MEMORANDUM

No 20/2012

Panel Data Evidence on the Role of Institutions and Shocks for Unemployment Dynamics and Equilibrium

Ragnar Nymoen
and Victoria Sparrman

ISSN: 0809-8786

Department of Economics
University of Oslo

This series is published by the
University of Oslo
Department of Economics

P. O.Box 1095 Blindern
N-0317 OSLO Norway
Telephone: + 47 22855127
Fax: + 47 22855035
Internet: http://www.sv.uio.no/econ
e-mail: econdep@econ.uio.no

In co-operation with
The Frisch Centre for Economic Research

Gaustadalleén 21
N-0371 OSLO Norway
Telephone: +47 22 95 88 20
Fax: +47 22 95 88 25
Internet: http://www.frisch.uio.no
e-mail: frisch@frisch.uio.no

Last 10 Memoranda

No 19/12	Erik Hernaes, Simen Markussen, John Piggott and Ola Vestad *Does Retirement Age Impact Mortality?*
No 18/12	Olav Bjerkholt *Økonomi og økonomer i UiOs historie: Fra Knut Wicksells dissens i 1910 til framstøt mot Thorstein Veblen i 1920*
No 17/12	John K. Dagsvik *Behavioral Multistate Duration Models: What Should They Look Like?*
No 16/12	Kjell Arne Brekke, James Konow and Karine Nyborg *Cooperation Is Relative: Income and Framing Effects with Public Goods*
No 15/12	Finn R. Førsund *Phasing in Large-scale Expansion of Wind Power in the Nordic Countries*
No 14/12	Berhe Mekonnen Beyene *The Link Between International Remittances and Private Interhousehold Transfers*
No 13/12	Berhe Mekonnen Beyene *The Effects of International Remittances on Poverty and Inequality in Ethiopia*
No 12/12	Olav Bjerkholt *Økonomi og økonomer I UiOs historie: Professorkonkurransen 1876-77*
No 11/12	Erik Biørn *Am Econometric Market Model of Capital and Investment Inspired by Haavelmo*
No 10/12	Jens Fredrik Baumgarten Skogstrøm *Entrepreneurial School Dropouts: A Model on Signalling, Education and Entrepreneurship*

Previous issues of the memo-series are available in a PDF® format at:
http://www.sv.uio.no/econ/english/research/memorandum/

Panel data evidence on the role of institutions and shocks for unemployment dynamics and equilibrium *

Ragnar Nymoen and Victoria Sparrman[†]
University of Oslo, Department of Economics

September 18, 2012

Abstract

We estimate the quantitative importance of labour market institutions for equilibrium unemployment in OECD. The empirical equation for unemployment is based on the solution of a dynamic macroeconomic model where wages and prices are jointly determined with unemployment. Compared to existing studies, the theoretical model implies a higher order dynamics in the final equation for unemployment and the sample has more variation in unemployment and in institutions. Finally, we incorporate objectively and automatically selected indicators for structural breaks. We find that institutional variables have statistical significance, but that these variables account for relatively little of the overall change in the OECD average unemployment rate. The shocks to the economy have been more important for the evolution in the actual average unemployment rate.

Keywords: *OECD area unemployment, dynamics, structural breaks, equilibrium unemployment, wage setting, NAIRU , labour market institutions, automatic variable selection*

JEL classification: *C22,C23, C26,C51, E02, E11 E24*

1 Introduction

The concept of equilibrium unemployment in the OECD area has been subject to both analytical and empirical research. One influential analytical approach, which also underlies our research, combines a model of monopolistic price setting among firms with collective bargaining over the nominal wage level, see Layard et al. (2005). Intuitively, when the system is not in a stationary situation, nominal wage and price adjustments constitute a wage-price spiral that leads to increasing or falling inflation. According to Layard et al. (2005), equilibrium of real wages require that unemployment becomes equal to the Non-Accelerating Inflation Rate of Unemployment (NAIRU). However, the equilibrium unemployment rate is not interpretable as a constant given from nature. Instead, it depends on different institutional labour market aspects such as wage bargaining coordination, the

*We would like to thank Erik Biørn, Neil Ericsson, Øyvind Eitrheim and Steinar Holden as well as participants at presentations at the Researchers Annual Meeting for Economists and Statistics Norway for comments and discussions. The numerical results in this paper were obtained by use of *OxMetrics 6/PcGive 13* and *Stata 9*. This paper is part of the project *Demand, unemployment and inflation* financed by the The Research Council of Norway.
† Corresponding author, Current address is Statistics Norway PO Box 8131 Dep, NO-0033 Oslo. Victoria.Sparrman@ssb.no.

generosity of the unemployment insurance system and the degree of employment protection. If these institutional variables change, the conflicting real wage aims will change, and the NAIRU will shift.

The panel data literature presents results that support the hypothesis of equilibrium unemployment being affected by the level of labour market institutions for most of the OCED countries. Empirical models for the unemployment rate typically include variables representing the labour market institutions as implied from the above theory, but also interaction between these variables, macroeconomic shocks and interaction between institutional variables and shocks; see Nickell et al. (2005), Bassanini and Duval (2006), Belot and van Ours (2001, 2004) and Blanchard and Wolfers (2000). Specifically, Nickell et al. (2005) find a strong role for institutional variables that have an effect on the wage and price setting relationship in explaining unemployment rates in OECD over the period 1960 to 1995. Belot and van Ours (2004) find that specific interactions between labour institutions are the driving forces over the period 1960 to 1999, and Blanchard and Wolfers (2000) find that interactions between institutions and shocks are the main driving forces over the period 1960 to 1995.

In the literature just mentioned, the theoretical framework is static, while the empirical specification of the unemployment equation is either static or dynamic. Dynamics is reasonable given that there are adjustment lags in the manifold of economic, administrative and political decisions that jointly determine the rate of unemployment. The existing studies rely on heuristics to motivate the dynamic specification of the econometric panel data model. Heuristics gives the empirical researcher considerable freedom to choose a specification that fits the data well. One strategy has been to use simple first-order dynamics in the regression and compensate by allowing flexible dynamics in the equations residuals. On the other hand, basing the specification on heuristics alone also means that there is a gap between the underlying theory of equilibrium unemployment, which is static, and the dynamic specification used to estimate the equilibrium rate unemployment.

In this paper we attempt to bridge the gap between the formal, but static, theoretical framework which are common for the studies mentioned, and the dynamic specification of the estimated model. Our specification of a dynamic econometric unemployment equation is derived from a a vector autoregressive model (VAR) for wages, prices and the rate of unemployment that in turn builds on explicit theoretical assumptions about wage and price setting.

The derived unemployment equation has several features that are makes it different from the the existing literature. First, the order of dynamics is three, while the custom is to impose first order dynamics. The higher order dynamics can be verified or refuted by testing, which we do in the empirical parts of the paper. A second difference is that the underlying theory has implication for the signs and the magnitude of the coefficients of the lags of unemployment. Third, by following the theory and hypothesizing that changes in wage and price settings are primary movers of the equilibrium rate of unemployment, the institutional variables associated with these changes also should enter with potentially long lags. Our specification implements institutions at lags one and two, and shows how the effect of institutions changes with different lag structures. Fourth, the formal derivation of the dynamic unemployment equation also shows that the equilibrium unemployment rate can be a function of other factors than the labour market institutions. We show that persistent shocks also from outside the labour market institutions will logically enter the long run solution of unemployment. A change in monetary regime is an example of a break that may have an influence on the equilibrium rate of unemployment, see Iversen (1999) and Holden (2005). The formal derivation also illustrates that even temporary shocks can be important to include in the model as controls to avoid a bias in the intercept of the equation, which is important for the inferred equilibrium unemployment rate also in panel data models. By allowing for temporary shocks, our formal model is consistent with, for instance the empirical findings in Blanchard and Wolfers (2000).

There are several ways to account for shocks that might affect equilibrium unemployment as implied by the formal derivation of the equation for unemployment. Earlier studies have addressed this problem by including time trends, year dummies and exogenous explanatory variables or by excluding certain countries and or years from the sample. Bassanini and Duval (2006) is an example of the latter approach, where Finland, Sweden and Germany are modelled separately due to the shock to these countries caused by the collapse of the Soviet Union. We include shocks that represent location shifts in the unemployment rates, see Doornik (2009). To our knowledge, this is a new approach within the panel literature and we refer to such shocks as *structural breaks*, the notation is commonly used within the time series literature. The structural breaks that we find are also interpretable by consulting the economic history of the countries in the data set in spite of that the shocks are detected in an objectively and statistical way: Most of the breaks are interpretable as extraneous shocks (the oil price hikes in the 1970s), policy instigated changes (increased interest rates in the US in 1981, and "Tatcherism" in the UK) or financial crises (the Nordic banking crisis in the early 1990s, see Reinhardt and Rogoff (2009). In this way, we also avoid a specificity problem, namely that one shock which is captured by an included variable may hide the effect of an omitted variable, see Blanchard (2006). Another interpretation of our method of detecting shocks is that it is an objective way of controlling for all "special events" which might otherwise have distorted the evidence. In principle the structural breaks could be due to institutional changes but correlation analysis shows that the breaks are uncorrelated with the institutional variables.

On the data side, and compared to existing empirical OECD panel data literature, we extend the data set to the period 1960 to 2007. This is important because our data set contains long periods with both increasing and falling unemployment. The earlier studies may have been dominated by the general increase in the unemployment rate over the period 1960-1995. As a result, there is more information in the time series dimension than before, which should increase the robustness of the results for the importance of institutions for equilibrium unemployment specifically.

The empirical results are consistent with our theoretical solution for unemployment. Moreover, the econometric evidence gives support for a role of institutions in the determining of the equilibrium rate, but the quantitative importance is considerably reduced as compared to previous findings in Nickell et al. (2005). This may in part be due to the extended sample, but it is also due to the new econometric specification which has both structural breaks and higher order dynamics. Specifically, if we decrease the most significant variable, the benefit replacement ratio, from its initial average level of 0.5 in 2007 by 20 percent, the OECD average unemployment rate will decrease by 0.8 percentage points. The absence of any large and negative shocks to the economy has been more important for the reduction in the actual average unemployment rate observed before the financial crisis and the following job crisis.

The paper is organized as follows. First, the dynamic model for equilibrium unemployment is derived from the theoretical dynamic model of the wage and price spiral in section 2. The data for the evolution of labour market institutions, and the evidence for large shocks (structural breaks), are presented in section 3. Econometric issues that are pertinent to the estimation of dynamic models on a macro panel data set are discussed in section 4. The results from the estimated dynamic unemployment equations, which include both institutional variables and breaks, are presented and interpreted in section 5. We summarize in section 6 where we also discuss some extensions and give suggestions for further work.

2 A dynamic model for wage-price formation and unemployement

The empirical model that we estimate is based on a dynamic model that includes both supply side and demand side effects on unemployment.

The supply side is modelled such that firms and workers have conflicting interests about the wage share of valued added, created by the joint utilization of capital and labour, within the individual firm as well as in the total economy. However, firms only set the nominal product price, and workers, through wage negotiations, only influence nominal wages. None of the parties have unilateral control over their target real wage variable. This means that when the real wage targeted by the firms is different from the real wage implied by the wage formation, there will be a wage-price spiral. This is an open-economy version of the relationship for the price- and wage-setting originally modelled by Layard, Nickell and Jackman; see e.g., Layard et al. (2005, p 13).[1]

Following, e.g., Bårdsen and Nymoen (2003) we add one important feature to the model, and that is equilibrium dynamics consistent with the co-integration implications of wage bargaining and monopolistic price setting, see Sparrman (2011, Chapter 3) for details. Because equilibrium correction dynamics in wage and prices is conditional on the level of unemployment, this type of dynamics is important also for the equilibrium rate of unemployment, which will deviate from the natural rate that is implied by a system of wage and price Phillips curves, see also Kolsrud and Nymoen (2010).

The model is completed by the use of standard assumptions about the demand side of the macroeconomy. Specifically, we assume that GDP output-gap is positively affected by the log of the real exchange rate, and that the unemployment rate is negatively correlated with the output gap, as predicted by Okun's law. The mechanism is that an increase in the real exchange rate leads to improved competitiveness. This increases the current account and thereby GDP increases and unemployment falls. This is standard aggregate demand reasoning, but Sparrman (2011, Chapter 3) shows that the same specification is logically consistent with the matching model of Pissarides (2000), and improved competitiveness increases the number of vacancies and unemployment rate falls. The lagged real exchange rate reflects that it takes time before a real depreciation lowers unemployment [2].

Formalization of the supply and the demand side leads to the following VAR of the log of real exchange rate (re_t), the log of the wage share (ws_t) and the unemployment rate (u_t).

$$\underbrace{\begin{pmatrix} re_t \\ ws_t \\ u_t \end{pmatrix}}_{\mathbf{y}_t} = \underbrace{\begin{pmatrix} l & -k & n \\ \lambda & \kappa & -\eta \\ -\rho & 0 & \alpha \end{pmatrix}}_{\mathbf{R}} \underbrace{\begin{pmatrix} re_{t-1} \\ ws_{t-1} \\ u_{t-1} \end{pmatrix}}_{\mathbf{y}_{t-1}} + \underbrace{\begin{pmatrix} e & 0 & -d \\ \xi & -1 & \delta \\ 0 & 0 & c_u \end{pmatrix}}_{\mathbf{P}} \underbrace{\begin{pmatrix} \Delta pi_t \\ \Delta a_t \\ 1 \end{pmatrix}}_{\mathbf{x}_t} + \underbrace{\begin{pmatrix} \epsilon_{re,t} \\ \epsilon_{prw,t} \\ \epsilon_{u,t} \end{pmatrix}}_{\epsilon_t}. \tag{1}$$

The non-modelled variables and the constant term are in the vector $(\Delta pi_t, \Delta a, 1)'$, where Δpi_t denotes import price growth and Δa_t is productivity growth. The vector $(\epsilon_{re,t}, \epsilon_{prw}, \epsilon_{u,t})$ contains the VAR disturbances.

The two first rows of $\mathbf{R}$ contain reduced form coefficients that are known expressions of the parameters of the model of the supply side (the dynamic wage-price model), see Kolsrud and Nymoen (2010) for details. The third row in the $\mathbf{R}$ matrix contains elements from the specification of aggregate demand in terms of the unemployment rate.

The eigenvalues of $\mathbf{R}$ govern the dynamic behavior of the vector variable $\mathbf{y}_t$. Kolsrud and Nymoen (2010) give the conditions for dynamic stability and cycles in the solution

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

[2] Hence, we abstract from the possibility that in the short-run there may be a negative term-of-trade effect on the current account

in terms of the underlying structural model. They find a globally asymptotically steady state, $\mathbf{y}^*$, when $-\rho < 0$ for quite general assumptions about the supply side of the model.

The second term, $\mathbf{Px_t}$, in (1) shows that both price growth, Δpi_t, from foreign wage-price setting and from the market for foreign exchange, and exogenous productivity growth, Δa_t, play a role for the dynamic behavior of $\mathbf{y}_t$. At first it may seem strange that nominal growth (Δpi_t) affects the real variable $\mathbf{y}_t$. The explanation is that although the underlying wage-price system is homogenous of degree one in nominal price levels, it is not constrained to be dynamically homogenous. Dynamic price homogeneity implies that domestic price growth is equal to imported price growth in each time period (for example a year). In line with this, the coefficient e and ξ in the $\mathbf{P}$ matrix are both zero in the case where the wage-price spiral is dynamically homogenous, see Kolsrud and Nymoen (2010).

The $\mathbf{P}$ matrix also contains the intercept coefficients d, δ and c_u. In the following, we assume that these parameters are conditioned by labour market institutions and by economic policy regimes. For example, the parameter δ, in the wage-share equation of the VAR can be shown to depend positively on the degree of mark-up in wage-setting and negatively on the mark-up in price setting.[3] As the literature shows, it is easy to imagine that the degree of mark-up in wage setting is conditioned by coordination in wage bargaining, and other aspects of labour market related institutions, see Nickell et al. (2005), Bassanini and Duval (2006), Belot and van Ours (2004), Belot and van Ours (2001) and Blanchard and Wolfers (2000). We therefore write $\delta(\mathcal{I})$ to symbolize that we interpret δ as a function of a vector of variables that represent the institutional factors that affects the wage setting, and that we have collected data for see section 3.2 below. For symmetry, and without adding new notation, we also write $d(\mathcal{I})$ to represent the understanding that also the intercept in the real-exchange rate equation in the VAR (1) is institutionally conditioned. [4]

Finally, the third intercept c_u in the VAR is also likely to be a function of shocks and structural changes in the macroeconomy. For example, in the matching model autonomous changes in both vacancies and the matching function will influence c_u, see Sparrman (2011), This is one of the reasons why, in the econometric panel data model, we allow for both country-specific intercept dummies and objectively estimated location shifts in the unemployment rates. More generally, c_u may be regarded as a parameter which is affected by large intermittent shocks in the macroeconomy, including changes in fiscal and monetary policy regimes. In section 3.3, we show that for each country in our sample, we are able to identify one or more large shock, or structural break in the unemployment time series, which we denote by $\mathcal{D}$. We use the notation $c_u(\mathcal{D})$ to make clear that, in general both the dynamics and equilibrium of unemployment, may be affected by structural breaks in the economy.

2.1 Unemployment dynamics

The VAR in (1) implies a final equation for u_t, with third order dynamics, which we write as

$$u_t = \Upsilon_0 + \Upsilon_1 u_{t-1} + \Upsilon_2 u_{t-2} + \Upsilon_3 u_{t-3} + \Upsilon_4 \mathcal{I}_{t-1} + \Upsilon_5 \mathcal{I}_{t-2} + \Upsilon_6 \mathcal{D}_t + \Upsilon_7 \mathcal{D}_{t-1} + \Upsilon_8 \mathcal{D}_{t-2} + \epsilon_{u,t}, \quad (2)$$

The autoregressive coefficients Υ_1, Υ_2 and Υ_3 are determined by the parameters in $\mathbf{R}$ as shown in equation (3) below and the discussion of that equation. The terms with $\mathcal{I}$ and $\mathcal{D}$ represent our hypotheses about the temporal effect of institutional changes and other structural breaks, and they are motivated below. $\epsilon_{u,t}$ is a composite term that contains

[3] Kolsrud and Nymoen (2010) Appendix B contains the algebra needed to prove this point.

[4] Kolsrud and Nymoen (2010) shows that the wage and price mark-up coefficients have different signs in the expression for d. The effects need not cancel though, and the price mark–up may be less institutionally conditioned, see Bjørnstad and Kalstad (2010).

lags of Δpi_t and Δa_t as well as lags of the error terms in equation (1), see Sparrman (2011) for details.

The dynamic solution for the rate of unemployment is globally asymptotically stable and converges to u^* in $\mathbf{y}^{*'} = (re^*, ws^*, u^*)$ if and only if the largest root of the characteristic equation:

$$r^3 - r^2\Upsilon_1 - r\Upsilon_2 - \Upsilon_3 = 0$$

have modulus less than one. In terms of the underlying parameters, the expressions for the three autoregressive coefficients are:

$$\begin{aligned} \Upsilon_1 &= \alpha + \kappa + l \\ \Upsilon_2 &= -\left[\alpha l(1-\kappa) + \kappa(\alpha + l) + n\rho + \lambda k\right] \\ \Upsilon_3 &= \alpha\lambda k + \rho(n\kappa - \eta k) \end{aligned} \tag{3}$$

As shown in Sparrman (2011), it follows form the assumptions of the model that Υ_1 is positive, and that it may well be larger than 1. The second autoregressive parameter is expected to be negative, since all the coefficients inside the brackets are positive from theory. We note that it is possible that $\Upsilon_1 > -\Upsilon_2$, since the additional terms in Υ_2 are products of factors that are less than one. The third autoregressive coefficient, Υ_3, is likely to be smaller in magnitude than the first two coefficients: $\alpha\lambda k$ is a small number and $\rho(n\kappa - \eta k)$ may be near zero or even negative. Therefore, it seems reasonable that the coefficient of the third lag of unemployment may be difficult to discover empirically with a finite amount of data. On the other hand, if the effect is tiny, the bias from estimation of a model with “too little dynamics” may not be significant in numeric terms either.

We now turn to the coefficients Υ_j $(j = 4, 5, 6, 7, 8)$ in equation (2) depend on how $\mathcal{I}_t$ affects $\delta(\mathcal{I}_t)$ and $d(\mathcal{I}_t)$, and how $\mathcal{D}_t$ primarily affects $c_u(\mathcal{D}_t)$.

First, note that an hypothesis that institutional evolution has no lasting effects on the unemployment equilibrium can be formulated as:

$$\Upsilon_4 + \Upsilon_5 = 0$$

This is a main hypothesis that we test empirically below. The institutional variables enter equation (2) in the following way:

$$\Upsilon_4\mathcal{I}_{t-1} = \rho d(\mathcal{I}_{t-1}) \tag{4}$$

$$\Upsilon_5\mathcal{I}_{t-2} = k\rho\delta(\mathcal{I}_{t-2}) - \rho\kappa d(\mathcal{I}_{t-2}) \tag{5}$$

The dating can be justified by the following argument: Changes in institutions in period $t-1$ affect unemployment and wage- and price setting in the next period, t. Another reason, which is also consistent with the above theory, is that mark-ups react to institutional changes first and unemployment reacts with longer lag. The distributed lag would then be in terms of $t-2$ and $t-3$. That said, a rejection of the null hypothesis of no long-run effect of institutional changes on unemployment should be robust to the exact distributed lag of the institutional variables.

Finally, the dynamics of the VAR in (1) implies that $\mathcal{D}_t$ follows a distributed lag:

$$\Upsilon_6\mathcal{D}_t = c_u(\mathcal{D}_t) \tag{6}$$

$$\Upsilon_7\mathcal{D}_{t-1} = -\left[l + \kappa\right] c_u(\mathcal{D}_{t-1}) \tag{7}$$

$$\Upsilon_8\mathcal{D}_{t-2} = l\kappa c_u(\mathcal{D}_{t-1}) \tag{8}$$

The two interpretations of the unemployment equation given above, implies that changes in the matching function or simple demand shocks enter the final equation of unemployment with an immediate effect, and with two lags.

In section 4 we discuss the econometric specification of (2) when the aim is estimation on the panel data set that is presented next.

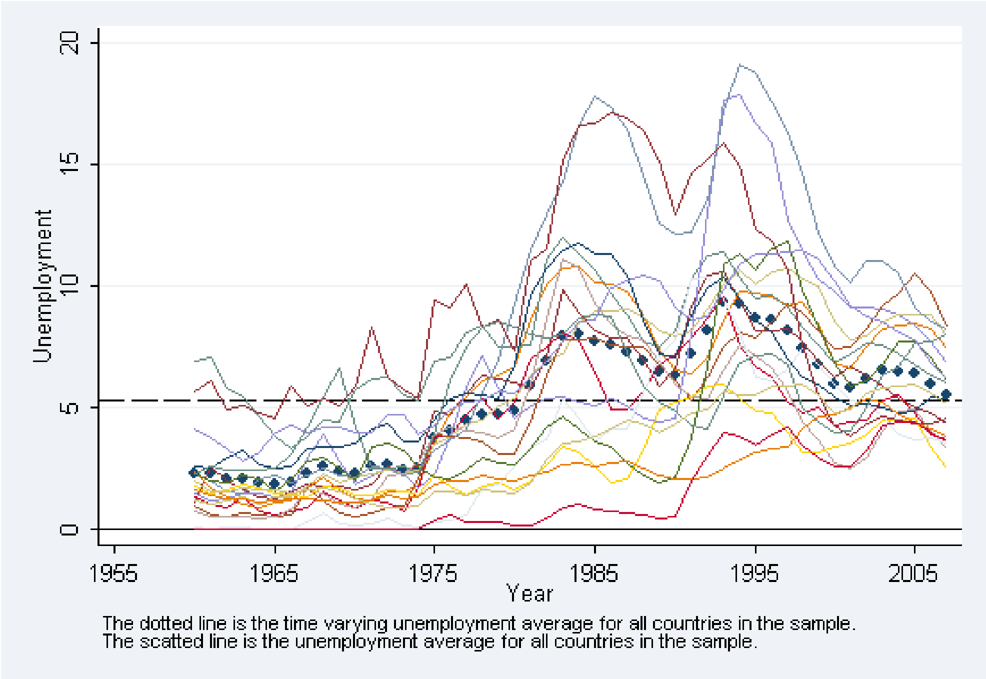

Figure 1: Unemployment rate in the OECD countries. Percent

3 Data

In this section, we present the evolution in the data set that we use to estimate equation (2); unemployment rates, labour market variables ($\mathcal{I}$) and shocks ($\mathcal{D}$). The panel consists of 20 OECD countries over the period 1960 to 2007. The countries in the data set are listed in appendix table A1.

3.1 The unemployment rate

The standardized unemployment rate in Economic Outlook at OECD (2008a) is used as a primary data source for the unemployment rate in the OECD countries, see the data appendix for detail.

There have been a substantial changes in the unemployment rates of the OECD countries in the period 1960 to 2007. Figure 1 shows the unemployment rates in all countries, together with the average unemployment rate. The figure illustrates that the rise in unemployment in the early 1970s went together with an increase in the dispersion. The difference between the highest and the lowest unemployment rate in 1995 is larger than in 1960. After 1995, both the average unemployment rate and the variation in unemployment rates across countries decreased. In our model, institutions and structural breaks capture this development in dispersion.

The evolution of the unemployment rate for each country in the sample in the period 1960 to 2007 is also summarised in appendix A in table A1. For instance, Norway and Switzerland have a relatively low unemployment rate throughout the period compared to most other countries in the sample. One might question the accuracy of the data showing low unemployment rates in New Zealand and Switzerland in the beginning of the sample period. However, our main results are robust to the exclusion of these countries and are found in a previous version of this paper, see Sparrman (2011) Chapter 3 for details. Ireland and Spain, on the other hand, are examples of countries with high levels of unemployment in some years and high volatility over time. Germany and Japan have

Table 1: Unemployment: Dickey-Fuller unit root tests

Alternative:	Homogenous $H1_a$ Statistic (p-value)	Heterogenous $H1_b$ Statistic (p-value)
lag 1	-4.28 (0.00)	-2.29 (0.01)
lag 1, $(U_{it} - \overline{U}_i)^a$	-4.34 (0.00)	-4.04 (0.00)
lag 2	-2.18 (0.02)	-0.45 (0.33)
lag 2, $(U_{it} - \overline{U}_i)^a$	-1.81 (0.03)	-1.99 (0.02)
lag 3	-2.82 (0.00)	-0.91 (0.18)
lag 3, $(U_{it} - \overline{U}_i)^a$	-1.67 (0.05)	-1.80 (0.04)

a) Unemployment (U) subtracted country specific mean ($\overline{U}_i$)

an upward sloping trend, i.e. there is a steady increase in the unemployment rate over time. No country in the data has a tendency of a declining trend in unemployment.

The trendlike behavior of the series makes it relevant to test for unit roots. Absence of a unit root is of course essential, since otherwise the empirical relevance of equilibrium unemployment as we have defined it can be questioned, as it has been in the "hysteresis" literature, see Røed (1997). The Dickey-Fuller tests are the standard tests for unit-root in panel data, see Mátyás and Sevestre (2008). There are two versions of the test, depending on how the alternative hypothesis ($H1$) is specified. $H1_a$ (homogenous alternative), it is assumed that the autoregressive parameter is identical for all cross section units. Under $H1_b$ (heterogenous alternative), it is assumed that N_0 of the N panel units are stationary with individual-specific autoregressive coefficients. A method for testing the null hypothesis against the first alternative is developed by Levin et al. (2002) and a method for the second heterogenous hypothesis alternative is described in Im et al. (2003).

Table 1 shows the results for the two alternative hypothesizes. The tests are performed for three types of augmentations of the basic Dickey-Fuller regression, where one, two and three lags in the change in the unemployment rate are included. The table also includes the test statistics based on a subtraction of the cross sample average of unemployment. The procedure mitigates the effect of cross-sectional dependence. "Homogenous alternative" in table 1 shows that the hypothesis of non-stationary is rejected at the conventional five percent significance level for all variations of the test. The "Heterogenous alternative" rejects non-stationarity when the data generating process includes one lag of the change in unemployment, and when the unemployment time series are adjusted for a cross sample average prior to deriving the test statistic.

Note that the test could depend on whether we control for breaks in the unemployment rate time series as claimed in Camarero et al. (2006). However, since the tests reject the null hypothesis of a unit root without the structural breaks or institutions, the test will also significantly reject the null hypothesis if breaks and institutions are included.

3.2 Institutional factors

The main hypothesis to be tested is whether the equilibrium rate of unemployment has been affected by changes in labour market institutions over the sample period. Institutional changes are measured by indices for employment protection (EPL), benefit replacement ratio (BRR), benefit duration (BD), union density ($UDNET$), tax level (TW) and the degree of coordination of wage setting (CO). These indicators are assumed to be correlated with $m_w(\mathcal{I})$ above. We do not have any indicators for $m_q(\mathcal{I})$ or c_{ut}. The data appendix contains a detailed description of all variables and their sources. The appendix also contains tables for the actual development for each variable for each country in the sample period. The last row of each table contains the unweighed average for each institutional variable.

The tax rates 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). Appendix table A2 illustrates a steady increase in tax rates in most OECD countries over the period 1960 to 2007. The largest increases are found in Sweden, Spain and Portugal, and the highest tax rates, larger than a 50 percent tax wedge, are found in the Nordic countries and in Austria, Belgium, France, Italy, Spain and Germany. In Canada and Germany, there was a small decline in the tax rate towards the end of the sample period.

The time series for employment protection measure the strictness of the employment protection for the employee. The overall indicator for employment protection is measured on a scale from 0 (low) to 5 (high). Some other measures only consider the employment protection for regular or temporary contracts. Appendix table A7 shows an average decline in the strictness of employment protection since the beginning of the 1970s.

The benefit replacement ratio is a measure of how much each unemployed worker receives in benefits from the government in the first period when being unemployed. There has been a steady increase in the average benefit ratio for the first period in the period 1960 to 2007, cf. appendix table A3. There are large differences in unemployment benefits between the OECD countries, the lowest benefits are found in Australia and the United Kingdom to the highest benefits in Sweden and Switzerland in period 2002-07. Some countries have reversed the benefits during the period, see for instance Canada, Denmark and the United Kingdom, while for instance the United States has been on a low level in the whole sample period.

Benefit duration is a measure of the unemployment benefits for recipients who have been unemployed more than one year, relative to benefits during the first year. Many countries stop the payments after one year and the index is then equal to zero, cf. appendix table A4. If benefits are the same for the first four years of unemployment, the value of the index is equal to one. If benefits increase over time, the index is larger than one. We observe that in most countries benefit duration has increased over the sample period.

We are interested in the effect of coordination on unemployment, i.e. through wage moderation. We use the index in OECD (2004) which measures the formal level of coordination and not whether the coordination actually results in wage moderation at all times as, for instance, in the index from Kenworthy (2001). The coordination index is shown in appendix table A6.

Union density rates are constructed using the number of union members divided by the number of employed. Trade union density rates are based on surveys, wherever possible. Where such data were not available, trade union membership and density in European Union countries, Norway and Switzerland were calculated using administrative data adjusted for non-active and self-employed members by Prof. Jelle Visser, University of Amsterdam. Appendix table A5 shows that union density has declined since the beginning of the 1970s in most countries.

We also investigate the interaction between the following institutional variables: benefit duration and benefit replacement ratio, coordination in wage setting and union density, and coordination and tax level. These interaction terms are measured as the deviations from country specific means. For instance, the interaction between coordination and tax is equal to $(CO - \overline{CO})(TW - \overline{TW})$, where $\overline{CO}$ and $\overline{TW}$ are the country specific mean of that variable.

3.3 Indicator variables for structural breaks

In the theoretical section we motivated briefly how a wider set of variables than institutional variables can be thought of as a part of the dynamic equation for the rate of unemployment. We can find two ways of extending the set of explanatory variables in previous panel data literature: First, some studies include theoretically motivated variables that represent short-run changes in the unemployment rates, cf. Blanchard and Wolfers (2000) and Nickell et al. (2005). Examples are the change in the interest rate and residuals from short-run changes in labour demand. A second and a complimentary approach is to give special treatment of some years, or some countries in the data set, on account of significant historical events. One example of this approach is Bassanini and Duval (2006) who model Finland, Sweden and Germany separately, because of the effects of the collapse of the Soviet Union on these economies.

In this paper, we take a third approach; we systematically treat the rate of unemployment as a variable which is subject to intermittent structural breaks that may lead to location-shifts. The argument is that the effect of changes in institutional variables on unemployment are likely to be gradual, and are modelled by relatively long lags in accordance with theory above. We have also shown that it is complementary to this hypothesis that the intermittent but large changes in the unemployment rate from one year to another can be due to other factors than institutions, like extraneous or domestic demand shocks, changes in households' preferences for work and leisure or changes in pro-or counter-cyclical economic policies. On the other hand, if the shocks are permanent they could in principle also capture omitted institutions.

To identify shocks in an objective way, we have used the procedures in *Autometrics* for finding the breaks, see Doornik (2009). For each country, we specified a second-order autoregression, and then used two methods called "large outlier" and "impulse saturation" to estimate the structural breaks. The method of "large outlier" adds dummies for years with significant outliers. "Impulse saturation" first adds dummies for each year and then uses the algorithms for automatic model selection to produce a final model with a smaller set of significant structural breaks. The properties of this class of automatic model selection procedures using *Autometrics* are discussed in Castle et al. (2010) and Hendry and Mizon (2010).

Research shows that it is advisable to use a lower level of significance for "impulse saturation" than for "large outliers", and the breaks used in the following are based on the significance level 5 percent of a "large outlier" and 2.5 or lower for impulse saturation, see Doornik (2009). The result is a relatively small number of break dummies. With "large outliers", there is typically just a couple of break dummies. With "impulse saturation", there are more breaks. Based on table 2, the average number of breaks per country from "impulse saturation" is 5.45. With the "large outlier" approach, the average number of breaks is only 1.65.

The majority of the shocks in table 2 are negative location shifts (higher u_t), but there are also positive shocks, in particular in the results from "impulse saturation". Some of these represent the effects of the well-know housing and credit market booms (for example the UK in 1988 and Norway in 2007). There are also effects of "bubbles" that burst at a later stage, for example in the UK in 1991.

To check whether the location-shifts capture something else than the effects of variation in our institutional variables, we have constructed two ("$N \times T$") data series by using the estimated coefficients for the break-dummies, and calculated the correlations between the two location-shift series and the institutional variables, see table 3. We observe that the correlation between changes in institutions and breaks is generally low, confirming that the breaks do not capture changes in institutions.

The estimated breaks are interpretable on basis of recent economic history. For example, the years 1981-82 are years with location shifts in the unemployment rates of nine countries (seven European countries plus Australia and the US). These years followed the stagflation in the 1970s, the two oil-price shocks, widespread closures in traditional manufacturing in many OECD countries, and marked the start of an evolution of a post-

Table 2: Impulse saturation and large outlier

Country	**Impulse saturation**	**Large outlier**
Australia	1975, 1977, 1978, 1982, 1983, 1990, 1991, 1992	1983, 1991
Austria	1975, 1981, 1982, 1983, 1989, 1993, 1999, 2000, 2002, 2006, 2007	1982
Belgium	1975, 1981, 1993, 2001, 2002	1975, 1981
Canada	1970, 1975, 1982, 1991	1982, 1991
Denmark	1975, 1981, 1986, 1994	1994
Finland	1967, 1969, 1976, 1977, 1979, 1991, 1992, 1993, 1997	1991, 1992
France	1975, 1984, 1995, 2000, 2007	2000
Germany	1975, 1981, 1982, 1992	1968, 1992
Ireland	1971, 1972, 1975, 1981, 1983, 1995, 1998	1975, 1981, 1983
Italy	1974, 1986, 1993, 1998	1986
Japan	1975, 1988, 2004	1998
Netherlands	1981, 1982, 1983, 1993	1981, 1982, 1984
New Zealand	1983, 1988, 1991	1991
Norway	1975, 1988, 1989, 2006	1989, 2006
Portugal	1970, 1975, 1987, 1993, 1998	1970
Spain	1980, 1984, 1990, 1992, 1993, 2002	1993
Sweden	1971, 1991, 1992, 1993, 1996, 1998, 2003	1993, 1996
Switzerland	1991, 1992, 1993, 1996, 1998, 2002, 2003	1991
UK	1964, 1973, 1980, 1981, 1988, 1991	1981, 1991
United States	1975, 1980, 1982	1975, 1982

Table 3: Correlations between breaks and changes in institutions

	Saturation break		Break by large outlier	
	Coefficent	Observations	Coefficent	Observations
Impulse saturation	1.00	960.00		
Change in employment protection	-0.07	940.00	-0.07	940.00
Change in benefit replacement ratio	0.01	940.00	-0.00	940.00
Change in benefit duration	-0.06	940.00	-0.07	940.00
Change in union density	0.12	870.00	0.04	870.00
Change in coordination	-0.14	940.00	-0.13	940.00
Change in tax rate	-0.09	935.00	-0.09	935.00
Large outlier detection			1.00	960.00
Obs.	960		960	

industrial society in many of these countries. For the US in particular, there is only a few breaks. The first US break, in 1975, can be interpreted as the effect of the oil-price shock. In our interpretation, the break in 1982 captures the effect of the FED's increase of the interest rate to 20 percent at the beginning of the 1980s. This policy was motivated by the need to curb inflation and much of the effect of the interest rate on inflation "went through" the labour market and the rate of unemployment. Another concentration of breaks (8) occur in the first years of the 1990s. This time, the Nordic countries, Finland and Sweden in particular, were also subject to very large cyclical fluctuations and involuntary sharp increase in unemployment.

4 Econometric issues

Our primary interest is to estimate the final equation for unemployment, equation (2), derived in section 2. To ensure sufficient variation in institutional indicators that may influence the wage and price mark-ups and therefore also unemployment, we follow Nickell et al. (2005) and use macro panel data that consists of 20 OECD countries; however, we extend the period from 1960 to 2007. The evolution of the variables is described in detail in section 3, and the definitions and sources are given in appendix A.

We add the subscript i for country i to equation (2):

$$u_{it} = \beta_{0i}+\beta_1 u_{it-1}+\beta_2 u_{it-2}+\beta_3 u_{it-3}+\beta_4 \mathcal{I}_{it-1}+\beta_5 \mathcal{I}_{it-2}+\beta_6 \mathcal{D}_{it}+\beta_7 \mathcal{D}_{it-1}+\beta_8 \mathcal{D}_{it-2}+\epsilon_{it} \quad (9)$$

where $i = 1, 2, ... \; 20$ and $t = 1960, 1961, ... \; 2007$. Theoretically, ϵ_{it} is a combination of disturbances in price and wage setting, firms' hiring, and the labour supply. We do not impose any particular error structure from the outset. Instead, we test the residual properties of a given specification of the regression and take note if e.g. a test statistic for residual autocorrelation is significant.

Formally, in panel data terminology, the model in equation (9) has heterogeneity in one dimension of the panel, country-specific shifts, and is referred to as one-way heterogeneity (Baltagi, 2008). The country-specific shifts are unobserved, but may be correlated with the explanatory variables and are therefore modelled by the inclusion of dummies for each country. In the case of correlation, omission of β_{0i} in the model would lead to a bias in the estimation of the parameters of the other explanatory variables. Moreover, since the variables that constitute $\mathcal{D}_{it}$ consist of dummies for country-specific structural breaks (for example large demand shocks), we can also interpret the equation as a model with two-way heterogeneity, i.e. with time effects.

It seems plausible that there is more heterogeneity in the "real world" than what our model is furnished with. However, in this paper, we are only interested in the average equilibrium unemployment, and we believe that the heterogeneity modelled here is sufficient for this purpose.

Estimation of equation (9) by OLS, the least square dummy variable estimation (LSDV), is biased for finite T, but the bias is relatively small for $T = 20$, see Judson and Owen (1999). In addition, alternative approaches which uses instruments to avoid the bias in the fixed effect estimation, like "Difference GGM", might suffer from week instrument problems, see Mátyás and Sevestre (2008). A more profound review of alternative estimators on this data set is given in Sparrman (2011). In this paper, the fixed effect estimator is reported. The estimator is bias-adjusted for heteroscedasticity.

5 Empirical results

In this section, we start by estimating versions of equation (9) where we allow for other forcing variables than the institutional factors, namely the "structural breaks" that we motivated in section 3. First, we discuss the role of institutions within this model. Then we explore whether the results are sensitive to the dynamic specification or the choice of method of detecting structural breaks.

5.1 The role of institutions

The column labelled "All countries" in table 4 shows the LSDV estimation results of equation (9) with the sequence of location-shift dummies obtained from the "large residuals" method. The lower part of the table contains the two χ^2-test relevant for the role of institutions. They both reject their respective joint null-hypotheses of no effect of institutions. The value of the test statistic for the significance of levels effects of the institutional variables is 37.63, and the value of the test statistics for the significance of the interaction terms is 22.62. From the detailed coefficient estimates of the different variables, we see that the level of employment protection and the benefit replacement ratio are both statistically significant at the 5 percent level so that both stricter employment protection and higher replacement ratio lead to higher unemployment. For the two interaction terms, only the short-term effects are significant, the change in the interaction between coordination and union density, and the change in interaction between coordination and taxes significantly reduces unemployment. At the significance level of 10 percent there is also evidence of a long-term effect on unemployment from the interaction between benefit replacement ratio and benefit duration, so that a change in this variable increases unemployment.

Table 4: Estimates from the fixed effect model with large outlier dummies

	All countries		All countries[a]		Heterosc.		Red. data set[b]	
	Coef.	Std	Coef.	Std	Coef.	Std	Coef.	Std
Unemployment prev. period	1.38	0.03	1.31	0.03	1.45	0.03	1.38	0.03
Unemployment two years ago	-0.52	0.05	-0.43	0.05	-0.65	0.05	-0.52	0.05
Unemployment three years ago	0.06	0.03	0.02	0.03	0.13	0.03	0.06	0.03
Employment protection (EPL), 1st diff. prev. period	0.12	0.24	-0.11	0.22	0.10	0.21	0.14	0.25
EPL, two years ago	0.14	0.07	0.04	0.07	0.15	0.06	0.14	0.07
Benefit replacement ratio (BRR), 1st diff. prev. period	-0.89	0.81	-0.85	0.73	-0.64	0.69	-0.88	0.84
BRR, two periods ago	0.63	0.24	0.35	0.21	0.55	0.20	0.63	0.26
Benefit duration (BD), 1st diff. prev. period	-0.51	0.54	-0.36	0.49	-0.14	0.43	-0.49	0.56
BD, two periods ago	0.00	0.17	-0.13	0.16	0.07	0.14	0.03	0.18
Interaction - BRR and BD, 1st diff. prev. period	-2.59	2.03	-1.31	1.81	-1.37	1.63	-2.90	2.16
Interaction - BRR and BD two periods ago	1.17	0.63	1.16	0.56	1.05	0.52	1.27	0.68
Interaction - CO and UDNET, 1st diff. prev. period	-4.16	2.15	-3.62	1.92	-3.06	2.35	-4.30	2.43
Interaction - CO and UDNET two periods ago	-0.77	0.46	-0.86	0.41	-1.05	0.36	-0.98	0.53
Interaction - CO and TW, 1st diff. prev. period	-8.02	2.48	-6.05	2.24	-4.63	1.92	-8.40	2.70
Interaction - CO and TW two periods ago	-0.18	0.81	0.10	0.71	-0.19	0.63	-0.05	0.84
Union density (UDNET), 1st diff. prev. period	0.43	2.02	1.84	1.88	-0.18	1.87	0.56	2.29
UDNET, two periods ago	0.26	0.28	0.11	0.30	0.23	0.27	0.39	0.31
Coordination (CO), 1st diff. prev. period	0.12	0.17	0.20	0.16	0.00	0.16	0.18	0.18
CO, two periods ago	-0.01	0.04	-0.01	0.04	-0.01	0.04	-0.00	0.04
Tax rate (TW), 1st diff. prev. period	-0.29	1.52	1.74	1.40	1.67	1.31	-0.05	1.61
TW, two periods ago	0.48	0.53	0.40	0.55	0.63	0.46	0.42	0.57
Break by Large outlier approach	0.94	0.05	0.79	0.04	0.90	0.05	0.94	0.05
Tot. obs and the number of countries	837	20	837	20	837	20	761	18
Standard deviation of residuals	0.6		0.5		0.6		0.6	
χ^2 of all the exogenous variables.[c]	531.93	(0.00)	417.04	(0.00)	451.42	(0.00)	490.27	(0.00)
χ^2 of institutional variables (level).[c]	37.63	(0.00)	31.41	(0.03)	37.33	(0.00)	33.83	(0.01)
χ^2 of institutional variables (interaction).[c]	22.62	(0.00)	20.28	(0.00)	22.52	(0.00)	21.47	(0.00)
1st order autocorrelation[c]	0.37	(0.71)	0.37	(0.71)	0.37	(0.71)	0.51	(0.61)
2nd order autocorrelation[c]	-1.71	(0.09)	-1.71	(0.09)	-1.71	(0.09)	-1.49	(0.14)

a) With time dummies.

b) Without New Zealand and Switzerland.

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

Table 4 also contains three additional estimation results; "All countries[a]" which includes time dummies for each year which are common to all the countries in the sample, "Heterosc." which is a GLS estimation which accounts for heterogeneity in the error term and "Red. data set" which excludes New Zealand and Switzerland due to the unrealistic low values for unemployment at the beginning of the period, see section 3 for data details. Time dummies are included in "All countries[a]" since macroeconomic shocks that are common to all countries in the sample might bias the estimated coefficents. "Heterosc." is included as a robustness test since the theoretical derivation shows that the disturbance term of the model may contain short term influences from changes in the world price and productivity growth.

For all models in table 4, the conclusions based on the χ^2-test are the same as in the "All countries" model, which is one way of illustrating the importance of institutions. A closer inspection of table 4 reveals that, as a rule, the sign and the significance of the coefficients in "All countries" are retained in all models. The exception is employment protection, which is insignificant in the "All countries[a]" model.

For other individual variables, both the direct effect of union density and the direct effect of tax rates have changed signs in the "Heterosc." model. However, it is not obvious what the correct short-run coefficient is. Several authors have claimed that the causality between institutions and unemployment is unclear: For instance, a higher coordination level can imply lower wage claims if the coordination level is above a certain level, cf. Calmfors et al. (1988). The wage claims are then a function of the degree of coordination, where medium level of coordination results in the highest wage clams. The low and high coordination levels result in low wage claims. A similar argument also applies to union density. Holden and Raaum (1991) argue that increased union density in some cases may facilitate wage moderation and thus induce lower unemployment.

The long-run solution of the estimated model in table 4, "All countries", is presented in equation (10). The numbers in parenthesis below the coefficients are asymptotic standard deviations, and the long-run t-values can be obtained by dividing the estimated coefficients by these standard deviations. The long-term effects of institutions all have the signs that we expect from theory. Benefit duration, coordination and the interaction between benefit replacement ratio and benefit duration, increase unemployment, while the interaction between coordination and union density decreases unemployment. The long-run t-value is larger than two in absolute value for all these variables. The institutional variables which are significant in the long-run equation correspond well to those variables which have low p-values in table 4.

$$
\begin{aligned}
u^* = {} & Constant + \underset{(0.9)}{1.6}\,EPL + \underset{(2.2)}{7.6}\,BRR + \underset{(1.6)}{0.03}BD \\
& + \underset{(2.8)}{3.1}\,UDNET - \underset{(0.5)}{0.1}\,CO + \underset{(6.4)}{5.2}\,TW + \underset{(5.5)}{14.2}(BRR - \overline{BRR})(BD - \overline{BD}) \\
& - \underset{(3.5)}{9.1}\,(CO - \overline{CO})(UDNET - \overline{UDNET}) - \underset{(6.9)}{3.0}\,(CO - \overline{CO})(TW - \overline{TW}) \qquad (10)
\end{aligned}
$$

We illustrate the quantitative effect of institutions on the average OECD unemployment rate by two dynamic simulations of the "All countries" model in table 4. Both simulations start in 1969 and end in 2007. The first simulation is conditional on the actual values of all non-modelled exogenous variables over the solution period. We call this the solution with *time varying institutions*. The second simulation is based on constant values (from 1968) of the institutional variables, and we call this the solution with *constant institutions*. The residual term is set to zero in both simulations. The result of the simulation is shown in figure 2.

Overall, the model with "large outlier breaks" seems to fit the data quite well since the gap between the simulated unemployment rate and actual unemployment is small in figure 2. The unweighted average unemployment rate in OECD is estimated to be 6.0 percent in 2007 which is close to 5.5 percent, i.e. the actual value of the average unemployment rate in OECD in 2007. The figure also shows a small gap between the simulation with time-varying and constant institutions, It illustrate that only a small part of the evolution of unemployment can be attributed to changes in institutions. Note however that on average there have been only small changes in the institutional variables over the OECD countries in table 5.

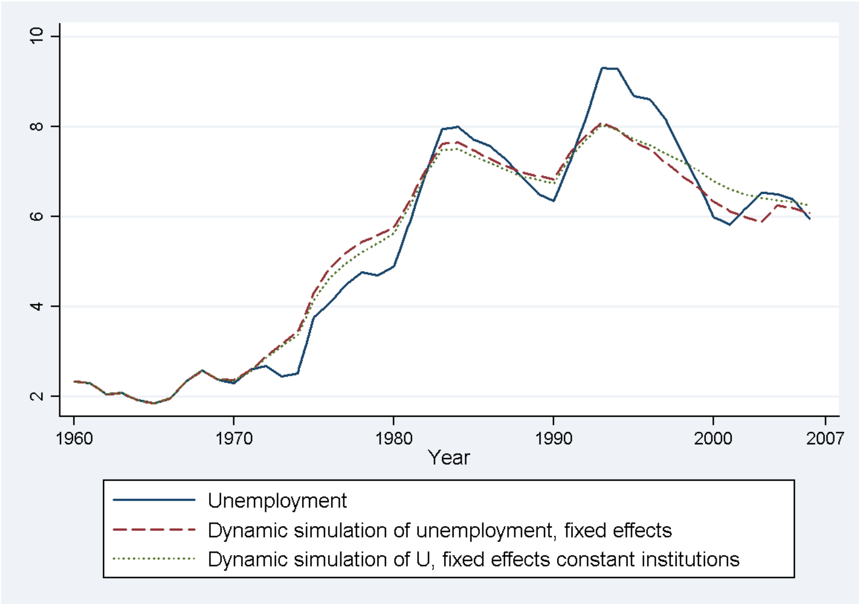

Figure 2: Dynamic simulation of the OECD average unemployment rate. Estimated coefficient values from table 4 “All countries” (break by large outlier). Simulations with and without time varying institutions

Several of the variables in table 4 and also in equation (10) have insignificant estimated coefficients. When we drop all variables that are insignificant at the 10 percent level from table 4 in “All countries” and reestimate the simplified equation, we obtain the more parsimonious model in the column of table 6 labelled “Fixed effects”. The results show that the variables which have sizable effects in the general model remain significant and the values of the estimated coefficients are of the same magnitude also in the simplified model. The corresponding long-run equation is:

$$
\begin{aligned}
u^* = {} & Constant + \underset{(0.8)}{2.0}\, EPL + \underset{(1.8)}{7.9}\, BRR \\
& + \underset{(7.5)}{13.5}(BRR - \overline{BRR})(BD - \overline{BD}) - \underset{(4.2)}{9.6}\,(CO - \overline{CO})(UDNET - \overline{UDNET}) \qquad (11)
\end{aligned}
$$

We can use equation (11) to illustrate the long-run effects of labour market institutions in a different way than the dynamic simulation. One of the most significant variables is the benefit replacement ratio. The average value is equal to 0.5 in 2007. According to equation (11), a reduction in the benefit replacement ratio of 20 percent will decrease average OECD unemployment with 0.8 percentage points. Note that the effect is somewhat stronger if the interaction effect with benefit duration is included. The conclusion is that the change in labour market institutions have to be quite large in order to lower the OECD unemployment rate substantially.

Table 6 also contains the results of the Arellano-Bond one- and two-step estimation method, with lagged levels of unemployment in addition to the exogenous variables as

Table 5: Changes in institutions over the period 1960 to 2007

Institutional variable X:	$\bar{X}^a_{69-60} - \bar{X}^b_{89-85}$	$\bar{X}^c_{07-00} - \bar{X}^b_{89-85}$	$\bar{X}^c_{07-00} - \bar{X}^a_{07-60}$
Employoment protection (EPL)	-0.03	-0.36	-0.39
Benefit replacement ratio (BRR)	0.21	0.01	0.22
Benefit duration (BD)	0.13	0.15	0.28
Interaction BRR BD	-0.04	0.00	-0.04
Interaction CO UDNET	0.00	0.00	0.00
Interaction CO TW	0.01	0.01	0.02
Union density (UDNET)	0.03	-0.08	-0.05
Coordination (CO)	-0.47	0.00	-0.48
Tax rate (TW)	0.10	0.03	0.13

a) $\bar{X}_{69-60}$ is the average level of the institutional variable in the period 1960 to 1969.

b) $\bar{X}_{89-85}$ is the average level of the institutional variable in the period 1985 to 1989.

c) $\bar{X}_{07-00}$ is the average level of the institutional variable in the period 2000 to 2007.

GMM instruments. The main impression is that there are small differences between the results for the two estimation methods, and all variables except for taxes have the same sign (compare the results under "Fixed effects", "Arellano bond, onestep" and "Arellano bond, two step" in table 6). Taken at face value, this shows that the "bias-problem" of the LSDV estimator does not represent a major issue for the parsimonious model. This is as expected for a sample like ours, where the time series are quite long and there are no roots "on" the unit circle.

Table 6: Estimation result for a simplified model with large outlier dummies, fixed effects and Arellano Bond one-step and two-step.

	Fixed effects			Arellano bond, onestep			Arellano bond, twostep		
	Coef.	Std	p-value	Coef.	Std	p-value	Coef.	Std	p-value
Unemployment prev. period	1.37	0.02	0.00	1.19	0.06	0.00	1.17	0.04	0.00
Unemployment two years ago	-0.45	0.02	0.00	-0.40	0.03	0.00	-0.43	0.04	0.00
EPL, two years ago	0.11	0.06	0.07	0.40	0.23	0.08	0.46	0.13	0.00
BRR, two periods ago	0.60	0.20	0.00	0.45	0.63	0.48	0.33	0.62	0.60
Interaction - BRR and BD two periods ago	0.98	0.55	0.07	0.35	1.67	0.83	0.45	1.41	0.75
Interaction - CO and UDNET 1st diff. prev. period	-4.59	2.09	0.03	-6.14	2.74	0.03	-5.30	0.83	0.00
Interaction - CO and TW 1st diff. prev. period	-7.58	2.37	0.00	-8.38	2.75	0.00	-4.89	3.14	0.12
Break by Large outlier approach	0.95	0.04	0.00	0.83	0.05	0.00	0.79	0.02	0.00
Tot. obs and the number of countries	913	20		893	20		893	20	
Standard deviation of residuals	0.59			0.52			0.52		
χ^2 of all the exogenous variables.[a]	26.69	(0.00)		17.32	(0.00)		95.17	(0.00)	
χ^2 of institutional variables (level).[a]	10.99	(0.00)		3.23	(0.20)		11.99	(0.00)	
χ^2 of institutional variables (interaction).[a]	17.00	(0.00)		12.64	(0.01)		49.81	(0.00)	
1st order autocorrelation[a]	1.07	(0.29)		-7.57	(0.00)		-2.22	(0.03)	
2nd order autocorrelation[a]	-0.04	(0.97)		-1.97	(0.05)		-0.46	(0.64)	
Sargan test[a]				16.35	(0.00)		16.35	(0.00)	
Hansen test[a]							13.46	(0.04)	

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

5.2 The role of dynamic specification

We now discuss how the empirical conclusions derived in the previous section depend on the dynamic specification and the exact dating of institutions on unemployment.

The autoregressive part of table 4 "All countries" corresponds to a characteristic equation with three roots; one real root is equal to 0.85 and two roots are complex with moduli equal to 0.59. Since all roots are well inside the unit circle, the model has a stable steady-state solution, which is also consistent with the more formal tests of stationarity in section 3. The absence of a unit root is of course essential since otherwise, the dynamic stability assumption that underlies the existence of an equilibrium level of unemployment would be empirically unfounded. Also the other models with heterogenous residuals and the results from the reduced data set are consistent with the assumption of a stable long-run mean of the rate of unemployment (conditional on a fixed value of the institutions).

The estimated autoregressive coefficients in table 4 "All countries" correspond well with the *a priori* magnitude derived from plausible assumptions for the model parameters which we discussed in section 2: First, the first-order coefficient is large and positive. Second, the coefficient of u_{t-2} is negative and highly significant. And, finally, u_{t-3} is numerically small.

Table 7, model 1 shows the results of an estimation where the autoregressive lags are reduced to one lag, but is otherwise similar to the model in table 4 "All countries". The value of the estimated autoregressive coefficient is close to one. Reduced dynamics therefore implies more persistence in the evolution of the unemployment rate. All the significant institutional variables in table 4 "All countries" are significant in table 7 in model 1, except for the interaction term between benefit replacement ratio and benefit duration. In addition, benefit duration, the 1st difference in union density, and union density in previous period are significant in table 7 in model 1. However, the first order autocorrelation test in the lower part of the table rejects the hypothesis of no autocorrelation. This is a sign of misspecification and it also damages the formal test based on t-values. In this sense our theoretically motivated dynamic specification is supported by the evidence.

As explained in the theoretical section above, the dynamic specification of the institutional variables is based on the assumption that changes in institutions in period $t-1$ jointly affect unemployment and the wage- and price setting in the next period, t. From another perspective, it might be hypothesized that we put institutional variables at a disadvantage by excluding within year effects. Indeed, the specification without lags has been used in previous literature, e.g. Nickell et al. (2005), Bassanini and Duval (2006) and Blanchard and Wolfers (2000).

The estimation results when we change the dynamic specification of institutions are shown in table 7, model 2 and 3. In model 2, all the institutional variables enter contemporaneously and with one lag, while in model 3 the institutions enter with a level this period. As shown in the lower part of table 7, model 2 and 3, the first χ^2-test for the institutional variables in level rejects the hypothesis of no joint effect from labour market institutions on unemployment. However, the χ^2-test for the interaction terms between the institutional variables are insignificant. The autocorrelation tests for model 2 model reject the hypothesis of 1st. and 2nd. order autocorrelation, while the 1st order autocorrelation is not rejected in model 3.

Equation (12) gives the corresponding equilibrium unemployment equation for model 2 in table 7:

$$\begin{aligned} u^* = {} & \mathit{Constant} + \underset{(1.0)}{1.8}\,EPL + \underset{(2.1)}{5.5}\,BRR + \underset{(1.5)}{0.4}\,BD \\ & + \underset{(3.3)}{5.5}\,UDNET - \underset{(0.5)}{0.4}\,CO + \underset{(7.2)}{8.6}\,TW + \underset{(5.0)}{11.0}(BRR - \overline{BRR})(BD - \overline{BD}) \\ & - \underset{(4.6)}{11.9}(CO - \overline{CO})(UDNET - \overline{UDNET}) - \underset{(8.5)}{6.1}\,(CO - \overline{CO})(TW - \overline{TW}) \end{aligned} \tag{12}$$

The estimated coefficients in this equation are not too different from the estimated coefficient in equation 10. We conclude that the exact lag specification is of minor importance for capturing the effect of the institutional variables. This is not surprising given that the labour market institutions change gradually.

Table 7 model 4 also shows the results of a static equation. The estimated coefficients in model 4 are completely different from the other models, and the test of the residual autocorrelation at the end of the table confirms an increasing degree of misspecification, since the test statistics indicate both first- and second-order residual autocorrelation.

Table 7: Estimation results for the fixed effect model with large outlier dummies, different dynamic specifications

	Model 1		Model 2		Model 3		Model 4	
	Coef.	Std	Coef.	Std	Coef.	Std	Coef.	Std
Unemployment previous period	0.95	0.01	1.38	0.03	1.39	0.03		
Unemployment two years ago			-0.52	0.05	-0.54	0.05		
Unemployment three years ago			0.06	0.03	0.07	0.03		
Employment protection (EPL), 1st diff. prev. period	-0.08	0.28						
EPL, two years ago	0.28	0.08						
Empl. protection (EPL), 1st difference			-0.36	0.24				
EPL prev. period			0.14	0.07				
EPL this period					0.11	0.07	-0.87	0.24
Benefit replacement ratio (BRR), 1st diff. prev. period	-0.54	0.94						
BRR, two periods ago	0.72	0.27						
Benefit repl. ratio (BRR), 1st difference			-0.66	0.81				
BRR prev. period			0.41	0.24				
BRR this period					0.50	0.23	5.62	0.80
Benefit duration (BD), 1st diff. prev. period	-1.32	0.63						
BD, two periods ago	-0.13	0.19						
Benefit duration (BD), 1st difference			-0.09	0.55				
BD prev. period			0.02	0.17				
BD this period					0.08	0.17	0.42	0.59
Interaction - BRR and BD, 1st diff. prev. period	-2.53	2.37						
Interaction - BRR and BD two periods ago	0.73	0.72						
Interaction BRR and BD, 1st difference			-0.09	2.04				
Interaction BRR and BD prev. period			0.83	0.63				
Interaction BRR and BD this period					0.96	0.62	16.16	2.13
Interaction - CO and UDNET, 1st diff. prev. period	-6.24	2.51						
Interaction - CO and UDNET two periods ago	-1.28	0.53						
Interaction CO and UDNET, 1st difference			0.28	2.15				
Interaction CO and UDNET prev. period			-0.89	0.46				
Interaction CO and UDNET this period					-0.81	0.45	-3.77	1.63
Interaction - CO and TW, 1st diff. prev. period	-9.79	2.87						
Interaction - CO and TW two periods ago	-0.92	0.92						
Interaction CO and TW, 1st difference			-2.87	2.46				
Interaction CO and TW prev. period			-0.31	0.81				
Interaction CO and TW this period					-0.45	0.80	-1.37	2.78
Union density (UDNET), 1st diff. prev. period	4.54	1.87						
UDNET, two periods ago	0.55	0.32						
Union density (UDNET), 1st difference			6.31	2.00				
UDNET prev. period			0.42	0.29				
UDNET this period					0.52	0.28	4.41	0.98
Coordination (CO), 1st diff. prev. period	-0.08	0.20						
CO, two periods ago	0.03	0.05						
Coordination (CO), 1st difference			0.06	0.17				
CO prev. period			-0.03	0.04				
CO this period					-0.02	0.04	-1.34	0.14
Tax rate (TW), 1st diff. prev. period	-2.89	1.74						
TW, two periods ago	-0.27	0.60						
Tax rate (TW), 1st difference			-1.56	1.52				
TW prev. period			0.70	0.54				
TW this period					0.28	0.53	16.30	1.70
Break by large outlier	0.99	0.05	0.92	0.05	0.94	0.04	0.65	0.17
Tot. obs and the number of countries	851	20	838	20	844	20	886	20
Standard deviation of residuals	0.7		0.6		0.6		2.2	
χ^2 of all the exogenous variables.[a]	497.21	(0.00)	528.53	(0.00)	495.32	(0.00)	549.98	(0.00)
χ^2 of institutional variables (level).[a]	70.42	(0.00)	29.54	(0.00)	12.75	(0.05)	495.24	(0.00)
χ^2 of institutional variables (interaction).[a]	25.26	(0.00)	6.81	(0.34)	5.68	(0.13)	61.57	(0.00)
1st order autocorrelation[a]	3.52	(0.00)	0.09	(0.93)	3.48	(0.00)	3.70	(0.00)
2nd order autocorrelation[a]	0.17	(0.87)	-1.61	(0.11)	0.70	(0.49)	3.64	(0.00)

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

5.3 The role of the structural breaks

As discussed above, we have used two methods for estimation of location-shift variables: "impulse saturation" and "large outliers". As also noted, the "impulse saturation" approach leaves less variation to be explained by changes in institutions as compared to the "large outlier" approach, simply because the "impulse saturation" approach gives more year dummies. Whether this leads to more or less explanatory power of the included variables remains to be seen. As a benchmark model, we also investigate the model where we exclude the break variables.

In table 8, "All countries" shows OLS results for the fixed effects model with breaks estimation determined by the "impulse saturation" method. Compared to table 4 (result with "large outlier"approach), employment protection and the difference in union density are no longer significant, and the effect of tax rates has changed sign even though the effect of taxes is insignificant both in tables 4 and 8.

The autoregressive part of table 8, "All countries" corresponds to a characteristic equation with three real roots equal to 0.91, 0.27 and 0.12, this implies that also this model has a stable steady-state solution.

The long-run solution to the estimated model in table 8 is:

$$\begin{aligned} u^* = {} & Constant + \underset{(1.0)}{1.3}\,EPL + \underset{(2.2)}{8.2}\,BRR + \underset{(1.7)}{0.4}\,BD \\ & + \underset{(3.0)}{0.6}\,UDNET - \underset{(0.5)}{0.9}\,CO - \underset{(6.5)}{2.1}\,TW + \underset{(7.6)}{18.0}(BRR - \overline{BRR})(BD - \overline{BD}) \\ & - \underset{(5.8)}{12.8}(CO - \overline{CO})(UDNET - \overline{UDNET}) - \underset{(6.8)}{5.6}\,(CO - \overline{CO})(TW - \overline{TW}) \end{aligned} \tag{13}$$

We observe that the benefit replacement ratio alone, the interaction with benefit duration, and the interaction between coordination and union density all have significant effects on unemployment. The long-run effects correspond well with the variables that have low p-values in table 8. Compared to the long-run solution in equation (10), the significant estimated coefficients have nearly the same magnitude in both equations, while the insignificant variable taxes, has changed sign.

Figure 3 shows the average dynamic simulated unemployment rate of equation (9) with the estimated coefficient values from "All countries" in tables 4 and 8 and appendix table B1. The motivation for bringing in the appendix result is that this model is estimated without any location-shift variable, hence the corresponding simulated solution is denoted "without breaks" in figure 3. The model with "impulse saturation" has a visually better fit than the model with "large outlier", and the estimated unweighted average unemployment rate in OECD with "impulse saturation" is 5.8 percent and closer to the actual average unemployment rate than the model with dummies from the "large outlier" data series.

A simulation with constant and timevarying institutions illustrates the quantitative effect of institutions on the average OECD unemployment rate. The importance of the institutional changes for the development of unemployment appears to be stronger with the "impulse saturation", i.e. with the larger number of breaks, since the gap between simulated unemployment with and without time-varying institutions is visually larger in figure 4 than in figure 2. This result is achieved despite of the fact that the first model leaves less of the variation to be explained by institutions. This could illustrate the importance of controlling for other factors influencing unemployment to achieve the true effect of institutions.

The results of the long-run steady-state projections are presented in figure 5. The models "All countries" in tables 4 and 8 and appendix table B1, where the latter is found in appendix B, extending into the future the end-of-sample values of the institutional variables and assuming no future location-shifting breaks in the rate of unemployment. This gives some insight into the speed of unemployment adjustment. It also gives a

Table 8: Estimates from the fixed effect model with saturation breaks

	All countries		All countries[a]		Heterosc.		Red. data set[b]	
	Coef.	Std	Coef.	Std	Coef.	Std	Coef.	Std
Unemployment prev. period	1.30	0.02	1.26	0.02	1.35	0.02	1.30	0.02
Unemployment two years ago	-0.39	0.04	-0.34	0.04	-0.49	0.04	-0.39	0.04
Unemployment three years ago	0.03	0.02	-0.00	0.02	0.08	0.02	0.03	0.02
Employment protection (EPL), 1st diff. prev. period	0.10	0.19	0.00	0.17	0.16	0.17	0.10	0.19
EPL, two years ago	0.08	0.05	0.05	0.05	0.10	0.05	0.08	0.05
Benefit replacement ratio (BRR), 1st diff. prev. period	-0.90	0.63	-0.88	0.59	-0.19	0.53	-0.90	0.63
BRR, two periods ago	0.52	0.19	0.34	0.17	0.45	0.16	0.52	0.19
Benefit duration (BD), 1st diff. prev. period	-0.18	0.43	-0.07	0.40	-0.21	0.33	-0.18	0.43
BD, two periods ago	0.02	0.13	-0.10	0.13	0.13	0.10	0.02	0.13
Interaction - BRR and BD 1st diff. prev. period	-2.01	1.59	-1.63	1.46	-0.29	1.29	-2.01	1.59
Interaction - BRR and BD two periods ago	1.16	0.49	1.06	0.45	1.23	0.43	1.16	0.49
Interaction - CO and UDNET 1st diff. prev. period	-6.73	1.69	-6.08	1.56	-4.70	1.87	-6.73	1.69
Interaction - CO and UDNET two periods ago	-0.84	0.36	-0.92	0.33	-1.33	0.28	-0.84	0.36
Interaction - CO and TW 1st diff. prev. period	-4.43	1.95	-4.00	1.81	-2.35	1.53	-4.43	1.95
Interaction - CO and TW two periods ago	-0.19	0.63	-0.09	0.58	0.01	0.49	-0.19	0.63
Union density (UDNET), 1st diff. prev. period	-0.31	1.58	1.19	1.52	0.33	1.45	-0.31	1.58
UDNET, two periods ago	0.03	0.22	0.08	0.24	0.08	0.19	0.03	0.22
Coordination (CO), 1st diff. prev. period	0.07	0.13	0.13	0.12	-0.06	0.13	0.07	0.13
CO, two periods ago	-0.06	0.03	-0.05	0.03	-0.06	0.03	-0.06	0.03
Tax rate (TW), 1st diff. prev. period	0.74	1.19	1.83	1.13	1.84	1.01	0.74	1.19
TW, two periods ago	-0.09	0.42	-0.23	0.45	0.08	0.35	-0.09	0.42
Saturation break	0.93	0.03	0.83	0.03	0.90	0.03	0.93	0.03
Tot. obs and the number of countries	837	20	837	20	837	20	837	20
Standard deviation of residuals	0.5		0.4		0.5		0.5	
χ^2 of all the exogenous variables.[c]	1397.41	(0.00)	1079.91	(0.00)	1401.92	(0.00)	1397.41	(0.00)
χ^2 of institutional variables (level).[c]	43.96	(0.00)	47.17	(0.00)	59.27	(0.00)	43.96	(0.00)
χ^2 of institutional variables (interaction).[c]	33.42	(0.00)	33.71	(0.00)	44.04	(0.00)	33.42	(0.00)
1st order autocorrelation[c]	0.62	(0.53)	0.62	(0.53)	0.62	(0.53)	0.74	(0.46)
2nd order autocorrelation[c]	-0.30	(0.76)	-0.30	(0.76)	-0.30	(0.76)	-0.17	(0.87)

a) With time dummies.
b) Without New Zealand and Switzerland.
c) Numbers in parenthesis are p-values for the relevant null.

picture of the implied equilibrium level of unemployment, u^*, based on the assumptions just mentioned. The steady-state solution of the estimated dynamic model in table 4 is, in practice, determined by simulation, keeping the institutional variables fixed at their 2007 level, and by switching off the “large outlier breaks”. The simulated unemployment rate will then converge to a steady state. The effect of the “large outlier breaks” influences the estimates of the institutional variables and the autoregressive parameter, even though they only have a temporary effect.

The graphs in figure 5 also show that even controlling for shocks that are impulses rather than step-functions is important for the estimated level of equilibrium unemployment. Intuitively, when the structural breaks explain a larger part of the growth in unemployment, the simulation until 2037 when no structural breaks are imposed, leads to lower unemployment. The figure illustrates that “impulse saturation” gives the lowest estimate for equilibrium unemployment, then comes “large outlier” and the highest level is the model without any dummy included.

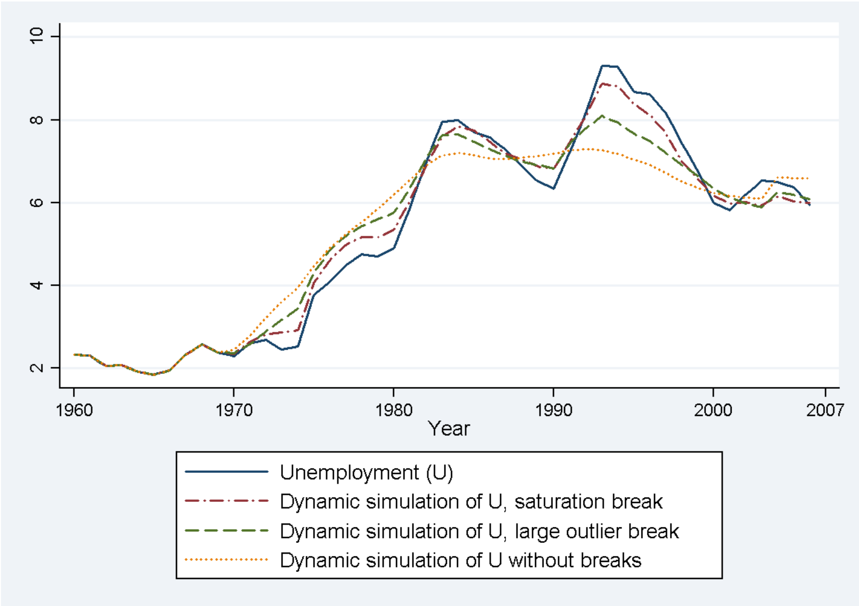

Figure 3: Dynamic simulation of unemployment by using the estimates in tables 8, 4 and B1, "All countries", where the latter is found in appendix B

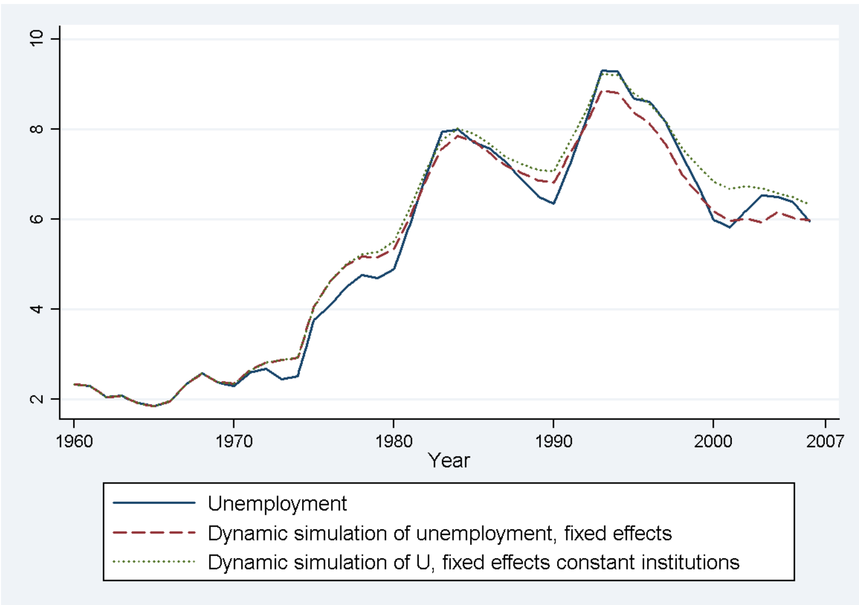

Figure 4: Dynamic simulation coefficient values from the estimation in table 8, "All countries" (saturation break) with and without time varying institutions, unweighed average of the unemployment rate in OECD

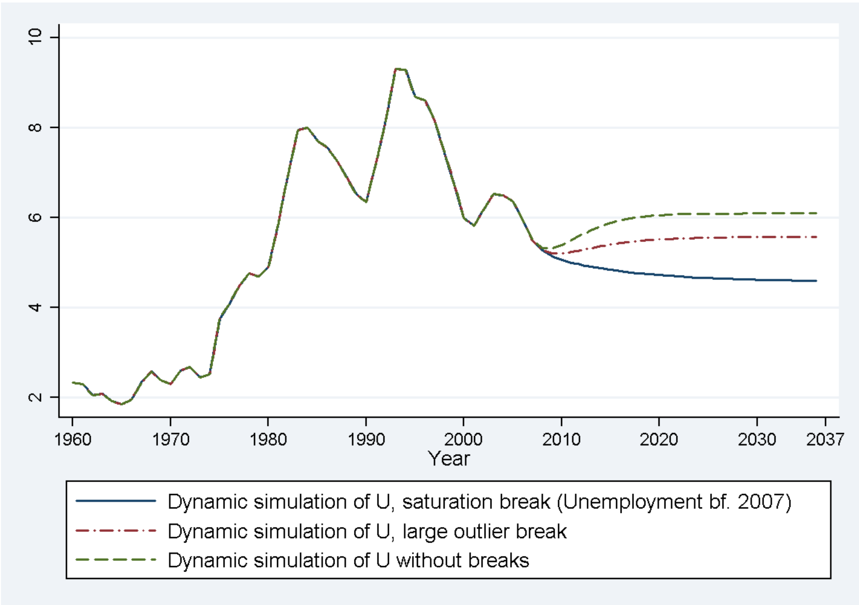

Figure 5: Dynamic simulation of estimates in tables 8, 4 and B1, where the latter is found in appendix B from 2007 to 2037. The unweighed average of the unemployment rate in OECD, within sample

6 Conclusions

The results in this paper confirm earlier findings that labour market institutions have a significant effect on the OECD unemployment rate. The estimated long-term effects of the institutions all have the signs as expected from theory (maybe with one exception, a increase in the union density leads to higher unemployment, but the effect is not significant). The most relevant result from this study is the following: unemployment is increasing in the level of employment protection, the unemployment benefit replacement ratio, and the interaction between benefit replacement ratio and benefit duration. An increase in the interaction between coordination and union density decreases unemployment. These results imply that appropriate institutional reforms have the potential of lowering equilibrium unemployment.

The results also show that the labour market institutions have to change quite substantially to achieve a sizeable reduction in the unemployment rate. For instance, the isolated effect of a reduction in benefit replacement ratio of 20 percent, from the OECD average in 2007, will lower the average OECD unemployment rate by 0.8 percentage points. This effect is half the size of the estimated long-run effect of the unemployment benefit replacement ratio that was found in Nickell et al. (2005). The small effect of institutions is consistent with historical evidence, a simulation of our main unemployment equation with and without time varying institutions reveal a small effect of institutions over the sample period, but one should be aware of the fact that on average there have been small changes in the institutional variables over the sample period.

Over the same period, we find that the actual rates of unemployment have reacted to shocks in a way that has dominated the evolution of the unemployment rate. We suggest to treat the rate of unemployment as a variable which is subject to intermittent structural breaks, that may lead to location-shifts. The argument is that the effect of changes in institutional variables on unemployment are likely to be gradual, and are modelled by relatively long lags in accordance with theory. The intermittent but large changes in the unemployment rate from one year to another is treated as caused by other factors than institutions, like extraneous or domestic demand shocks, changes in households' preferences for work and leisure, or changes in pro-or counter-cyclical economic policies. We call these changes structural breaks. We have chosen two statistical methods of detecting such shocks, "large outliers" and "impulse saturation".

The inclusion of structural breaks that capture location shifts in the distributions for the unemployment rates turns out to be important for our estimate of the equilibrium rate. If we do not correct for these structural breaks, the equilibrium rate is simulated to almost 6.2 percent, while the lowest adjusted estimate is 4.3 percent. However, comparing the simulation of the two models with structural breaks shows that the model with more breaks illustrate a larger gap between time varying and constant institutions. This might illustrate the importance of controlling for other factors influencing unemployment in order to achieve the true effect of institutions.

In terms of modelling methodology, this paper has also illustrated the importance of the dynamic specification of the panel data model for the rate of unemployment. We show that a reduced lag structure on the autoregressive coefficients increases the residual autocorrelation, which might be a sign of misspecification. The chosen dynamic specification is derived theoretically and has the status of a final equation of a system consisting of equations for wage and price setting and an equation of unemployment as a function of the real exchange rate. The theoretical derivation gives *a priori* assumptions regarding the magnitude of the autoregressive coefficients. The assumptions are confirmed by the empirical evidence. On the other hand our results also show that the exact lag structure of the institutional variables are of minor importance for capturing the effects of labour market institutions on unemployment.

In this paper, the shocks have been identified using the automatic model specification for each country. An interesting extension and improvement of this methodology is to use the panel dimension also in the identification of the structural breaks. Another extension is to provide interval estimates for equilibrium rate of unemployment.

Appendix A The Data: Definitions and sources

This appendix contains information about variables that are important for the evolution of the unemployment rate in 20 OECD countries. The countries in the sample are:

Australia	Finland	Japan	Spain
Austria	France	Netherlands	Sweden
Belgium	Germany	Norway	Switzerland
Canada	Ireland	New Zealand	United Kingdom
Denmark	Italy	Portugal	United States

The variables in this data set are divided into two groups; economic variables and labour market institutions. This data set contains observations from 1960 to 2007.

A.1 Economic variables

The economic variables are available at a yearly frequency in OECD (2008a)[5] and missing observations are replaced with observations from earlier data bases OECD (2002), OECD (2006) and OECD (2008b).[6] **U: Unemployment rate**
The standardized unemployment rate (UNR) in Economic Outlook OECD (2008a) is used as a primary data source for the unemployment rate in the OECD countries, and missing observations are replaced by the growth rate in a corresponding time series in an earlier data base, OECD (2002). Australia, Denmark, Germany, Spain and Switzerland are prolonged by the formula in equation (A1):

$$Y_{it} = Y_{it+1} * \frac{X_{it}}{X_{it+1}} \tag{A1}$$

where Y_{it} denotes (UNR) in OECD (2008a) and X_{it} denotes the (UNR) in the earlier data base OECD (2002) for country i in time period t. Australia and Denmark are prolonged five years backwards. Germany from 1991, Spain from 1976, Switzerland from 1969 and backwards. The actual development in unemployment in the sample period is presented in table A1

A.2 Labour market institutions

New information for institutional variables is available every second or fifth year. Labour market institutions such as the tax wedge, union density, coordination among wage setters, and benefit replacement ratio and duration are used in this paper. The variables and the method of combining data sources are discussed in detail in the next sections. **TW: Tax wedge**
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' total wage costs calculated by the sum of wages received by employees and taxes payed by the employer to the government. This gives the following relationship; $t1 = SSRG/(IE - SSRG)$, where SSRG is social security contributions and IE is compensation to employees. The latter two consist of two main components, wages and salaries and social contributions. Social contributions are payed by the employers to

[5] Data are collected and organized by the author. This implies that neither OECD nor any other source is responsible for the analysis or the interpretation of the data in this paper.

[6] An comprehensive overview of data and data sources is available upon request.

Table A1: Average unemployment in the OECD countries. Percent

Country	1960-64	1965-72	1973-79	1980-87	1988-95	1996-01	2002-07
Australia	1.75	1.79	4.66	7.70	8.41	7.33	5.31
Austria	1.70	1.42	1.38	3.25	4.89	5.49	5.67
Belgium	1.48	1.48	4.23	9.61	8.05	8.34	8.05
Canada	6.00	4.76	6.98	9.84	9.53	8.11	6.92
Denmark	1.07	1.04	3.56	6.48	7.50	5.00	4.62
Finland	1.41	2.41	4.14	5.17	10.85	11.54	8.34
France	1.18	1.95	3.71	7.67	9.10	9.66	8.48
Germany	0.69	0.86	3.06	6.56	6.94	8.31	9.29
Ireland	5.32	5.82	8.08	14.05	14.68	7.30	4.47
Italy	3.46	4.17	4.87	7.96	9.91	10.81	7.71
Japan	1.34	1.24	1.84	2.52	2.46	4.22	4.62
Netherlands	0.57	1.26	3.57	8.28	6.60	4.29	4.03
New Zealand	0.08	0.29	0.74	3.95	8.14	6.37	4.12
Norway	1.71	1.53	1.74	2.44	5.13	3.69	3.89
Portugal	2.46	3.91	5.63	8.23	5.48	5.23	6.90
Spain	1.78	2.31	4.04	14.51	15.00	13.61	9.76
Sweden	2.11	2.61	2.62	3.59	6.22	9.06	6.92
Switzerland	0.03	0.01	0.29	0.63	2.24	3.30	3.99
UK	2.79	3.40	4.81	10.44	8.77	6.31	5.10
United States	5.72	4.47	6.51	7.75	6.16	4.63	5.27
Total	2.14	2.34	3.82	7.03	7.80	7.13	6.17

social security schemes or private funded social insurance schemes. $t2$, are direct taxes payed by the households (TAXh) divided by current receipts of households (CRh), i.e. $t2 = TAXh/CRh$. Finally $t3 = (TAXind - SUB)/Cp$, where TAXind are net indirect taxes, SUB is the value of subsidies and Cp is the value of private final consumption expenditure. The main data source for tax wedges is OECD (2008c) which contains information for the period 1960 to 2010. The latter years are predictions. The tax rates are calculated by the formulas above, and when a tax rate is missing, the growth rate in the same tax rate but from the data base of Nickell (2006) in the period 1960 to 2003 is used to prolong the time series for the following countries: Belgium is prolonged before 1965, Denmark is prolonged before 1966, Germany before 1970, Portugal is prolonged in the period 1960 to 1995 and Switzerland is prolonged before 1990 with the tax rates in OECD (2008c). Tax rates for Australia, Austria, Canada, Finland, France, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States are not prolonged and are taken directly from the main data source OECD (2008c). New Zealand has the main data source Nickell et al. (2005) for the period 1975 to 1986 due to missing observations in OECD (2008c). Time series for $t1$, $t2$ and $t3$ from Nickell (2006) are used to extend the main data source: The growth rate of the sum of $t1$ and $t2$ is used before 1975, and the growth rate in $t3$ after 1986. Note also that the $t3$ is interpolated due to one missing observation in 1991. The actual development in the tax rates are found in table A2. **BRR: Benefit replacement rates**

The benefit replacement ratio is a measure of how much each unemployed worker receives in benefits from the government. The benefit replacement ratio is described in detail below. The detailed rate for unemployment benefits divides data in three different family types: single, with a dependent spouse and with a working spouse. The benefits also depend on the employment situation: 67 percent and 100 percent of the average earnings. Within these groups, benefits are divided into the duration of benefits when being unemployed. One variable for how much each of the former groups receives in the first year, the second and third year and the fourth and fifth year. This results in six different groups:

Table A2: Average tax rate in the OECD countries

Country	1960-64	1965-72	1973-79	1980-87	1988-95	1996-01	2002-07
Australia	0.23	0.26	0.31	0.35	0.34	0.36	0.37
Austria	0.43	0.48	0.50	0.52	0.52	0.54	0.54
Belgium	0.47	0.51	0.51	0.53	0.59	0.60	0.61
Canada	0.30	0.37	0.38	0.40	0.46	0.47	0.44
Denmark	0.43	0.53	0.53	0.58	0.59	0.63	0.63
Finland	0.41	0.44	0.50	0.54	0.64	0.69	0.68
France	0.66	0.60	0.56	0.60	0.63	0.66	0.64
Germany	0.45	0.45	0.47	0.47	0.47	0.48	0.49
Ireland	0.31	0.35	0.37	0.40	0.42	0.44	0.49
Italy	0.39	0.37	0.36	0.43	0.53	0.64	0.64
Japan	0.24	0.25	0.27	0.31	0.34	0.34	0.35
Netherlands	0.39	0.43	0.48	0.50	0.47	0.45	0.48
New Zealand	0.32	0.32	0.29	0.32	0.40	0.37	0.38
Norway	0.51	0.55	0.57	0.58	0.56	0.59	0.58
Portugal	0.2	0.25	0.26	0.33	0.40	0.44	0.48
Spain	0.20	0.25	0.31	0.40	0.45	0.46	0.51
Sweden	0.38	0.50	0.61	0.69	0.74	0.76	0.75
Switzerland	0.16	0.17	0.21	0.21	0.21	0.24	0.24
United Kingdom	0.34	0.39	0.37	0.40	0.39	0.39	0.40
United States	0.28	0.29	0.30	0.30	0.31	0.32	0.30
Total	0.36	0.39	0.41	0.44	0.47	0.49	0.50

brr67a1, brr67a2, brr67a4, brr100a1, brr100a2 and brr100a4. brr67a1: First year benefit replacement rate for workers with 67 percent of average earnings and the average over family types. brr67a2: Benefit replacement rate for the second and third year. 67 percent of average earnings and the average over family types brr67a4: Benefit replacement rate for the fourth and fifth year. 67 percent of average earnings and the average over family types brr100a1, brr100a2 and brr100a4: The same as the former but for 100 percent of average earnings. The main source for the more detailed benefit ratios is tables in employment outlook, see OECD (2004). Observations are provided every second year from 1961 to 2001. The time series are interpolated over the years, and extracted by the last known observation. The actual development in the sample period is presented in table A3 **BD: Benefit duration**

Benefit duration is a measure of how long the benefits last when being unemployed. The ratio is calculated by the time series described under benefit replacement rates and equation (A3).

$$BDj_{it} = \alpha \frac{brrja2_{it}}{brrja1_{it}} + (1-\alpha)\frac{brrja4_{it}}{brrja1_{it}} \tag{A3}$$

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 A4.

UDNET: Union density

Union density rates are constructed using the number of union memberships divided by

Table A3: Average benefit replacement ratio in the OECD countries

Country	**1960-64**	**1965-72**	**1973-79**	**1980-87**	**1988-95**	**1996-01**	**2002-07**
Australia	0.18	0.15	0.22	0.23	0.26	0.24	0.19
Austria	0.16	0.16	0.28	0.34	0.34	0.40	0.40
Belgium	0.39	0.37	0.55	0.51	0.48	0.46	0.44
Canada	0.40	0.40	0.60	0.57	0.58	0.52	0.50
Denmark	0.36	0.53	0.79	0.78	0.74	0.66	0.65
Finland	0.20	0.25	0.37	0.43	0.60	0.52	0.35
France	0.47	0.51	0.46	0.59	0.58	0.60	0.61
Germany	0.43	0.42	0.39	0.39	0.38	0.37	0.38
Ireland	0.21	0.24	0.39	0.51	0.41	0.35	0.36
Italy	0.10	0.07	0.04	0.02	0.09	0.45	0.66
Japan	0.36	0.37	0.33	0.28	0.30	0.36	0.40
Netherlands	0.32	0.64	0.65	0.67	0.70	0.70	0.71
New Zealand	0.39	0.30	0.27	0.30	0.29	0.29	0.32
Norway	0.12	0.12	0.24	0.53	0.62	0.63	0.65
Portugal	0.00	0.00	0.14	0.39	0.65	0.66	0.70
Spain	0.17	0.50	0.58	0.74	0.68	0.63	0.64
Sweden	0.24	0.31	0.70	0.85	0.87	0.77	0.74
Switzerland	0.17	0.12	0.27	0.50	0.67	0.72	0.74
United Kingdom	0.27	0.35	0.34	0.27	0.22	0.20	0.19
United States	0.22	0.23	0.28	0.31	0.25	0.29	0.29
Total	0.26	0.30	0.40	0.46	0.49	0.49	0.50

Table A4: Average benefit duration in the OECD countries

Country	**1960-64**	**1965-72**	**1973-79**	**1980-87**	**1988-95**	**1996-01**	**2002-07**
Australia	1.02	1.02	1.02	1.02	1.02	1.01	1.00
Austria	0.00	0.00	0.58	0.75	0.75	0.73	0.78
Belgium	1.00	0.99	0.78	0.79	0.77	0.78	0.80
Canada	0.32	0.33	0.19	0.24	0.23	0.35	0.39
Denmark	0.45	0.49	0.60	0.62	0.69	0.97	0.90
Finland	0.00	0.04	0.65	0.60	0.51	0.66	0.80
France	0.30	0.24	0.20	0.35	0.49	0.50	0.62
Germany	0.57	0.57	0.61	0.61	0.61	0.70	0.81
Ireland	0.67	0.78	0.45	0.38	0.55	0.75	0.75
Italy	0.00	0.00	0.00	0.00	0.00	0.25	0.40
Japan	0.00	0.00	0.00	0.00	0.00	0.04	0.17
Netherlands	0.03	0.35	0.49	0.65	0.60	0.60	0.67
New Zealand	1.02	1.02	1.02	1.03	1.04	1.01	1.00
Norway	0.00	0.02	0.43	0.49	0.50	0.56	0.60
Portugal	0.00	0.00	0.00	0.07	0.35	0.51	0.66
Spain	0.00	0.00	0.00	0.19	0.26	0.31	0.35
Sweden	0.00	0.00	0.04	0.05	0.05	0.05	0.04
Switzerland	0.00	0.00	0.00	0.00	0.07	0.29	0.30
United Kingdom	0.89	0.63	0.54	0.69	0.71	0.80	0.84
United States	0.08	0.16	0.19	0.16	0.19	0.21	0.20
Total	0.32	0.33	0.39	0.44	0.47	0.55	0.60

Table A5: Average union density in the OECD countries

Country	1960-64	1965-72	1973-79	1980-87	1988-95	1996-01	2002-07
Australia	0.48	0.45	0.49	0.46	0.38	0.27	0.21
Austria	.	0.62	0.59	0.53	0.45	0.38	0.34
Belgium	0.40	0.42	0.52	0.52	0.54	0.53	0.53
Canada	0.28	0.30	0.34	0.34	0.33	0.31	0.30
Denmark	0.57	0.59	0.71	0.79	0.76	0.75	0.71
Finland	0.35	0.47	0.66	0.69	0.77	0.77	0.72
France	0.20	0.21	0.21	0.15	0.10	0.08	0.08
Germany	0.34	0.32	0.35	0.35	0.32	0.26	0.22
Ireland	0.49	0.56	0.62	0.61	0.55	0.41	0.35
Italy	0.25	0.32	0.48	0.45	0.39	0.36	0.34
Japan	0.34	0.35	0.33	0.30	0.25	0.22	0.19
Netherlands	0.41	0.39	0.37	0.30	0.25	0.24	0.21
New Zealand	.	0.57	0.62	0.59	0.40	0.23	0.22
Norway	0.60	0.57	0.54	0.58	0.58	0.55	0.55
Portugal	.	.	0.59	0.43	0.26	0.21	0.19
Spain	.	.	.	0.10	0.15	0.16	0.15
Sweden	0.66	0.68	0.75	0.80	0.82	0.81	0.76
Switzerland	0.24	0.25	0.27	0.26	0.23	0.21	0.20
United Kingdom	0.40	0.42	0.49	0.48	0.38	0.30	0.29
United States	0.29	0.27	0.23	0.19	0.15	0.13	0.12
Total	0.38	0.42	0.48	0.45	0.40	0.36	0.34

the number of employed. The main data source is Visser (Visser), 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 database Nickell (2006) contains additional information for Sweden before 1975 and Ireland in 1960. The time series for Sweden in the latter source is interpolated, and this growth rate is then used to prolong the original time series from Visser (Visser). 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 A5 **CO: Coordination of wage setting**

The index for coordination of wage setting describes the coordination level in the wage setting. The index ranges from 1 to 5, and the most coordinated countries have an index equal to 5: The main source is OECD (2004), see table 3.5. The frequency for observations are five-year intervals over the period 1970-2000. The years are interpolated between means, i.e. between 1972-1977, and with 1970 and 2000 equal to the first and last five-year intervals. In the period 1960 to 1970, the observations are prolonged backwards by the last known observation for all countries. The same procedure is used to extend the time series until 2007. The actual development in coordination is found in table A6.

EPL: Employment protection

The time series for employment protection measures the strictness of the employment protection for the employer. The overall measure for employment protection is measured on a scale from 0 to 5. Strictness is increasing in scale. Some other measures only measure the employment protection for regular- or temporary employment. The time series for employment protection is provided by OECD (2004) for the period 1985 to 2004. The time series are based on the point observations in Annex 2.A2. 6. Note, however, that OECD (2004) claims that judgement is made when constructing the time series. That implies that time series for employment protection not are only a linear interpolation between the point observations. The measure of employment protection refers to the protection of overall employment (EPL). Before 1985, the time series are prolonged backwards using

Table A6: Average coordination in the OECD countries

Country	**1960-64**	**1965-72**	**1973-79**	**1980-87**	**1988-95**	**1996-01**	**2002-07**
Australia	4.00	4.00	4.04	4.28	2.50	2.00	2.00
Austria	5.00	5.00	4.96	4.35	4.00	4.00	4.00
Belgium	4.00	4.00	3.69	3.96	4.07	4.48	4.50
Canada	1.00	1.00	2.26	1.15	1.00	1.00	1.00
Denmark	5.00	5.00	4.83	3.53	3.40	3.97	4.00
Finland	5.00	5.00	4.91	4.45	5.00	5.00	5.00
France	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Germany	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Ireland	4.00	4.00	3.74	1.79	3.63	4.00	4.00
Italy	2.00	2.00	2.13	2.83	2.90	3.97	4.00
Japan	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Netherlands	3.00	3.00	3.76	4.28	4.00	4.00	4.00
New Zealand	4.00	4.00	4.00	4.00	1.75	1.00	1.00
Norway	4.50	4.50	4.41	3.95	4.50	4.50	4.50
Portugal	5.00	5.00	4.20	3.08	3.75	4.00	4.00
Spain	5.00	5.00	4.29	3.81	3.13	3.00	3.00
Sweden	4.00	4.00	3.96	3.35	3.00	3.00	3.00
Switzerland	4.00	4.00	4.00	4.00	4.00	4.00	4.00
United Kingdom	3.00	3.00	3.46	1.23	1.00	1.00	1.00
United States	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	3.67	3.67	3.68	3.25	3.13	3.20	3.20

data from Belot and van Ours (2004). The source contains data in five-year intervals, but the data are here used annually by interpolation between the means of the observation points. The percentage change is used to prolong the time series in OECD (2004), by equation (A4):

$$Y_t = Y_{t+1} * \frac{X_t}{X_{t+1}} \ where\ Y = epl\ and\ X = ERTOT\_bo \tag{A4}$$

Portugal and Spain are prolonged backwards by the last known observation in the period 1960 to 1984. The United States is prolonged backwards by the last known observation in the period 1960 to 1982. The actual development in employment protection is found in table A7.

Table A7: Average employment protection in the OECD countries

Country	**1960-64**	**1965-72**	**1973-79**	**1980-87**	**1988-95**	**1996-01**	**2002-07**
Australia	0.54	0.54	0.54	0.76	0.90	1.20	1.20
Austria	2.20	2.20	2.20	2.20	2.20	2.20	1.95
Belgium	3.32	3.32	3.43	3.30	3.20	2.37	2.20
Canada	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Denmark	2.01	2.01	2.01	2.16	2.19	1.40	1.40
Finland	1.46	1.78	2.30	2.30	2.22	2.08	2.00
France	3.89	4.11	4.11	3.35	2.93	3.00	3.00
Germany	3.52	3.58	3.65	3.43	3.17	2.60	2.25
Ireland	0.63	0.63	0.75	0.89	0.90	0.90	1.07
Italy	3.85	3.91	3.94	3.77	3.60	2.83	1.94
Japan	1.97	1.97	2.07	2.16	2.12	1.90	1.80
Netherlands	2.35	2.35	2.67	2.74	2.70	2.40	2.10
New Zealand	0.90	0.90	0.90	0.90	0.90	1.10	1.50
Norway	3.95	3.95	3.33	2.92	2.88	2.67	2.60
Portugal	4.19	4.19	4.19	4.19	3.95	3.70	3.57
Spain	3.80	3.80	3.80	3.80	3.63	2.97	3.10
Sweden	3.89	3.82	3.55	3.49	3.12	2.25	2.20
Switzerland	0.73	0.76	1.02	1.10	1.10	1.10	1.10
United Kingdom	0.51	0.52	0.57	0.60	0.60	0.63	0.70
United States	0.00	0.00	0.00	0.10	0.20	0.20	0.20
Total	2.23	2.26	2.29	2.25	2.16	1.91	1.83

Appendix B

Estimation results of equation (9) without break variables. The results presented here are used to simulate figure 3 and 5 in section 5.3. The figures illustrate the effect of demand shocks for unemployment. The results without any location-shift variables serve as references and are therefore relegated to the appendix.

Table B1: Estimates from the fixed effect model without dummy variable.

	All countries			Heterogenous residuals			Reduced dataset[a]		
	Coef.	Std	p-value	Coef.	Std	p-value	Coef.	Std	p-value
Unemployment previous period	1.39	0.03	0.00	1.49	0.03	0.00	1.40	0.04	0.00
Unemployment two years ago	-0.56	0.06	0.00	-0.75	0.06	0.00	-0.57	0.06	0.00
Unemployment three years ago	0.07	0.03	0.05	0.17	0.03	0.00	0.07	0.04	0.06
Employment protection (EPL), 1st difference previous period	0.08	0.29	0.78	0.06	0.25	0.81	0.10	0.31	0.76
EPL, two years ago	0.16	0.08	0.05	0.17	0.07	0.01	0.17	0.09	0.06
Benefit replacement ratio (BRR), 1st difference previous period	0.44	1.00	0.66	-0.10	0.82	0.90	0.49	1.04	0.64
BRR, two periods ago	0.95	0.29	0.00	0.72	0.23	0.00	0.94	0.32	0.00
Benefit duration (BD), 1st difference previous period	-0.87	0.67	0.20	-0.33	0.50	0.52	-0.79	0.69	0.25
BD, two periods ago	-0.19	0.21	0.37	-0.03	0.17	0.85	-0.13	0.22	0.54
Interaction - BRR and BD 1st difference previous period	1.24	2.49	0.62	0.03	1.89	0.99	1.13	2.65	0.67
Interaction - BRR and BD two periods ago	1.66	0.77	0.03	1.18	0.60	0.05	1.82	0.84	0.03
Interaction - CO and UDNET 1st difference previous period	-2.40	2.65	0.36	-0.86	2.82	0.76	-3.05	3.00	0.31
Interaction - CO and UDNET two periods ago	-1.22	0.57	0.03	-1.49	0.43	0.00	-1.53	0.65	0.02
Interaction - CO and TW 1st difference previous period	-13.29	3.04	0.00	-6.90	2.34	0.00	-14.20	3.31	0.00
Interaction - CO and TW two periods ago	-0.48	0.99	0.63	-0.33	0.78	0.67	-0.25	1.03	0.81
Union density (UDNET), 1st difference previous period	-0.22	2.49	0.93	-1.11	2.21	0.61	0.18	2.82	0.95
UDNET, two periods ago	0.66	0.35	0.06	0.49	0.32	0.12	0.85	0.38	0.03
Coordination (CO), 1st difference previous period	-0.54	0.20	0.01	-0.51	0.20	0.01	-0.47	0.22	0.03
CO, two periods ago	-0.06	0.05	0.22	-0.03	0.05	0.56	-0.04	0.05	0.40
Tax rate (TW), 1st difference previous period	0.03	1.87	0.99	1.72	1.57	0.27	0.55	1.99	0.78
TW, two periods ago	1.28	0.66	0.05	1.14	0.55	0.04	1.15	0.70	0.10
Tot. obs and the number of countries	837	20		837	20		761	18	
Standard deviation of residuals	0.7			0.7			0.7		
χ^2 of all the exogenous variables.[b]	66.78	(0.00)		51.98	(0.00)		60.92	(0.00)	
χ^2 of institutional variables (level).[b]	66.78	(0.00)		51.98	(0.00)		60.92	(0.00)	
χ^2 of institutional variables (interaction).[b]	28.63	(0.00)		25.85	(0.00)		28.49	(0.00)	
1st order autocorrelation[b]	-0.18	(0.86)		-0.18	(0.86)		0.51	(0.61)	
2nd order autocorrelation[b]	0.61	(0.54)		0.61	(0.54)		-1.48	(0.14)	

a) Without New Zealand and Switzerland.
b) Numbers in parenthesis are p-values for the relevant null.

Appendix C Additional results for section 2.

We first find the coefficients in the reduced form for the mode in equation (1). For re_t :

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

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

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

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

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

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

References

Baltagi, B. H. (2008). *Econometric Analysis of Panel Data.* UK: John Wiley & Sons, Ltd.

Bårdsen, G. and R. Nymoen (2003). Testing steady-state implications for the NAIRU. *Review of Economics and Statistics 85*, 1070—1075.

Bassanini, A. and R. Duval (2006). "The determinants of unemployment across OECD countries: reassessing the role of policies and institutions". *OECD Economic Studies 2006*(1).

Belot, M. and J. C. van Ours (2001). Unemployment and Labor Market Institutions: An Empirical Analysis. *Journal of the Japanese and International Economies 15*(4), 403–418.

Belot, M. and J. C. van Ours (2004). Does the recent success of some OECD countries in lowering their unemployment rates lie in the clever design of their labor market reforms? *Oxford Economic Papers 56*(4), 621–642.

Bjørnstad, R. and K. O. Kalstad (2010). Increased Price Markup from Union Coordination - OECD Panel Evidence. *Economics: The Open-Access, Open-Assessment E-Journal 4*(2010-30).

Blanchard, O. (2006). A review of "Unemployment. Macroeconomic Performance and the Labour Market", by Richard Layard, Stephen Nickell, and Richard Jackman.

Blanchard, O. (2009). *Macroeconomics* (5 ed.). New Jersey: Pearson Education.

Blanchard, O. and J. Wolfers (2000, March). The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence. *Economic Journal 110*(462), C1–33.

Calmfors, L., J. Driffill, S. Honkapohja, and F. Giavazzi (1988). Bargaining Structure, Corporatism and Macroeconomic Performance. *Economic Policy 3*(6), 14–61.

Camarero, M., Josep, and C. Tamarit (2006, April). Testing for Hysteresis in Unemployment in OECD Countries: New Evidence using Stationarity Panel Tests with Breaks. *Oxford Bulletin of Economics and Statistics 68*(2), 167–182.

Castle, J., J. Doornik, and J. F. Hendry (2010). Evaluating automatic model selection. *Journal of Time Series Econometrics*. Forthcoming.

Doornik, J. A. (2009). Autometrics. In J. Castle and N. Shephard (Eds.), *The Methodology and Practise of Econometrics*, Chapter 8, pp. 88—121. Oxford: Oxford Univeristy Press.

Hendry, D. and G. Mizon (2010). Econometric modelling of time serie with outlying observations. *Journal of Time Series Econometrics*. Forthcoming.

Holden, S. (2005, May). Monetary regimes and the co-ordination of wage setting. *European Economic Review 49*(4), 833–843.

Holden, S. and O. Raaum (1991, July). Wage Moderation and Union Structure. *Oxford Economic Papers 43*(3), 409–23.

Im, K. S., M. H. Pesaran, and Y. Shin (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics 115*(1), 53–74.

Iversen, T. (1999). *Contested Economic Institutions. The Politics of Macroeconomics and Wage Bargaining in Advanced Democracies.* Cambridge: Cambridge University Press.

Judson, R. A. and A. Owen (1999). Estimating dynamic panel data models: a guide for macroeconomists. *Economic Letters 65*(1), 9—15.

Kenworthy, L. (2001). Wage-Setting Measures: A Survey and Assessment. *World politics 54*(1), 57–98.

Kolsrud, D. and R. Nymoen (2010). Macroeconomic stability or cycles? the role of the wage-price spiral. Memorandum from Department of Economics, University of Oslo.

Layard, R., S. Nickell, and R. Jackman (2005). *Unemployment* (2 ed.). Oxford: Oxford University Press. First published 1991.

Levin, A., C.-F. Lin, and C.-S. James Chu (2002, May). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics 108*(1), 1–24.

Mátyás, L. and P. Sevestre (2008). *The Econometrics of Panel Data. Fundamentals and Recent Developments in Theory and Practice*, Volume 46. Berlin Heidelberg: Springer.

Nickell, S., L. Nunziata, and W. Ochel (2005). Unemployment in the OECD Since the 1960s. What Do We Know? *Economic Journal 115*(500), 1–27.

Nickell, W. (2006). *The CEP-OECD Institutions Data Set (1960-2004)*, Volume 759. CEP Discussion Paper: Centre for Economic Performance, London School of Economics and Political Science, London, UK.

OECD (2002). Economic Outlook No. 71. *Economic Outlook: Annual Projections for the OECD Countries (database).*

OECD (2004). "Wage-setting Institutions and Outcomes", in OECD. *OECD Employment Outlook*, 145–206.

OECD (2006). Economic Outlook No. 80. *Economic Outlook: Annual Projections for the OECD Countries (database).*

OECD (2008a). Economic Outlook No. 84. *Economic Outlook: Annual Projections for the OECD Countries (database).*

OECD (2008b). OECD Economic Outlook No. 83. *OECD Economic Outlook: Annual Projections for the OECD Countries (database).*

OECD (2008c). OLIS - OECD online information service.

Pissarides, C. A. (2000). *Equilibirum Unemployment Theory.* MIT Press. Second edition.

Reinhardt, C. and K. S. Rogoff (2009). *This Time is Different: Eight Centuries of Financial Folly.* Princeton Univeristy Press.

Røed, K. (1997). Hysteresis in unemployment. *Journal of Economic Surveys 11*, 389–428.

Sørensen, P. and H. J. Whitta-Jacobsen (2010). *Introducing Advanced Macroeconomics: Growth and Business Cycles* (Second ed.). McGraw-Hill Education.

Sparrman, V. (2011). *Unemployment in OECD countries. Empirical Essays.* Ph. D. thesis, Department of Economics, Univeristy of Oslo.

Visser, J. *Database on Institutional Characteristics of Trade Unions, WageSetting, State Intervention and Social Pacts in 34 countries between 1960 and 2007.* Amsterdam Institute for Advanced Labour Studies (AIAS): University of Amsterdam.