specific simulated employment rates, based on WG-, WG-IIS- estimation. Actual unemployment rates shown for comparison.

6 Concluding remarks

The employment rate is an important indicator of economic performance. In addition, predicting realistic estimates of equilibrium rates are sought by those responsible for fiscal policy planning, in particular important in determining future tax income. Employment rates are likely to be determined in complex systems, where institutions, markets and demography are both separate and interacting factors. In this paper we have utilized a framework that allows the inclusion of many of these factors, while still being feasible to estimate and simulate. On the estimation side, we have demonstrated that a new a method, utilizing impulse indicator saturation (IIS), can be used to alongside the standard estimation methods for macro panels, as a robust estimation method for coefficients that are assumed to be homogenous between countries.

The hypothesis that receives most support from our results is that a higher benefit replacement ratio (BRR) jointly with long benefit duration BD is associated with a lower employment rate. A change in benefit replacement ratio of 0.1 in an average duration country, like Germany, reduces the employment rate by 0.2 percentage points in the long term. Although it is a consistent pattern from the estimation results, that lower benefits, shorter duration, and lower taxation are associated with higher employment rates, the rather low number of really significant institutional labour market variables nevertheless imply that labour market institutions seem to play a less role in explaining the development in the employment rate compared to the role in explaining the unemployment rate (compare our results to Nickell et al. (2005)). The economic interpretation would also have carried more weight if the precision of the estimates had been higher.

We find a statistically and numerically strong evidence of large and long lasting effects of macroeconomic shocks on the employment rate. Within sample, the two simulation paths, with and without shocks, are almost identical, while there is a difference of around 2 percentage points between to two simulated employment rates in the post-estimation period. The estimated effect imply that positive shocks have a greater effect on the employment rate in economies with more regulated labour markets. While less regulated labour markets are less affected by shocks. The negative shocks on the other hand, have a moderating effect on the employment rate when labour market are regulated and larger effect if the labour markets are less regulated. The implication for policy is that activity regulation policies is important also when the focus is on the employment rate. Fiscal and monetary policies can potentially reduce the cost of negative shock in the form of both increased unemployment and inactivity rates.

The results of our investigation are also supportive of the view that the ongoing demographic transition in many countries represents a drag on the employment rate. To counteract that effect, new reforms, policies or institutional changes may have to be introduced if it is desirable to counteract secular decline in the employment rate.

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A Appendix: Data definitions and sources

The data are from OECD (2016f) unless otherwise noted. The labour market data is also based on the this source, but a more detailed description is given in Nymoen and Sparrman (2015). The sample period is from 1960 to 2015 (some variables are calculated using observations from earlier years).

The countries in the panel are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States (for Germany, the data starts in 1991). This data appendix supplements the information given in the main text.

A.1 Labour market institutions

A.1.1 Tax on second wage earner

There may be different tax systems depending on if there are one or two tax earners in the family, see OECD (2011b). The total extra tax for the second wage earner is derived by calculating the extra income tax and social security tax (both employer and employee) the family will have to pay as a result of the second earner entering employment. The tax rate is then this amount divided by the second earners total income plus the employers social security contribution. This is a more correct measure of the tax rate that the second wage earner is facing, see Jaumotte (2003). This rate should also capture differences in tax system depending on if the tax system is based on the individual level or household income, which in turn may affect the participation rate of the person who earns least.

The actual development in tax on second wage earner is found in Table A1. The indicator starts in 2000 and is prolonged backward with the first known observation.

A.1.2 Coordination of Wage bargaining

The coordination of wage bargaining is based on Kenworthy's 5-point classification of wage-setting coordination scores. The index ranges on a scale from 1 to 5 in 34 Countries 1960 and 2014. Source: Visser (2016). 1 equals fragmented wage bargaining and 5 equals a centralized wage bargaining. The time series are prolonged forward to 2015 with last known observation in 2014. For Portugal and Spain are the time series also extended backwards before 1977 with observations in Nickell (2006) database.

The actual development in coordination is found in Table A2.

A.1.3 Employment Protection Legislation Indicator (EPL)

The time series for employment protection measures the strictness of the employment protection for the employer. The OECD indicators of EPL are indicators of the strictness of regulation on dismissals of individuals or groups, and the procedures involved in hiring workers on fixed-term or temporary work agency contracts. OECD have compiled the indicators by reading statutory laws, collective bargaining agreements and receiving advice from country experts.

OECD release three different measures on employment protection: Individual dismissal of workers with regular contracts, additional cost for collective dismissals, regulations of temporary contracts. The overall measure of EPL is calculated as an average of the three indicators. The overall measure for employment protection is measured on a scale from 0 to 5. Strictness is increasing in scale.

The data is from OECD (2010). The time series for employment protection is prolonged backwards for all the countries in the sample before 1985 except for New Zealand which was prolonged before 1990, by the growth rate of the measure of employment protection, *ep*, in the Nickell (2006) database.

The actual development in the overall unweighted employment protection is found in Table A3.

A.1.4 Trade Union Density

Trade union density corresponds to the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners (OECD Labor Force Statistics). Density is calculated using survey data, wherever possible, and administrative data adjusted for non-active and self-employed members otherwise.

Union density rates are constructed using the number of union memberships divided by the number of employed. The main data source is OECD (2012c), where they have mainly calculated the trade union density index based on surveys. When data were unavailable, they have used administrative data adjusted for non-active and self-employed members. The union density is prolonged by last known observation for New Zealand, Portugal and Spain before respectively 1970, 1977 and 1980. The interaction terms between union density and coordination are prolonged by the last known observation for these countries.

The actual development in union density is found in Table A4.

A.1.5 Benefit Replacement Rates

The benefit replacement rate is a measure of how much each unemployed worker receives in benefit from the government. The OECD also provides information about benefit replacement rate for three durations of unemployment, i.e. for year 1, the average of year two and three, and the average of year four and five dependent on the family type and initial income level. The three different family types are: Single, with a dependent spouse and with a working spouse. The income levels are: 67 percent and 100 percent of average earnings. The measures used are:

Table A1: Tax on second wage earner in the OECD countries

country	**Yr0010**	**Yr1014**
Australia	0.19	0.17
Austria	0.42	0.42
Belgium	0.61	0.61
Canada	0.35	0.34
Denmark	0.44	0.41
Finland	0.40	0.37
France	0.48	0.49
Germany	0.59	0.55
Ireland	0.28	0.30
Italy	0.45	0.47
Japan	0.28	0.31
Netherlands	0.42	0.33
New Zealand	0.39	0.37
Norway	0.19	0.15
Portugal	0.38	0.39
Spain	0.40	0.41
Sweden	0.44	0.37
Switzerland	0.26	0.25
United Kingdom	0.31	0.30
United States	0.35	0.34
Total	0.38	0.37

Source: OECD (2016c)

Table A2: Average coordination in the OECD countries

country	**Yr6069**	**Yr7079**	**Yr8089**	**Yr9099**	**Yr0010**	**Yr1014**
Australia	3.00	3.00	3.50	2.40	2.00	2.00
Austria	5.00	5.00	4.30	4.00	4.00	4.00
Belgium	4.00	3.70	4.50	4.30	5.00	5.00
Canada	1.00	2.20	1.00	1.00	1.00	1.00
Denmark	5.00	5.00	3.50	3.90	4.00	4.00
Finland	3.40	4.80	4.20	4.40	4.20	4.33
France	2.20	2.20	2.10	2.00	2.00	2.00
Germany	3.60	3.20	4.00	3.80	3.80	4.00
Ireland	1.00	2.80	2.50	5.00	4.60	1.00
Italy	2.00	2.60	2.40	2.80	3.00	3.00
Japan	5.00	5.00	5.00	4.80	4.00	4.00
Netherlands	4.20	3.60	3.80	3.80	4.00	4.00
New Zealand	3.00	3.00	2.60	1.00	1.00	1.00
Norway	4.80	4.90	4.00	4.10	4.10	4.00
Portugal	.	3.00	2.60	2.80	2.00	2.00
Spain	.	5.00	3.30	2.00	3.40	3.00
Sweden	5.00	5.00	3.90	3.60	4.00	4.00
Switzerland	4.00	4.00	4.00	3.00	3.00	3.00
United Kingdom	2.80	3.50	1.00	1.00	1.00	1.00
United States	1.00	1.80	1.00	1.00	1.00	1.00
Total	3.35	3.64	3.16	3.04	3.06	2.87

Source: Visser (2016)

Table A3: Average employment protection in the OECD countries

country	Yr6069	Yr7079	Yr8089	Yr9099	Yr0010	Yr1014
Australia	0.61	0.61	0.90	1.06	1.11	1.27
Austria	2.03	2.03	2.03	2.03	1.90	1.84
Belgium	3.36	3.44	3.32	3.01	2.13	2.20
Canada	0.59	0.59	0.59	0.59	0.59	0.59
Denmark	2.32	2.32	2.52	1.85	1.75	1.78
Finland	1.33	1.97	2.02	1.89	1.88	1.86
France	3.60	3.71	2.90	2.96	3.02	3.00
Germany	3.22	3.32	3.08	2.77	2.01	1.84
Ireland	0.59	0.67	0.84	0.84	0.92	0.97
Italy	4.11	4.18	3.96	3.66	2.52	2.38
Japan	1.58	1.63	1.72	1.67	1.24	1.12
Netherlands	1.92	2.11	2.24	2.13	1.91	1.88
New Zealand	0.81	0.81	0.81	0.81	1.23	1.25
Norway	3.72	3.31	2.74	2.74	2.60	2.67
Portugal	4.19	4.19	4.19	3.92	3.51	2.94
Spain	3.65	3.65	3.65	3.23	2.77	2.51
Sweden	3.81	3.55	3.43	2.55	1.96	1.71
Switzerland	0.91	1.17	1.36	1.36	1.36	1.36
United Kingdom	0.58	0.62	0.67	0.67	0.80	0.82
United States	0.00	0.00	0.15	0.25	0.25	0.25
Total	2.15	2.19	2.16	2.00	1.77	1.71

Source: OECD (2016c)

Table A4: Average union density in the OECD countries

country	Yr6069	Yr7079	Yr8089	Yr9099	Yr0010	Yr1014
Australia	47.44	48.13	45.00	33.74	21.77	18.39
Austria	65.78	59.55	52.12	41.72	32.94	27.91
Belgium	38.40	47.03	49.53	52.30	54.87	54.62
Canada	28.21	33.39	34.71	32.84	27.77	27.33
Denmark	58.08	68.23	77.50	75.44	70.18	66.85
Finland	38.03	62.71	69.89	78.19	71.83	68.71
France	19.89	21.30	14.38	8.89	7.76	7.74
Germany	33.13	33.85	34.24	29.85	21.74	18.16
Ireland	45.89	52.35	51.54	45.12	34.76	32.17
Italy	26.78	45.64	43.72	37.70	33.90	35.81
Japan	34.59	33.73	28.94	24.12	19.36	18.45
Netherlands	38.57	36.91	28.84	24.93	20.41	18.16
New Zealand	58.93	54.04	57.51	56.99	54.14	53.49
Norway	.	60.68	58.56	31.06	21.42	20.70
Portugal	.	60.43	44.48	25.62	21.08	19.80
Spain	.	.	12.42	16.51	16.12	17.42
Sweden	68.64	73.38	80.41	82.06	75.03	67.74
Switzerland	28.33	26.60	25.15	22.30	19.07	16.66
UK	38.76	44.88	45.71	34.24	28.60	25.94
USA	28.59	25.18	18.43	14.48	12.17	11.26
Total	41.06	46.13	43.65	38.41	33.25	31.37

Source: OECD (2016c)

Table A5: Average benefit replacement ratio in the OECD countries

country	**Yr6069**	**Yr7079**	**Yr8089**	**Yr9099**	**Yr0010**	**Yr1014**
Australia	0.17	0.19	0.23	0.26	0.19	0.19
Austria	0.15	0.25	0.34	0.36	0.40	0.40
Belgium	0.37	0.51	0.51	0.47	0.44	0.44
Canada	0.39	0.55	0.57	0.56	0.50	0.50
Denmark	0.39	0.77	0.77	0.71	0.65	0.65
Finland	0.20	0.35	0.45	0.60	0.36	0.35
France	0.49	0.48	0.59	0.59	0.61	0.61
Germany	0.42	0.40	0.38	0.37	0.38	0.38
Ireland	0.22	0.35	0.49	0.38	0.36	0.36
Italy	0.09	0.05	0.03	0.20	0.66	0.66
Japan	0.36	0.35	0.29	0.31	0.40	0.40
Netherlands	0.48	0.65	0.68	0.70	0.71	0.71
New Zealand	0.36	0.27	0.30	0.29	0.32	0.32
Norway	0.11	0.21	0.55	0.62	0.65	0.65
Portugal	0.00	0.10	0.44	0.65	0.70	0.70
Spain	0.36	0.53	0.74	0.66	0.64	0.64
Sweden	0.28	0.58	0.86	0.83	0.74	0.74
Switzerland	0.15	0.22	0.53	0.69	0.74	0.74
United Kingdom	0.31	0.35	0.26	0.22	0.19	0.19
United States	0.22	0.27	0.30	0.27	0.29	0.29
Total	0.28	0.37	0.47	0.49	0.50	0.50

Source: OECD (2016c)

Brr67a1: First year benefit replacement rate for workers with, 67 percent of average earnings and the average over family types.
Brr67a2: Benefit replacement for the second and third year, with 67 percent of average earnings and the average over family types.
Brr67a4: Benefit replacement for the fourth and fifth year, with 67 percent of average earnings and the average over family types.
Brr100a1: First year benefit replacement rate for workers with, 100 percent of average earnings and the average over family types.
Brr100a2: Benefit replacement for the second and third year, with 100 percent of average earnings and the average over family types.
Brr100a4: Benefit replacement for the fourth and fifth year, with 100 percent of average earnings and the average over family types.

The benefit replacement rate is calculated by taking the average of brr67a1 and brr100a1:

$BRR = \frac{brr61a1+brr100a1}{2}$

The actual development of BRR over the sample period is presented in Table A5

Data is provided every 2. year in the period 2000 to 2011, . The time series are prolonged forward with the last observation in 2011. The time series are also prolonged backward, before 2000, with data provided by OECD by e-mail, OECD (2012a). Since the data only exists for odd-numbered years a linear interpolation is applied.

A.1.6 Benefit Duration

The benefit duration corresponds to the benefits received during the first year of unemployment relative to the benefits received in the following years of unemployment. It is a measure of the duration of the benefits and how the benefits changes over the duration.

Table A6: Average benefit duration in the OECD countries

country	Yr6069	Yr7079	Yr8089	Yr9099	Yr0010	Yr1014
Australia	1.01	1.02	1.02	1.02	1.00	1.00
Austria	0.00	0.40	0.75	0.72	0.71	0.71
Belgium	1.00	0.84	0.79	0.78	0.83	0.78
Canada	0.00	0.00	0.00	0.00	0.00	0.00
Denmark	0.46	0.59	0.62	0.83	0.80	0.80
Finland	0.00	0.49	0.57	0.53	0.58	0.56
France	0.27	0.21	0.38	0.48	0.53	0.53
Germany	0.57	0.60	0.61	0.60	0.50	0.41
Ireland	0.72	0.55	0.39	0.66	0.74	0.74
Italy	0.00	0.00	0.00	0.07	0.45	0.45
Japan	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.19	0.45	0.67	0.68	0.45	0.26
New Zealand	1.02	1.02	1.03	1.03	1.00	1.00
Norway	0.00	0.32	0.49	0.52	0.78	0.35
Portugal	0.00	0.00	0.12	0.39	0.50	0.58
Spain	0.00	0.00	0.20	0.32	0.38	0.38
Sweden	0.00	0.03	0.05	0.05	0.39	0.53
Switzerland	0.00	0.00	0.00	0.17	0.22	0.18
United Kingdom	0.78	0.55	0.70	0.73	0.84	0.80
United States	0.11	0.19	0.17	0.19	0.21	0.28
Total	0.30	0.36	0.43	0.49	0.55	0.52

Source: OECD (2016c)

Benefit duration is given by the equation:

$$BDj_{it} = \alpha \frac{brrja2_{it}}{brrja1_{it}} + (1-\alpha)\frac{brrja4_{it}}{brrja1_{it}} \tag{A1}$$

where $\alpha = 0.6$, $j = \{67, 100\}$, $i = 1, 2...20$ and $t = 1960, 1961...2007$. $brrja1_{it}$ is the benefit replacement rate in year 1, $brrja2_{it}$ is the benefit replacement rate in year 2 and 3, and finally, $brrja4_{it}$ is the benefit replacement rate in years 4 and 5. $\alpha = 0.6$ gives more weight to the second and third year as compared to the fourth and fifth year. The index is calculated for both employment situations, i.e. 67 percent and 100 percent of average earnings. The average of $bd67_{it}$ and $bd100_{it}$ is used as an indicator of benefit duration, i.e. BD_{it}. If benefit duration stops after one year, then brr67a2 = brr67a4 = 0, and BD67 = 0. If benefit provision is constant over the years, then brr67a1 = brr67a2 = brr67a4, and BD67 = 1. However, some countries increase payments over time and the value of benefit duration is above one.

The actual development in benefit duration is found in Table A6.

A.1.7 Tax Wedge

Tax wedge is equal to the sum of the employment tax rate, the direct tax rate and the indirect tax rate. The rates described here are calculated from actual tax payments. The total tax wedge is equal to the sum of the employment tax rate (t1), the direct tax rate (t2) and the indirect tax rate (t3), as given in Equation (A2).

$$TW = t1 + t2 + t3 \tag{A2}$$

t1: is equal to employers actual wage cost calculated by the sum of wages received by employees and taxes paid by the employer to the government.

$$t1 = \frac{EC}{IE - EC} = \frac{D6111}{NFD1R - D6111}$$

EC-Employers Social Security contributions
Social contributions are the actual or imputed payments to social insurance schemes to make provision for social insurance benefits. They may be made by employers on behalf of their employees or by employees, self-employed or non-employed persons on their own behalf. The contributions may be compulsory or voluntary and the schemes may be funded or unfunded.

IE- Compensation of employees
Compensation of employees is made up of two components: Wages and salaries payable in cash or in kind: These include the values of any social contributions, income taxes, etc., payable by the employee even if they are actually withheld by the employer and paid on behalf of the employee.

t2 Direct Tax Rate

$$t2 = \frac{IT + WC}{HRC} = \frac{NFD61P - NFD12R + NFD5P}{NFR22}$$

WC- Employees social security contributions
Social contributions are the actual or imputed payments to social insurance schemes to make provision for social insurance benefits. They may be made by employers on behalf of their employees or by employees, self-employed or non-employed persons on their own behalf. The contributions may be compulsory or voluntary and the schemes may be funded or unfunded.

IT- Income tax
Current taxes on income, wealth, etc.

HCR- Current receipts of households
Current receipts of households consist of all income to a household, whether monetary or in kind received by the household or by individual members of the household. It includes income from employment, investments, current transfers, etc.

t3 Indirect Tax Rate

$$t3 = \frac{TX - SB}{CC} = \frac{D2 - NFD3P}{P31}$$

TX-Indirect taxes
Taxes on consumption goods.

SB- The value of subsidies
Value of subsidies paid by government.

CC- Final consumtion
Final consumption expenditure for entire economy.

The variables are, with the exception of Australia and Canada, collected from the OECD national accounts database OECD (2016d), OECD (2016b) and OECD (2016a). D2 and D6111 are collected from Table 10. NFD1R, NFD12R, NFR22, NFD3P, NFD5P

Table A7: Average tax wedge in the OECD countries

country	Yr6069	Yr7079	Yr8089	Yr9099	Yr0010	Yr1014
Australia	0.11	0.17	0.27	0.32	0.35	0.34
Austria	0.47	0.53	0.54	0.56	0.57	0.58
Belgium	0.49	0.49	0.52	0.57	0.57	0.55
Canada	0.30	0.37	0.40	0.49	0.47	0.44
Denmark	0.56	0.56	0.62	0.64	0.68	0.65
Finland	0.40	0.47	0.54	0.64	0.63	0.60
France	0.63	0.56	0.62	0.66	0.64	0.64
Germany	0.45	0.46	0.47	0.48	0.49	0.51
Ireland	0.39	0.44	0.47	0.50	0.52	0.47
Italy	0.39	0.36	0.45	0.59	0.63	0.64
Japan	0.24	0.27	0.32	0.33	0.34	0.36
Netherlands	0.41	0.47	0.48	0.48	0.51	0.54
New Zealand	0.39	0.37	0.41	0.48	0.42	0.41
Norway	0.53	0.58	0.59	0.58	0.58	0.58
Portugal	0.38	0.38	0.38	0.38	0.40	0.41
Spain	0.23	0.31	0.44	0.47	0.50	0.47
Sweden	0.51	0.62	0.66	0.71	0.73	0.70
Switzerland	0.27	0.27	0.27	0.28	0.33	0.34
United Kingdom	0.41	0.43	0.45	0.42	0.43	0.44
United States	0.27	0.29	0.30	0.30	0.29	0.28
Total	0.39	0.42	0.46	0.49	0.50	0.50

Source: OECD (2016c)

and NFD61P are from Table 14a and finally P31 is from Table 1. For Australia and Canada are the data collected from their respective bureau of statistics. Se table A7 for a detailed overview.

All variables were extended backwards before 2000 with data found in National Accounts, OECD (2016c). EC (NFD12R), IE (NFD1R), WC (NFD61P-NFD12R), IT (NFD5P), HCR (NFB5GR) and SB (NFD3P) were found in Table 14.A (Non-Financial accounts by sector) in sector household and non-profit institutions serving households for all except SB which was found in general government sector. TX(D2) was found in Table 10, general government sector. CC(P3) was found in Table 1. Which in turn are extended backwards with the growth rate of the series for tax wedge used in Nymoen and Sparrman (2012) before 1995 for: Austria, Belgium, Denmark, France, Germany, Netherlands, Norway, Portugal and Sweden. It is extended backwards before the 1990 for UK and Italy, before 1975 for Finland, before 2002 for Ireland, Before 2000 for Spain and before 1998 for US. Australia, Canada, New Zealand and Switzerland are replaced for the entire time series.

The development in the actual tax wedges are found in Table A7. .

A.2 Other variables

A.2.1 Unemployment Rate (UNR)

The standardized unemployment rate (UNR) from OECD (2013). The data are prolonged backward for some countries, using the growth rate of numbers found in older versions of OECD's Economic Outlook: Germany before 1992 using numbers from OECD (2011a) for Former Federal Republic of Germany, Ireland before 1990 using OECD (2012b) and Spain before 1967 using OECD (2005).