An empirical analysis of macroeconomic resilience

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An Empirical Analysis of Macroeconomic Resilience: The Case of the Great Recession in the European Union

Jan Brůha and Oxana Babecká Kucharčuková *

Abstract

In this paper, we analyse macroeconomic developments in European economies since the Great Recession. We present evidence that macroeconomic developments in the EU countries can be classified into latent classes. Countries in a given class exhibit a similar pattern of economic and labour market developments during and after the crisis. We then present evidence that the latent classes of countries differ in terms of quality of institutions and regulation. Based on this, we conclude that quality of institutions and regulation are crucial for the resilience of countries to shocks. The most important country characteristics associated with a quick recovery after the initial shock are low protection of temporary contracts, political stability, regulatory quality and pre-crisis fiscal space. On the other hand, other types of employment protection and generosity of unemployment benefits seem to not influence resilience.

Abstrakt

V tomto článku analyzujeme makroekonomický vývoj v evropských zemích po Velké recesi. Ukazujeme, že tento vývoj lze v zemích EU klasifikovat do latentních tříd. Země v dané třídě vykazují podobný vzorec ekonomického vývoje a vývoje na trhu práce během krize i po ní. Následně ukazujemes, že se třídy zemí mezi sebou liší kvalitou institucí a regulace. Na tomto základě tvrdíme, že kvalita institucí a regulace je klíčová pro odolnost zemí vůči šokům. Nejdůležitější charakteristiky, které jsou spojeny s rychlým překonáním počátečního šoku, jsou nízká míra ochrany dočasných pracovních kontraktů, politická stabilita, kvalita regulace a předkrizový fiskální prostor. Na druhou stranu, ostatní typy ochrany zaměstnanosti a štědrost dávek v nezaměstnanosti zřejmě odolnost vůči šokům neovlivňují.

JEL Codes: C14, E02, E65.
Keywords: Great Recession, institutions, regulation, resilience.

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Nontechnical Summary

In this paper, we contribute to the study of countries' resilience to adverse shocks by means of a case study of macroeconomic developments in the European Union countries during and after the Great Recession. To do so, we propose a novel two-step methodological approach to investigate how institutions, regulation and structural policies affect resilience.

The first step consists in characterising the commonalities and differences in macroeconomic developments in the European countries since 2007 by means of a hierarchical non-parametric model. The hierarchical model divides countries into latent classes. Countries in a given class exhibit a similar pattern of economic and labour market developments during and after the crisis, while the different classes capture different patterns.

This model is applied to unemployment dynamics and real GDP growth. Based on these time series, the model identifies four latent classes. The first class consists of countries that recovered relatively quickly from the initial decline in economic activity. Moreover, the unemployment rate in these countries is now lower than in the pre-crisis period. Real output in the second class of countries also recovered, but their unemployment rates remain higher than in the pre-crisis period. The countries in the third class experienced a huge initial decline in economic activity, from which they started to recover quickly. The fourth latent class consists of stressed countries that experienced a long period of economic stagnation and high unemployment rates followed by a slow recovery.

The second step consists in demonstrating that countries in different latent classes systematically also differ in quality of regulation and institutions. Our analysis suggests that the most important country characteristics associated with resilience are quality of regulation, political stability and pre-crisis fiscal space. The two last-mentioned characteristics are the most important.

On the other hand, generosity of unemployment benefits and employment protection for contracts other than temporary contracts seems not to be important for the classification of countries into latent classes. That may mean that employment protection and generosity of the social system need not threaten macroeconomic resilience.

1. Introduction

Macroeconomic developments are determined to a large extent by institutional factors such as institutions (labour market institutions, in particular), regulation and policies. The relationship between these factors and macroeconomic performance is multi-dimensional. Labour market institutions, regulation and structural policies influence countries' long-run performance, such as long-run output, productivity growth and the equilibrium level of unemployment,[1] but they also contribute to volatility of macroeconomic variables as well as influencing the interdependency among economic segments, such as co-movements between the labour market and other macroeconomic variables.[2] It is therefore natural to expect quality of institutions and regulation also to affect economies' resilience to adverse shocks, i.e. their ability to quickly recover with limited output and employment losses.

In this paper, we study countries' resilience in conjunction with macroeconomic developments and institutional quality. Most studies in the literature are essentially event-based: they investigate the macroeconomic and labour market responses to shocks for samples of countries with different levels of regulation. We aim to contribute to this research stream by using a novel methodology to investigate how institutions, regulation and structural policies affect this resilience. We are interested in finding and characterising commonalities and differences in a selected group of economies. We then check if the common and different features are systematically related to regulation and institutions. For this purpose, we look at the patterns of macroeconomic experience of European countries during and after the Great Recession by means of a hierarchical non-parametric curve-fitting model. We are the first to apply this model to study macroeconomic resilience. The model divides countries into latent classes. Countries in a given class exhibit a similar pattern of economic and labour market developments during and after the crisis, while the different classes capture different patterns. We use the proposed model to identify and describe several latent classes that represent different patterns of labour market and economic developments.

We are primarily interested in unemployment and GDP growth. Unemployment is one of the key measures of social conditions and is linked to the population's well-being and social equity, while GDP growth is the key indicator of a country's overall macroeconomic performance. The period under consideration is not chosen at random. The Great Recession, which in 2008 hit the majority of advanced economies, including those of the EU, seems to be an interesting case study of countries' resilience. While the crisis started and ended at different times across the globe, the period 2008–2009 can generally be considered the peak of the initial economic downturn. The crisis interrupted a relatively long period of steady growth in prosperity. Our intention to cluster countries is motivated by the apparently uneven patterns of recovery across Europe. Substantial heterogeneity in economic developments is found both on the regional level and across individual countries within the same bloc. We focus on the EU region, which generates a large part of global GDP. The EU economies differ substantially not only in terms of the magnitude of the initial shock, but also in terms of subsequent developments and the speed of recovery. The heterogeneity of the initial downturn in economic activity was affected by a range of exogenous factors, such as external demand and the sectoral composition of national economies. The subsequent economic developments and, among other things, the response of the labour market to the shock were undoubtedly also affected by domestic conditions, especially economic policies and quality of institutions. Our results show that countries in different classes differ systematically as regards labour market regulation and quality

[1] Acemoglu et al. (2005) summarise the effects of institutions on long-term growth. Boeri and van Ours (2013) provide a survey of the effects of labour market institutions on equilibrium unemployment.
[2] See, for example, Gnocchi et al. (2015), Brůha and Polanský (2015), Juvonen (2017) and Abbritti and Weber (2010).

of institutions. This demonstrates the relevance of institutions and regulation for the resilience of economies to shocks.

The literature studying the influence of structural policies and quality of institutions on the resilience of countries to shocks is quite rich. Blanchard and Wolfers (2000), for example, investigate the resilience of the labour market to shocks and evaluate the role of institutions in shock propagation to unemployment dynamics on a panel of European countries. They find that shocks have a larger and more persistent effect in countries with poor labour market institutions.

Duval et al. (2007) find that structural policies affect both the strength and persistence of the effects of outside exogenous output shocks. They also find that the effectiveness of macroeconomic stabilisation policies is influenced by structural policy settings. The corresponding findings on the labour market (i.e. that institutions affect the strength and persistence of exogenous shocks) have been confirmed by Furceri and Mourougane (2012). Furceri et al. (2012) investigate the effects of financial crises on unemployment. They find that for economies with flexible labour markets, financial crises have pronounced but relatively short-lived effects, while the increase in the unemployment rate is initially less pronounced but more persistent in economies with more rigid labour markets.

Three papers are particularly close to our research: Sapir (2005), Izquierdo et al. (2017) and Brůha and Babecká Kucharčuková (2017).

Sapir (2005) classifies European countries into four types according to strictness of employment protection legislation and generosity of unemployment benefits. Although his results are not directly comparable to ours due to differences in the time period and the sample of countries used, he finds that the strictness of employment protection matters for labour market efficiency, and this is consistent with our findings. Generosity of unemployment benefits, on the other hand, is found to have only a limited impact on efficiency.

Izquierdo et al. (2017) split the EU countries into three groups using pre-specified criteria and then analyse wage and employment adjustments in these groups. They find systematically different behaviour across the groups. Although we use a completely different approach to assigning the EU countries to a particular group, in the end the composition of each of our groups is similar to that obtained by Izquierdo et al. (2017). The significant difference is that our approach identifies four distinct groups and our latent classes I and III coincide with Group I of Izquierdo et al. (2017).

Finally we use a similar type of model as in Brůha and Babecká Kucharčuková (2017), with two substantial differences: (i) the econometric methodology differs and (ii) in this paper, we look at a wider set of indicators of quality of institutions and regulation; in particular, we analyse subindices of the employment protection legislation separately. The conclusions of the two papers, however, are in broad agreement.

The rest of the paper is organised as follows. The next section describes the data that we used and the stylised facts that inspired our research. Section 3 describes the econometric model and presents the results. Section 4 links quality of institutions and regulation to the clusters identified. The last section concludes.

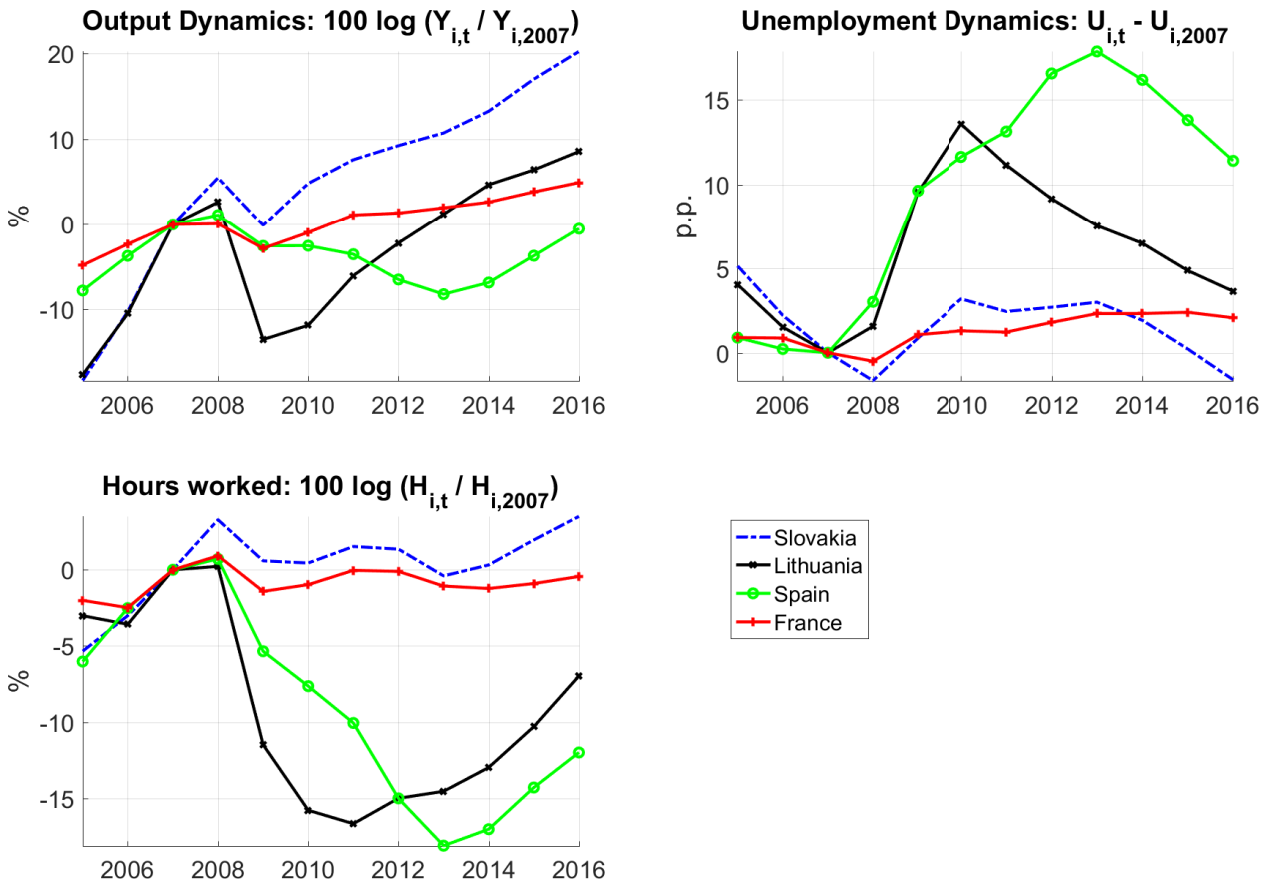
2. Data and Stylised Facts

2.1 Macroeconomic Data

The main source of the macroeconomic data used in our analysis is Eurostat, from which annual national accounts data are collected. The series considered include real GDP, nominal GDP, nominal wages (both wages and salaries and compensation of employees), employment (thousands of persons and hours worked) and the ratio of government debt to GDP as a measure of fiscal space. In addition, we use the unemployment rate. Nominal GDP and nominal wages are used to calculate the labour share. All data are in national currencies where appropriate and are collected or computed for each of the 28 EU countries over 2007–2016.

Some insights into the various patterns in countries' resilience can be obtained by comparing the dynamics of GDP growth, the unemployment rate and hours worked in four European economies: France, Lithuania, Slovakia and Spain (Figure 1). The upper left chart shows cumulative GDP growth since 2007 (i.e. the difference of the log of real GDP), the upper right chart illustrates the change in unemployment rate (the difference relative to 2007) and the lower left chart displays cumulative growth in hours worked, also relative to 2007.

Figure 1: Dynamics of Selected Key Macroeconomic Indicators in Selected European Economies



These four countries exhibit clearly different patterns of development. In all cases, GDP fell after 2008. This was accompanied by a surge in the unemployment rate and a fall in hours worked. In two countries (Slovakia and France) the decline in GDP was relatively modest and by 2012 GDP exceeded the pre-crisis levels, but in the other two countries (Lithuania and Spain) the initial fall was large and the output losses were more persistent. The unemployment dynamics relative to the pre-crisis year were also different. By 2015 the unemployment rate in Slovakia was lower than in 2007. The same is not true for France, Lithuania and Spain. Comparing the two countries that experienced a dramatic initial decline in economic activity, the unemployment rate in Lithuania was also higher in 2016 than in 2007, but the difference between 2016 and 2007 is much smaller than for Spain, which experienced a huge output loss too. Finally, the differences in unemployment dynamics are mirrored in the dynamics of hours worked. Again, there was an initial drop in all four countries in 2009. In Slovakia and France it was similar in magnitude, but the subsequent dynamics diverged, with hours worked in Slovakia starting to increase robustly in 2014. In Lithuania and Spain, the drop after the beginning of the recession was dramatic, but in Lithuania hours worked started to recover sooner and the gap with respect to the pre-crisis level is now smaller in Lithuania than in Spain.

Moreover, these differences cannot be explained solely by the size of the initial shocks. All four countries experienced a fall in external demand of about 10% between 2007 and 2009.

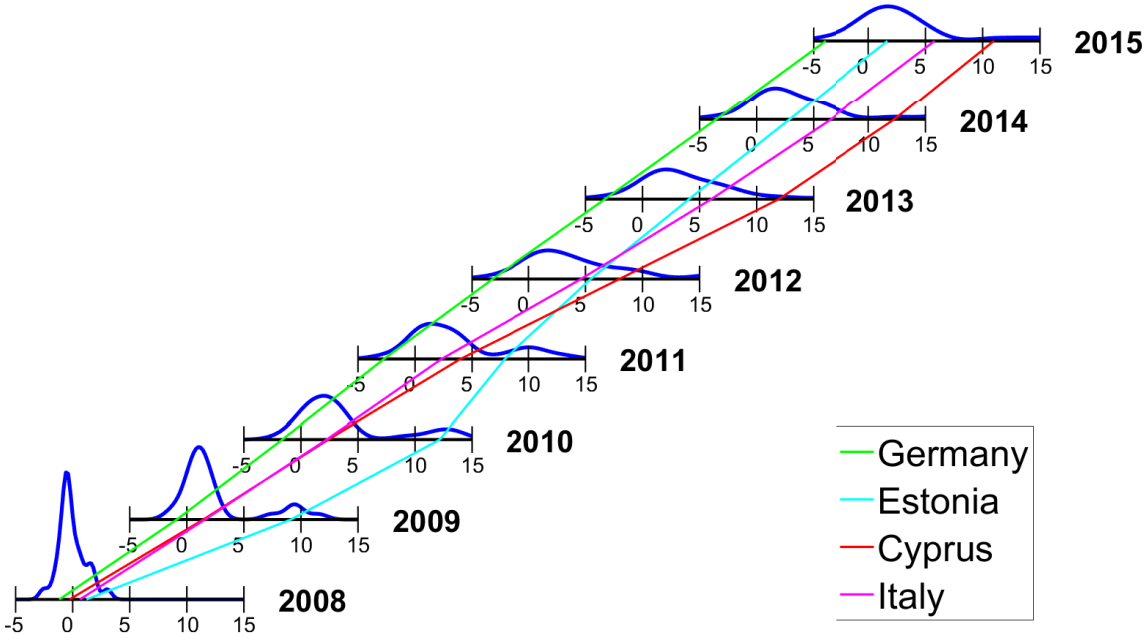
Systematic differences in output and labour market dynamics are also apparent from Figures 2 and 3. Figure 2 displays non-parametric kernel estimates of the distribution of unemployment rates across selected EU countries relative to their unemployment rates in 2007: $dU_{j,t} \equiv U_{j,t} - U_{j,2007}$, where $U_{j,t}$ is the unemployment rate in country j in year t. From 2009 on, the distribution of the change in the unemployment rate vis-à-vis 2007 is clearly bi-modal. This means that some countries experienced a systematically larger increase in the unemployment rate than others. Figure 2 also displays the path of $dU_{j,t}$ for four selected countries. There are countries, such as Germany, which are located in only one of the two modes (in the case of Germany, in the more favourable one). However, some countries switched from one mode to the other: this is the case for Estonia, which in 2009–2011 was located in the unfavourable mode but in 2012 switched to the more favourable one. The situation for Cyprus is the opposite: it switched from the favourable mode to the unfavourable one sometime around 2012.

Figure 3 is the analogous chart for output. It displays cumulative output growth since 2007, i.e. $dY_{j,t} \equiv \log Y_{j,t} - \log Y_{j,2007}$, where $Y_{j,t}$ is real GDP in country j in year t. For this variable, the distribution widens for years further from the beginning of the recession. Again, as in the case of $dU_{j,t}$, the relative position of the countries changed during the period.

2.2 Indicators of Regulation and Institutions

We also collect indicators that are used to approximate the quality of regulation and institutions. We focus primarily on labour market institutions. For this purpose, we employ subcategories of the employment protection legislation (EPL) index constructed by the OECD. We use the main indicator *Strictness of employment protection – individual and collective dismissals* ('EPRC') along with the following subindicators: *Strictness of employment protection – individual dismissals (regular contracts)* ('EPR'), *Strictness of employment protection – collective dismissals* ('EPC') and *Strictness of employment protection – temporary employment* ('EPT').

Figure 2: Distribution of Changes in Unemployment Rates across EU Countries (vis-à-vis 2007)



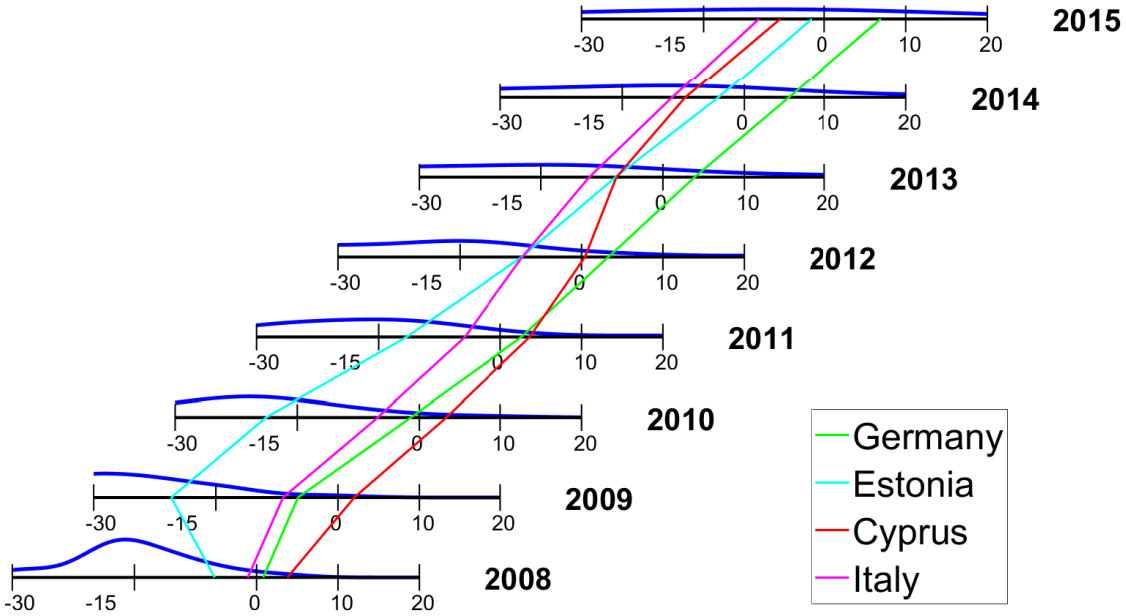
We complete our data base with widely used broad measures of the institutional environment, such as the World Governance Indicators (WGI) published by the World Bank.[3] Since some of the WGI indicators display low variability across European countries, we select only four subindices: *Quality of regulation*, *Government effectiveness*, *Rule of law* and *Political stability*. We also consider selected indicators from the World Bank' Doing Business database, namely *DB Start*, *DB Taxes* and *DB Insolvency*.

Countries can be classified based on types of institutions and regulation. To get an insight, we construct a matrix from the above-mentioned indicators and include two more time series: the measure of unemployment benefit generosity and the 2007 level of the government debt-to-GDP ratio. We employ the latter series as an imperfect, but robust and simple, measure of the pre-crisis fiscal space. We then apply principal component analysis to this matrix of institutions.

It turns out that the first two principal components explain more than half of the variability in these indicators (the first component being the dominant one). The mapping of the data to the principal component space is shown in Figure 4. It is apparent that the first principal component is driven by the Doing Business and WGI indicators. Countries scoring favourably in these indicators tend

[3] See Kaufmann et al. (2010) for methodology.

Figure 3: Distribution of Cumulative Output Growth across EU Countries (since 2007)

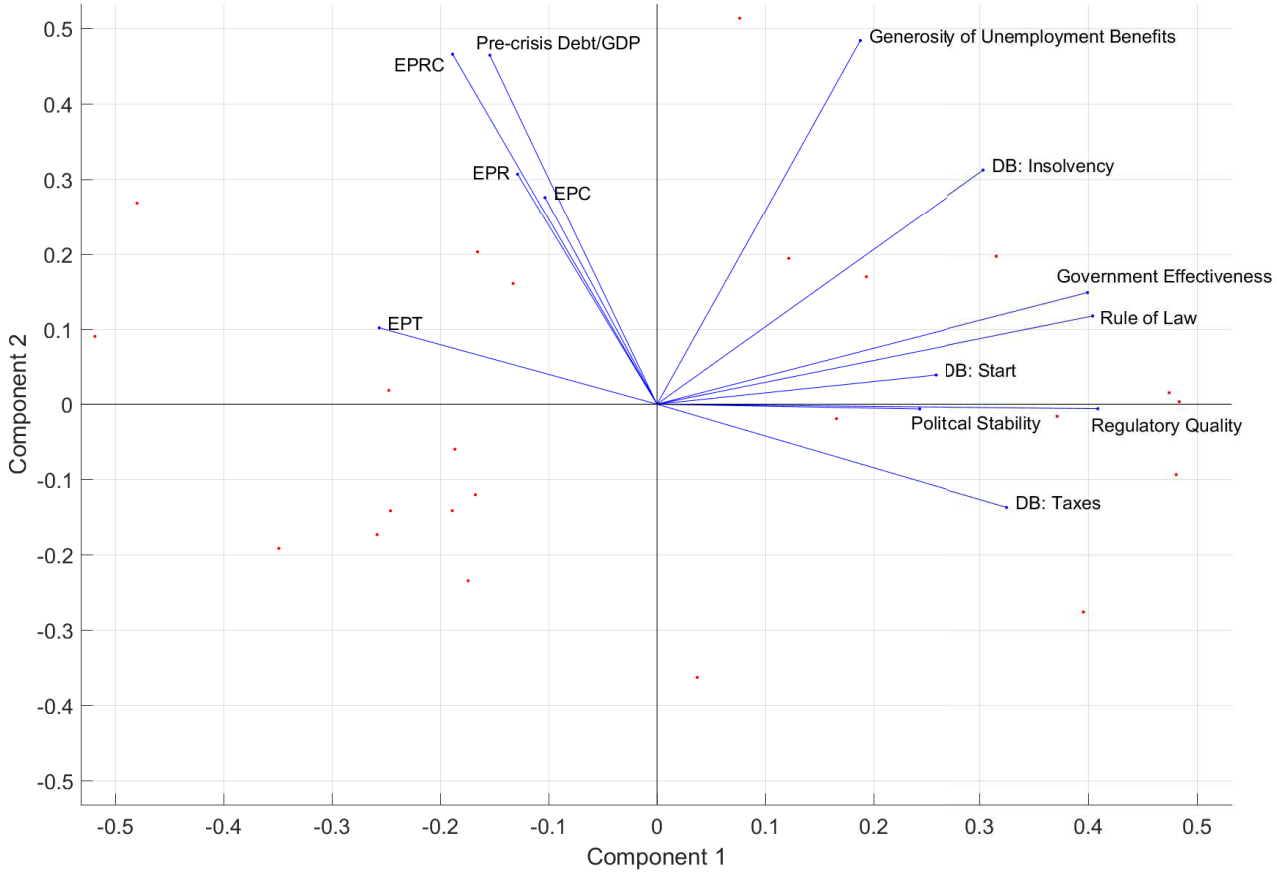


to have a positive value of the first principal component. Heavily regulated labour markets tend to reduce the value of the first principal component, as is the case for the high pre-crisis government debt-to-GDP ratio. Interestingly, the loading of generosity of unemployment benefits into the first component is positive. It is the second principal component that unites countries with high levels of employment protection and generous unemployment benefits. Therefore, the principal component results are consistent with the classification by Sapir (2005), who identified four types of countries according to generosity of unemployment benefits and level of employment protection.

As a preliminary analysis, we further look at how the selected indicators are associated with unemployment developments after 2008. This is shown in Figure 5, which displays the estimated non-parametric lines (estimated using local linear models) of the change in unemployment between 2008 and three years (2010, 2012 and 2016) as a function of the selected indicators. Data for individual countries are also shown in the figure.

The first subchart displays the evolution of unemployment as a function of strictness of employment protection – individual and collective dismissals (EPRC). The lines are almost horizontal, meaning that the EPRC values alone are uninformative for unemployment dynamics. The same conclusions would be obtained for the EPR and EPC indicators. On the other hand, if we look at the second

Figure 4: Principal Component Space of Indicators of Regulation and Institutions



subchart, it is obvious that the strictness of protection for temporary contracts (EPT) is informative for unemployment dynamics during the crisis. Countries with heavier regulation of temporary contracts have significantly higher unemployment in all three years investigated (2010, 2012 and 2016) compared to 2008.

The effects of the WGI indicators are also significant for unemployment dynamics. The next four subcharts show that countries with better WGI indices experienced much smaller increases in unemployment than countries with lower values of these indices. This holds especially for 2012 and 2016.

The level of the pre-crisis government debt-to-GDP ratio matters for unemployment dynamics, too: countries with higher pre-crisis debt experienced larger increases in unemployment in 2012 and 2016 compared to the pre-crisis levels. This is consistent with the findings of Romer and Romer (2017) that policy space contributes strongly to countries' resilience to shocks. It is also worth noting that this relationship does not hold for the unemployment increase between 2010 and 2008, which means that the overall conclusion is not affected by the size of the initial shock.

Finally and interestingly, generosity of unemployment is not associated with changes in the unemployment rate (the last subchart). This is analogous to the conclusions of Sapir (2005), who claims that there are countries that are able to achieve high social equity without necessarily compromising on economic efficiency (growth).

3. Econometric Model

This part of the paper introduces the model describing patterns of economic and labour market developments in EU countries after 2007. Based on the stylised facts presented in Section 2.1, we opt for a mixture model. Mixture models are a convenient way of modelling heterogeneity across units. It is assumed that there are $\mathscr{L}$ latent classes of countries. Countries in a given class exhibit qualitatively similar patterns, while these patterns differ across classes.

The model is specified using non-parametric kernel estimates for the modelled macroeconomic time series $x_{c,t}$, where $x_{c,t}$ is the vector of time series for country c at time t. The countries (conditionally on belonging to a latent class) are modelled non-parametrically. In particular, if country c belongs to latent class ℓ, then the probability density function of the vector $x_{c,t}$ at time t is given as:

$$p(x|t,c\in\ell)=\frac{\sum_{\varsigma}\pi_{\varsigma,\ell}\sum_{\tau}K_{h_t}(\tau-t)K_{h_x}(x-x_{\varsigma,\tau})}{\sum_{\varsigma}\pi_{\varsigma,\ell}\sum_{\tau}K_{h_t}(\tau-t)}=\frac{\sum_{\tau}K_{h_t}(\tau-t)\sum_{\varsigma}\pi_{\varsigma,\ell}K_{h_x}(x-x_{\varsigma,\tau})}{\left(\sum_{\varsigma}\pi_{\varsigma,\ell}\right)\left(\sum_{\tau}K_{h_t}(\tau-t)\right)}, \tag{3.1}$$

where $\pi_{c,l}$ is the posterior probability that country c belongs to class l and K_h is the kernel[4] with bandwidth h. The summation $\sum_{\varsigma}$ runs through countries and the summation $\sum_{\tau}$ runs through time.

Formula (3.1) has a straightforward interpretation. The distribution of the vector $x_{c,t}$, $p(x|t,c\in\ell)$, is given as a weighted average of all values of this vector through countries and time. The weights are larger for countries belonging to the same latent class (which is why the term $\pi_{\varsigma,\ell}$ enters the formula) and for times closer to time t (which is why $K_{h_t}(\tau-t)$ enters the formula).

The posterior probabilities are given by Bayes' law:

$$\pi_{c,\ell}=\frac{\zeta_{\ell}\prod_t p(x_{c,t}|t,c\in\ell)}{\sum_{l=1}^{\mathscr{L}}\zeta_l\prod_t p(x_{c,t}|t,c\in l)}, \tag{3.2}$$

where unconditional allocations are given as:

$$\zeta_{\ell}=\frac{\sum_{\varsigma}\pi_{\varsigma,\ell}}{\sum_{l=1}^{\mathscr{L}}\sum_{\varsigma}\pi_{\varsigma,l}}.$$

Again, formula (3.2) has a clear interpretation: the expression $\prod_t p(x_{c,t}|t,c\in\ell)$ is the likelihood that country c belongs to class ℓ based on all observations for that country. The normalisation is just Bayes' rule.

If the posterior probabilities $\pi_{c,l}$ were known, the distribution of interest (3.1) would be easily obtained. To estimate these probabilities, we devised an EM-type algorithm that iterates between

[4] In our analysis, we use the normal density function as the kernel. In the multidimensional case, the kernel is – as usual – the product of the corresponding univariate kernels.

equations (3.1) and (3.2). The iterative scheme is the following:

$$\pi_{c,\ell}^{(k)} \to \frac{\frac{\sum_{\varsigma} \pi_{\varsigma,\ell}^{(k-1)}}{\sum_{l=1}^{\mathscr{L}} \sum_{\varsigma} \pi_{\varsigma,l}^{(k-1)}} \prod_t \left(\frac{\sum_{\tau} K_{h_t}(\tau - t) \sum_{\varsigma} \pi_{\varsigma,\ell}^{(k-1)} K_{h_x}(x - x_{\varsigma,\tau})}{\left(\sum_{\varsigma} \pi_{\varsigma,\ell}^{(k-1)}\right)\left(\sum_{\tau} K_{h_t}(\tau - t)\right)} \right)}{\sum_{\lambda=1}^{\mathscr{L}} \left[\frac{\sum_{\varsigma} \pi_{\varsigma,\lambda}^{(k-1)}}{\sum_{l=1}^{\mathscr{L}} \sum_{\varsigma} \pi_{\varsigma,l}^{(k-1)}} \prod_t \left(\frac{\sum_{\tau} K_{h_t}(\tau - t) \sum_{\varsigma} \pi_{\varsigma,\lambda}^{(k-1)} K_{h_x}(x - x_{\varsigma,\tau})}{\left(\sum_{\varsigma} \pi_{\varsigma,\lambda}^{(k-1)}\right)\left(\sum_{\tau} K_{h_t}(\tau - t)\right)} \right) \right]}. \tag{3.3}$$

The estimated posterior probabilities are then fixed points of the mapping (3.3). We use our own Matlab codes to implement this algorithm.

Based on the estimated distributions $\pi_{c,\ell}$, we can derive other quantities of interest, such as moments. In particular, the conditional mean for latent class ℓ at time t is estimated as follows:

$$\mu_{t,\ell} = \frac{\sum_{\varsigma} p(x_{\varsigma,t} | t, \varsigma \in \ell) x_{\varsigma,t}}{p(x_{\varsigma,t} | t, \varsigma \in \ell)}, \tag{3.4}$$

i.e. it is a weighted mean of all the observations, where the weights are given by the values of the non-parametric densities at the observations.

Model (3.1) is basically the conditional probability distribution conditional on time and on the latent class. We condition on time to capture the dynamic nature of the data. Nevertheless, in principle, we could have used any statistical method for clustering, and if we only considered selected features of the data (for example, the difference between unemployment rates before and after the crisis or the change in real GDP over the same period) we could apply standard clustering algorithms as well.[5]

This model was applied to the bivariate series of macroeconomic data for the EU countries. For each country, we consider the vector of the following two series $x_{c,t} \equiv [dU_{c,t}\, dY_{c,t}]^T$, where – consistently with Section 2.1 – $dU_{c,t}$ is the difference in the unemployment rate with respect to 2007 in country c and $dY_{c,t}$ is the log difference of real output.

Using the model, we opt for four distinct latent classes. If we choose three or fewer, there is obvious heterogeneity within some of the classes. If the number of latent classes is five or higher, the estimation results become unstable, with some classes represented by just one country. It therefore seems that $\mathscr{L} = 4$ is the correct number. Based on the two series in vector $x_{c,t}$, the classification results are given in Table 1. As a robustness check, we also consider the classification based on an expanded set of series that also includes the log difference of hours worked and the difference in the labour share with respect to 2007. The results are very similar. The results for the expanded set of variables are provided in Table B.1 in Appendix B.

Countries in the **first latent class** recorded an initial decline in GDP of 4.5% on average between 2008 and 2010. This was associated with a rise in the unemployment rate of 3 percentage points on average. Over time, GDP growth resumed and unemployment subsequently started to fall. Interestingly, in countries in latent class I, the unemployment rate was lower in 2016 than in 2008.[6] Wage

[5] In fact, Izquierdo et al. (2017) use a set of preselected features to classify the EU countries according to their labour market performance and obtain similar results to ours.

[6] Interestingly, this feature is unique to this latent class, even though it was not used directly for the classification. It is also noteworthy that the dynamics of youth unemployment closely follow the dynamics of the general unemployment rate: in 2016 the youth unemployment rate is lower or the same in the countries belonging to the first latent class, while it is higher in the rest of the countries. It remains especially high in latent class IV.

Table 1: Estimated Posterior Probabilities

Latent class	I	II	III	IV
Belgium	0.00	1.00	0.00	0.00
Bulgaria	0.00	1.00	0.00	0.00
Czech Republic	0.93	0.07	0.00	0.00
Denmark	0.00	1.00	0.00	0.00
Germany	1.00	0.00	0.00	0.00
Estonia	0.00	0.00	1.00	0.00
Ireland	0.00	0.00	1.00	0.00
Greece	0.00	0.00	0.00	1.00
Spain	0.00	0.00	0.00	1.00
France	0.00	1.00	0.00	0.00
Croatia	0.00	0.98	0.00	0.02
Italy	0.00	0.00	0.00	1.00
Cyprus	0.00	0.00	0.00	1.00
Latvia	0.00	0.00	1.00	0.00
Lithuania	0.00	0.00	1.00	0.00
Luxembourg	0.00	1.00	0.00	0.00
Hungary	1.00	0.00	0.00	0.00
Malta	1.00	0.00	0.00	0.00
Netherlands	0.00	1.00	0.00	0.00
Austria	0.00	1.00	0.00	0.00
Poland	1.00	0.00	0.00	0.00
Portugal	0.00	0.00	0.00	1.00
Romania	0.00	1.00	0.00	0.00
Slovenia	0.00	0.00	0.00	1.00
Slovakia	1.00	0.00	0.00	0.00
Finland	0.00	1.00	0.00	0.00
Sweden	0.00	1.00	0.00	0.00
United Kingdom	0.99	0.01	0.00	0.00

growth in this group of countries was subdued, broadly reflecting the usual cyclical pattern. After 2008, the average wage rose faster than whole-economy labour productivity, a phenomenon typical of advanced economies.[7] In the period that followed, labour productivity started to rise again and caught up with (or slightly overtook) wage growth.

The **second class** comprises countries where GDP had reached or overcome the pre-crisis level by 2016, but unemployment was higher in 2016 than in 2008, albeit by less than 2 percentage points. Similarly to the class I countries, the labour share exhibits a clear countercyclical pattern; nevertheless, in most countries of this latent class the labour share was higher in 2016 than in 2008. Based on this observation, we refute the notion that the post-crisis period has been a time of 'subdued wage growth', as is sometimes argued[8]. Wage growth was faster than GDP and productivity growth after the crisis hit the European economies, and this is a typical business cycle pattern. The fact

[7] This reflects the countercyclicality of the labour share, which is a well-established stylised fact for advanced economies; see Brůha and Polanský (2015).

[8] See, for instance, the October 2017 IMF World Economic Outlook.

that wage growth is slower than GDP growth – a phenomenon observed recently in some European countries – may just represent a return to the steady-state relationship between wages and output.

The **third latent class** of countries comprises Ireland, Lithuania, Latvia and Estonia, i.e. countries that were hit by a severe adverse shock in 2008–2010 and recorded a significant initial drop in GDP accompanied by a rapidly rising unemployment rate. The economic situation of these countries started to improve after 2010. This was reflected in a decline in unemployment, which, however, had still not fallen below the 2008 level by the start of 2016. Since 2010, labour productivity in this group of countries has been rising much faster than the average wage (which has been recording weakly positive or even negative growth). This is another characteristic in which these economies differ from the rest. It is plausible that these countries overcame the crisis thanks also to more moderate growth in wages, which rose more slowly than labour productivity and even declined at the start of the period under review. This helped reduce the unemployment rate from its initial high levels.

The **fourth latent class** consists of 'stressed countries' where the unemployment rate was higher at the start of 2016 than in 2008 (by more than 2 percentage points) and the GDP level was lower. Their labour markets did not start to improve significantly after 2011. In addition, these countries recorded relatively rapid wage growth, which significantly outpaced labour productivity growth on average. The differences between the latent classes can be illustrated in more detail using the model-based and sample moments. This is done in the tables in Appendix A.

4. The Role of Institutions and Regulation

The stylised facts presented in Section 2 that relate institutions to macroeconomic performance inspired us to investigate the relationship more deeply. We have a large number of possible institutional and regulation characteristics, and some of them may not be relevant. In order to select the relevant ones, we run elastic net regression on a multinomial logit model that explains the allocation to latent classes based on institutional and regulation characteristics.[9] The following variables were selected as important predictors for the class allocations: protection of temporary contracts (ERPT), two WGI indices (Government Effectiveness and Political Stability) and the pre-crisis debt-to-GDP ratio, which is our measure of fiscal space. Table 2 displays the sample means and medians for the latent classes for these variables.

First, there are some differences in the employment protection legislation index (ERP) between countries. In particular, countries in latent class IV (the stressed one) tend to have higher ERP indices than the other countries. Nevertheless, these differences are more pronounced for the protection of temporary contracts. The stressed class IV countries exhibit much higher values of this index than the rest, while the countries in latent class I have the lowest regulation of this segment. Moreover, conditional on the protection of temporary contracts, the other EPL indices are unimportant for countries' classifications. Secondly, institutional quality is more important than employment protection. The stressed class IV performs the worst in both the government effectiveness and political stability indices. Finally, countries in this stressed class had very limited fiscal space before the crisis. Curiously, generosity of unemployment benefits seems not to be important for the classification of countries. This may mean that it is possible to establish a relatively secure social net without compromising on macroeconomic resilience.

[9] Elastic nets are regularisation tools that can be used for selecting relevant predictors for statistical models. We employ the elastic net for multinomial logit implemented in the glmnet package for R by Friedman et al. (2010).

Table 2: Institutions and Regulation for Latent Classes

Institutions		ERP	ERPT	Regulatory Quality	Political Stability	Fiscal Space
Latent class I	sample mean	2.40	1.77	1.23	0.86	47.97
	sample median	2.44	1.97	1.12	0.89	44.20
Latent class II	sample mean	2.58	2.30	1.32	0.84	39.45
	sample median	2.52	2.17	1.49	0.98	37.70
Latent class III	sample mean	2.37	2.09	1.33	0.71	12.98
	sample median	2.28	2.10	1.29	0.71	12.15
Latent class IV	sample mean	2.81	2.80	0.87	0.45	63.87
	sample median	2.64	2.71	0.84	0.50	60.95

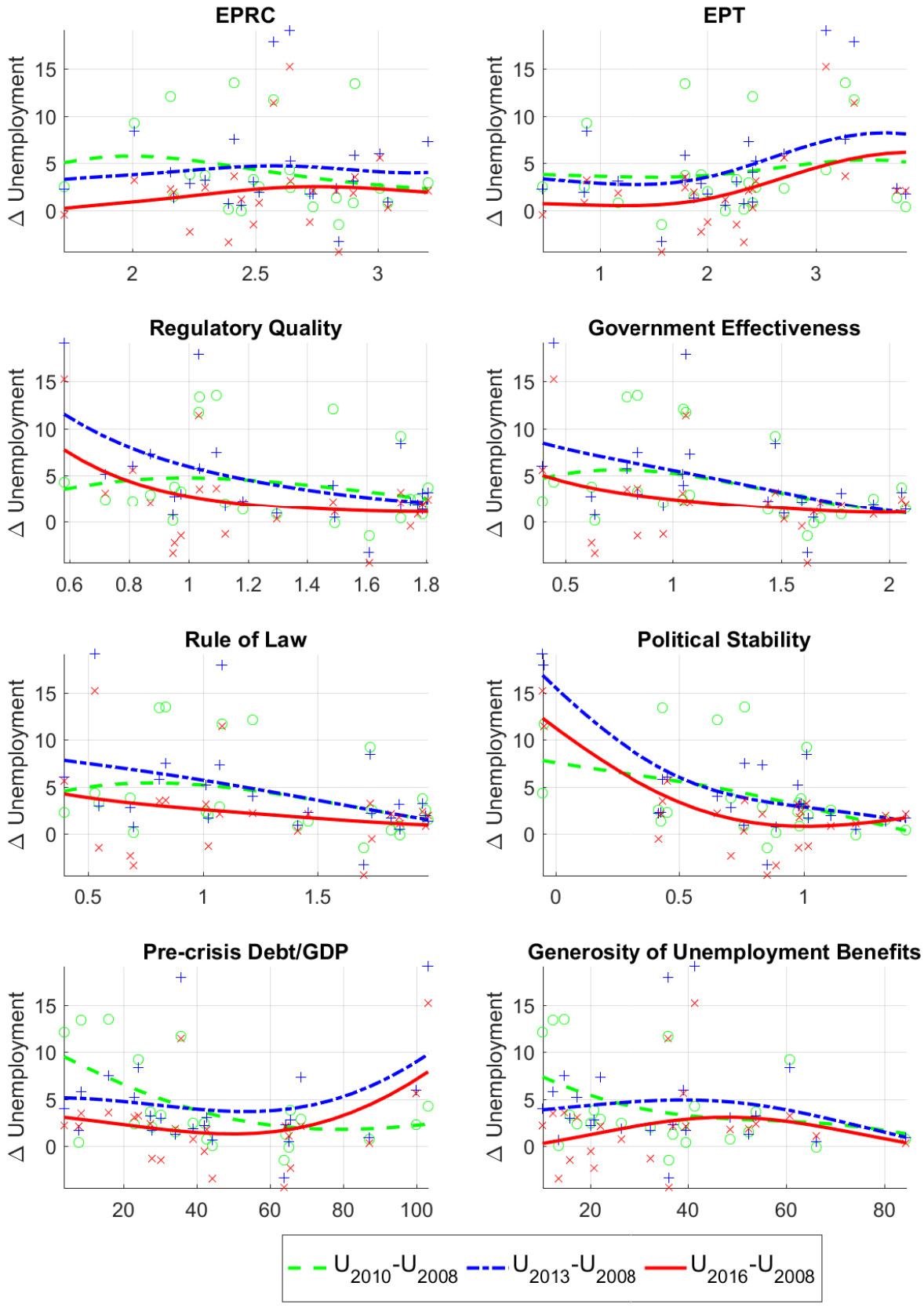
5. Conclusions

The aim of this paper was to contribute to the research investigating how institutions and regulation affect the resilience of countries to macroeconomic shocks. We took the Great Recession and its consequences for European countries as a case study.

First, we showed that EU countries can be classified into four latent classes. These classes represent different patterns of economic and labour market developments in the EU countries. Countries in latent classes differ systematically in the initial downturn in GDP, in the increase in unemployment, in wage dynamics and in the number of hours worked. They also differ systematically in whether (and when) the initial downturn was overcome.

We presented evidence that countries in different latent classes differ in terms of their quality of institutions and labour market regulation indices. Our analysis suggests that the most important country characteristics associated with a quick recovery after the initial shock are low protection of temporary contracts, quality of regulation, political stability and pre-crisis fiscal space. The two last-mentioned characteristics (fiscal space and political stability) are the most important. The finding on the importance of fiscal space for overcoming crises is consistent with recent literature such as Romer and Romer (2017). On the other hand, generosity of unemployment benefits seems not to be associated with macroeconomic resilience.

Figure 5: Institutions and Unemployment Dynamics



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Appendix A: Model-based Moments and Sample Moments for Latent Classes.

In this appendix, we report moments (both those implied by the mixture model and sample moments) for four selected macroeconomic variables for each latent class. Mixture-based means are computed using formula (3.4). The sample-based moments are simply raw means and medians based on the maximum a posterior probable classification, i.e. for each country we identify the class to which the country most probably belongs (see Table 1) and the moments are computed on the sets so defined.

Tables A.1 and A.2 compare the model and sample moments for the two time series used for the classification, i.e. the unemployment rate and cumulative output growth since 2007. Tables A.3, A.4 and A.5 provide the sample moments for an additional three variables – hours worked, the labour share and the unemployment rate among the youth population. As these moments were not used for the classification, these tables provide just the sample moments. Nevertheless, it is apparent that the latent classes differ along these variables as well.

Table A.1: Change in the Unemployment Rate vis-à-vis 2007 ($dU_{c,t}$) ***(in percentage points)***

		2008	2009	2010	2012	2014	2016
Latent class I	model mean	-0.84	0.74	1.51	1.12	-0.14	-2.18
	sample mean	-0.84	0.74	1.51	1.13	-0.13	-2.17
	sample median	-0.90	0.90	2.00	1.70	0.30	-1.80
Latent class II	model mean	-0.54	0.74	1.53	2.04	2.49	1.45
	sample mean	-0.54	0.74	1.53	2.05	2.51	1.47
	sample median	-0.50	0.40	1.30	1.60	1.80	1.80
Latent class III	model mean	1.43	9.28	12.05	8.35	5.13	3.13
	sample mean	1.43	9.28	12.05	8.35	5.13	3.13
	sample median	1.55	9.20	12.75	9.00	5.55	3.35
Latent class IV	model mean	0.35	2.76	4.33	9.32	10.49	7.74
	sample mean	0.35	2.77	4.33	9.33	10.50	7.75
	sample median	-0.25	1.55	2.65	7.35	9.40	7.35

Table A.2: Cumulative Output Growth ($dY_{c,t}$) vis-à-vis 2007 (in %)

		2008	2009	2010	2012	2014	2016
Latent class I	model mean	2.43	-1.43	1.52	4.80	10.12	16.80
	sample mean	2.43	-1.44	1.50	4.76	10.05	16.74
	sample median	2.65	-2.27	-0.03	3.38	5.78	10.86
Latent class II	model mean	1.68	-3.32	-1.28	0.23	2.72	7.44
	sample mean	1.68	-3.32	-1.30	0.21	2.69	7.40
	sample median	0.78	-2.79	-0.76	1.40	3.84	6.37
Latent class III	model mean	-2.65	-15.71	-15.31	-6.74	-0.30	9.87
	sample mean	-2.65	-15.71	-15.31	-6.74	-0.30	9.87
	sample median	-3.81	-16.30	-15.54	-5.86	0.88	4.90
Latent class IV	model mean	1.16	-3.28	-3.21	-8.90	-10.65	-7.05
	sample mean	1.16	-3.27	-3.20	-8.90	-10.65	-7.05
	sample median	0.66	-3.78	-3.08	-6.69	-7.08	-2.94

Table A.3: Cumulative Growth of Hours Worked since 2007 ($dH_{c,t} = \log H_{c,t} - \log H_{c,2007}$) (in %)

		2008	2009	2010	2012	2014	2016
Latent class I	sample mean	1.52	-0.46	-2.44	-1.78	0.94	5.06
	sample median	2.44	0.02	0.01	0.42	1.55	3.51
Latent class II	sample mean	1.91	-0.77	-1.23	-2.09	-2.07	-0.62
	sample median	1.45	-1.24	-1.37	-0.43	-0.60	0.30
Latent class III	sample mean	0.56	-13.82	-18.72	-17.28	-14.96	-11.54
	sample median	-0.76	-12.08	-18.33	-16.18	-14.75	-11.02
Latent class IV	sample mean	1.54	-1.15	-3.16	-9.69	-12.60	-9.48
	sample median	0.88	-1.90	-4.38	-9.77	-12.07	-8.77

Table A.4: Change in the Labour Share vis-à-vis 2007 (in percentage points)

		2008	2009	2010	2012	2014	2016
Latent class I	sample mean	0.40	1.16	0.62	0.78	0.26	0.48
	sample median	0.07	1.10	0.98	1.30	0.67	1.00
Latent class II	sample mean	1.14	2.78	1.61	1.75	1.83	1.75
	sample median	0.95	2.50	1.69	2.18	2.10	1.67
Latent class III	sample mean	3.31	3.32	0.05	-2.04	-1.26	-0.79
	sample median	3.59	3.02	-0.14	-2.05	-1.99	1.81
Latent class IV	sample mean	0.88	2.54	2.44	1.21	-0.25	-0.03
	sample median	0.70	2.28	2.19	1.18	-0.30	0.05

Table A.5: Change in the Unemployment Rate vis-à-vis 2007 (in percentage points)

		2008	2009	2010	2012	2014	2016
Latent class I	sample mean	-1.09	3.61	4.94	5.84	2.24	-2,31
	sample median	-1.03	4.80	5.60	6.90	2.30	-2.50
Latent class II	sample mean	-0.50	2.45	3.98	5.30	6.06	2.88
	sample median	-0.80	1.30	3.80	3.30	4.70	3.10
Latent class III	sample mean	3.50	19.0	23.6	17.1	9.90	6.05
	sample median	3.60	19.3	24.2	18.1	9.95	6.40
Latent class IV	sample mean	0.95	6.42	9.83	21.2	22.7	16.5
	sample median	0.25	3.75	7.15	17.1	24.1	18.2

Appendix B: Estimation of Posterior Probabilities for the Expanded Set of Macroeconomic Series

The following table shows what the estimation results would be if, besides the two benchmark series, an additional two series were considered (specifically the log differences of hours worked and the differences in the labour share vis-à-vis 2007).

Table B.1: Posterior Probabilities for the Expanded Set of Macroeconomic Series

Latent class	I	II	III	IV
Belgium	0.00	1.00	0.00	0.00
Bulgaria	0.00	1.00	0.00	0.00
Czech Republic	0.00	1.00	0.00	0.00
Denmark	0.00	1.00	0.00	0.00
Germany	1.00	0.00	0.00	0.00
Estonia	0.00	0.00	1.00	0.00
Ireland	0.00	0.00	1.00	0.00
Greece	0.00	0.00	0.00	1.00
Spain	0.00	0.00	0.00	1.00
France	0.00	1.00	0.00	0.00
Croatia	0.00	0.98	0.00	0.02
Italy	0.00	0.00	0.00	1.00
Cyprus	0.00	0.00	0.00	1.00
Latvia	0.00	0.00	1.00	0.00
Lithuania	0.00	0.00	1.00	0.00
Luxembourg	0.00	1.00	0.00	0.00
Hungary	1.00	0.00	0.00	0.00
Malta	1.00	0.00	0.00	0.00
Netherlands	0.00	1.00	0.00	0.00
Austria	0.00	1.00	0.00	0.00
Poland	1.00	0.00	0.00	0.00
Portugal	0.00	0.00	0.00	1.00
Romania	1.00	0.00	0.00	0.00
Slovenia	0.00	1.00	0.00	0.00
Slovakia	1.00	0.00	0.00	0.00
Finland	0.00	1.00	0.00	0.00
Sweden	0.00	1.00	0.00	0.00
United Kingdom	0.99	0.01	0.00	0.00

In fact, there are only three differences between the results in Table 1 and those in Table B.1. The countries concerned are the Czech Republic, Romania and Slovenia.

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