Additional notes and results for the theoretical framework of: "Equilibrium unemployment dynamics in a panel of OECD countries "

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January 9, 2014

Appendix A Additional notes and results for the theoretical framework of section 2

A.1 A dynamic model for wage-and-price setting

Equation (1) in the published paper is linked to wage and price setting, and the institutional changes in that part of the economy, through the real exchange rate, re_t. This variable is measured in logarithms, and we write it as $re_t = pi_t - q_t$ where pi_t denotes an index (in log scale) of import prices and q_t is an index of "home" producer prices.

q_t will be an endogenous variable in the domestic wage-and price formation process, while pi_t is represented as a random-walk with drift:

$$pi_t = g_{pi} + pi_{t-1} + \varepsilon_{pit} \tag{A1}$$

This equation represents a common nominal trend in our model. We also include a common real trend, for the log of average labour productivity a_t:

$$a_t = g_a + a_{t-1} + \varepsilon_{at} \tag{A2}$$

ε_{at}, and ε_{pit} are assumed to be innovations with zero expectations.

We now model wage and price setting as conditional on pi_t and a_t. Equations (A1) and (A2) therefore imply that q_t, the (log of the) price level on domestic products, and w_t, the (log of) wage compensation per hour will be non-stationary, integrated of order one, $I(1)$, in a common notation.

Let p_t denote the logarithm of the consumer price index, and p_t is defined by:

$$p_t = \phi q_t + (1-\phi) pi_t \tag{A3}$$

where the parameter ϕ measures the share of imports in total consumption.

We next define two theoretical (latent) real wage variables: The optimal real wages from the point of view of the firms, rw_t^f, and the bargained real wage, rw_t^b. They are given by the following two equations:

$$rw_t^f \equiv w_t^{ef} - q_t^f = -m_q \quad + \quad a_t + \vartheta\, u_t \tag{A4}$$

$$rw_t^b \equiv w_t^b - q_t^{eb} = \quad m_w + \omega \left(p_t^{eb} - q_t^{eb} \right) + \iota\, a_t - \varpi\, u_t. \tag{A5}$$

Equations (A4) and (A5) can seen as open-economy versions of the relationship for price- and wage-setting in Layard et al. (2005, p 13).[1]

[1] See also Sørensen and Whitta-Jacobsen (2010, Ch 12 and 17), Blanchard (2009, Ch 6).

In the price-setting equation (A4), q_t^f denotes the price level set by the firm on basis of expected nominal marginal labour costs $w_t^{ef} - a_t$. w_t^{ef} denotes the *expected* hourly wage cost. In the wage setting equation (A5), w_t^b denotes the nominal wage outcome and q_t^{eb} and p_t^{eb} are the price expectations that affect that bargaining outcome. A main implication of the bargaining model is that the elasticity ι with respect to productivity is close to unity, as in Nymoen and Rødseth (2003). The standard assumption about the sign of the coefficient for unemployment ϖ is that it is non-negative, hence $-\varpi < 0$. The coefficient ω is called the wedge-coefficient since $\left(p_t^{eb} - q_t^{eb}\right)$ is the wedge between expected consumer and producer real wages (when we abstract from tax rates). The wedge coefficient is assumed to be non-negative, $\omega \geq 0$.

We proceed by making the assumption that rw_t^f and rw_t^b are *co-integrated* with the actual real wage. Similarly, on the price side, it is reasonable that equation (A4) captures the secular trend in the actual price q_t, but not the period-to-period changes in the price level.

We assume that the wage and price expectations errors $w_t^{ef} - w_t$, $q_t^{eb} - q_t$ and $p_t^{eb} - p_t$ are $I(0)$. The expectation variables in equations (A4) and (A5) is then replaced by w_t, q_t and p_t, without changing the order of integration. Cointegration therefore carries over to observable variables, and we have the following equilibrium correction model with reference to the Granger-Engle (1987) representation theorem:

$$\Delta q_t = c_q + \psi_{qw}\,\Delta w_t + \psi_{qpi}\,\Delta pi_t - \varsigma\,u_{t-1} + \theta_q\,ecm_{t-1}^f + \varepsilon_{qt}, \tag{A6}$$

$$\Delta w_t = c_w + \psi_{wq}\,\Delta q_t + \psi_{wp}\,\Delta p_t - \varphi\,u_{t-1} - \theta_w\,ecm_{t-1}^b + \varepsilon_{wt}, \tag{A7}$$

where ε_{qt}, and ε_{wt} are innovations and all parameters are assumed to be non-negative. The equilibrium correction terms, ecm_{t-1}^f and ecm_{t-1}^b, are consistent with equations (A4) and (A5), with $w_t^{ef} = w_t$, $q_t^{eb} = q_t$ and $p_t^{eb} = p_t$ imposed. They are defined by

$$ecm_t^f = w_t - q_t - \quad a_t \qquad\qquad - \vartheta\,u_t + m_q \tag{A8}$$

$$ecm_t^b = w_t - q_t - \iota\,a_t - \omega\,(p_t - q_t) + \varpi\,u_t - m_w, \tag{A9}$$

see Bårdsen et al. (2005) and Bårdsen and Nymoen (2009) for similar derivations.

The dynamic model of the wage-price spiral is:

$$\begin{aligned}\Delta q_t &= (c_q + \theta_q\,m_q) + \psi_{qw}\,\Delta w_t + \psi_{qpi}\,\Delta pi_t - \mu_q\,u_{t-1} \\ &\quad + \theta_q\,(w_{t-1} - q_{t-1} - a_{t-1}) + \varepsilon_{q,t},\end{aligned} \tag{A10}$$

$$\begin{aligned}\Delta w_t &= (c_w + \theta_w\,m_w) + \psi_{wq}\,\Delta q_t + \psi_{wp}\,\Delta p_t - \mu_w\,u_{t-1} \\ &\quad - \theta_w\,(w_{t-1} - q_{t-1} - \iota\,a_{t-1}) + \theta_w\,\omega\,(p_{t-1} - q_{t-1}) + \varepsilon_{w,t},\end{aligned} \tag{A11}$$

$$\Delta p_t = \phi\,\Delta q_t + (1-\phi)\,\Delta pi_t, \tag{A12}$$

where equation (A12) is the result of taking the difference on both sides of the definition in equation (A3).[2] Note that in equations (A10) and (A11), notations $\mu_q = \theta_q\,\vartheta + \varsigma$ and $\mu_w = \theta_w\,\varpi + \varphi$ are used for the coefficients on u_{t-1}. This is in order to encompass Phillips curve based versions of the price-wage formation process, which logically entails $\mu_w = 0$ and $\varphi > 0$ in wage-formation for example, cf. Kolsrud and Nymoen (1998).

[2]For coefficients ψ_{wq}, ψ_{qw} and ψ_{wp}, ψ_{qpi}, the non-negative signs are standard in economic models. Negative values of θ_w and θ_q imply an explosive evolution in wages and prices (hyperinflation), which is different from the low to moderately high inflation scenario that we have in mind for this paper.

(A10)-(A12) can be re-formulated as a (open) VAR model for the real exchange rate re_t and the log of the wage share $ws_t = w_t - q_t - a_t$. This conditional VAR is found in the two first rows of (2) in the main text. For re_t the coefficients are:

$$
\begin{aligned}
l &= 1 - \theta_w \, \omega \, \psi_{qw} \, (1 - \phi)/\chi, \\
k &= (\theta_q - \theta_w \psi_{qw})/\chi, \\
e &= 1 - (\psi_{qpi} + \psi_{qw} \, \psi_{wp} \, (1 - \phi))/\chi, \quad = 0 \text{ if dynamic homogeneity} \\
n &= (\mu_q \, + \mu_w \, \psi_{qw})/\chi, \\
d &= (m_q \, \theta_q + c_q + (m_w \, \theta_w + c_w) \, \psi_{qw})/\chi,
\end{aligned}
$$

where the denominator is: $\chi = 1 - \psi_{qw}(\phi\psi_{wp} + \psi_{wq}) > 0$. For ws_t the coefficients are:

$$
\begin{aligned}
\lambda &= \theta_w \, \omega \, (1 - \psi_{qw})(1 - \phi)/\chi, \\
\kappa &= 1 - (\theta_w \, (1 - \psi_{qw}) + \theta_q \, (1 - \psi_{wq} - \phi \, \psi_{wp}))/\chi, \\
\xi &= (\psi_{wp} \, (1 - \psi_{qw})(1 - \phi) - \psi_{qpi} \, (1 - \psi_{wq} - \phi \, \psi_{wp}))/\chi, \qquad = 0 \text{ if dynamic homogeneity} \\
\eta &= (\mu_w \, (1 - \psi_{qw}) - \mu_q \, (1 - \psi_{wq} - \phi \, \psi_{wp}))/\chi, \\
\delta &= ((m_w \, \theta_w + c_w)(1 - \psi_{qw}) - (m_q \, \theta_q + c_q)(1 - \psi_{wq} - \phi \, \psi_{wp}))/\chi.
\end{aligned}
$$

By inspection, it is clear that all coefficients are non-negative for reasonable values of the structural coefficients. The exception is δ which can be both positive and negative. The first two VAR disturbances are

$$\epsilon_{re,t} = (\varepsilon_{q,t} + \psi_{qw} \, \varepsilon_{w,t})/\chi \quad \text{and} \quad \epsilon_{ws,t} = (\varepsilon_{q,t} \, (1 - \psi_{wq} - \phi \, \psi_{wp}) - \varepsilon_{w,t} \, (1 - \psi_{qw}))/\chi,$$

while the third is identical to ε_{ut} in the unemployment equation.

The steady-state solution for u_t, the equilibrium rate of unemployment, is given by (3) with coefficients

$$\mathfrak{e}_{ss} = \rho \, (\theta_q(1 - \psi_{wq} - \psi_{wp}) + \theta_w(1 - \psi_{qw} - \psi_{qpi}))/(\theta_q \, \theta_w \, \Omega), \tag{A13}$$

$$\mathfrak{b}_{ss} = \rho \, (\theta_q - \theta_w \, \psi_{qw})/(\theta_q \, \theta_w \, \Omega), \tag{A14}$$

$$\mathfrak{d}_{ss} = [\rho \, (m_w + m_q + c_w/\theta_w + c_q/\theta_q) + c_u \, \omega \, (1 - \phi)]/\Omega. \tag{A15}$$

with $\Omega = \omega \, (1 - \phi) \, (1 - \alpha) + \rho \, (\varpi + \vartheta)$.

For simplicity, the expression (4) for $\mathfrak{d}_{ss}$ in the main text is for the case where the drift terms c_w and c_q have been set to zero.

A.2 A numerical example

To illustrate the properties of the structural model, and of a simple one-off estimation of the equilibrium rate, we have used the VAR representation (2) in the main text, together with (A1)-(A3) to generate a data set (T=200) for re_t, ws_t, u_t, pi_t, a_t and p_t using parameter values that give stationarity, and with a single location shift in period 150. The structural disturbances are Gaussian and independent. We then estimate the structural form (not the VAR) on a data set that ends in period 160, and simulate the estimated structural form dynamically over a period that starts in period 160 and ends in period 200. The dynamic simulation is stochastic (1000 replications). The average of the solution paths represent the estimated expectations of the endogenous variables. Since we have estimated the true model, the solution converges to the imputed steady-state values of the endogenous variables.

The figure contains four panels with lines (in blue) for the actuals (i.e., the computer generated data) of re_t, ws_t, Δp_t (i.e., inflation) and u_t. The dashed line (in green) is

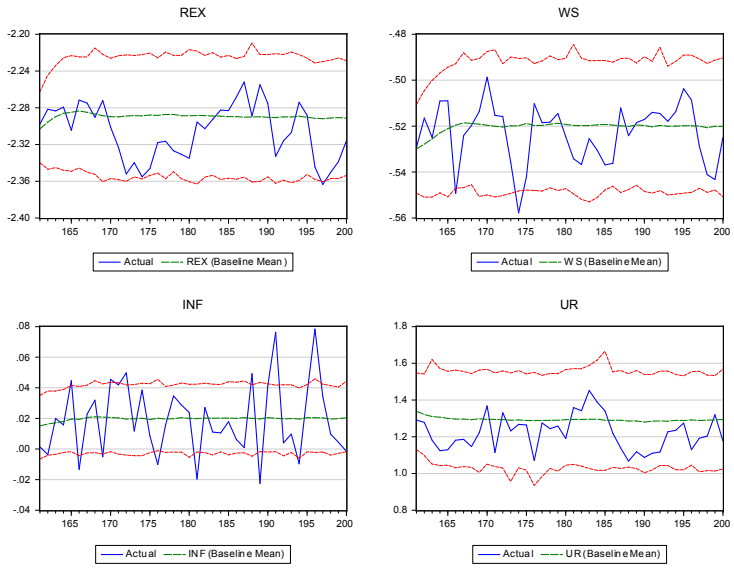

Figure A1: Data from calibrated version of theoretical model, and stochastic simulation based on estimated true structural form. Means and ± 2 standard errors shown for four of the model's endogenous variables: Panel a) The real exchange rate (REX). Panel b) The wage-share (WS) c) Panel c) Inflation (INF). Panel d) The unemployment rate (UR).

the model shows the average of the simulated solutions. The stable equilibrium nature of the solutions are evident. The dotted lines (in red) are upper and lower 95 % prediction intervals around the solution. There are no structural breaks after period 150, so when two actuals for inflation are significantly outside the prediction interval, they are the result of tail observations rather than products of location shifts.

The line representing the solution for u_t is stable at 1.28 % showing that this is the true u^* for this structure. If we use the computer generated data for u_t and estimate a third order autoregressive model over the sample period 1-160 by OLS, we obtain:

$$\begin{aligned} u_t \quad = \quad & \underset{(0.08)}{0.7728}\ u_{t-1} \ - \ \underset{(0.0994)}{0.2247}\ u_{t-2} \ + \ \underset{(0.0797)}{0.1379}\ u_{t-3} \\ & + \underset{(0.0922)}{0.4094} \end{aligned} \tag{A16}$$

with standard errors below the estimates. The estimated equilibrium rate from this simple final equation model is:

$$\hat{u}^* = \underset{(0.36)}{1.304} \tag{A17}$$

which we see is a good estimate of the true equilibrium rate. Nevertheless, the final equation diagnostics shows that there are significant first order ARCH effects, and departures form normality (Jarque-Bera test). Since we know that there is a location shift in the data these significant misspecification test are not surprising.

When we use WG-IIS to select location break indictor variables, retaining the intercept and the three lags, and setting the 'target size' to 0.001, WG-IIS includes two dummies for period 151 and period 152. This finding is correct since the effect of the structural impulse in period 150 is carried over to the following period(s) by the dynamics. The result is

$$
\begin{aligned}
u_t \;=\; & \underset{(0.094)}{0.7195}\; d151_t \;+\; \underset{(0.106)}{0.5123}\; d152_t \;+\; \underset{(0.0709)}{0.4946} \\
& +\; \underset{(0.0686)}{0.5338}\; u_{t-1} \;+\; \underset{(0.0768)}{0.01005}\; u_{t-2} \;+\; \underset{(0.0607)}{0.06647}\; u_{t-3}
\end{aligned}
$$

For this model the are no significant misspecification tests, even though we know that there must be a moving-average in the true disturbance of the final equation model, i.e., like (9) since it is the calibrated theory model that has generated the data.

The ISS estimated equilibrium rate is

$$
\hat{u}^*_{WG-IIS} = \underset{(0.30)}{1.269} \tag{A18}
$$

showing that in this case, the main effect of the robustification is to lower the standard error of the estimated equilibrium rate.

Appendix B Additional results from the estimation of equation (10)

This appendix contains additional information to sections 5 and 6 in the published paper. Figures B1 and B2 show the fit using WG-IIS estimators derived in section 5. Figures B3 and B4 contain the residuals from a simulation using WG and WG-IIS estimators. Finally, the equilibrium unemployment rates, given the level of institutions in 2012 and the WG-IIS estimators of Table 4, are presented in figures B5 and B6.

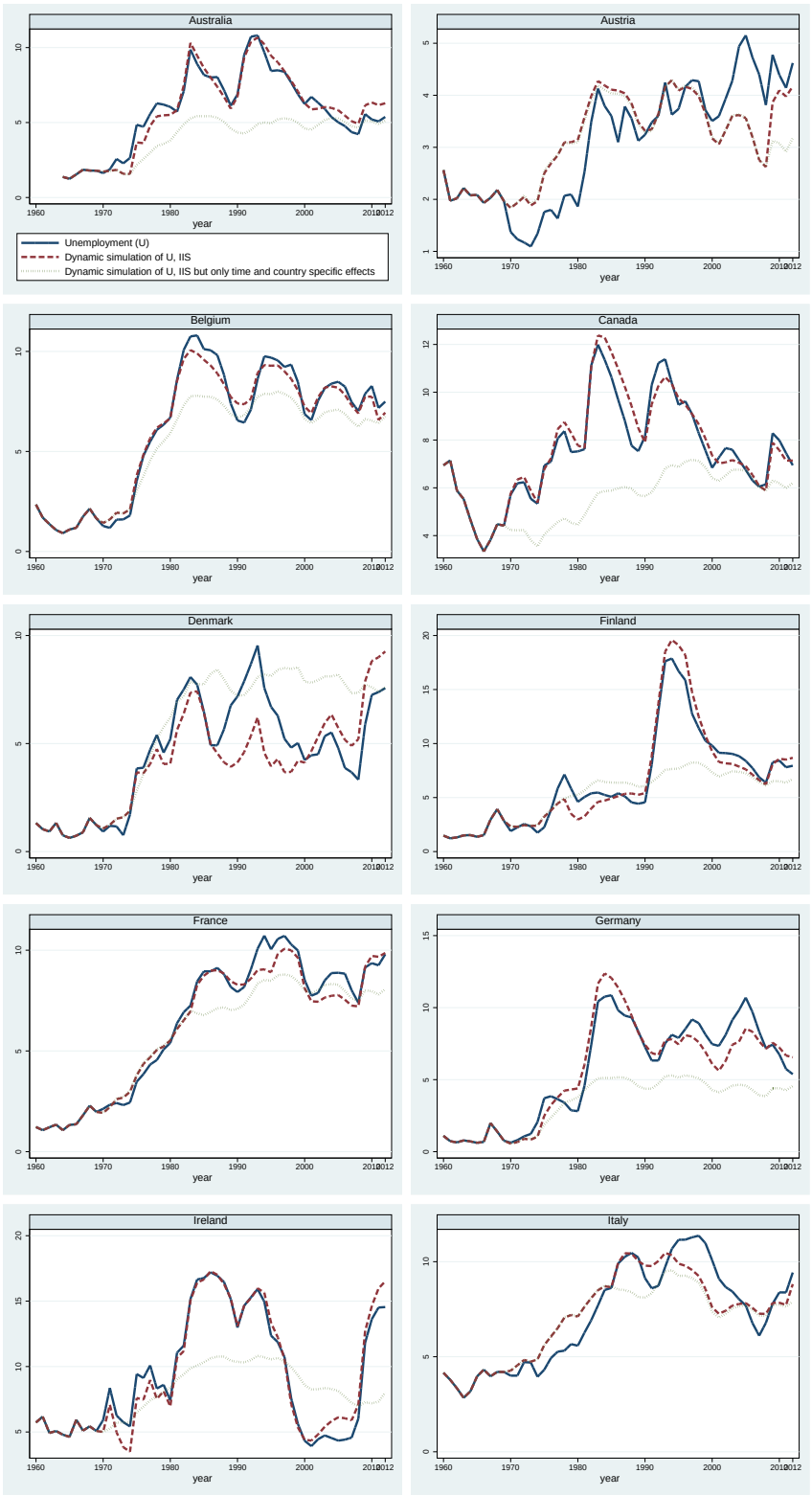

Figure B1: The actual unemployment rate, the WG-IIS estimated model and the WG-IIS estimated model with only country and time specific effects for each country in the panel

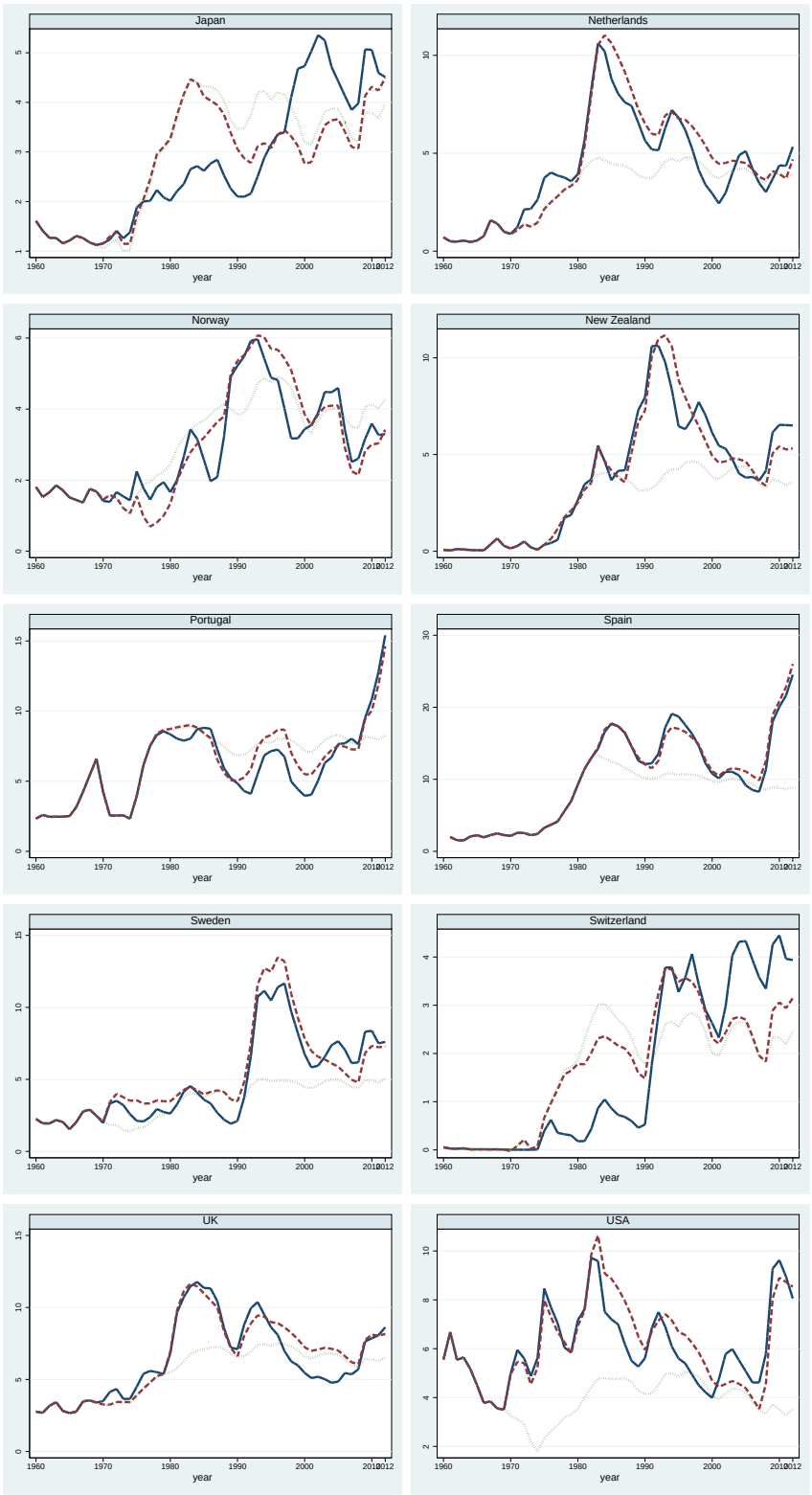

Figure B2: The actual unemployment rate, the WG-IIS estimated model and the WG-IIS estimated model with only country and time specific effects for each country in the panel, cont.

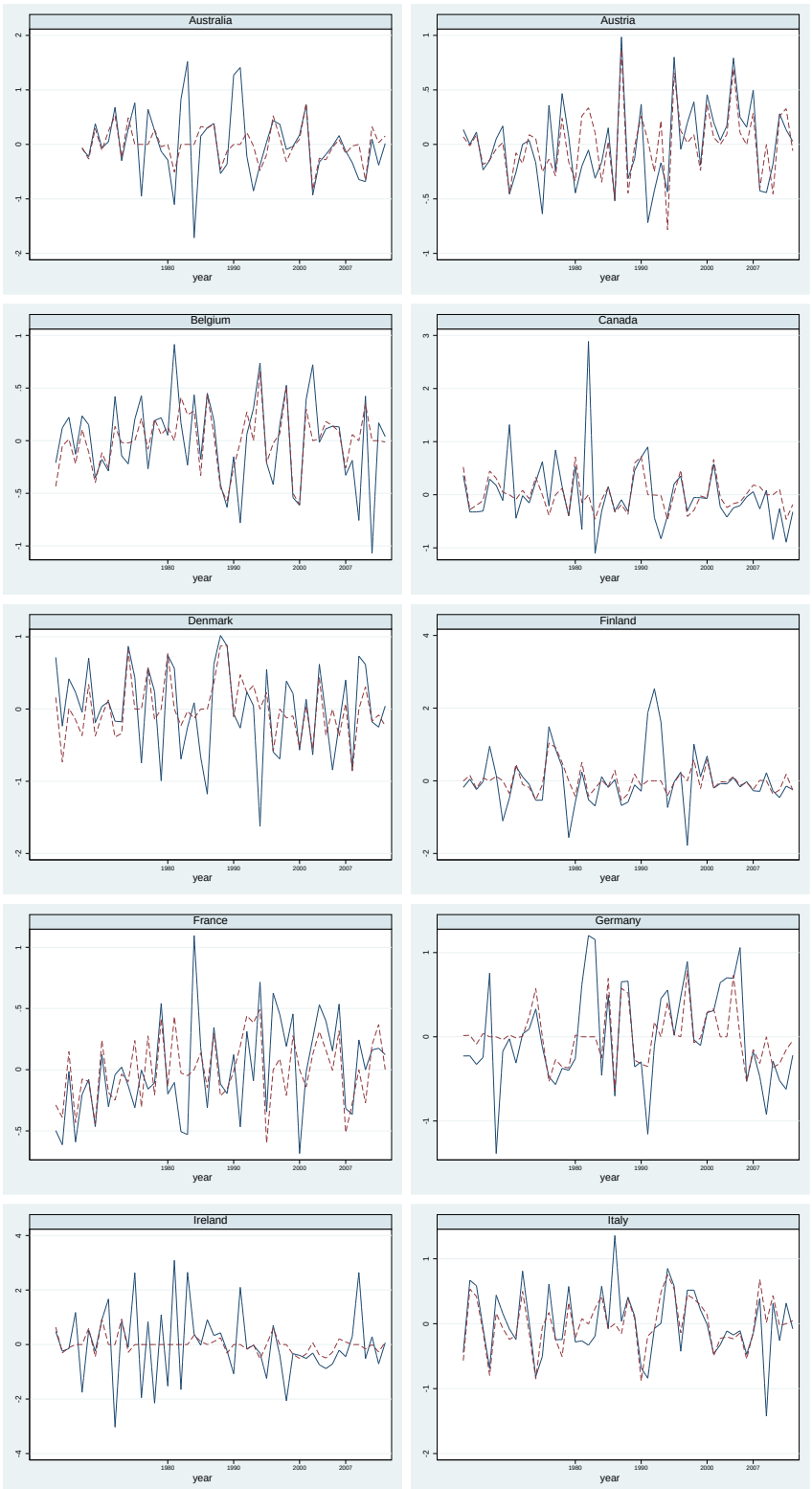

Figure B3: Residuals from the WG-IIS estimated model and the WG estimated model

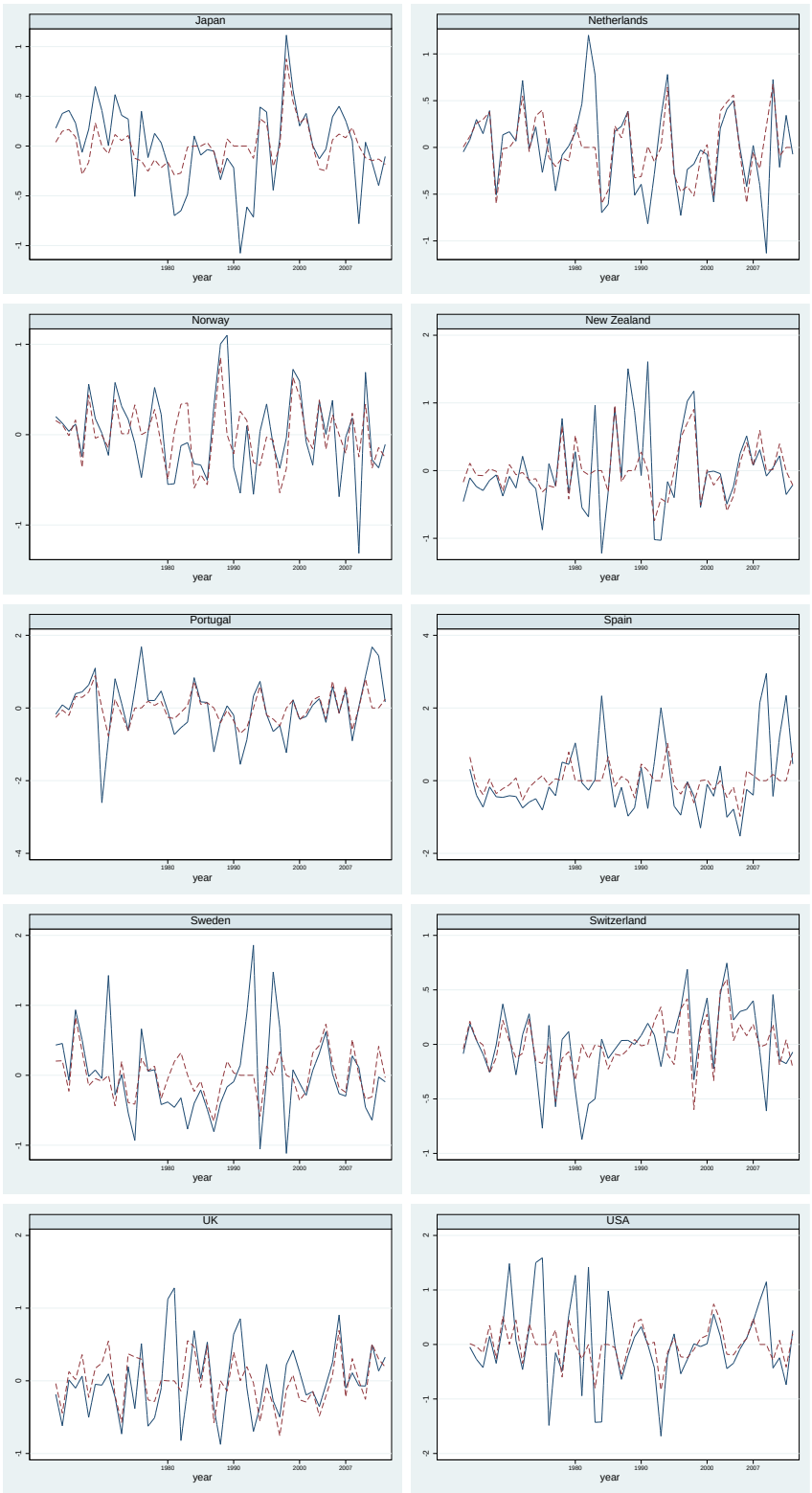

Figure B4: Residuals from the WG-IIS estimated model and the WG estimated model, cont.

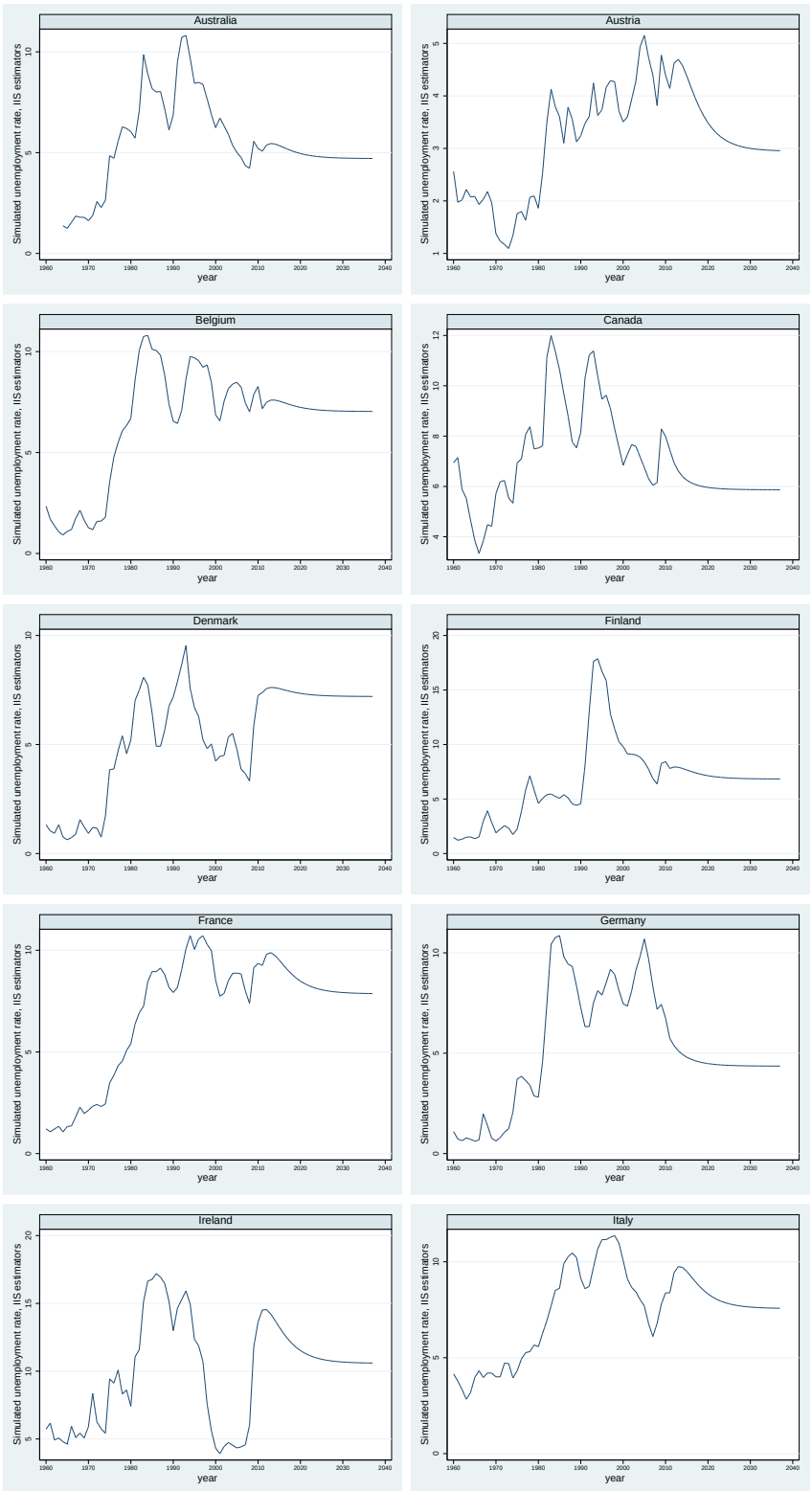

Figure B5: Simulated equilibrium unemployment rates, WG-IIS estimated model

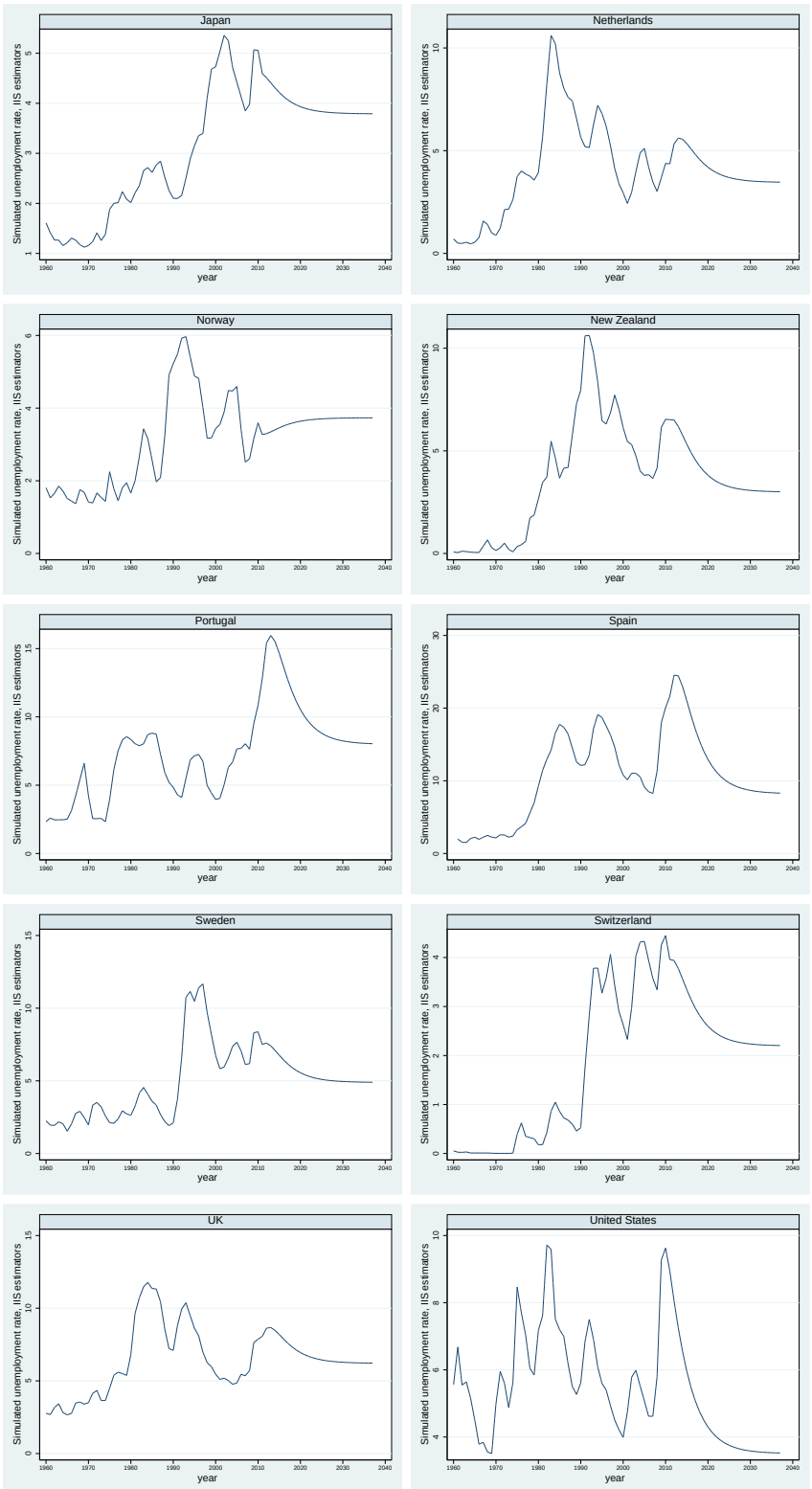

Figure B6: Simulated equilibrium unemployment rates, WG-IIS estimated model, cont.

Appendix C Data Appendix

C.1 Unemployment Rate (UNR)

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

C.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. It was found in: ICTWSS Data on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts in 34 Counties Between 1960 and 2007, Version 3 Visser (2011).

The actual development in coordination is found in Table C1.

C.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 synthetic 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. They are compiled of 21 items, and divided into three areas: Individual dismissal of workers with regular contracts, additional cost for collective dismissals, regulations of temporary contracts, and an overall measure of EPL which is an average of the indicators for regulations for temporary and regular contracts. 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 employment protection is found in Table C2.

C.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 C3

Table C1: Average coordination in the OECD countries

Country	Yr6064	Yr6572	Yr7379	Yr8087	Yr8895	Yr9601	Yr0208	Yr0912
Australia	3.00	3.00	3.00	3.38	3.00	2.00	1.71	2.00
Austria	5.00	5.00	5.00	4.38	4.00	4.00	4.00	4.00
Belgium	4.00	4.00	3.71	4.63	4.25	4.50	4.29	4.00
Canada	1.00	1.00	2.71	1.00	1.00	1.00	1.00	1.00
Denmark	5.00	5.00	5.00	4.00	3.00	3.50	3.29	3.00
Finland	4.60	4.75	4.14	3.75	3.38	3.83	3.71	3.00
France	2.40	2.00	2.43	2.38	2.00	2.00	2.00	2.00
Germany	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Ireland	1.00	1.75	3.14	1.75	4.25	5.00	5.00	2.00
Italy	2.00	2.00	2.57	2.75	3.00	4.00	4.00	4.00
Japan	4.00	4.00	4.00	4.00	4.00	3.50	3.00	3.00
Netherlands	4.60	3.88	3.86	4.38	4.00	4.00	4.00	4.00
New Zealand	4.00	4.25	5.00	4.38	1.75	1.00	1.57	2.00
Norway	5.00	4.50	4.43	3.50	4.50	4.33	4.00	4.00
Portugal	5.00	5.00	5.00	2.38	3.25	3.17	2.57	3.00
Spain	5.00	5.00	5.00	3.75	3.00	3.00	4.00	3.75
Sweden	5.00	5.00	5.00	4.25	3.63	3.00	3.00	3.00
Switzerland	4.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00
UK	1.00	3.50	4.00	1.00	1.00	1.00	1.00	1.00
USA	1.00	1.50	1.57	1.00	1.00	1.00	1.00	1.00
Total	3.53	3.66	3.88	3.23	3.10	3.04	3.01	2.84

Table C2: Average employment protection in the OECD countries

Country	Yr6064	Yr6572	Yr7379	Yr8087	Yr8895	Yr9601	Yr0208	Yr0912
Australia	0.56	0.56	0.57	0.80	0.94	1.19	1.18	1.15
Austria	2.21	2.21	2.21	2.21	2.21	2.21	1.97	1.93
Belgium	3.27	3.27	3.38	3.25	3.15	2.33	2.18	2.18
Canada	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Denmark	2.10	2.10	2.10	2.25	2.29	1.50	1.50	1.50
Finland	1.48	1.80	2.33	2.33	2.22	2.08	2.01	1.96
France	3.89	4.11	4.11	3.35	2.91	2.99	3.05	3.04
Germany	3.49	3.55	3.62	3.39	3.16	2.46	2.11	2.12
Ireland	0.65	0.65	0.78	0.92	0.93	0.93	1.08	1.11
Italy	3.81	3.88	3.91	3.74	3.57	2.79	1.86	1.89
Japan	1.71	1.71	1.80	1.88	1.84	1.52	1.43	1.43
Netherlands	2.37	2.37	2.70	2.78	2.73	2.42	2.08	1.95
New Zealand	0.86	0.86	0.86	0.86	0.86	1.06	1.46	1.40
Norway	3.95	3.95	3.33	2.92	2.87	2.65	2.62	2.69
Portugal	4.19	4.19	4.19	4.19	3.95	3.67	3.48	2.88
Spain	3.82	3.82	3.82	3.82	3.62	2.96	2.99	2.98
Sweden	3.87	3.81	3.54	3.48	3.11	2.28	2.19	1.87
Switzerland	0.76	0.79	1.05	1.14	1.14	1.14	1.14	1.14
UK	0.51	0.52	0.57	0.60	0.60	0.63	0.75	0.75
USA	0.00	0.00	0.00	0.10	0.21	0.21	0.21	0.21
Total	2.26	2.25	2.28	2.24	2.15	1.89	1.80	1.75

Table C3: Average union density in the OECD countries

country	Yr6064	Yr6572	Yr7379	Yr8087	Yr8895	Yr9601	Yr0208	Yr0912
Australia	0.49	0.45	0.49	0.46	0.38	0.27	0.21	0.18
Austria	0.67	0.63	0.59	0.53	0.45	0.38	0.32	0.28
Belgium	0.40	0.42	0.52	0.52	0.54	0.53	0.53	0.52
Canada	0.28	0.30	0.35	0.37	0.36	0.31	0.30	0.29
Denmark	0.58	0.59	0.71	0.79	0.76	0.76	0.71	0.69
Finland	0.35	0.47	0.66	0.69	0.77	0.77	0.72	0.70
France	0.20	0.21	0.21	0.15	0.10	0.08	0.08	0.08
Germany	0.34	0.32	0.35	0.35	0.32	0.26	0.21	0.19
Ireland	0.45	0.48	0.53	0.52	0.48	0.40	0.34	0.35
Italy	0.25	0.32	0.48	0.45	0.39	0.36	0.34	0.35
Japan	0.34	0.35	0.33	0.30	0.25	0.22	0.19	0.19
Netherlands	0.39	0.37	0.37	0.30	0.25	0.24	0.20	0.19
New Zealand	0.57	0.56	0.63	0.60	0.40	0.23	0.21	0.21
Norway	0.60	0.57	0.54	0.58	0.58	0.55	0.54	0.55
Portugal	0.61	0.61	0.61	0.47	0.28	0.23	0.21	0.20
Spain	0.08	0.08	0.08	0.10	0.15	0.16	0.15	0.16
Sweden	0.70	0.68	0.75	0.80	0.82	0.81	0.74	0.68
Switzerland	0.34	0.31	0.32	0.26	0.23	0.21	0.19	0.18
UK	0.39	0.41	0.46	0.47	0.38	0.31	0.29	0.26
USA	0.29	0.27	0.24	0.19	0.15	0.13	0.12	0.11
Total	0.42	0.42	0.46	0.44	0.40	0.36	0.33	0.32

C.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 gives information about the unemployment benefits for year 1, the average of year two and three, and the average of year four and five for unemployed person in different family situations and with different initial income level. The three different family types are: Single, with a dependent spouse and with a working spouse.

The different income levels are: 67 percent and 100 percent of average earnings. The measures used are:
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 C4

The data source is provided from OECD by e-mail, OECD (2012a).

Table C4: Average benefit replacement ratio in the OECD countries

Country	Yr6064	Yr6572	Yr7379	Yr8087	Yr8895	Yr9601	Yr0208	Yr0912
Australia	0.18	0.15	0.22	0.23	0.26	0.25	0.22	0.21
Austria	0.16	0.16	0.28	0.34	0.36	0.40	0.39	0.40
Belgium	0.39	0.37	0.55	0.51	0.48	0.46	0.46	0.51
Canada	0.40	0.40	0.60	0.57	0.58	0.47	0.39	0.44
Denmark	0.36	0.53	0.79	0.78	0.74	0.67	0.66	0.61
Finland	0.19	0.25	0.37	0.43	0.58	0.53	0.53	0.52
France	0.47	0.51	0.46	0.59	0.58	0.59	0.61	0.60
Germany	0.43	0.42	0.39	0.39	0.38	0.37	0.40	0.40
Ireland	0.21	0.24	0.39	0.51	0.41	0.35	0.42	0.54
Italy	0.10	0.07	0.04	0.02	0.09	0.43	0.56	0.52
Japan	0.36	0.38	0.33	0.28	0.30	0.35	0.40	0.40
Netherlands	0.42	0.65	0.65	0.68	0.70	0.70	0.71	0.71
New Zealand	0.39	0.30	0.27	0.30	0.29	0.28	0.26	0.25
Norway	0.12	0.12	0.24	0.53	0.62	0.63	0.64	0.64
Portugal	0.00	0.00	0.14	0.39	0.65	0.66	0.67	0.65
Spain	0.17	0.50	0.58	0.74	0.69	0.65	0.63	0.62
Sweden	0.24	0.31	0.70	0.85	0.87	0.77	0.74	0.68
Switzerland	0.17	0.12	0.27	0.50	0.67	0.72	0.75	0.75
UK	0.27	0.35	0.34	0.27	0.22	0.20	0.17	0.15
USA	0.22	0.23	0.28	0.31	0.25	0.29	0.31	0.51
Total	0.26	0.30	0.40	0.46	0.49	0.49	0.50	0.51

C.6 Benefit Duration

The benefit duration is a measure of how long benefits last when you are unemployed and how the amount given changes over the duration. Benefit duration is given by the equation:

$$BDj_{it} = \alpha \frac{brrja2_{it}}{brrja1_{it}} + (1-\alpha)\frac{brrja4_{it}}{brrja1_{it}} \tag{C1}$$

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 C5.

The data source is provided from OECD by e-mail, OECD (2012a).

C.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 (C2).

Table C5: Average benefit duration in the OECD countries

Country	**Yr6064**	**Yr6572**	**Yr7379**	**Yr8087**	**Yr8895**	**Yr9601**	**Yr0208**	**Yr0912**
Australia	1.01	1.01	1.03	1.02	1.03	1.01	1.00	1.00
Austria	0.00	0.00	0.58	0.75	0.74	0.70	0.71	0.71
Belgium	1.00	0.99	0.78	0.79	0.78	0.79	0.85	0.78
Canada	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Denmark	0.46	0.50	0.60	0.62	0.69	0.95	0.78	0.80
Finland	0.00	0.04	0.65	0.60	0.52	0.55	0.58	0.56
France	0.30	0.24	0.20	0.35	0.49	0.50	0.51	0.53
Germany	0.57	0.57	0.61	0.62	0.61	0.60	0.48	0.41
Ireland	0.66	0.77	0.46	0.38	0.55	0.76	0.74	0.74
Italy	0.00	0.00	0.00	0.00	0.00	0.26	0.45	0.45
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.03	0.35	0.49	0.65	0.70	0.66	0.41	0.26
New Zealand	1.02	1.01	1.02	1.03	1.04	1.01	1.00	1.00
Norway	0.00	0.02	0.43	0.49	0.50	0.63	0.83	0.35
Portugal	0.00	0.00	0.00	0.07	0.35	0.46	0.49	0.58
Spain	0.00	0.00	0.00	0.19	0.28	0.37	0.38	0.38
Sweden	0.00	0.00	0.04	0.05	0.05	0.14	0.40	0.53
Switzerland	0.00	0.00	0.00	0.00	0.07	0.29	0.20	0.18
UK	0.89	0.63	0.54	0.69	0.71	0.80	0.83	0.80
USA	0.08	0.16	0.19	0.16	0.19	0.21	0.21	0.28
Total	0.30	0.31	0.38	0.42	0.46	0.53	0.54	0.52

$$TW = t1 + t2 + t3 \tag{C2}$$

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.

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

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

$t2 = \frac{IT+WC}{HRC}$

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 be-

half. 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

$t3 = \frac{TX-SB}{CC}$

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.

All variables were found in National Accounts, OECD (2013a). 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 household sector 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.

The series 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 rates are found in Table C6.

Table C6: Average tax rate in the OECD countries

Country	**Yr6064**	**Yr6572**	**Yr7379**	**Yr8087**	**Yr8895**	**Yr9601**	**Yr0208**	**Yr0912**
Australia	0.23	0.26	0.31	0.35	0.34	0.36	0.37	0.36
Austria	0.43	0.48	0.50	0.52	0.52	0.54	0.54	0.53
Belgium	0.46	0.49	0.50	0.52	0.57	0.59	0.58	0.55
Canada	0.30	0.37	0.38	0.40	0.46	0.47	0.44	0.43
Denmark	0.42	0.52	0.52	0.57	0.58	0.61	0.62	0.58
Finland	0.41	0.45	0.50	0.52	0.63	0.66	0.63	0.59
France	0.67	0.60	0.56	0.60	0.63	0.65	0.64	0.63
Germany	0.43	0.44	0.46	0.45	0.46	0.48	0.49	0.50
Ireland	0.33	0.38	0.40	0.43	0.45	0.48	0.52	0.48
Italy	0.39	0.37	0.36	0.43	0.53	0.64	0.63	0.63
Japan	0.23	0.24	0.26	0.31	0.33	0.33	0.35	0.35
Netherlands	0.44	0.48	0.54	0.56	0.52	0.52	0.54	0.55
New Zealand	0.32	0.32	0.29	0.32	0.40	0.37	0.38	0.38
Norway	0.50	0.54	0.56	0.57	0.55	0.58	0.56	0.56
Portugal	0.17	0.21	0.22	0.28	0.34	0.38	0.40	0.39
Spain	0.21	0.26	0.32	0.41	0.46	0.47	0.51	0.47
Sweden	0.36	0.48	0.57	0.65	0.70	0.72	0.71	0.68
Switzerland	0.16	0.17	0.21	0.21	0.21	0.24	0.24	0.25
UK	0.39	0.44	0.42	0.46	0.43	0.43	0.44	0.44
USA	0.22	0.23	0.24	0.24	0.24	0.25	0.22	0.20
Total	0.35	0.39	0.41	0.44	0.47	0.49	0.49	0.48

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