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What really drives unemployment? A bayesian approach to determine the impact of institutions on the unemployment rate

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Abstract

Labor and product market regulations affect the unemployment rate without a doubt. Econometricians, however, have yet to establish an unequivocal significance of this impact. The bayesian model averaging approach applied in this paper permits to unambiguously identify institutional indicators related to unemployment. For a panel of 17 countries, 24 years, and 19 institutional variables, eight indicators are identified as robust and significant determinants of unemployment, while the remaining eleven indicators are not related to the unemployment rate.

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1 Introduction

The link between labor and product market institutions and unemployment has been documented in several theoretical contributions. Nickell and Layard (1999) deliver a general overview. More specific discussions can be found in Blanchard and Giavazzi (2003) for the bargaining system, Ljungqvist (2002) for employment protection, Holmlund (1998) for the unemployment benefit system, Schiantarelli (2008) for product market regulation, and Daveri and Tabellini (2000) for the labor tax system. Empirical evidence, however, is yet to unambiguously confirm or refute the predictions of the theory. Nickell et al. (2005) or Amable et al. (2007) conducted empirical exercises in a dynamic setting, while Baccaro and Rei (2007) or Bassanini and Duval (2006) are good examples for static models. Howell et al. (2007) describe the selection of variables from a rather large pool of institutional indicators as well as the lack of robustness, both due to a limited number of observations, as central sources for the inconclusive results. While several indicators for most of the institutional categories are available, it is unclear which ones really matter for unemployment. Additionally, theoretical guidance is limited. No comprehensive macroeconomic model is available which permits the clear-cut specification of the empirical model explaining unemployment.

I propose to use a bayesian model averaging approach (Bayesian Averaging of Classical Estimates (BACE), introduced by Sala-I-Martin et al. (2004)) to tackle this crucial problem of the literature. The core of this method is to explicitly allow for model uncertainty. Instead of focussing on one particular model, information from models consisting of all combinations of explanatory variables is exploited. Three advantages of the approach deserve attention. Firstly, it permits to test all available indicators for significance. The selection of a subset of indicators is therefore not required. Secondly, multicollinearity due to highly correlated indicators does hardly influence the findings. Thirdly, the robustness of the results is ensured by taking model uncertainty particularly into account.

Using data on five institutional categories (the bargaining system, employment protection legislation, the unemployment benefit system, product market regulation, and the labor tax system) for 17 OECD countries over 24 years, this paper shows that eight indicators are robust and significant determinants of unemployment, while the remaining eleven indicators are not significant.

2 Econometric model specification

The estimation of robust and significant effects of institutions on unemployment is hampered by a rather low number of observations and a rather high number of potentially explanatory factors. Under such circumstances, the specification of the econometric model and the robust identification of significant variables is a challenging task.

On the one hand, considering all available indicators reduces the number of degrees of freedom and might create a multicollinearity problem if the correlation between institutional indicators is high. Indeed, some of the indicators like, for example, bargaining centralization and bargaining coordination are considerably correlated. Both aspects, a low number of degrees of freedom as well as multicollinearity, give rise to the estimation of biased parameters and standard errors.

On the other hand, subjectively excluding some indicators might cause misleading estimates as well. If, for instance, no measure for the bargaining system is considered in the estimation, the results will probably be biased since the bargaining system is likely correlated with, for example, employment protection legislation. A significant impact of the neglected bargaining system measure might affect the significance of the employment protection variable.

Three questions emerge: Which indicators should be considered for estimation? Are the results robust to the model specification? And how can multicollinearity be taken into account? Within the model averaging framework applied in this study, the aforementioned issues can be tackled appropriately. The estimation of a large number of models permits the inclusion of all indicators, and the clear identification of significant variables. These results are independent of the model specification. Hence, the significance of a variable does not depend on the inclusion of another variable, and possible multicollinearity between both factors is not a problem. According to the comment of David Draper in Hoeting et al. (1999), this is particularly the case when the number of explanatory variables is relatively small compared to the number of observations, as in this paper.

Equation (1) describes the basic econometric model which will be estimated with an altering set of explanatory factors. The annual unemployment rate is the dependent variable and will be regressed on several institutional factors which explain the long-run evolution of the unemployment rate, and on a set of macroeconomic control variables, i.e. four shock variables.

$$UR = X_1\beta + X_2\gamma + \varepsilon, \tag{1}$$

where UR is a NTx1 vector representing unemployment, X_1 is a NTxK_1 matrix including all institutional factors which influence the unemployment rate in the long run, and X_2 is a NTxK_2 matrix containing the macroeconomic control variables to capture short-run fluctuations in the unemployment rate. β and γ are the corresponding coefficient vectors of size K_1x1 and K_2x1, respectively. N is the number of countries and T the number of years. As usual in the literature, the potential problem of endogeneous institutions is not considered due to the fact that no valid instruments for institutions exist. Using lagged institutional values would be an obvious solution. However, it is hard to believe that institutions are not a function of future unemployment, especially for slowly changing institutional variables.

3 Bayesian Model Averaging

The central idea of the model averaging approach is to exploit information of a large set of models. It determines the impact of a variable independent of the inclusion of additional variables. In this study, all combinations of institutional indicators are estimated. A particular model consists of fixed regressors (the macroeconomic control variables) plus a set of varying regressors (the institutional indicators). In bayesian terms, the expected coefficient value and the variance of an indicator can be calculated as follows:

$$\mathbb{E}(\beta|y) = \sum_{j=1}^{2^K} P(M_j|y)\widehat{\beta}_j \tag{2}$$

$$VAR(\beta|y) = \sum_{j=1}^{2^K} P(M_j|y)Var(\beta|y, M_j) + \sum_{j=1}^{2^K} P(M_j|y)(\widehat{\beta}_j - E(\beta|y))^2 \tag{3}$$

where $P(M_j|y)$ is the weight (or the quality) of model j in relation to the sum of the weights (the qualities) of all possible models. Thus,

$$P(M_j|y) = \frac{P(M_j)NT^{-k_j/2}SSE_j^{-NT/2}}{\sum_{i=1}^{2^K} P(M_i)NT^{-k_i/2}SSE_i^{-NT/2}}. \tag{4}$$

The term SSE considers the sum of squared errors of a regression to account for the goodness of a model, and is corrected for degrees of freedom using the Schwartz model selection criterion. According to Ley and Steel (2009), the BACE approach is a special case of a pure bayesian model averaging where the g-prior specification to approximate the marginal likelihood of a model is just $g = \frac{1}{NT}$, what is a valid approximation for NT going to infinity. K is the total number of explanatory variables, and k_j is the number of explanatory variables in model j. $P(M_j)$ is the prior model probability related to model j. This probability is calculated as

$$P(M_j) = \left(\frac{\overline{k}}{K}\right)^{k_j} \left(1 - \frac{\overline{k}}{K}\right)^{K-k_j}. \tag{5}$$

$P(M_j)$ is a weighting factor to correct for the model size, i.e. for the number of explanatory variables. $\overline{k}$ is the prior model size the researcher has to specify. Models with a size close to the prior model size is given a higher weight. This corrects for the fact, that models with a large number of explanatory variables per se achieve a better fit than models with only few explanatory factors. Prior knowledge about the true model size could be incorporated through $\overline{k}$. A detailed description of the method is given in Sala-I-Martin et al. (2004) while the extension to a panel is extensively discussed in Moral-Benito (2011). Applications of the approach can be found in, for instance, Lamla (2009) for long-run determinants of pollution, Schrimpf (2010) for international stock return predictability, or Bryant and Davis (2008) concerning the demand for meat in the US.

4 Data

In order to ensure comparability to earlier studies, I rely on established data sources on institutional characteristics. In contrast to Sala-I-Martin et al. (2004) who use a cross-section approach, a fixed effects panel data estimator is applied in this study. At least two arguments militate in favor of using a panel. First, considerably more information on institutions and unemployment can be exploited. Second, by applying a fixed effects estimator, unobserved heterogeneity can be taken into account what reduces the omitted variable bias. This comes at the cost of leaving out all measurable time-invariant variables. The existing data have been updated, resulting in a comprehensive data set of 19 institutional indicators from 1982 to 2005. The econometric approach which is applied here requires the application of a panel data set without any gaps which is why only 17 OECD countries are considered. Besides the 5 institutional categories analyzed here some more institutional factors exist. However, similar to the literature, variables like family or migration policies, the regulation of working hours, housing ownership or active labor market policies are not taken into account due to data constraints. In other words, all institutional indicators available for the complete set of countries and periods have been collected. The institutional indicators under inspection as well as the control variables are briefly described in the following. Further information on the construction and composition of the data set is given in the Appendix.

- The *labor tax system* is represented by the payroll tax, the income tax and the consumption tax.

- Bargaining coordination and centralization, union density and coverage as well as the minimum wage all cover a part of the *bargaining system and the workers' bargaining power.*

- The OECD provides two indicators for the strictness of *employment protection* (EPL). While the first indicator measures the degree of employment protection for regular employment, the second describes the degree of employment protection for temporary employment.

- *Unemployment benefit system* indicators are constructed according to Nickell and Nunziata (2001). Thus, indicators for the replacement rate for the first year, for the second and third year, and for the fourth and fifth year of unemployment are used. Additionally, the OECD provides an overall indicator for the replacement rates which is the average of the three aforementioned partial replacement rates, and an indicator for the duration of payment which consists of weighted shares of the first year and the fourth and fifth year benefits. Furthermore, a measure for the coverage of the unemployment benefit system is used. It expresses how many unemployed are entitled to receive transfer payments.

- Indicators for barriers to entry and for public ownership, as well as an overall indicator for the degree of *product market regulation* (PMR) are used. The overall indicator is the average of different partial indicators of product market regulation and comprises, amongst other things, the barriers to entry and the public ownership. The remaining parts of the overall indicator cannot be considered since data is missing for some countries or periods.

- I follow Nickell et al. (2005) in considering four *shock variables*. More specifically, productivity shocks, labor demand shocks, real import price shocks and the real interest rate are included. Unfortunately, it was impossible to construct a money supply shock variable due to data constraints for the time frame required in this paper. However, the results in Nickell et al. indicate at most only slight importance of that shock. According to Dromel et al. (2010), a measure for credit volume delivered to the private sector over GDP is included to take financial market regulations into account. The higher the value the lower are the *constraints to credits.* Furthermore, the Within transformation for a two-way error component regression model suggested by Baltagi (2003) is applied to get rid of *time- and country-specific effects.*

5 Estimation Results

5.1 Baseline Estimation

Applying the model averaging approach gives the posterior inclusion probability and the (weighted) coefficient as well as the (weighted) standard deviation for each factor, both unconditional on inclusion. Variables with a higher inclusion probability are more likely to be significant explanatory factors of the dependent variable. In other words, the posterior inclusion probability gives a measure of the model fit containing a particular variable compared to models estimated without this variable. A posterior inclusion probability above the prior inclusion probability complies with a recommendation for inclusion while a value below the prior probability means omission.

Table 1: Baseline estimation

Prior inclusion probability	0.3	(k = 6)		
Variable	Posterior inclusion probability (1)	Posterior mean (2)	Posterior standard deviation (3)	Sign certainty probability (4)
Payroll tax	0.999	0.00267	0.00040	0.999
Employment protection temporary	0.999	-0.01005	0.00160	0.999
Consumption tax	0.999	-0.00309	0.00058	0.999
Fourth/Fifth year benefits	0.974	-0.00068	0.00145	0.999
Union coverage	0.902	0.00066	0.00029	0.999
Bargaining coordination	0.894	-0.00376	0.00170	0.998
Income tax	0.699	0.00126	0.00096	0.994
Employment protection regular	0.633	0.00788	0.00686	0.993
First year benefits	0.407	0.00015	0.00145	0.987
Aggregate benefits	0.385	0.00015	0.00433	0.947
Public ownership	0.281	0.00201	0.00368	0.983
Entry barriers	0.252	-0.00112	0.00225	0.980
Second/Third year benefits	0.115	0.00004	0.00144	0.889
Unemployment benefits duration	0.083	-0.00207	0.00865	0.910
Bargaining centralization	0.080	-0.00021	0.00085	0.920
Aggregate PMR	0.072	0.00009	0.00198	0.509
Unemployment benefits coverage	0.057	-0.00033	0.00169	0.900
Minimum wages	0.026	0.00000	0.00014	0.500
Union density	0.025	0.00000	0.00005	0.573

The dependent variable is the unemployment rate. Overall, 1048576 (2^{20}) estimations have been performed. The shock variables (labor demand shock, productivity shock, real import price shock and the interest rate) are included in each regression.

Three indicators for the tax system, two measures for employment protection, five indicators for the bargaining system, three factors for product market regulation, and six measures for the unemployment benefit system are included. An indicator for financial market regulation is also considered, but not displayed in the result table. The prior model size is specified to be equal to six, i.e. the true model is expected to consist of six variables. Thus, the prior inclusion probability is $\frac{6}{20}$. The corresponding estimation output can be found in table 1, where the variables are sorted in descending order regarding their posterior inclusion probabilities in column (1). The weighted coefficients and standard deviations are displayed in columns (2) and (3). Three indicators show a posterior inclusion probability close to one. Hence, it is virtually certain that these three indicators are essential determinants of unemployment. More precisely, the payroll tax, employment protection legislation for temporary contracts, and the consumption tax are indubitably linked to the unemployment rate. Five additional variables, fourth and fifth year benefits, union coverage, bargaining coordination, the income tax, and employment protection for regular contracts show lower posterior inclusion probabilities which are nevertheless clearly above the prior. Hence, it is highly probable that these five variables are robust and significant determinants of unemployment. Furthermore, first year benefits as well as aggregate benefits have posteriors marginally above the prior what indicates significance. In contrast, the nine variables with a posterior inclusion probability below the prior are not related to unemployment.

Some of the significant variables show rather high posterior standard deviations in relation to the corresponding posterior means. The fourth and fifth year benefits, for instance, have a posterior mean of 0.00068 and a posterior standard deviation of 0.00145. Denoting a variable significant is questionable if the direction of impact is uncertain. Sala-I-Martin et al. (2004) suggest to calculate sign certainty probabilities for the estimates of each variable in order to shed light on this sign uncertainty. The sign certainty probability measures the probability that a coefficient has the same sign as its mean. The closer the value to one, the higher the probability that the signs of the estimated coefficients do not change across models. The sign certainty probabilities for all variables in table 1 are reported in column (4). All significant variables show sign certainty probabilities above the threshold level of 0.975 suggested by Sala-I-Martin et al. (2004). The high standard deviations for a variable occur due to dispersed coefficient estimates which nevertheless lie on the same side of zero.

5.2 Alternative Prior Model Sizes

The prior model size expresses the researcher's belief about the true model size and can be used as a sensitivity check. A higher weight is assigned to models with a size close to the prior model size. If a variable appears to have a posterior inclusion probability above the prior for small models, and below the prior for larger models, this specific variable probably works as a "catch-all" for other effects. A posterior below the prior for small models, and above the prior for large models indicates that a variable needs other conditioning variables to be significant. Generally, a variable can only be called robust and significant if the posterior is above the prior independently of the prior model size.

In the baseline specification, a prior model size of six was assumed. Since the true model size is unknown in advance, the same estimations are performed for prior model sizes of two, four, eight and ten in order to evaluate whether this affects the outcomes. Table 2 shows that the alteration of the prior model size does only moderately influence the results of the baseline estimation. First year benefits, aggregate benefits, public ownership, and entry barriers turn out to be significant for some lower prior model sizes written in italics, but the effect disappears for larger prior model sizes. Since eight significant variables are always identified independent of the prior model size, a model consisting of eight institutional factors seems to represent the ideal model size with respect to the panel used in this study. The significance of four variables for smaller models should not be overrated and they are not considered as robust and significant.

Remarkably, the fourth and fifth year benefits and the public ownership show a decreasing posterior inclusion probability when the prior model size is increased. One would expect a larger model size to be linked to higher posterior inclusion probabilities for all

Table 2: Posterior inclusion probabilities for different prior model sizes

Variable					
Model size	k = 2	k = 4	k = 6	k = 8	k = 10
Prior inclusion probability	(0.1)	(0.2)	(0.3)	(0.4)	(0.5)
Payroll tax	0.999	0.999	0.999	0.999	0.999
Employment protection temporary	0.999	0.999	0.999	0.999	0.999
Consumption tax	0.999	0.999	0.999	0.999	0.999
Fourth/Fifth year benefits	0.985	0.979	0.974	0.969	0.961
Union coverage	0.490	0.792	0.902	0.948	0.970
Bargaining coordination	0.517	0.800	0.894	0.930	0.947
Income tax	0.307	0.571	0.699	0.765	0.806
Employment protection regular	0.238	0.498	0.633	0.705	0.749
First year benefits	*0.199*	*0.346*	*0.407*	*0.440*	0.468
Aggregate benefits	*0.164*	*0.313*	*0.385*	*0.425*	0.453
Public ownership	*0.593*	*0.346*	0.281	0.285	0.320
Entry barriers	*0.319*	*0.246*	0.252	0.304	0.385
Second/Third year benefits	0.049	0.089	0.115	0.137	0.162
Unemployment benefits duration	0.024	0.053	0.083	0.115	0.155
Bargaining centralization	0.091	0.084	0.080	0.087	0.103
Aggregate PMR	0.062	0.058	0.072	0.100	0.142
Unemployment benefits coverage	0.014	0.034	0.057	0.085	0.121
Minimum wage	0.007	0.016	0.026	0.038	0.056
Union density	0.007	0.015	0.025	0.037	0.053

The dependent variable is the unemployment rate. Overall, 1048576 (2^{20}) estimations have been performed. The shock variables (labor demand shock, productivity shock, real import price shock and the interest rate) are included in each regression.

variables. Nevertheless, the significance of the fourth and fifth year benefits is unaffected with posteriors always clearly above the prior for which reason this indicator remains in the group of robust and significant variables. The public ownership has a posterior inclusion probability above the prior for smaller models, and below the prior for larger models. Hence, it is a good example for a "catch-all" variable, and should not be considered as robust and significant.

6 Conclusions

The bayesian model averaging framework used in this paper allows the unambiguous identification of institutional indicators which affect the unemployment rate for 17 OECD countries from 1982 to 2005. In accordance with the insights of this paper, the inconclusive results of earlier studies can be at least partially traced back to variations in the indicator selection and the model specification.

Eight institutional indicators (payroll and consumption tax, employment protection for temporary employment, bargaining coordination, union coverage, income tax, fourth and fifth year benefits, and employment protection for regular employment) have been identified as robust and significant and should be included in cross-country regressions explaining unemployment. In contrast, the remaining eleven indicators are not important.

While the model averaging approach has been restricted to the identification of direct effects of institutions on unemployment, several extensions are feasible within such a framework. The approach can be beneficial for the analysis of interdependencies between institutions, for instance. This topic has to a large extent been neglected by the literature so far (two exceptions are Belot and van Ours (2004) and Bassanini and Duval (2006)) due to the fact that the number of possible interactions is considerably large and not reasonably estimable with a rather limited number of observations. Obviously, model averaging techniques are perfectly suitable for such data constraints.

7 Appendix

7.1 Data Sources and Construction

All variables are on an annual basis and have been gathered for the period from 1982 to 2005. Note, that the data set is balanced. The countries included in the analysis are Australia, Austria, Belgium, Canada, Denmark Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The dependent variable in the empirical analysis is the harmonized unemployment rate taken from the OECD. Some data is missing for earlier periods of some countries. To ensure consistent time series, I calculate the growth rates of the unemployment rate as a percentage of civilian labor force (which is not harmonized) and extend the harmonized unemployment rates by concatenating the change of the country-specific unemployment rate.

The taxes have been constructed according to the definition given in Nickell and Nunziata (2001). The payroll tax $t1$ is calculated as $t1 = \frac{ess}{ie-ess}$ with ess equal to the employer's social security contributions and ie equal to the compensation of employees. The income tax $t2$ is $t2 = \frac{it}{hcr}$ where it is the direct tax spending and hcr the household current receipt. Finally, the consumption tax $t3$ is the result of $t3 = \frac{tls}{fce}$ with tls equal to taxes less subsidies on products and imports and fce equal to the final consumption expenditure of households. Note that I did not just update the Nickell and Nunziata data but recalculated the whole series. Some considerable changes compared to the Nickell and Nunziata data occurred probably due to data updates made by the OECD.

Overall, five indicators for the bargaining system and power are available. The union density, union coverage, minimum wages, bargaining coordination and bargaining centralization all have been taken from the Visser database (see Visser (2009)).

The employment protection legislation indicators for regular and temporary employment have been taken from the OECD labour statistics database.

According to Nickell (2006), I construct the replacement rates for the first year, the second and third year, as well as for the fourth and fifth year of unemployment as indicators for the unemployment benefit system. Additionally, I include an overall indicator for the level of benefits which is the unweighted average of the three sub-measures, and a measure for the benefit duration. The benefit duration indicator bd equals $bd = 0.6\frac{brr23}{brr1} + 0.4\frac{brr45}{brr1}$ where brr23 are the second and third year benefits, brr45 the fourth and fifth year benefits, and brr1 the first year benefits. The Fondazione Rodolfo de Benedetti delivers data on unemployment benefit coverage. When data is missing, I assign the missing observations the same value as the first preceding or successive observation with a valid value. If both a preceding and successive value is available, the mean is constructed.

Data on product market regulation come from the OECD, as well. I use the regulation indicators in energy, transport and communication sectors (ETCR). This database delivers information on the barriers to entry and on public ownership as well as an aggregate indicator for product market regulation for the described sectors.

Concerning macroeconomic shocks, I closely follow the approach proposed by Nickell et al. (2005). The real import price is the import price deflator divided by the GDP deflator. According to the following equation, the shock is the log change of the real import price (IPS) times the import share in GDP $IPS = \frac{Imports}{GDP} log\left(\frac{IP_{deflator}}{GDP_{deflator}}\right)$ with $IP_{deflator}$ being the import price deflator. The real interest rate is the long-term interest rate corrected for the current inflation rate. For the construction of the total factor productivity (TFP) shocks I follow Bassanini and Duval (2006) and calculate first the change in the log of TFP as $\Delta ln(TFP) = \frac{\Delta ln(Y) - \alpha \Delta ln(TE) + (1-\alpha)\Delta ln(K)}{\alpha}$ with Y equal to the GDP in the business sector, TE is total employment, K the gross capital stock, and α the share of labor income in total business sector income. Cumulating the changes in the log TFP's over years gives the TFP in each year. Finally, TFP trend deviations are taken to construct an index for TFP shocks by applying the HP-filter with a λ of 100. The labor demand shock is the change in the residuals of a labor demand model to be estimated. Hence, I estimate the following equation for each country and take ε as the country-specific labor demand shock $ln(TE_t) = \beta_0 + \sum_{i=1}^{3} \beta_i ln(TE_{t-i}) + \beta_4 ln(Y_t) + \beta_5 ln(LC_t) + \varepsilon_t$. Again, TE is total employment, Y is the real GDP and LC are the real labor costs per employee.

For the credit constraints I use data from Beck and Demirgüç-Kunt (2009). More specifically, the indicator for private credit by deposit money banks and other financial institutions over GDP is used.

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