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Abstract
In an influential study, Nickell et al. (2005) find that institutions explain most of the variation in OECD unemployment, using panel data for 20 countries from 1960 to 1995. However, the importance of Nickell et al. (2005)’s conclusions has spurred a lively debate, and several authors have criticized their findings. This paper re-assesses the main findings in Nickell et al. (2005), benefitting from the inclusion of twelve additional years of data. A dynamic simulation of their main unemployment equation shows that unemployment is severely underpredicted in the post sample period for 17 of the 20 countries, while it is only overpredicted for one country. The analysis shows that the underprediction is largely driven by the model dynamics and that the accounting exercise in Nickell et al. (2005) is not suited to analyze how much of the variation in unemployment that can be attributed to changes in institutions in the post-sample period. However, there is a clear tendency that countries which have changed their institutions in an “employment-friendly” way, like Denmark and Finland have experienced a larger reduction in unemployment than the countries that have changed their institutions in the opposite direction like Germany and Portugal. This indicates that labour market institutions affect unemployment in the direction found by Nickell et al. (2005).

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1 Introduction

A number of recent papers have tried to explain the evolution of unemployment in the OECD area, based on an equilibrium unemployment framework. One of the most influential is Nickell et al. (2005), NNO hereafter. They find that the development in labor market institutions can account for 55 percent of the increase in European unemployment for the period 1960 to 1995. In their analysis, the effect of institutions to unemployment is the same for all the 20 OECD countries in the panel.

There are several reasons to re-asses the paper by NNO. First, the results are strong, explaining the bulk of the variation in unemployment by variation in institutions. It is also noteworthy to obtain homogenous effects of institutions for all the countries in the panel. Second, the strand of research focusing on the link between labour market institutions and unemployment has been very influential. NNO is a major, recent contribution to this literature, spurring a lively debate and receiving 461 references in Google Scholar. The recommendations of international organizations like the OECD for how countries should organize their economies efficiently are strongly influenced by this approach. The results of this strand of research have been interpreted as a recommendation to countries for how they should change their institutions in order to avoid or reduce unemployment. According to the findings of this literature, reducing institutional variables like the benefit replacement ratio, employment protection, union density and taxes would lower the unemployment rate considerably.

This paper evaluates the results in NNO over the extended sample 1995 to 2007. I ask the question of whether the NNO results could be used to forecast the evolution of unemployment in the OECD countries, if one were able to predict perfectly the evolution of the explanatory variables. To this end, I undertake a dynamic simulation of the model for unemployment with the original estimated coefficients. Dynamic simulation from 1995 to 2007 shows strong underprediction for 17 of the 20 countries, while unemployment is only overpredicted for one country. The difference between simulation and actual unemployment rate for the period 1995 to 2007 motivates a closer look at the empirical model in NNO. I also take a closer look at NNO’s finding that 55 percent of the increase in unemployment is caused by changes in institutions in Europe in the sample period. I explore whether this result survives data revisions within the sample period, and what the method gives for the post-sample period.

This paper is not the first to discuss the results and method in NNO, see eg contributions of Baker et al. (2005), Blanchard (2006), Berger and Everaert (2008) and in Belot and van Ours (2004). The issues in this debate can roughly be divided in four parts: the size of the estimated coefficients, the variables in the empirical analysis, the chosen indexes, and the method. However, in spite of the extensive literature, it is difficult to evaluate how the various elements of the critique affect the overall validity of the NNO results. The problem arises because key features like the time period, the method, and the time series for the variables generally vary across papers. This is a recurrent problem in empirical literature, implying that it is difficult to compare new results with existing papers. When different data or methods are used, it is hard to identify the source of the difference in results. This also makes it difficult to determine which parts of the original results that are still valid, and which parts that are not.

In this paper every source to variation in results is separated by looking at one source at the time: revision of time series and extension of the time period. In addition, a replication of the original results in NNO ensures that the same method is used throughout the paper.

The results from the extended time period show that the data generating process has changed somewhat, but the change in estimated coefficients has not led to a markedly better the fit of the model in the extended time period. Institutions explain a larger share of the increase in unemployment in Europe, but this is because the actual increase
in unemployment is lower. The results for how much of the increase in unemployment that can be explained by institutions are not convincing and the underprediction of the unemployment rate in the post sample period is still unexplained.

The empirical specification of the model in NNO is evaluated further in section 5. A dynamic simulation where the specified error term is taken into account in the simulation illustrates that the estimated model has a non stationary solution for three of the countries; Japan, Netherland and New Zealand. However, also for the other countries a simulation of only the dynamic part of the equation, i.e. the lagged unemployment rate, the trend and the fixed effects, yields severe instability. A stable dynamics is essential to be able to predict a stationary time series such as unemployment. This is likely the source of the underprediction.

One possible objection to the present analysis is that the empirical model of NNO was developed to explain the evolution of unemployment in the period 1960 to 1995, and to explore the link between institutions and unemployment, but not to predict unemployment. However, the high impact of the policy recommendations clearly show that the results in this and similar studies have been regarded as being of general validity. Moreover, if the empirical model of NNO captures the crude features of the data generating process, and this data generating process has been fairly stable over time, then one would expect the model also to be able to perform well in a post-sample dynamic simulation, given the correct values of the explanatory variables. A failure in the post-sample simulation would suggest that either the model explains unemployment behavior less well than the in-sample results indicate, or that the unemployment behavior has changed over time. Both conclusions would be of considerable interest, as well as motivate further research.

In light of the severe underprediction of unemployment, it seems worthwhile to explore the link between institutions and unemployment in isolation, ignoring the other parts of the model. Using the estimated coefficients, the change in labour market institutions would predict that average unemployment increase by 1.3 percentage points over the period 1995 to the average period 2002 to 2007, while actual unemployment fell by 2.3 percentage points in the same period. However, if one takes country dispersion into account, a different picture emerges.

The paper is organized as follows. First I present the development in actual unemployment in the post-sample period, some related literature and the empirical model in NNO which is used throughout the paper in section 2. Then, in section 3 I show that this model underpredicts the unemployment rate in 17 of the 20 countries in the panel. The model in NNO is reestimated in section 4, and the results show that the data generating process has changed somewhat, but the reestimation does not lead to a markedly better fit. In section 5 I explore the dynamic specification of the model and find that it is unstable for most countries. The link between institutions and unemployment in the post-sample period are evaluated from a different angle in section 6. Section 7 concludes. Appendix A describes the construction of the data. Appendix B presents some additional results that don’t change the main picture of the prediction results in section 3. The replication of the model in NNO and some additional results to section 4 and 5 are presented in Appendix C.

2 Background

Before turning to the model specification, it is interesting to look at the actual development in the unemployment rates in the sample period available, i.e. 1960 to 2007. Then, the theoretical framework for explaining the evolution in unemployment as given in NNO is presented.
2.1 The evolution of unemployment in the OECD area

The unemployment rate in the OECD countries changed substantially in the period 1960 to 2007, see table 1. For instance, Switzerland have a relatively low but increasing unemployment throughout the period, while Ireland and Spain on the other hand have high volatility over time. Germany and Japan have a steady increase in the unemployment rate over time, ending on a fairly high unemployment. The unweighted average unemployment rate (se last row) was very low at the beginning of the period, but increased sharply and peaked at the beginning of the 1980s and the 1990s. Then unemployment fell slightly towards the end of the period.

Table 1: The unweighted average of unemployment. Revised and extended data set.

<table>
<thead>
<tr>
<th>Country</th>
<th>Yr6064</th>
<th>Yr6572</th>
<th>Yr7379</th>
<th>Yr8087</th>
<th>Yr8895</th>
<th>Yr9601</th>
<th>Yr0207</th>
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<tbody>
<tr>
<td>Australia</td>
<td>1.75</td>
<td>1.79</td>
<td>4.66</td>
<td>7.70</td>
<td>8.41</td>
<td>7.33</td>
<td>5.31</td>
</tr>
<tr>
<td>Austria</td>
<td>1.70</td>
<td>1.42</td>
<td>1.38</td>
<td>3.25</td>
<td>4.89</td>
<td>5.49</td>
<td>5.67</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.48</td>
<td>1.48</td>
<td>4.23</td>
<td>9.61</td>
<td>8.05</td>
<td>8.34</td>
<td>8.05</td>
</tr>
<tr>
<td>Canada</td>
<td>6.00</td>
<td>4.76</td>
<td>6.98</td>
<td>9.84</td>
<td>9.53</td>
<td>8.11</td>
<td>6.92</td>
</tr>
<tr>
<td>Denmark</td>
<td>1.07</td>
<td>1.04</td>
<td>3.56</td>
<td>6.48</td>
<td>7.50</td>
<td>5.00</td>
<td>4.62</td>
</tr>
<tr>
<td>Finland</td>
<td>1.41</td>
<td>2.41</td>
<td>4.14</td>
<td>5.17</td>
<td>10.85</td>
<td>11.54</td>
<td>8.34</td>
</tr>
<tr>
<td>France</td>
<td>1.18</td>
<td>3.95</td>
<td>3.71</td>
<td>7.67</td>
<td>9.10</td>
<td>9.66</td>
<td>8.48</td>
</tr>
<tr>
<td>Germany</td>
<td>0.69</td>
<td>0.86</td>
<td>3.06</td>
<td>6.56</td>
<td>6.94</td>
<td>8.31</td>
<td>9.29</td>
</tr>
<tr>
<td>Ireland</td>
<td>5.32</td>
<td>5.82</td>
<td>3.08</td>
<td>14.05</td>
<td>14.68</td>
<td>7.30</td>
<td>4.47</td>
</tr>
<tr>
<td>Italy</td>
<td>3.46</td>
<td>4.17</td>
<td>4.87</td>
<td>7.96</td>
<td>9.91</td>
<td>10.81</td>
<td>7.71</td>
</tr>
<tr>
<td>Japan</td>
<td>1.34</td>
<td>1.24</td>
<td>1.84</td>
<td>2.52</td>
<td>2.46</td>
<td>4.22</td>
<td>4.62</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.57</td>
<td>1.26</td>
<td>3.57</td>
<td>8.28</td>
<td>6.60</td>
<td>4.29</td>
<td>4.03</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.08</td>
<td>0.29</td>
<td>0.74</td>
<td>3.95</td>
<td>8.14</td>
<td>6.37</td>
<td>4.12</td>
</tr>
<tr>
<td>Norway</td>
<td>1.17</td>
<td>1.53</td>
<td>1.74</td>
<td>2.44</td>
<td>5.13</td>
<td>3.69</td>
<td>3.89</td>
</tr>
<tr>
<td>Portugal</td>
<td>2.46</td>
<td>3.91</td>
<td>5.63</td>
<td>8.23</td>
<td>5.48</td>
<td>5.23</td>
<td>6.90</td>
</tr>
<tr>
<td>Spain</td>
<td>1.78</td>
<td>2.31</td>
<td>4.04</td>
<td>14.51</td>
<td>15.00</td>
<td>13.61</td>
<td>9.76</td>
</tr>
<tr>
<td>Sweden</td>
<td>2.11</td>
<td>2.61</td>
<td>2.62</td>
<td>3.59</td>
<td>6.22</td>
<td>9.06</td>
<td>6.92</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.03</td>
<td>0.01</td>
<td>0.29</td>
<td>0.63</td>
<td>2.24</td>
<td>3.30</td>
<td>3.99</td>
</tr>
<tr>
<td>UK</td>
<td>2.79</td>
<td>3.40</td>
<td>4.81</td>
<td>10.44</td>
<td>8.77</td>
<td>6.31</td>
<td>5.10</td>
</tr>
<tr>
<td>United States</td>
<td>5.72</td>
<td>4.47</td>
<td>6.51</td>
<td>7.75</td>
<td>6.16</td>
<td>4.63</td>
<td>5.27</td>
</tr>
<tr>
<td>Total</td>
<td>2.14</td>
<td>2.34</td>
<td>3.82</td>
<td>7.03</td>
<td>7.80</td>
<td>7.13</td>
<td>6.17</td>
</tr>
</tbody>
</table>

Source: OECD (2008a)

Figure 1 also shows the unemployment rate for all countries in the sample in the period 1960 to 2007. We observe that the rise in unemployment in the early 1970s went together with an increase in the dispersion across the countries in the sample. After 1995, both the average unemployment rate and the variation in the unemployment rates across countries have decreased. Figure A1 in Appendix A displays the evolution of unemployment for various groups of countries.

2.2 The empirical specification as given in NNO

The approach of NNO is based on an equilibrium unemployment framework. In the short run actual unemployment may deviate from equilibrium unemployment due to shocks, but unemployment eventually returns to its equilibrium level. The equilibrium unemployment theory could be based on several different micro-founded theories of unemployment, like wage bargaining, efficiency wages, or search and matching theories, see e.g Layard et al. (1991) and Pissarides (2000).

The empirical model for unemployment in table 5 in NNO is specified by a simultaneous system that consists of the following two equations:
Figure 1: Actual unemployment. Revised and extended data set over the years 1960 to 2007.

\[
U_{it} = \theta U_{i,t-1} + \beta_1 epl_{it} + \beta_2 brr_{it} + \beta_3 (bd_{it} - \bar{bd}) \times (brr_{it} - \bar{brr}) \\
+ \beta_4 (udnet_{it} - udnet_{i,t-1}) + \beta_5 co_{it} + \beta_6 (co_{it} - \bar{co}) \times (udnet_{it} - \bar{udnet}) \\
+ \beta_7 tw_{it} + \beta_8 (co_{it} - \bar{co}) \times (tw_{it} - \bar{tw}) + \alpha_1 lds_{it} + \alpha_2 Dprod_{hp_{it}} \\
+ \alpha_3 TTS_{it} + \alpha_4 D2.MS_{it} + \alpha_5 RIRL_{it} + \gamma_1 t + \gamma_2 i + \gamma_3 i \times t + v_{it}
\]  

(1)

and

\[
v_{it} = \rho_i v_{i,t-1} + \epsilon_{it}
\]  

(2)

Where the institutional variables and the interaction terms among these variables in the first part of equation (1) determines the equilibrium unemployment level. The institutional variables are such as (indexes for) employment protection (epl), benefit replacement ratio (brr), benefit duration (bd), union density (udnet), tax rate (tw) and coordination of wage setting (co). The interaction are: benefit duration and benefit replacement ratio, coordination in wage setting and union density, and coordination and tax rate. The interaction terms are measured as deviation from the variable mean. The second part of Equation (1) consists of five variables meant to capture deviations from the equilibrium unemployment rate over the business cycle, the shocks. The shock variables are; labour demand (lds), total factor productivity (Dprodhp), import prices (TTS), money supply (D2.MS) and real interest rate (RIRL). \((U_{i,t-1})\) is the unemployment in the previous period. Finally, the heterogenous part of the model is captured by unobserved country and time specific shift in the intercept \((\gamma 1 \text{ and } \gamma 2)\), a country specific trend \((\gamma 3_i \times t)\) and a country specific autoregressive error term \((v_{it})\). The latter is defined in equation (2), where \(\rho_i\) is the country specific auto regressive coefficient and \(\epsilon_{it}\) is white noise.

The coefficients in equation (1) are estimated with feasible general least squares where the \(\rho_i\) in the error term is estimated simultaneously for every country \(i\) by a iteration process using panel data for 20 OECD countries over the period 1960-1995.
The results in Model A in table C1 in Appendix C are in line with what we would expect from the equilibrium theory of unemployment: Higher taxes and more generous unemployment benefits increase unemployment, while more coordination in wage setting leads to lower unemployment.

NNO chose to evaluate the empirical model and the effect of institutions by a dynamic simulation of the unemployment rate, disregarding the error term by setting the expected value of the error term in Equation (2) to zero in every period and for every country. They claim that the close visual similarity between the simulation and the actual unemployment rate over the estimation period illustrates that the model explains the data well.

Based on the dynamic simulation keeping institutions fixed at their 1960s level (i.e. the unweighted mean over the period 1960 to 1969) they claim that institutions account for 55% of the increase in European unemployment in the period 1960s to the early 1990s, measured as the increase in the unweighted mean of unemployment from the 1960s to the period 1990-1995. Changes in the benefit system are the most important, contributing 39%. Increases in labour taxes generate 26%, shifts in the union variables are responsible for 19%, and movements in employment protection law contribute 16%.

3 Forecast of the unemployment rate by using the NNO model in the post-sample period 1995 to 2007

This section re-assesses the findings of NNO, benefitting from twelve additional years of data. Specifically, I explore to what extent the empirical model of NNO is able to forecast the subsequent post-sample evolution of unemployment, given that we now in general know the correct values of the explanatory variables.

I evaluate the model by use of static and dynamic simulation of unemployment. The model does very well in a static simulation, see Appendix B. However, as the static simulation is conditional on the lagged unemployment rate, which plays a large role in the model, the static simulation may not give the right impression about the model’s out of sample explanatory power and hence the results are relegated to an appendix. Here I will focus on the dynamic simulation, which is also used by NNO. In a dynamic simulation the simulated value of unemployment in period \( T + t \) is used to forecast unemployment in period \( T + t + 1 \), see Ch. 2.7 Clements and Hendry (1998).

In general, the sample period is extended by using the time series for the institutional variables available up to 2003, except for taxes that are available up to 2007, and the time series for the macro variables that are available up to 2007. Note that even if most of the institutional variables only are available up to 2001, 2002 and 2003, this is not a major problem for predicting unemployment up to 2007 by this model. This is because changes in institutions are slow and changes takes a long time to materialize in the unemployment rate. With a estimated coefficient of the lagged dependent variable of 0.86, 47% of the full effect of changes in institutions remains after 5 years (0.86^5). This means that most of the changes in institutions up to 2003 have materialized in unemployment by 2007, while changes in institutions after 2003 not year have materialized in unemployment. See Appendix A for details regarding the extended and revised data set. The time dummies for new years are set to zero in the simulations. The time trend is prolonged and the estimated coefficients from the original data set are used in the simulations.

Formally, the dynamic simulation of unemployment this period can be written as

\[
\tilde{U}_{i,T+t} = E(U_{i,T+t|\tilde{U}_{i,T+t-1}, X_{i,T+t}, \hat{\beta}}),
\]

where \( \tilde{U}_{i,T+t-1} \) is the dynamic simulated unemployment rate for country \( i \) in the previous period, \( X_{i,T+t} \) is a vector that contains all explanatory variables for country \( i \) in period \( T + t + 1 \) and \( \hat{\beta} \) is a vector with all the within

\(^{1}\)The vector contains mostly actual values of the explanatory variables, but it also contains some predictions for some of the institutions in the period 2001-7, see Appendix A for details regarding time periods
sample period estimated coefficients as given in NNO\textsuperscript{2}. The error term is set to zero in every period in this simulation, but the simulations of unemployment follows the same pattern if the error term is equal to the last estimated value of the country specific error term, but the results are not reported here.

The dynamic simulation results are shown in Figure 2. The figure reveals a large disparity between the dynamic simulation and the actual unemployment rate for most countries in the post sample period. The simulated unemployment rate is lower than the actual unemployment rate for 17 countries, i.e. Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, United Kingdom and United States. The simulated unemployment rate is substantially higher than the actual rate for Spain. The model simulates well for only two countries Finland and Ireland.

If the empirical model specified by NNO explains the development in unemployment, the difference between the simulated and the actual value of the unemployment can be caused by the development in the institutional variables, the specified shock variables or the error term or how the trend and time dummies are prolonged.

The discrepancy between the simulated and actual unemployment rate remains even if the trend or the time dummies are prolonged in various ways, and some examples follow. The estimated trend is negative for most countries in the sample, exceptions are Finland, Ireland, New Zealand and Spain, but the simulated unemployment rate follows a similar pattern if the trend variable is prolonged by the last value of the trend in 1995 or by the average value of the trend. The latter gives the largest change in simulations and is shown in Figure B3 in Appendix C. The simulations show that in this specification the predictive power of the empirical model improves somewhat for most countries in the sample, i.e. the simulated value of unemployment by the model is closer to actual unemployment in the post sample period, but the improvement is small compared with the distance between actual and simulated unemployment. The prediction of the model improved also in Sweden, but the model now overpredicts the change in unemployment. The predictive power worsens for New Zealand, Germany and United Kingdom. The simulations of the unemployment rate follow a similar pattern even if the time series are prolonged by the estimated average of the time dummies (results omitted for space considerations).

The specified shock variables have a small impact on the simulations, compare the simulations in figure 2 and figure B4 in appendix C. Thus, the underprediction is not caused by the shocks included in the NNO model.

On the other hand figure 2 illustrates a large effect of changes in institutions on the development of the unemployment rates. More specifically, the figure displays the actual unemployment rate, the dynamic simulation described above and a dynamic simulation where the values of the institutional variable are kept fixed at their 1995 level. For 14 of the 20 countries, incorporating the changes in the institutions leads to a reduction in the distance between actual and simulated unemployment rate. This is the case for Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Sweden, and Switzerland. For Ireland, there is no difference between the simulated unemployment rate with constant and time-varying institutions. However, for Finland, New Zealand, Spain, United Kingdom and United States, including the variation in institutions increases the difference between actual unemployment and the simulated unemployment rate. There is large effect of changes in institutions on unemployment even if we modify the trend, the time dummies or the shocks as described above.

The dynamic simulation of unemployment presented in Figure 2 motivates a further investigation of the model in NNO post sample. The predictive power of the NNO model is weak, but changes in institutions still contributes to explain some of the development

\textsuperscript{2}The country specific dummies are taken from the replication in section 4.1.
Figure 2: Actual unemployment and dynamic simulation of the unemployment rate with and without time-varying institutions. Estimated coefficients on the original data set are used in simulation, Table C1. Institutions are constant.
in unemployment for 11 of the 15 European countries. One is intrigued to know what the reason for the underprediction is. Has the data generating process, i.e. the link between the explanatory variables and unemployment changed after 1995? Or were there weaknesses in the empirical specification already in the original time period? The underprediction may also raise questions about the findings that changes in institutions explain the bulk of the increase in unemployment in Europe. Thus, it becomes important also to extend this analysis to the longer sample period. This is the topic of the following sections, where every source to variation in results is separated by looking at one source at the time: revision of time series and extension of the time period. Finally, the model dynamics and institutions effect on unemployment from a different angle are investigated.

4 Empirical investigation

In this section the data generating process is investigated and also if these changes affect the explanatory power of the changes in institutional variables on unemployment.

The starting point in section 4.1 is an attempt to replicate the main results in NNO on the original data. Then, the empirical model in NNO is estimated on the revised data on two sample periods 1960 to 1995 and 1960 to 2007 in section 4.2.

4.1 Replication of model 1 in Table 5 in NNO

A replication of the empirical model in Table 5 in NNO and of their evaluation by using the original data set ensures that any differences in results that are found later in the paper are due to changes in data revisions, definitions or sample length. The estimation procedures and results in NNO are described in section 2.

I find that the estimated coefficients exactly replicates the coefficient values in NNO, cf. Model A in Table C1 in Appendix C. In addition, a detailed visual inspection of the dynamic simulation on the original data set with and without time-varying institutions are also the same as in NNO. The replicated simulations are presented in Appendix C in Figure C1.

As the lagged unemployment rate enters among the regressors, the long run effect of a change in institutions differ from the short run effect. To find the exact long run effect of changes in institutions in the period 1960s to 1990s, NNO compare the outcome of a dynamic simulation with the actual development of the institutional variables with dynamic simulation where the institutional variables are kept fixed at their 1960s values as described in section 2. To replicate their analysis, I also compare the outcome of a dynamic simulation with changing institution with the outcome of a dynamic simulation where institutions are fixed at the 1960s values. The results which differ somewhat from those of NNO, are presented in Table 2 and commented below. However, due to the discrepancy between NNO and my results, I also calculate the long run effect by another method, by comparing the long run multiplier also used by p.19 Nickell and Nunziata (2002). This method intends to capture the permanent effect of a change in institutions by the standard formulae; the value of the estimated coefficient of the variable that represents the institution multiplied by the change in the same variable and divided by one minus the value of the estimated coefficient of the lagged unemployment rate. For instance, the long run multiplier for the change in employment protection is equal to $0.47 \times \Delta epl/(1 - \theta)$. Note that the two methods should not give the same results. The long run multiplier is intended to capture the total effect of a change in the variables that represent the institutions over an infinite time period, and not the exact effect of these variables to unemployment in the limited time period 1960 to 1995. If institutional variables that have a negative impact on unemployment and have changed late in the sample period, the full effects will not yet

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3 The data is received from Luca Nunziata.
have materialized within the sample period, and hence the formula will exaggerate the effect of institutions on unemployment.

Table 2: Effects of institutions on unemployment in Europe. Original data set and the estimated coefficients in model A in table C1 in Appendix C.

<table>
<thead>
<tr>
<th>Actual change in the unemployment rate and overall effects of institutions:</th>
<th>Dynamic simulation of U, all institutions change:</th>
<th>Dynamic simulation of U, all institutions constant:</th>
<th>Contribution of institutions to U:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Dynamic simulation</td>
<td>Dynamic simulation; Long run multiplier;</td>
</tr>
<tr>
<td>Actual of U, all of U, all</td>
<td>Dynamic simulation;</td>
<td>Long run multiplier;</td>
<td></td>
</tr>
<tr>
<td>percentage share of percentage share of</td>
<td></td>
<td>percentage points</td>
<td>share of total</td>
</tr>
<tr>
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<td></td>
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</tr>
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<td>$U_{60-69}$</td>
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<td>2.09</td>
<td>2.01</td>
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<td>$U_{90-95}$</td>
<td>8.86</td>
<td>9.16</td>
<td>4.60</td>
</tr>
<tr>
<td>$U_{90-95} - U_{60-69}$</td>
<td>6.80</td>
<td>7.07</td>
<td>2.59</td>
</tr>
</tbody>
</table>

Decomposition to specific institutions:

<table>
<thead>
<tr>
<th>Dynamic simulation of U, all institutions change:</th>
<th>Dynamic simulation of U, one type of institution constant:</th>
<th>Contribution of specific institutions to U:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dynamic simulation;</td>
<td>Long run multiplier;</td>
</tr>
<tr>
<td>percentage points</td>
<td>Long run multiplier;</td>
<td>percentage points</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant:</td>
<td>3.30</td>
<td>0.74</td>
</tr>
<tr>
<td>Benefits</td>
<td>7.07</td>
<td>3.77</td>
</tr>
<tr>
<td>Unions</td>
<td>7.07</td>
<td>7.16</td>
</tr>
<tr>
<td>Taxes</td>
<td>7.07</td>
<td>6.15</td>
</tr>
<tr>
<td>Empl. protection</td>
<td>7.07</td>
<td>6.71</td>
</tr>
<tr>
<td>Sum</td>
<td>4.48</td>
<td>1.00</td>
</tr>
</tbody>
</table>

a) $U_{60-69}$ is the unweighted average of the unemployment rate, simulated or actual, in the period 1960 to 1969
b) $U_{90-95}$ is the unweighted average of the unemployment rate, simulated or actual, in the period 1990 to 1995
c) The long run multiplier is calculated by the use of formula; $\hat{\beta}^{*} \Delta X^{1} - \theta$ with the actual change in the specific institution ($X$)
d) Share of total increase in unemployment in Europe
e) Share of total increase in unemployment explained by institutions in Europe

The upper panel in Table 2 shows that the actual unweighted average unemployment rate increased with 6.8 percentage points, from 2.06 to 8.86, in the period 1960s to 1990s ($U_{90-95} - U_{60-69}$), this is the same as in NNO. Table 2 upper panel also shows that in the dynamic simulation with time-varying institutions, unemployment increases by 7.07 percentage points from 1960s to 1990s ($\overline{U}_{90-95} - \overline{U}_{60-69}$), while with constant institutions, unemployment increases by 2.59 percentage points. Thus, changes in institutions can explain 4.48 percentage points of the actual 6.8 percentage points increase in the unemployment rate over the sample period, or 66%. The long run multiplier gives a somewhat higher share, as changes in institutions account for 77 percent of the increase in unemployment in Europe. The dynamic simulation method of calculating the contribution from institutions to unemployment is higher than the reported results in NNO, but lower than the long run multiplier method.

The lower panel in Table 2 decomposes the contribution to the different types of institutions. In the dynamic simulation where benefits are kept constant, while the other institutional variable vary over the sample, unemployment increased by 3.30 percentage points. When all institutions change, unemployment increased by 7.07 percentage points, thus the increase in the benefit replacement ratio contributes to $7.07 - 3.77 = 3.30$ of the total increase by dynamic simulation of 4.48. Of this, the increase in replacement ratio accounts for 74 percent, union variables (union density, coordination and interaction between the two union variables) -2 percent, tax variables (tax rate and the interaction between the tax rate and coordination) 20 percent and employment protection 8 percent. The decomposition effects are different from the contributions reported in NNO. Especially, the effect of benefits is higher than the one reported in NNO. The long run multiplier shows that the increase in the benefit system accounts for 71%, unions 9% (coordination, union density and the interaction between these two variables), taxes 13% (tax rate and interaction between coordination and taxes) and employment protection legislation 7% of the actual increase in the unemployment rate. The decomposition on types of institutions is also here quite different from that of NNO, especially the effect of the changes in the
benefit replacement ratio which accounts for 71 percentage points here versus 39 percentage points in NNO.

In sum: The replication of regression results has been successful with respect to obtaining the exact same coefficients values and the close visual similarity in the dynamic simulation with constant and time varying institutions as compared with NNO. The long term effects are somewhat different, in spite of my attempt to use the same method as they use. In the following I use the approach described above to compare the long run effects of institutions from the extended data set.

4.2 Estimation on the revised and extended data set

This section explores the effect of data revisions and an extended sample length on the results derived in the previous section. To isolate the effect of data revision, I first replicate the results on the original sample period, and then extend the sample length.

The economic variables are revised after the publication of NNO. Generally the data revisions are small. A comparison of the unemployment rate in Table 1 with a similar Table in NNO show no clear pattern of that the unemployment rates are revised up or down since NNO presented their work. The largest increase in the unemployment rate was in Sweden, where it is revised up with more than 1 percentage point for several periods in the sample. This revision was from a very low level implying a large relative percentage increase. The unemployment rates are revised down in Belgium, Denmark, Netherland, Spain and Switzerland throughout the period. The data revision range from -0,17 to -4,59 percentage points, with the largest decrease in Spain. Some of the decrease in the unemployment rate for Spain could be explained by that the time series used here is from OECD (2008a) while NNO used a time series from ILO. However, the revision in percentage is larger for instance Belgium and Switzerland in some years. See Appendix A for data details.

The model in section 4.1 and data revisions

Figure 3 and table 3 present the estimated coefficients of the model in NNO on the revised data set over the time period from 1960 to 1995 \(^4\). The left panel of figure 3 illustrates the estimated coefficients on the revised data set divided by the replicated coefficients in model A in table C1 in appendix C. The value is equal to one if the coefficient is equal in both estimations. In general, the figure illustrates a reduced direct effect of institutions to unemployment on the revised data set, as most of the normalized coefficient values are smaller than one. In addition, a comparison of Table 3 with Table C1 in Appendix C not only show that the effects of benefit replacement ratio and coordination to unemployment are reduced, but they are also outside the original confidence interval. However, these estimated coefficients are still positive and significant. The estimated direct effects of employment protection, benefit duration and union density have changed sign, but are not significant. All the coefficients of the interaction terms are reduced. Two of the shocks, money supply and labour demand, have a stronger effect on unemployment than previously reported. The real interest rate, productivity and import price shock have a smaller effect than previously reported. The effect of the real interest rate is no longer significant.

The changes in the values of the coefficients indicate that the empirical specification is sensitive to small changes in the data set, i.e. to the revisions of the time series. This may reduce the relevance of their results to other samples. Note also that the persistence

\(^4\)Note however, that the revised data set includes 33 more observations than the original data set, because missing observations due to missing data for shock variables are included by setting the shocks to zero. The extra observations does not affect the main picture. In addition, to obtain convergence in the specified empirical model on the extended time period the time dummies are pooled for four more years, i.e. in the period 1960 to 1969. The change does not lead to large changes in the estimated coefficients on the original data set, compare Model A and B in table C1 in appendix C.
Figure 3: Estimated coefficients of equation (1) on the revised and extended data in table 3 divided by the original estimated coefficients in model A in in table C1 in appendix C (so that value 1 means identical estimate).

Table 3: Estimation of model 1, Table 5 in NNO, on the extended and revised data set.

<table>
<thead>
<tr>
<th></th>
<th>1960 to 2007</th>
<th></th>
<th></th>
<th></th>
<th>1960 to 1995</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>t-value</td>
<td>min95</td>
<td>max95</td>
<td>Coef.</td>
<td>t-value</td>
<td>min95</td>
<td>max95</td>
</tr>
<tr>
<td>Unemployment previous period</td>
<td>0.90</td>
<td>65.64</td>
<td>0.88</td>
<td>0.93</td>
<td>0.89</td>
<td>45.66</td>
<td>0.86</td>
<td>0.93</td>
</tr>
<tr>
<td>Employment protection</td>
<td>0.46</td>
<td>2.84</td>
<td>0.14</td>
<td>0.78</td>
<td>-0.13</td>
<td>-0.54</td>
<td>-0.58</td>
<td>0.33</td>
</tr>
<tr>
<td>Benefit replacement ratio (BRR)</td>
<td>0.27</td>
<td>1.08</td>
<td>-0.22</td>
<td>0.77</td>
<td>0.98</td>
<td>2.91</td>
<td>0.32</td>
<td>1.64</td>
</tr>
<tr>
<td>Benefit duration (BD)</td>
<td>-0.06</td>
<td>-0.45</td>
<td>-0.29</td>
<td>0.18</td>
<td>-0.13</td>
<td>-0.77</td>
<td>-0.47</td>
<td>0.21</td>
</tr>
<tr>
<td>Interaction - BRR and BD</td>
<td>0.33</td>
<td>0.54</td>
<td>-0.88</td>
<td>1.55</td>
<td>0.19</td>
<td>0.23</td>
<td>-1.42</td>
<td>1.79</td>
</tr>
<tr>
<td>Interaction - CO and UDNET</td>
<td>-2.08</td>
<td>-3.76</td>
<td>-3.16</td>
<td>-0.99</td>
<td>-2.42</td>
<td>-3.19</td>
<td>-3.91</td>
<td>-0.93</td>
</tr>
<tr>
<td>Interaction - CO and TAX</td>
<td>-1.41</td>
<td>-1.56</td>
<td>-3.17</td>
<td>0.36</td>
<td>-2.98</td>
<td>-2.48</td>
<td>-5.34</td>
<td>-0.62</td>
</tr>
<tr>
<td>First difference in Union density</td>
<td>1.52</td>
<td>0.93</td>
<td>-1.67</td>
<td>4.70</td>
<td>-0.32</td>
<td>-0.18</td>
<td>-3.82</td>
<td>3.19</td>
</tr>
<tr>
<td>Coordination</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.37</td>
<td>0.37</td>
<td>-0.29</td>
<td>-1.12</td>
<td>-0.81</td>
<td>0.22</td>
</tr>
<tr>
<td>Tax rate</td>
<td>1.67</td>
<td>2.52</td>
<td>0.37</td>
<td>2.97</td>
<td>1.37</td>
<td>1.70</td>
<td>-0.21</td>
<td>2.95</td>
</tr>
<tr>
<td>Total factor productivity shock</td>
<td>-4.44</td>
<td>-5.16</td>
<td>-6.13</td>
<td>-2.76</td>
<td>-3.87</td>
<td>-4.06</td>
<td>-5.73</td>
<td>-2.00</td>
</tr>
<tr>
<td>Money supply shock</td>
<td>0.53</td>
<td>2.27</td>
<td>0.07</td>
<td>0.98</td>
<td>0.64</td>
<td>2.48</td>
<td>0.13</td>
<td>1.15</td>
</tr>
<tr>
<td>Real interest rate</td>
<td>0.69</td>
<td>0.90</td>
<td>-0.81</td>
<td>2.19</td>
<td>0.13</td>
<td>0.14</td>
<td>-1.64</td>
<td>1.90</td>
</tr>
<tr>
<td>Import price shock</td>
<td>3.50</td>
<td>2.41</td>
<td>0.65</td>
<td>6.34</td>
<td>4.70</td>
<td>2.82</td>
<td>1.43</td>
<td>7.97</td>
</tr>
</tbody>
</table>

| Obs                      | 853          |       |       |       | 633          |       |       |       |
| Time periods             | 45           |       |       |       | 33           |       |       |       |
| Numb groups              | 20           |       |       |       | 20           |       |       |       |
| Min groups               | 30           |       |       |       | 21           |       |       |       |
| Max groups               | 45           |       |       |       | 33           |       |       |       |
| Avg groups               | 42.65        |       |       |       | 31.65        |       |       |       |
| Coef                     | 93           |       |       |       | 81           |       |       |       |
| Est cov                  | 20           |       |       |       | 20           |       |       |       |
| Est autocorr             | 20           |       |       |       | 20           |       |       |       |
| Log like                 | -822.09      |       |       |       | -655.80      |       |       |       |
| Autocorr                 | 666757       |       |       |       | 565092       |       |       |       |
of unemployment in the previous period has increased in the empirical model from 0.86 to 0.90.

The aggregate long run effects of institutions to unemployment are presented in the upper panel of Table 4. The results from the dynamic simulation with and without time-varying institutions shows that changes in institutions can explain 2.78 percentage points of the 6.79 percentage points actual increase in the unemployment rate in Europe in the time period 1960s to 1990s, i.e. 41%. The results from the long run multiplier effect of changes in institutions to unemployment is 0.55 %.
Table 4: Effects of institutions on unemployment in Europe. The revised and extended data set and the estimated coefficients in model A in Table 3.

**Actual change in the unemployment rate and overall effects of institutions:**

<table>
<thead>
<tr>
<th>Actual change in the unemployment rate and overall effects of institutions:</th>
<th>Dynamic simulation of U, all institutions change</th>
<th>Dynamic simulation of U, all institutions constant</th>
<th>Contribution of institutions to U:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual (U)</td>
<td>Dynamic simulation</td>
<td>Dynamic simulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>percentage share of total$^e$</td>
<td>percentage points</td>
</tr>
<tr>
<td>$\bar{U}_{60-69}$</td>
<td>2.04</td>
<td>2.04</td>
<td>2.03</td>
</tr>
<tr>
<td>$\bar{U}_{60-95}$</td>
<td>8.84</td>
<td>8.40</td>
<td>5.59</td>
</tr>
<tr>
<td>$\Delta \bar{U}_{60-90}$</td>
<td>$\bar{U}<em>{60-95} - \bar{U}</em>{60-69}$</td>
<td>6.79</td>
<td>6.35</td>
</tr>
<tr>
<td>$\bar{U}_{60-97}$</td>
<td>6.36</td>
<td>6.54</td>
<td>3.24</td>
</tr>
<tr>
<td>$\Delta \bar{U}_{60-00}$</td>
<td>$\bar{U}<em>{60-97} - \bar{U}</em>{60-69}$</td>
<td>4.32</td>
<td>4.49</td>
</tr>
</tbody>
</table>

**Decomposition to specific institutions:**

<table>
<thead>
<tr>
<th>Decomposition to specific institutions:</th>
<th>Dynamic simulation of U, all institutions change</th>
<th>Dynamic simulation of U, one type of institution constant</th>
<th>Contribution of specific institutions to U:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta \bar{U}_{60-90}$</td>
<td>$\Delta \bar{U}_{60-00}$</td>
<td>$\Delta \bar{U}_{60-90}$</td>
</tr>
<tr>
<td></td>
<td>percentage points</td>
<td>share of total$^f$</td>
<td>percentage points</td>
</tr>
<tr>
<td>Constant:</td>
<td>5.99</td>
<td>4.11</td>
<td>6.35</td>
</tr>
<tr>
<td>Benefits</td>
<td>6.32</td>
<td>4.12</td>
<td>6.35</td>
</tr>
<tr>
<td>Unions</td>
<td>5.08</td>
<td>2.80</td>
<td>6.35</td>
</tr>
<tr>
<td>Taxes</td>
<td>5.28</td>
<td>3.74</td>
<td>6.35</td>
</tr>
<tr>
<td>Empl. protection</td>
<td>2.74</td>
<td>1.00</td>
<td>3.21</td>
</tr>
</tbody>
</table>

---

$a$) $\bar{U}_{60-69}$ is the unweighted average of the unemployment rate, simulated or actual, in the period 1960 to 1969.
b) $\bar{U}_{90-95}$ is the unweighted average of the unemployment rate, simulated or actual, in the period 1990 to 1995.
c) $\bar{U}_{60-97}$ is the unweighted average of the unemployment rate, simulated or actual, in the period 2000 to 2007.
d) The long run multiplier is calculated by the use of formula: $\hat{\beta} \Delta X / \Delta U$ with the actual change in the specific institution $(X)$.
e) Share of total increase in unemployment in Europe.
f) Share of total increase in unemployment explained by institutions in Europe.
Thus, with revised data, the change in institutions explains a smaller share of the increase in unemployment than with the original data set. Surprisingly, as the data now differ, the results are more in line with those of NNO.

The lower panel of Table 4 shows the contribution of institutions on unemployment. The dynamic simulation shows that the largest contributors to the increase in the simulated unemployment rate are the increase in taxes which accounts for 46% percent and the increase in employment protection which accounts for 39% on the revised data. The main contributors to increased unemployment by the long run multiplier method are benefits and taxes, which contribute with 60% and 63%. Changes in union variables and employment protection decrease the unemployment rate in the period 1960s to 1990s with −21% and −2%.

The model in section 4.1 and extended sample length

We now turn to the effect of extending the sample period. The coefficient estimates on the extended time period are also divided by the original coefficients in the right panel of Figure 3. We observe that all the institutional variables except for benefit duration have the same sign as the original coefficients in Table C1 in Appendix C. The direct effect of employment protection and taxes have increased. The effect of benefit replacement ratio, the union variables and all the interaction terms are reduced.

Table 3 summarises the estimated coefficients and the related t-statistic. As seen from the table, employment protection, taxes and the interaction term between the union variables have a significant positive effect on unemployment in the extended time period. For employment protection the significance may reflect that increased variation due to extended time period have made it easier to capture the effect on unemployment. The benefit and union variables no longer have a significant effect on the unemployment rate. By comparing the results in Table 3 and C1, the coefficient estimates of employment protection, benefit replacement ratio and taxes are the only among the institutional variables that are within the original 95 percent confidence interval. The coefficients of labour demand shock and money supply have increased and the latter is now also significant. The coefficients for the other shocks have decreased, but the effects are still significant.

It is interesting to look at the static and dynamic simulation of the model to investigate if the values of the estimated coefficients on the revised data set result in a better fit of changes in the actual unemployment rate and the contribution of changes in institutions on unemployment.

In light of the considerable changes in the coefficient estimates, one might expect that the model would result in a bad fit of unemployment, at least for the period 1960 to 1995. However, it seems that the new coefficients in a static simulation simulate unemployment well over that period, see Figure C2 in Appendix C. One possible explanation is that the model is quite flexible because of time dummies and country specific trends, in the sense that the model can capture actual unemployment also with the new values of the estimated coefficients of the institutional and shock variables on the revised data set. However, as mentioned in section 3, the static simulation is conditional on the lagged unemployment rate, which plays a large role in the simulation implying that static simulation is not a powerful way to test the model. Thus, I also undertake a dynamic simulation.

The dynamic simulation of the estimated coefficients from Table 3 is presented in figure 4. The overall picture is that the estimated model on the revised and extended data set simulates unemployment well for most countries in the sample, but not so good when the unemployment rate increases sharply at one point in time, cf. for instance Belgium, Canada, Finland, Sweden and Switzerland. However, this seems to be the case also with the dynamic simulation based on the original estimated coefficients. The simulations of the two empirical models are compared in Figure 5. As seen from the figures, the original empirical model in NNO has a better visual fit for 10 countries as compared with the empirical model on the extended and revised data set. The new model has a better visual
Figure 4: Dynamic simulation of Equation (1) with constant and time-varying institutions on the revised and extended data set. Coefficients values from Table 3 over the years 1960 to 2007.
The effect of institutions is illustrated in Figure 4. We observe that the simulation with time varying institutions for most countries tracks actual unemployment quite well, while the simulation with constant institutions quite often is far off the evolution of actual unemployment. This suggests that changes in institutions still are important in explaining the development of unemployment.

The long run effect of institution is summarised in Table 4. Based on the dynamic simulation with constant and time-varying institutions, the upper panel shows that the actual unemployment rate increased by 4.32 percentage points, from 2.04 to 6.36, in the period 1960s to the average of the 2000 to 2007 ($U_{00} - U_{07} - U_{60-69}$). Changes in institutions account for 76% of the increase in unemployment in Europe from 1960s to the 2000s ($U_{00} - U_{07} - U_{60-69}$). By using the formula for the long run multiplier, institutions account for the same percentage share as the dynamic simulation, 76%. According to this exercise, institutions explain a larger share of the increase in unemployment than for the period 1960s to 1990s, and also a larger share than in NNO. Note however, that the reason is that actual unemployment increased less. The increase in unemployment that according this analysis is due to changing institutions is actually lower for the longer period until the 2000s.

The decomposed effect of institutions on unemployment is presented in the lower panel of Table 4. The change in benefits account for 12 percent, union variables 12%, taxes 53% and employment protection 24% of the increase in the unemployment rate. The long run multiplier shows that the increase in the benefit system accounts for 11%, unions 12%, taxes 64% and employment protection legislation 13% of the actual increase in the unemployment rate. Overall, the two methods for calculating long run effects give rather similar results. As compared to the results for the period 1960s to the average of 1990 to 1995 (table 2) the effects of benefits have decreased while the effect of taxes and employment protection has increased.

The analysis has not revealed what the reason for the underprediction of unemployment that was found in section 4, but a simulation of the unemployment rate seems to capture the development in actual unemployment also for the countries that has contributed to the decline in the unweighted average, Australia, Canada, Denmark, Finland, France, Ireland, Italy, Netherlands, New Zealand, Norway, Spain, United Kingdom and United States, exceptions might be Canada, Denmark, Norway and United States. And the estimated effect of institutions still have the same direction of impact on unemployment. In fact, extending the sample, suggest that some of the previous critique of NNO is perhaps less serious on the extended sample. Berger and Everaert (2008) claim that the cointegration of unemployment and institutions is spurious due to a non-rejection of a unit root in unemployment. However, the unweighted average of the unemployment rate has fallen since 1995, and a similar test on the extended data set would probably reject a unit root.

5 The dynamic specification of the NNO model.

To sum up so far: The underprediction is not due to the development in the included shock variables in NNO, as shown in figure B2 in appendix B. The data generating process has changed somewhat in the extended sample period, as shown by the estimated coefficient values displayed in table 3, and also the change to the original estimated coefficients as illustrated in figure 4. The new estimated coefficient values does not lead to a markedly better fit in the dynamic simulation over the extended sample period, as compared with the original coefficient estimates. The accounting exercise show that changes in institutions can explain a large part of the actual change in unemployment and is a rather similar result to what NNO found. In fact, the analysis for the extended period shows that changing institutions account for a larger share of the increase in unemployment, but this is due to
Figure 5: Dynamic simulation of Equation (1) with time-varying institutions. Coefficient values from the original estimation in Table C1 in Appendix C and from Table 3.
the actual increase being smaller. In this section, I explore another possible explanation for the underprediction which is weaknesses in the dynamic specification. The first four sections 5.1 to 5.4 reveal weaknesses of the heterogenous specification of the model, while 5.5 show that the model has unstable dynamics even if the heterogenous error term is neglected and the formal stability restrictions are met.

5.1 The solution of the full model

The empirical specification of NNO imposes the same coefficient values for all countries. Literally speaking, the interpretation is that the effect of, say, stricter employment protection on unemployment is the same in all countries. However, the specification of NNO also includes several country-specific terms, which leads to more flexibility across countries than one might expect given the assumption of common coefficients. The heterogeneity in the structural part of the model is included "... to ensure that the estimated coefficients are not distorted by omitted trended variables in each country or common shocks (NNO, page 15)". The heterogeneity specified in the error term is justified by a rejection of the joint hypothesis \( \rho_i = 0 \) for all countries in the panel (NNO, page 20). To illustrate the effect of the heterogenous lagged error term on the solution of the model for unemployment, Equation (1) can be rewritten as follows:

\[
U_{it} = \theta U_{i,t-1} + \beta X_{it} + \alpha Y_{it} + \gamma_1 t + \gamma_2 i + \gamma_3 i t + v_{it} \tag{3}
\]

where \( X \) is a vector consisting of the institutional variables and the interaction terms in Equation (1) and the vector \( \beta \) ensembles the corresponding coefficients. The vector \( Y \) represents the shocks and the coefficients in vector \( \alpha \).

Second, by multiplying Equation (3) with \( (1 - \rho_i L) \) on both sides of this equation, using that \( (1 - \rho_i L) v_{it} = \epsilon_{it} \) defined by Equation (2), we obtain

\[
(1 - \rho_i L)U_{it} = \theta(1 - \rho_i L)U_{i,t-1} + \beta(1 - \rho_i L)X_{it} + \alpha(1 - \rho_i L)Y_{it} + (1 - \rho_i L)\gamma_1 t + (1 - \rho_i L)\gamma_2 i + (1 - \rho_i L)\gamma_3 i t + \epsilon_{it} \tag{4}
\]

Equation (4) has a white noise error term, \( \epsilon_{it} \). The equation can be organized as follows

\[
(1 - (\rho_i + \theta)L + \rho_i \theta L^2)U_{it} = \beta(1 - \rho_i L)X_{it} + \alpha(1 - \rho_i L)Y_{it} + (1 - \rho_i L)\gamma_1 t + (1 - \rho_i L)\gamma_2 i + (1 - \rho_i L)\gamma_3 i t + \epsilon_{it} \tag{5}
\]

Equation (5) highlights important features of the specification used by NNO. The equation implies a 2nd order dynamics in the solution for the unemployment rate. This means that the stochastic process for the unemployment rate is an autoregressive moving average process with exogenous variables. This has some implications for the stability conditions and to use simulations to illustrate the fit of the model. It also implies that the estimated coefficients depend on some restrictions.

Equation (5) reveals that even if the coefficient vector \( \beta \) and \( \alpha \) by assumption are common across all countries, the dynamic effects of the explanatory variables will vary across countries. For the dynamic effects, the specification imposes the same relationship for all explanatory variables, but allowing for variation among countries. To be concrete Equation (5) implies that an increase in, say, employment protection has the same direct effect on unemployment in all countries. However the effect of lagged employment protection on unemployment will vary across countries, depending on the country specific value of \( \rho_i \). On the other hand, the relationship between short run and long run effects of the explanatory variables, eg. employment protection and the tax wedge, is assumed to be the same within each country, also given by \( \rho_i \). This is not discussed in NNO.
5.2 Stability

The stability conditions of the homogenous part of the model depend on the coefficient value $|\theta| < 1$. This condition is met in NNO since $\theta = 0.86$. However, the stability conditions of both Equation (1) and (2) can be divided into two parts; the stability of the homogenous part of the equation, i.e. Equation (1), and the stability of the full model, i.e. Equation (5). The second stability condition is not explored in NNO. It depends on the roots of the lag polynomial of order 2 being outside the unit root circle or equivalently that the corresponding characteristic polynomial lie inside the unit circle, see for instance Sydsaeter (1994, Ch. 6.5).

Table 5 lists the stability conditions in terms of $\rho_i$’s to the solution of the estimated model in NNO. The conditions are calculated by finding stability conditions of the 2nd order differential equation in Equation (5) with the estimated coefficients in Table C1 in Appendix C. All roots of the characteristic equation are real roots. If the values of the last three columns of Table 5 are greater than zero, the 2nd order differential Equation (5) will be stable. As seen from the table, Japan, New Zealand and Portugal have values lower than zero implying that the stability conditions are not met. This means that the effect of the error term, for instance unspecified shocks, to unemployment increases over time. New Zealand has positive autocorrelation in the error term. This means that unemployment will increase or decrease steadily over time. Japan and Portugal have negative autocorrelation in the error term. This means that the error term in one period will increase unemployment but decrease unemployment in the next period. The positive and the negative effect of the error term to unemployment will increase over time.

Finally, note that an empirically unstable solution for unemployment contradicts the equilibrium theory of unemployment. The effects are illustrated by a dynamic simulation in the next section.

Table 5: The error term and stability restrictions of Equation (5) and the estimated coefficients in Table C1 in Appendix C.

<table>
<thead>
<tr>
<th>Country</th>
<th>$\rho_i$</th>
<th>$a_1$</th>
<th>$a_2$</th>
<th>Rot 1</th>
<th>Rot 2</th>
<th>$1 + a_1 + a_2 &gt; 0$</th>
<th>$1 - a_1 + a_2 &gt; 0$</th>
<th>$1 - a_2 &gt; 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.39</td>
<td>-1.25</td>
<td>0.33</td>
<td>0.87</td>
<td>0.38</td>
<td>0.08</td>
<td>2.58</td>
<td>0.67</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.19</td>
<td>-0.67</td>
<td>-0.16</td>
<td>0.86</td>
<td>-0.19</td>
<td>0.16</td>
<td>1.51</td>
<td>1.16</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.59</td>
<td>-0.27</td>
<td>-0.51</td>
<td>0.86</td>
<td>-0.59</td>
<td>0.22</td>
<td>0.76</td>
<td>1.51</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.33</td>
<td>-0.53</td>
<td>-0.29</td>
<td>0.86</td>
<td>-0.33</td>
<td>0.18</td>
<td>1.24</td>
<td>1.29</td>
</tr>
<tr>
<td>Denmark</td>
<td>-0.49</td>
<td>-0.37</td>
<td>-0.42</td>
<td>0.86</td>
<td>-0.49</td>
<td>0.20</td>
<td>0.95</td>
<td>1.42</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.98</td>
<td>0.11</td>
<td>-0.84</td>
<td>0.86</td>
<td>-0.97</td>
<td>0.27</td>
<td>0.05</td>
<td>1.84</td>
</tr>
<tr>
<td>France</td>
<td>0.11</td>
<td>-0.98</td>
<td>0.10</td>
<td>0.86</td>
<td>0.11</td>
<td>0.12</td>
<td>2.08</td>
<td>0.90</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.34</td>
<td>-0.52</td>
<td>-0.30</td>
<td>0.86</td>
<td>-0.34</td>
<td>0.18</td>
<td>1.22</td>
<td>1.30</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.21</td>
<td>-0.65</td>
<td>-0.18</td>
<td>0.86</td>
<td>-0.21</td>
<td>0.17</td>
<td>1.46</td>
<td>1.18</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.68</td>
<td>-0.19</td>
<td>-0.58</td>
<td>0.86</td>
<td>-0.67</td>
<td>0.23</td>
<td>0.61</td>
<td>1.58</td>
</tr>
<tr>
<td>Japan</td>
<td>-1.11</td>
<td>0.25</td>
<td>-0.96</td>
<td>0.86</td>
<td>-1.11</td>
<td>0.29</td>
<td>-0.21</td>
<td>1.96</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.78</td>
<td>-0.08</td>
<td>-0.67</td>
<td>0.86</td>
<td>-0.78</td>
<td>0.25</td>
<td>0.41</td>
<td>1.67</td>
</tr>
<tr>
<td>Norway</td>
<td>-0.43</td>
<td>-0.43</td>
<td>-0.37</td>
<td>0.86</td>
<td>-0.43</td>
<td>0.20</td>
<td>1.06</td>
<td>1.37</td>
</tr>
<tr>
<td>New Zealand</td>
<td>2.92</td>
<td>-0.78</td>
<td>2.51</td>
<td>2.92</td>
<td>0.86</td>
<td>-0.27</td>
<td>7.29</td>
<td>-1.51</td>
</tr>
<tr>
<td>Portugal</td>
<td>-1.15</td>
<td>0.29</td>
<td>-0.99</td>
<td>0.86</td>
<td>-1.15</td>
<td>0.30</td>
<td>-0.28</td>
<td>1.99</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.95</td>
<td>0.08</td>
<td>-0.81</td>
<td>0.86</td>
<td>-0.94</td>
<td>0.27</td>
<td>0.11</td>
<td>1.81</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.51</td>
<td>-0.35</td>
<td>-0.44</td>
<td>0.86</td>
<td>-0.51</td>
<td>0.21</td>
<td>0.91</td>
<td>1.44</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.70</td>
<td>-0.16</td>
<td>-0.61</td>
<td>0.86</td>
<td>-0.70</td>
<td>0.23</td>
<td>0.55</td>
<td>1.61</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-0.41</td>
<td>-0.45</td>
<td>-0.36</td>
<td>0.86</td>
<td>-0.41</td>
<td>0.19</td>
<td>1.09</td>
<td>1.36</td>
</tr>
<tr>
<td>United States</td>
<td>-0.35</td>
<td>-0.32</td>
<td>-0.30</td>
<td>0.86</td>
<td>-0.34</td>
<td>0.18</td>
<td>1.22</td>
<td>1.30</td>
</tr>
</tbody>
</table>

5.3 Dynamic simulation rewritten

The simulations in NNO are based on Equation (1), but Equation (5) illustrates that the endogenous unemployment rate is also affected by the value of $\rho_i$. A simulation of Equation (5) could give a more correct impression of how the model fits the data and how
exogenous shocks not included in the empirical model will affect the unemployment rate
in the long run.

A dynamic simulation of Equation (5) with the estimated coefficient values in Table C1
in Appendix C is shown in Figure 6 and in Figure C3 in Appendix C. Figure C3 illustrates
a similar pattern as the corresponding graphs in Figure C1 which were based on Equation
(1). This means that the effect of the heterogeneity in the error term on the simulations
is small for a majority of countries. In contrast for the countries with unstable solutions
discussed in section 5.2 above, the effect of the heterogenous error term increases over
time. As seen from Figure 6, the simulated unemployment rate in New Zealand shows
an explosive path. For Japan and Portugal there is a negative autocorrelation and for
Portugal the positive and negative effects increase over time.

Figure 6: Simulations of Equation (5). Estimated coefficients in Table C1 in Appendix C.

The simulations illustrate that the empirical model has an unstable solution for three
of the countries when the error term is seen as an integrated part of the econometric model
as in Equation (5). This illustrates the instability results for these countries in table 5.

5.4 The heterogeneity and estimation method

As mentioned in the beginning of this section, the coefficients of both the lagged en-
dogenous variable and the exogenous variables in Equation (5) implicitly depend on the
relationship between the current and lagged values of the variables included in the model.
The relationship between the current and lagged value of the included variables is the
same for all variables captured by the common factor \(1 - \rho_i L\). One should note that the
feasible general least squares with fixed effects which is used to estimate the coefficients,
normally results in a bias for the lagged endogenous variable. The bias occurs since the
value of the unemployment rate in the previous period per assumption is correlated with
the error term, see for instance Ch. 8 in Baltagi (2008). Since both \(\theta\) and \(\rho_i\) are estimated
jointly, a bias in the value of $\theta$ could possible affect the value of $\rho_i$ and hence the value of the coefficients of the exogenous variables.

An equivalent procedure to the feasible general least squares estimation method used by NNO, is to perform a within-transformation of Equation (3), (Ch. 3, Baltagi (2008)):

$$U_{it} - L.U_i = \theta(U_{i,t-1} - L.U_i) + \beta(X_{it} - L.X_i) + \alpha(Y_{it} - L.Y_i)$$

$$+ (\gamma_1 t - \gamma_1 t - 1) + \gamma_3 i (t - 1) + (v_{it} - L.v_i)$$  (6)

$U_{i,t-1} - L.U_i$ is the unemployment rate previous period minus the average sum of unemployment summed over all time periods up to period $t - 2$. This term is correlated with $v_{it} - L.v_i$ by definition. Since $\theta$ is positive, this will imply that the estimated persistence is underestimated. Since the error term is autocorrelated in the empirical specification and estimated jointly with the autoregressive parameter, the problem is even more severe given the difficulty of deriving a consistent estimate of the AR parameters in that context.

If the estimated value of $\theta$ are biased, the $\rho_i$'s are probably biased too. Due to the common factor described above, the estimated coefficients of the explanatory variables might also be affected. In addition, if some of the regressors are correlated with the lagged dependent variable to some degree, their coefficients may be seriously biased for this reason as well.

One solution to the bias problem that arises with the combination of an endogenous lagged variable and country specific shifts, is to take a 1st order differences of the original model, see Ch. 8 Baltagi (2008). The 1st difference transformation removes the country specific effect. There is still a correlation between the difference lagged dependent variable and the disturbance process (which now is a 1st order moving average, MA(1)), but now an instrument variable is available. This is true even if the $v_{it}$ follows an AR(1) process.

In the model described in NNO the error term follows an AR(1) process.

$$U_{it} - U_{it-1} = \theta(U_{i,t-1} - U_{it-2}) + \beta(X_{it} - X_{it-1}) + \alpha(Y_{it} - Y_{it-1})$$

$$+ (\gamma_1 t - \gamma_1 t - 1) + \gamma_3 i (t - (t - 1)) + (v_{it} - v_{it-1})$$  (7)

since $(\gamma_1 t - \gamma_1 t - 1) = \gamma_1 t$ and $t - (t - 1) = 1$ the equation can be reduced to

$$U_{it} - U_{it-1} = \theta(U_{i,t-1} - U_{it-2}) + \beta(X_{it} - X_{it-1}) + \alpha(Y_{it} - Y_{it-1})$$

$$+ \gamma_1 t + \gamma_3 i + (v_{it} - v_{it-1})$$  (8)

One way to use the 1st difference approach on the specified model in section 2 is to assume a second order dynamic equation (according to the dynamics in the rewritten Equation (5)) with or without heterogenous error terms.

However, one should be aware of that the bias caused by the endogenous lagged variable and the fixed effect decreases with a increase in the sample period, see Judson and Owen (1999). An analysis along these lines is undertaken in Nymoen and Sparrman (2010).

5.5 The dynamics of the homogenous part of the empirical model in NNO

The difference between the simulated and the actual value of unemployment is still not found. It is therefore interesting to check if some of the difference could be explained by the dynamics of the specified model in NNO.

Figure 7 shows the simulated unemployment rate out of sample for the dynamic part of the equation, which means that only the lagged unemployment rate, the trend and the
Figure 7: Dynamic simulation of $\hat{U}_{it} = \theta \hat{U}_{i,t-1} + \gamma_2 i + \gamma_3 i t$ on the revised and extended data set. Coefficient estimates from Table C1 over the years 1960 to 2037.
fixed effects are included in the simulation. The figure illustrates that the unemployment rate out of sample is largely driven by this dynamics, where only New Zealand seems to have a stable path for the rate of unemployment. Stable dynamics is essential for the ability to predict a stationary time series such as unemployment by simulation.

6 The effect of changes in labour market institutions

In view of the strong and in some cases erratic effects of the dynamic specification of NNO, it is useful to explore the effect of the institutional variables on the rate of unemployment by other methods. In this section, I explore the predicted change in the rate of unemployment from the NNO model, taking into account only the changes in the institutional variables. More specifically, for each country I compute the change in unemployment that follow from the change in the institutional variables from 1995 to the 5 year average in the period 2002 to 2007 (2007s hereafter), as measured by long run multiplier using the coefficient estimates of Model A in table C1 in appendix C. Table 6 presents the results for all countries put together, but viewing one institutional variable at the time. We see from line 1 that on average, employment protection legislation has become somewhat less strict, with a reduction in the average index value of 0.10. Given the estimated coefficients, this should lead to a long run reduction of the rate of unemployment of 0.11 percentage points. The long run effect of the change in all institutional variables from 1995 to 2007s is an increase in unemployment of 1.28 percentage points, cf. the last row in table 6. In contrast, actual fell by 2.3 percentage points over the same period.

At first thought, the difference between the predicted increase and actual fall in unemployment does not look good for the predictive power of the NNO model. However, by matching separate computations for each country, calculating the predicted change in unemployment due to changes in all the institutional variables for the country, a more flattering picture emerges. Figure 8 displays a cross plot of the predicted change in unemployment due to institutional changes and the actual change in unemployment, for all European countries and for the whole sample, the positive relationship is clear, and the slope is estimated to be 0.4 and is significant at a 5% level if Ireland is treated as an outlier (significant at a 1% level if the slope is estimated on the whole sample). This is a fairly strong positive correlation, and 9 out of 14 countries are in the predicted quadrant. In particular Denmark and Finland have changed their labour market institutions in a way that should give lower unemployment, and these countries also experienced a large reduction in actual unemployment. In contrast, Germany and Portugal have changed their institutions in the opposite direction, and unemployment has increased. The positive correlation suggest that changes in institutions do explain an important part of the changes in unemployment. However, as compared to an upward sloping 45° degree line through origin, which would prevail the hypothetical case where the model were correct and no other changes took place, we also observe three discrepancies. First, the observations are too low, indicating that unemployment has fallen for other reasons. A likely reason is the fairly positive overall evolution of most OECD economies over this period, with considerable growth of GDP. Second, we observe two notable outliers, Ireland and Spain, which have experienced a large reduction in unemployment in spite of the adverse change in labour market institutions. Given the subsequent sharp deterioration of the Spanish and Irish economies, it seems reasonable to explain part of the reduction in unemployment as caused by unsustainable overheating of the economy. Adjusting for this would make these countries more in line with the other countries. Third, we observe that the slope is less steep than 45°. However, one should remember that while the figure is based on long run effects, the full impact of institutional changes late in the sample period will not be reaped in 2007, implying that the figure in fact may exaggerate somewhat the predicted effect of the institutional variables. Note also that the scale of the induced change in
unemployment, calculated by the long run multiplier, depends crucially on the estimated value of the lagged unemployment rate coefficient. As discussed above, this value could be biased, and vary between countries if the heterogeneity is taken into account. This means that the total effect of institutions, and general validity of institutions effects on unemployment should be interpreted with care.

Table 6: The predicted effect on unemployment calculated using actual changes in institutions and the estimated coefficients in model A in Table C1.

<table>
<thead>
<tr>
<th>Institutional variable X:</th>
<th>Coefficient values from table C1 in appendix C</th>
<th>Actual change in institution X; $\Delta X = \bar{X}<em>{07-02} - X</em>{95}$</th>
<th>The long run multiplier $\hat{\beta}^*\Delta X_{1-\theta}$</th>
<th>Contribution of institutions to $U$: percentage points $^{c}$</th>
<th>Share of total increase in unemployment rate induced by changes in institutions $^{b}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment protection (ep)</td>
<td>0.15</td>
<td>-0.10</td>
<td>-0.11</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>Benefit replacement ratio (brr)</td>
<td>2.21</td>
<td>0.02</td>
<td>0.36</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Benefit duration (bd)</td>
<td>0.47</td>
<td>0.12</td>
<td>0.41</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>Interaction brr and bd</td>
<td>3.75</td>
<td>0.00</td>
<td>0.08</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Interaction co and udnet</td>
<td>-6.98</td>
<td>-0.01</td>
<td>0.56</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Interaction co and tax</td>
<td>-3.46</td>
<td>0.01</td>
<td>-0.37</td>
<td>-0.29</td>
<td></td>
</tr>
<tr>
<td>First difference in union density (udnet)</td>
<td>6.99</td>
<td>0.01</td>
<td>0.28</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>Coordination (co)</td>
<td>-1.01</td>
<td>0.04</td>
<td>-0.30</td>
<td>-0.23</td>
<td></td>
</tr>
<tr>
<td>Tax rates (tax)</td>
<td>1.51</td>
<td>0.03</td>
<td>0.37</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td>1.28</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

$^{a}$ $\bar{X}_{07-02}$ is the average level of the institutional variable in the period 2002 to 2007

$^{b}$ The long run multiplier is calculated by the use of formula; $\hat{\beta}^*\Delta X_{1-\theta}$ with the actual change in the specific institution ($X$)

$^{c}$ Share of total increase in unemployment rate induced by changes in institutions

Figure 8: The predicted change in unemployment is calculated by the long run multiplier, using the formula; $\hat{\beta}^*\Delta X_{1-\theta}$ with the actual change in the specific institution ($X$). The changes in institutions are calculated on the revised and extended data set, and $\beta$ and $\theta$ are the estimated coefficients in model A in Table C1.

Table 7 shows the decomposition of the predicted effect on unemployment to specific institutions for the European countries in the sample. Increases in the benefit system for the unemployed workers and increases in unions density are the largest contributors to the predicted increase in unemployment. Reduction in employment protection and increase in coordination among the wage setters have lowered the predicted increase in unemployment. The table also reveals the large variation in the institutional development among the countries in the sample.
Table 7: The predicted effect on unemployment by each institutional variable calculated using the actual changes in institutions and the estimated coefficients in model A in Table C1.

<table>
<thead>
<tr>
<th>Country</th>
<th>Empl. prot.</th>
<th>Benefit replacement (brr)</th>
<th>Benefit duration (bd)</th>
<th>brr and co</th>
<th>co and udnet</th>
<th>udnet tax</th>
<th>Union density (udnet)</th>
<th>Union density (udnet)</th>
<th>Coord. (co)</th>
<th>Tax</th>
<th>Tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>-0.1</td>
<td>1.4</td>
<td>0.1</td>
<td>0.7</td>
<td>3.6</td>
<td>-0.3</td>
<td>-0.3</td>
<td>0</td>
<td>0.1</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.4</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.1</td>
<td>-0.7</td>
<td>-0.3</td>
<td>-0.3</td>
<td>-0.7</td>
<td>0.2</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>0</td>
<td>-0.5</td>
<td>-0.3</td>
<td>-1.2</td>
<td>-3.2</td>
<td>-1.3</td>
<td>-0.2</td>
<td>-1.8</td>
<td>0.4</td>
<td>-8.2</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>-0.1</td>
<td>-5.1</td>
<td>0.9</td>
<td>-1.3</td>
<td>0.7</td>
<td>-0.1</td>
<td>-0.4</td>
<td>0</td>
<td>0.1</td>
<td>-5.1</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>0</td>
<td>0.6</td>
<td>0.4</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>-0.3</td>
<td>0.3</td>
<td>0.7</td>
<td>-0.1</td>
<td>3.6</td>
<td>-0.2</td>
<td>0.2</td>
<td>0</td>
<td>0.1</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>0.1</td>
<td>0.6</td>
<td>0</td>
<td>0.4</td>
<td>5</td>
<td>-1.6</td>
<td>4</td>
<td>0</td>
<td>0.7</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>-0.6</td>
<td>8.1</td>
<td>1.4</td>
<td>-3.2</td>
<td>2</td>
<td>-2.2</td>
<td>0.3</td>
<td>-2</td>
<td>0.9</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.2</td>
<td>0.2</td>
<td>0.6</td>
<td>-0.2</td>
<td>0</td>
<td>-0.2</td>
<td>0.2</td>
<td>0</td>
<td>0.3</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>0</td>
<td>0.5</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
<td>-0.2</td>
<td>0.2</td>
<td>0</td>
<td>0.2</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.1</td>
<td>0.8</td>
<td>0.9</td>
<td>2.1</td>
<td>-0.2</td>
<td>0.1</td>
<td>-0.2</td>
<td>0</td>
<td>0.7</td>
<td>4.2</td>
<td></td>
</tr>
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<td>Spain</td>
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<td>0.2</td>
<td>0.5</td>
<td>0</td>
<td>0.1</td>
<td>0.5</td>
<td>0</td>
<td>0.8</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.1</td>
<td>-1.1</td>
<td>0</td>
<td>0.7</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.4</td>
<td>0</td>
<td>0.6</td>
<td>-0.5</td>
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<tr>
<td>Switzerland</td>
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<td>0.7</td>
<td>0.5</td>
<td>0.9</td>
<td>0.3</td>
<td>-0.1</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>UK</td>
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<td>0.4</td>
<td>-0.9</td>
<td>-2.2</td>
<td>0.4</td>
<td>1</td>
<td>0</td>
<td>0.2</td>
<td>-1.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-0.1</td>
<td>0.4</td>
<td>0.4</td>
<td>0.1</td>
<td>0.6</td>
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<td>0.3</td>
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<td>0.4</td>
<td>1.3</td>
<td></td>
</tr>
</tbody>
</table>

7 Conclusion

This paper has replicated and assessed the model of Nickell et al. (2005). Specifically, I use the replicated model to predict unemployment out of sample, benefitting from twelve additional years of data. The dynamic simulation reveals that the model in Nickell et al. (2005) is not useful to forecast the evolution of the unemployment rate in the post-estimation period as it delivers a severe underprediction of the change in unemployment.

For most countries, taking into account the change in institutions reduces the underprediction, even if it is still big. This is the case for Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Sweden, and Switzerland. For Ireland, there is no difference between simulated unemployment rate with constant and time-varying institutions. For Finland, New Zealand, Spain, United Kingdom and United States taking into account the changes in institutions worsens the fit to the actual unemployment rate.

I then explore possible explanations for the underprediction. One obvious candidate is that the shocks that are included as explanatory variables in the empirical model have evolved differently in the post sample period and caused underprediction of the unemployment rate. However, the results of a simulation with variation in the shock variable and a simulation where the shock variables are set to zero in the post sample period shows nearly no effect of the shocks in the extended period, with Japan and Italy being the only exceptions.

Another possible explanation for the underprediction could be that the data generating process has changed over time. This might be in line with some of the earlier critique which have argued that there have been limited possibilities to detect plausible effects of institutions to unemployment due to short time series (Belot and van Ours, 2004). The model in Nickell et al. (2005) was reestimated on the revised and extended data set. The reestimation showed that the size of the coefficients changed quite substantially both on the revised data set and on the extended time period. However, dynamic simulation does not give a better fit with the reestimated coefficients than with original ones, even for the extended sample period, suggesting that changes in the coefficient values is not the key
explanation for the underprediction.

The model dynamics have been investigated to detect if this is the cause of the underprediction in the post sample period on the original data set. A dynamic simulation of the full model, when the error term is explicitly taken into account, reveals that the model is non stationary for some countries. This is verified by the roots of the 2nd order differential equation that is implied by the model in Nickell et al. (2005). The result suggest a re-consideration of the dynamic specification of the model. Especially since the underlying solution to the specified model implies a 2nd order dynamics in the unemployment rate. However, this is not the main cause to the underprediction of the unemployment rate, as the most of the countries has a stable solution of the model. Instead it turns out that the underprediction of the unemployment rates is largely driven by the dynamic specification of the model where the combination of the large coefficient for the lagged unemployment rate, the trend and the fixed effects, implies a tendency for unemployment to diverge in one direction or the other. This implies that forecasting a stationary time series as the unemployment rate is impossible.

One could argue that the model in Nickell et al. (2005) was not developed to predict unemployment, but to explore the link between institutions and unemployment. What about the link between institutions and unemployment, which was the main topic of interest for Nickell et al. (2005)? Repeating their analysis of the long run effect of changes institutions for the extended sample period for the European countries, I find that changes in institutions now account for 76% of the total change in unemployment from the 1960s to 2002-2007, up from 41% in my replication of their results over the shorter time period until 1990-1995. At face value, this might suggest that institutions have become more important. However, the interpretation is less clear cut. First, the larger share reflects that unemployment increased less over the longer period, so there is less to explain. More importantly, looking only at the effect of the change in institutions, this would actually predict that unemployment increased by 1.3 percentage points over the period 1995 to 2002-2007, while actual unemployment instead fell by 2.3 percentage points. Thus, the sign in this aggregate relationship is wrong. Yet taking into account country variation, a different picture emerges. There is a clear tendency that countries which have changed their institutions in an ”employment-friendly” way, like Denmark and Finland, have experienced a larger reduction (or smaller increase) in unemployment than the countries that have changed their institutions in the opposite direction, like Germany and Portugal. This is a clear indicator that labour market institutions affected unemployment in the direction found by Nickell et al. (2005), even if the large underprediction of unemployment for the majority of the countries shows that their model is unable to account for the overall evolution of the rate of unemployment.

References


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OECD (2008c). Olis - oecd online information service.


Visser, J. Database on institutional characteristics of trade unions, wage setting, state intervention and social pacts in 34 countries between 1960 and 2007.
Appendix A  The Data: Definitions and sources

This appendix contains information about variables that are important for the development of 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 are collected in two data bases. The first data base contains the original data set from NNO and contains observations from 1960 to 1995. The definitions are as given in the appendix in NNO. The second data base, referred to as the revised and extended data set hereafter, contains revised and extended time series for the same variables as the original data set. The sources of the second data base is OECD (2002), OECD (2006), OECD (2008b), OECD (2008a) and Nickell (2006).

The revised and extended data set follows the set up in NNO where the variables are divided into two groups; economic variables described in section A.1 and institutional variables described in section A.2. The extended at revised data set contains observations from 1960 to 2010, but the observations in the latter years are economic projections for the variables and not used in the estimations or simulations in this paper.

A.1 Economic variables

The economic variables are available at a yearly frequency at 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 at 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 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 5 years backwards. Germany from 1991, Spain from 1976, Switzerland from 1969 and backwards.

The revised and extended data set has one less observation for Spain in 1960 than the data base from NNO.

**RIRL: Real interest rate**

The real interest rate is calculated in two steps from the nominal interest rate and the consumer price index. First, inflation is calculated by the change in the time series for consumer price index as in Equation (A2). Then, the real interest rate is defined as the nominal interest rate minus the inflation rate as in Equation (A3).

\[
\pi_{it} = 100 * \frac{\Delta CPI_{it}}{CPI_{it-1}} \tag{A2}
\]

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

\(^6\)An comprehensive overview of data and data sources are available upon request.
Figure A1: Actual unemployment. Revised and extended data set over the years 1960 to 2007.
Inflation for country \( i \) in time period \( t \), \( \pi_{it} \), is the difference between the price level this period, \( CPI_{it} \), minus the price level previous period, \( CPI_{it-1} \), divided by the price level previous period. The real interest rate, \( r_{it} \), is then calculated by subtracting the inflation rate from the long term nominal interest rate, \( IRL_{it} \).

\[
 r_{it} = \frac{IRL_{it} - \pi_{it}}{100}
\]  

(A3)

The main source for the long term nominal interest rate on government bonds, \( IRL \), and the consumer price index, \( CPI \) is OECD (2008a). \( CPI \) for United Kingdom is from OECD (2006) with the last observation in 2008. \( CPI \) for Spain is from OECD (2007) with the last observation in 2009. For Germany before 1991, \( CPI \) is prolonged with the growth rate in the same time series in data base OECD (2002), by Equation (A1) where \( Y \) is \( CPI \) in OECD (2008a) and \( X \) is \( CPI \) in OECD (2002). Note that the base year in \( CPI \) varies between countries and data bases. The base year is however not important since we are only interested in the price growth.

The missing observations in the nominal interest rate for Germany are replaced by the growth rate in \( IRL \) in OECD (2002) by equation (A1) where \( Y \) is \( IRL \) in OECD (2008a) and \( X \) is \( CPI \) in OECD (2002).

Compared with the real interest rate in the original data set in NNO: 1 observation in 1969 is missing for Australia. One observation in 1960 for France, Germany, Italy, Sweden, Switzerland, UK and United States is missing. The years 1960 to 1970 are missing for Ireland. Observations for the years 1960 to 1961 are missing for Netherlands. Finally the years 1961 to 1969 are missing for New Zealand.

**PRODHP: Productivity shock**

Productivity shocks are measured by the difference between actual productivity and the productivity trend. Productivity trend is calculated by a Hodrick Prescott filter of log real gross domestic product, minus log of total employment. The trend is defined by Equation (A4):

\[
 PRODHP_t = HPtrend[log(GDPV_t) - log(ET_t)]
\]  

(A4)

where \( GDPV \) is real gross domestic product and \( ET \) total employment.

The main source for both variables the real gross domestic product and total employment are \( GDPV \) and \( ET \) in OECD (2008a). Missing observations in Denmark, Germany and Switzerland for \( GDPV \) are replaced by observations in OECD (2002) adjusted by differences in mean and slope in the time series as in Equation (A5).

\[
 Y_{1it} = Y_{1i,t+1} \ast \frac{(X_{1it} \ast b_i + a_i)}{(X_{1i,t+1} \ast b_i + a_i)}
\]  

(A5)

where \( Y \) is \( GDPV \) in OECD (2008a), \( X \) is \( GDPV \) in OECD (2002), and \( a \) and \( b \) are the estimated coefficients from a regression between the two time series for country \( i \).

The regression reveals significant differences in both coefficients for most countries. \( a \) is the average difference in level and \( b \) the average difference in slope between the two series for country \( i \).

The missing observations for \( ET \) in Australia before 1964, Denmark before 1966, Germany before 1991 and Switzerland before 1970 are replaced by the formula in Equation (A1) where \( Y \) is \( ET \) from OECD (2008a) and \( X \) is \( ET \) from in OECD (2002).

**LDS: Labour demand shock**

Labour demand shocks are defined as the residuals, \( \epsilon_t \), from the following regression:

\[
 log(ET_{it}) = \beta_0 + \beta_1 log(ET_{it-1}) + \beta_2 log(ET_{it-2}) + \beta_3 log(ET_{it-3}) + \beta_4 log(GDPV_{it}) + \beta_5 log(w_{it}) + \epsilon_{it}
\]  

(A6)

32
where $ET$ is total employment and $GDPV$ is real gross domestic product as the variables defined under the productivity shock above. $w$ is labour cost and defined by Equation (A7).

$$w = \log(IE) - \log(ET) - \log(PGDP)$$

where, $IE$ is compensations of employees, $ET$ is total employment and $PGDP$ is gross domestic product deflator at market prices.

The data source of the variable $ET$ are described in the previous section, i.e productivity shocks.

The main data source for compensations of employees is $IE$ in OECD (2008a), but the main source is $IE$ in OECD (2006) for New Zealand and contains observations from 1986 to 2008. Compensations of employees is prolonged in Austria before 1964, Germany before 1991, Norway in the period 1962 to 1974, New Zealand in the period 1971 to 1986 and Switzerland before 1990 by the formula in equation (A5), where $Y_1$ is $IE$ in OECD (2008a) and $X_1$ is $IE$ in OECD (2002).

The main data source for $PGDP$ is OECD (2008a). The deflator is prolonged backward in Denmark before 1966, France before 1993, Germany before 1991 and Switzerland before 1966 by equation (A1) where $Y$ is the $PGDP$ in OECD (2008a) and $X$ is the $PGDP$ in OECD (2002) when observations are missing.

Note also that the deflator used here is different from the GDP deflator at factor costs used in the original data set. It could be argued that this deflator is more consistent, since the variable IE includes the effect of value added tax.

Compared with the original data set, there are still some observations missing for the labour demand shock. The missing observations are replaced by the shocks in NNO for Canada in 1960, Denmark in 1960 to 1965, France in 1960 to 1962, Norway 1960 to 1962, New Zealand 1960 to 1971 and Portugal in the period 1960 to 1982.

**d2ms: Acceleration in money supply**

Acceleration in money supply is equal to the second difference of the money supply $\Delta^2 MS$.

The main source for money supply is $MONEY_5$ in OECD (2008a). Observations for $MONEY_5$ in Australia, Canada, Germany, New Zealand, Uk and Sweden are from OECD (2008b). Time series for $MONEY_5$ in Denmark, Spain and Switzerland are from OECD (2006). $MONEY_5$ from OECD (2008a) and OECD (2008b) are first prolonged backwards with the growth rate in $MONEY_5$ in OECD (2006) when differences in mean and slope is adjusted for as in equation (A5). Then, the prolonged $MONEY_5$ from OECD (2008a), OECD (2008b) and OECD (2006) are prolonged backwards with the growth rate in $MONEY_5$ in OECD (2002) when differences in mean and slope is adjusted for as in equation (A5).

Sill, there are some missing observations. The missing observations are therefore replaced backwards with the shocks in the original data set: Belgium in the period 1962 to 1970, Canada in the period 1962 to 1969, Denmark in the period 1962 to 1965, Finland in the period 1962 to 97, France in the period 1962 to 1978, Germany in the period 1962 to 1970, Italy in the period 1962 to 1976, New Zealand in the period 1962 to 1966, Spain in the period 1962 to 1964 and United Kingdom in the period 1962 to 1964.

**TTS: Terms of trade shock**

Terms of trade shock are calculated by the change in the import price deflator relative to the real GDP deflator at market prices multiplied with the share of imports to GDP. The following Equation (A8) calculates the shocks:

$$TTS = \frac{MGS}{GDP} \Delta \{ln\left(\frac{PMGS}{PGDP}\right)\}$$

$MGS$ are imports at current prices, $GDP$ is GDP at current prices, $PMGS$ is import price deflator and $PGDP$ is the real GDP deflator at market prices described under labour
The sources of the time series for \( PGDP \) is previously described under labour demand shock. The main source for import price deflator and GDP at current prices is \( PMGS \) and \( GDP \) in OECD (2008a). \( GDP \) and \( PMGS \) in OECD (2002) is used to prolong the variables from OECD (2008a) backwards when observations are missing by equation (A5).

The replaced observations for \( GDP \) and \( PMGS \) are Denmark before 1966, Germany before 1991 and Switzerland before 1965. \( MGS \) in OECD (2002) prolongs the time series for Denmark before 1966, Germany before 1991 and Switzerland before 1965 by equation (A5).

### A.2 Structural variables

New information for institutional variables are available every second or fifth year. The main data source is OECD (2004), but due to missing observation some data are collected from Nickell (2006). Benefit replacement ratio is found at OECD Directorate for Employment, Labour and Social Affairs (2006). The time series are replaced by data from other sources when observations are missing. Observations for prolonging are provided by Belot and van Ours (2004); Kenworthy (2001); Herbertsson and Zoega (2006); Bassanini and Duval (2006). The variables and the method for prolonging are discussed in detail in the next sections.

#### t1, t2 and t3: Tax wedge

The rates described here are calculated from actual tax payments. The total tax wedge is equal to the sum of employment tax rate (t1), direct tax rate (t2) and indirect tax rate (t3), as given in Equation (A9).

\[
TW = t1 + t2 + t3 \tag{A9}
\]

\( t1 \) 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 following relationship; \( t1 = SSRG/(IE - SSRG) \), where SSRG is social security contributions and IE is compensation of employees. The latter consists of two main components, wages and salaries and social contributions. Social contributions are payed by the employers to social security schemes or to private funded social insurance schemes. \( t2 \), is 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 is 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) witch contains information in 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 data base Nickell (2006) in the period 1960 to 2003 is in general used to prolong the time series:

- Belgium is prolonged by 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 only from the main data source OECD (2008c).
- In contrast and due to missing observations, New Zealand has main data source NNO, but is prolonged backwards before 1975 with the growth rate in the sum of \( t1 \) and \( t2 \) from the source Nickell (2006). The time series is then prolonged forward with the growth rate in \( t3 \) from source Nickell (2006) after 1986. Note also that the \( t3 \) is interpolated due to one missing observation in 1991.
ibrr: Benefit replacement rates

Benefit replacement ratio is a measure of how much each unemployed worker receives in benefits from the government. There are several indexes on the benefit replacement ratio: an aggregated overall replacement ratio and ratios depending on employment and family situations. The various measures are described in detail below.

The aggregated benefit replacement ratio does not depend on family or work experience previous to unemployment, but is an average over the various family and employment situations described below.

The main source for the overall benefit replacement rates (brr) is OECD Directorate for Employment, Labour and Social Affairs (2006). The index contains one observation every second year from 1961 to 2003. The time series are extended to 1960 to 2004 by letting missing observations take the same value as the last observation in either direction. Missing years are interpolated between two observation points.

The more detailed rate for unemployment benefits divides data in three different family types: single, with dependent spouse and with working spouse. The benefits also depend on the employment situation: 66 percent and 100 percent of 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 the first year, the second and third year and the fourth and fifth year. The indexes used in this paper uses the indexes aggregated over over family types. This results in six different groups: brr67a1, brr67a2, brr67a4, brr100a1, brr100a2 and brr100a4.

brr67a1: First year benefit replacement rate for workers with 66 percent of average earnings and the average over family types.

brr67a2 and brr67a4: Benefit replacement rate but brr67a2 is for second and third, and brr67a4 is for fourth and fifth year.

brr100a1, brr100a2 and brr100a4: The same as the former but for 100 percent of average earnings.

The average of brr67a1 and brr100a1 is used as an indicator for benefit replacement ratios, i.e. ibrr.

The main source for the more detailed benefit ratios are 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.

ibd: Benefit duration

Benefit duration is a measure on how long the benefits last when being unemployed. The ratio is calculated by the time series described under Benefit replacement ratio, by Equation (A10).

\[ \text{ibdj}_i = \alpha \frac{\text{brrja2}_i}{\text{brrja1}_i} + (1 - \alpha) \frac{\text{brrja4}_i}{\text{brrja1}_i} \quad \text{where} \quad \alpha = 0.6 \quad \text{and} \quad j = \{67, 100\} \quad i = 1, 2...22 \quad \text{(A10)} \]

brrja1i is benefit replacement rate in year 1, brrja2i is benefit replacement rate in year 2 and 3, and finally brrja4i is benefit replacement rate in year 4-5. \( \alpha = 0.6 \) gives more weight to second and third year compared with the fourth and fifth year. The index is calculated for both employment situations: 66 percent and 100 percent of average earnings.

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.

Dudnet: Union density

Union density rates are constructed by using the number of Union memberships 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, along the model used in the ICTWSS Database (Visser, 2009); Ebbinghaus and Visser (E and V, 2000); and in OECD (1991), divided by the corresponding total number of wage and salary earners taken from OECD Labour Force Statistics.

The main data source is Visser (Visser). 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 first interpolated and the growth rate is calculated to prolong the original time series from Visser (Visser).

It is the first difference in union density that is used in the regressions in the paper, \textit{Dudnet}.

By comparing the time series with the original data set in NNO, some observations are still missing. The time series, \textit{Dudnet} are extended by splicing in data from NNO. The countries are: Australia before 1965, Austria before 1969, New Zealand before 1972, Portugal in 1975 and 1977, Spain before 1982 and Sweden before 1964. The time series are dividing by 100 to achieve comparable results to the database in NNO.

The intersection terms between union density and coordination is prolonged by last known observation for these countries.

\textbf{iecoord: Coordination of wage setting}

The index for coordination of wage setting describes the coordination level in the wage setting. The index range from 1 to 5, and the most coordinated countries have index equal to 5:

$1 = \text{Fragmented company/plant bargaining, little or no co-ordination by upper-level associations}.$

$2 = \text{Fragmented industry and company-level bargaining, with little or no pattern-setting}.$

$3 = \text{Industry-level bargaining with irregular pattern-setting and moderate co-ordination among major bargaining actors}.$

$4 = \text{a) informal co-ordination of industry and firm-level bargaining by (multiple) peak associations; b) co-ordinated bargaining by peak confederations, including government-sponsored negotiations (tripartite agreements, social pacts), or government imposition of wage schedules; c) regular pattern-setting coupled with high union concentration and/or bargaining co-ordination by large firms; d) government wage arbitration}.$

$5 = \text{a) informal co-ordination of industry-level bargaining by an encompassing union confederation; b) co-ordinated bargaining by peak confederations or government imposition of a wage schedule/freeze, with a peace obligation}.$

The main source is OECD (2004), see Table 3.5. The frequency for observations are five-years 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 5-years intervals. In the period 1960 to 1970 the observations is prolonged backwards by the last known observation for all countries. The same procedure is used to extended the time series until 2007.

\textbf{co_nic: Coordination of wage setting}

The index for coordination of wage setting describes the coordination level in the wage setting. The index range from 1 to 3, and the most coordinated countries have index equal to 3.

The main source is NNO. The time series are prolonged by the growth rate in the index for coordination in Nickell (2006), i.e. \textit{co_oecdint_nic1}. 
**epl_nic1_ext: Employment protection**

A measure of the overall employment protection is found in Nickell (2006). See their appendix for data definitions and sources for more details.

The time series exists in the period 1960 to 2003. The time series are prolonged backwards and forward by last known observation.
Appendix B

This Appendix gives additional information to the dynamic simulation of the unemployment rate in section 3. The dynamic simulation explore to what extent the empirical model of Nickell et al. (2005) is able to forecast the subsequent post-sample evolution of unemployment, given that we now in general know the correct values of the explanatory variables. The model is evaluated by use of static and dynamic simulation of unemployment for twelve additional years of data. The model does very well in a static simulation. However, as the static simulation is conditional on the lagged unemployment rate, which plays a large role in the model, the static simulation may not give the right impression about the model’s out of sample explanatory power. For this reason, the results from the static simulation and some additional dynamic simulations that don’t change the main result of the dynamic analysis in section 3 are explored here.

In general, the sample period is extended by using the time series for the institutional variables available up to 2003, except for taxes that are available up to 2007, and the time series for the macro variables that are available up to 2007. See Appendix A for details regarding the extended and revised data set. The time dummies are set to zero in the simulations. The time trend is prolonged or prolonged by the average value of the trend and the estimated coefficient from the original data set is used in the simulations. The simulations are robust to different time series extensions: By prolonging the time series by last known observation or by prolonging the times series by the estimated average of the time dummies, but is not reported in this paper.

B.1 Static simulation of unemployment by using the model in NNO on the extended time period 1995 to 2007

The static simulation method simulates unemployment by the empirical model as specified in NNO, one year ahead out of sample. Within sample period has \( T \) periods. This means that we use all available information up to last period, \( T + t - 1 \), to simulate the unemployment rate this period, \( T + t \), Ch. 2.7 Clements and Hendry (1998).

Formally, the static simulated unemployment rate for country \( i \) can be written as

\[
\hat{U}_{i,T+t} = E(U_{i,T+t}|U_{i,T+t-1}, X_{i,T+t}, \hat{\beta}),
\]

where \( U_{i,T+t-1} \) is the actual unemployment rate for country \( i \) in period \( T + t - 1 \), \( X_{i,T+t} \) is a vector that contains all explanatory variables for country \( i \) in period \( T + t \) and \( \hat{\beta} \) is a vector with all the within sample period estimated coefficients as given in NNO\(^8\). The error term is set equal to zero in the simulations.

Figure B1 presents the actual unemployment rate and the static simulated unemployment rate. The model simulates well for Austria, Belgium, Finland, France, Germany, Ireland, Netherlands, Sweden and Switzerland. The simulated unemployment rate is somewhat lower than actual unemployment for 10 countries (Australia, Canada, Denmark, Italy, Japan, New Zealand, Norway, Portugal, United Kingdom and United States) while it is higher for only one country Spain.

As in the dynamic simulation the difference between the simulated and the actual value of the unemployment can be caused by the development in the institutional variables, the specified shock variables or the error term.

Figure B1 also displays the results of a static simulation where the institutional variables are kept constant. Generally, the simulation shows a fairly close fit of the model.

Including institutional variables in the simulation of unemployment generally improves the fit. However, for some countries notable New Zealand, Spain, United Kingdom and United States including institutions actually leads to a worse fit.

\(^7\)The vector contains mostly actual values of the explanatory variables, but it also contains some predictions for some of the institutions in the period 2001-7, see Appendix A for details regarding time periods for the different variables.

\(^8\)The country specific dummies are taken from the replication in section 4.1
Figure B1: Static simulation and actual unemployment rate. Estimated coefficients on the original data set are used in simulation, table C1.
Figure B2: Static simulated and actual unemployment rate. Estimated coefficients on the original data set are used in simulation, Table C1. Shocks are zero after 1995.
The difference between the static simulation and the actual unemployment rate could in principle be due to the development in the specified shock variables. But a simulation where these variables are set to zero after 1995 illustrates that the evolution in static simulated unemployment rate with and without the shocks, essentially have the same development see Figure B2.

B.2 Dynamic simulation of unemployment by using the model in NNO on the extended time period 1995 to 2007

The dynamic simulation in section 3 showed a substantial over- and underprediction of the unemployment rate in the post sample period. However, this is not only caused by continuing the time trend. The unemployment rate follows a similar pattern if the trend is prolonged by the last value of the trend in 1995 or by the average value of the trend. The latter gives the largest change in simulations and is shown in Figure B3. The simulations shows that the predictive power of the empirical model improves for most countries in the sample, since the simulated value of unemployment by the model is closer to actual unemployment in the post sample period. The prediction of the model improved also in Sweden, but the model now overpredicts the change in unemployment. The predictive power worsens for New Zealand, Germany and United Kingdom.

If the empirical model specified by NNO explains the development in unemployment, the difference between the simulated and the actual value of the unemployment can be caused by the development in the institutional variables, the specified shock variables or the error term. A simulation where the specified shock variables are set to zero after 1995 gives nearly no disparity to the simulation in Figure 2, see Figure B4.
Figure B3: Dynamic simulation and actual unemployment rate. Estimated coefficients on the original data set are used in simulation, Table C1. Trend is prolonged with the average value of the trend after 1995.
Figure B4: Dynamic simulation and actual unemployment rate. Estimated coefficients on the original data set are used in simulation, Table C1. Shocks are set to zero after 1995.
Appendix C

This appendix gives some additional information to section 4 and 5. First, the empirical model in table 5 in Nickell et al. (2005) (NNO hereafter) and of their evaluation by using the original data set is replicated. Second, a static simulation of the model in NNO on the revised and extended data set. Third, a dynamic simulation of the full model, where also the error term specification is taken into account in the simulations on the original data set.

C.1 Replication of the NNO model

A replication of empirical model in Table 5 in NNO and of their results ensures that any differences in results that are found in this paper are due to changes in data revisions or sample length. The estimation procedures and results in NNO are described in section 2.

I find that the estimated coefficients exactly replicates the coefficient values in NNO, cf. Model A in Table C1 and the original results in Table 5 in NNO. In addition, a detailed visual inspection of the dynamic simulation on the original data set with and without time-varying institutions are also the same as NNO. The replicated simulations are presented in Figure C1.

Table C1: Model A and B is a replication of model 5 in NNO on the original data set. In Model A, the time dummies are pooled in the time period 1960 to 1966, while the time dummies are pooled in the period 1960 to 1969 in Model B.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th>Model B</th>
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<td>max95</td>
<td>Coef.</td>
<td>t-value</td>
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<td>0.46</td>
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<td>0.10</td>
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<td>1.90</td>
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</table>

9The data is received from Luca Nunziata.
Figure C1: Unweighted Dynamic simulation with the coefficients estimated on the original data set in NNO in the period 1960 to 1995. With constant and time-varying variation in institutions.
C.2 Static simulation on revised and extended data set

The dynamic simulation explore to what extent the empirical model of Nickell et al. (2005) is able to explain the evolution of unemployment within the sample period when the time series are revised and time period extended.

In general, the sample period is extended by using the time series for the institutional variable available up to 2003, except for taxes that are available up to 2007. See appendix A for details regarding the revised and extended data set.

In light of the considerable changes in the coefficient estimates in section 4 when the time series are revised and extended, one might expect that the model would result in a bad fit of unemployment, at least for the period 1960 to 1995. However, it seems that the new coefficients in a static simulation simulate unemployment well over that period, cf. figure C2. One possible explanation is that the model is quite flexible because of time dummies and country specific trends, in the sense that the model can capture actual unemployment also with the new values of the estimated coefficients of the institutional and shock variables on the revised data set.

However, as the static simulation is conditional on the lagged unemployment rate, which plays a large role in the model, the static simulation may not give the right impression about the fit of the model. For this reason, the results from the static simulation is explored here and the dynamic simulation in section 4.

C.3 Dynamic simulation of the rewritten model

One possible objection to the empirical specification in NNO is that all the heterogeneity is captured by unobserved country and period specific intercepts (a two way error component model), a country specific time trend and a country specific autoregressive error term. In equation (5) in section 5, the model is rewritten to explicitly take the effect of the heterogenous lagged error term into the solution of the model for unemployment.

A dynamic simulation of equation (5) with the estimated coefficient values in table C1 above is shown in figure 6 in section 5 and in figure C3. Figure C3 illustrates a similar pattern as the corresponding graphs in figure C1 which were based on the original model in NNO. This means that the effect of the heterogeneity in the error term on the simulations is small for a majority of countries, and the two figures shows a good correspondence between the two simulations. See further discussion for the countries with unstable solutions in figure 6 in section 5.
Figure C2: Static simulation of unemployment in the period 1960 to 2007. Estimated coefficients used in simulation are found in Table 3.
Figure C3: The transformed Equation (5). Model A in Table C1.