What if you were German? - DSGE approach to the Great Recession on labour markets

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In this paper we utilize an open economy DSGE model to analyse the factors behind the Great Recession and its transmission into the labour markets of selected Southern European countries. We introduce a number of shocks which form the potential sources of macroeconomic disturbances, in particular the following: foreign demand, productivity, bargaining power, labour demand, labour supply, government spending and job destruction shocks. Using quarterly data for the 1995-2013 period, we estimate the model for Germany, Greece, Italy, Portugal and Spain. We identify shocks determining macroeconomic and labour market fluctuations in each of the countries studied. We also conduct experiments allowing us to assess to what extent differences between countries with regards to macroeconomic and labour market fluctuations resulted from different shocks affecting them, and to what extent from the varying resilience of particular economies.

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Abstract

In this paper we use the DSGE model of a real open economy with search and matching as well as endogenous separation on the labour market, to identify sources of macroeconomic disturbances during the Great Recession and show how they were transmitted into the labour markets in Greece, Italy, Portugal, Spain and a reference country - Germany. We estimate models using quarterly data for 1995-2013 and conduct two types of simulations. First, using the Kalman filter we identify shocks determining the macroeconomic fluctuations in each country. Secondly, we perform counterfactual simulations to study what the Great Recession in the GIPS would have been like if all these countries had reacted to their country-specific shocks in the way Germany would have reacted. We find that all GIPS countries would have experienced a lower volatility of GDP, but would have reacted differently on the labour market. We find Spain and Italy to be two extremes - Spain would have experienced more wage and less employment adjustments, whereas Italy would have experienced bigger labour market fluctuations and flows. The trade-offs between wage and employment adjustments could possibly have important consequences for the impact of recessions on society, but the policy agenda for each of the GIPS countries should reflect the country-specific adjustment mechanisms.

Keywords: Unemployment, Rigidities, Great Recession, DSGE models

JEL Classification Numbers: E32, J20, J60

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1 Introduction

The Great Recession was extraordinary in its reach, depth and the durability of the economic slowdown. In many countries its impact on labour markets was as severe as on economic growth. In the 4th quarter of 2009, the average unemployment rate in OECD countries was 8.7%, the highest level in the post-war period. Despite improvements in job creation, in 2013 the harmonised unemployment rate in the OECD countries averaged 7.9%, which meant that 45 million people were looking for jobs (OECD, 2014). However, the Great Recession was quite diverse in its impact on various countries. In the OECD, most affected were the GIPS countries[1] and Ireland. Between 2008 and 2012 real GDP in Greece declined by 23.7%, in Italy by 8.5%, in Portugal by 6.7% and in Spain by 5.9%. Although some continental European and Scandinavian countries[2] (Denmark, Finland, Netherlands) also didn't return to pre-crisis GDP levels by the end of 2013, none of them suffered as severe a recession as in the GIPS countries, and as a whole this group recovered. Diverse macroeconomic developments were accompanied by diverse changes in the labour market. The unemployment rate in the GIPS countries more than doubled between 2008 and 2011, and in 2012-2013 it was still growing while employment was falling. The unemployment rate in continental European and Scandinavian countries increased by 1/4 on average between 2008 and 2010, but hasn't increase further. The Great Recession widened the unemployment rate gap between the two groups, meaning that in 2013 the highest unemployment rates in the OECD were recorded in Greece (27.3%), Spain (26.1%), Portugal (16.5%), and Italy (12.2%),[3], while the lowest were recorded in Norway (3.5%), Austria (4.9%), Switzerland (4.4%) and Germany (5.3%). The slowdown has also triggered wage adjustments which also differed amongst the GIPS countries. These adjustments were largest in Greece - according to the OECD data, between 2008 and 2013 real hourly wages declined at an annual rate of 3.9% on average, which (adjusted for changes in labour productivity) translated into a decrease in nominal unit labour cost by 1.1% on average per year. In Spain real wages declined by 0.2% and unit labour costs by 0.4% per year. In Portugal real hourly wages declined by 0.5% annually, but unit labour cost increased by 0.4% per year. Italy recorded a 0.3% average annual decline in real hourly wages but a 2.3% average annual rise in unit labour costs. The wage adjustments on GIPS labour markets seem relatively small compared to those experienced by countries like the United Kingdom (average annual real wage decline of 1.1%), Hungary or Czech Republic (both -1.3%) and Ireland (which recorded an average annual real wage decline of 0.4% and the biggest reduction of unit labour costs in the OECD, by 1.1% per year on average) who have experienced smaller and less prolonged rises in unemployment.

In this paper we focus on the GIPS countries and study the factors behind fluctuations on their labour markets during the Great Recession. In particular, we try to answer the question of to what extent these developments were due to idiosyncratic disturbances, and to what extent they were due to a country-specific, possibly institutionally driven, ability to absorb shocks. This question has been studied econometrically in the past,[4] but we address it using a DSGE model of open economy with search and matching on the labour market. This model allows us to identify the shocks which caused fluctuations

[1] Greece, Italy, Portugal, Spain.

[2] Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland.

[3] As well as the in Slovak Republic (14.2%) and Ireland (13.1%).

[4] By e.g. Layard, Nickell and Jackman (1991), Bean (1994), Blanchard and Wolfers (2000), Nickell, Nunziata and Ochel (2005), Blanchard (2006), Bassanini and Duval (2006), Bukowski, Koloch and Lewandowski (2013).

in particular countries, and analyse how these economies would have evolved during the Great Recession if they had adapted differently to the shocks. We chose Germany as a reference point for adapting to shocks, which, as argued by Rinne and Zimmermann (2013) and Zimmermann (2013), can be used as a template for a resilient labour market in Europe. By comparing country-specific adjustments in the GIPS countries with hypothetical "German-like" adjustments to the same shocks, we are able to distinguish between the impact of disturbances and country-specific adjustment characteristics in the GIPS countries. Our approach follows for example, Smets and Wouters (2005), who compare shocks and frictions in the US and Euro area business cycles, and Bentolila et al. (2012), who study the effects on unemployment volatility of the increase of dismissal costs in Spain to French levels. However, in comparison to Smets and Wouters (2005) our model is a real open-economy model with a more elaborate labour market, and contrary to Bentolila et al. (2012) we do not focus on a single institution, but on overall adjustments in general equilibrium.

The paper is structured as follows. In section 2 we present the model, solution as well as the estimation methodology. In section 3 the model is used to identify shocks determining macroeconomic and labour market fluctuations in the countries studied. We also conduct experiments allowing us to assess to what extent developments in the GIPS countries can be attributed to country-specific shocks, and to what extent they can be attributed to adjustment mechanisms, compared to Germany's adjustments to shocks. Section 4 provides the conclusion.

2 Methodology

This section presents the dynamic stochastic general equilibrium (DSGE) model, estimated for the four Southern European countries studied - Greece, Italy, Spain and Portugal - and the reference country - Germany. The main economic elements included in the model are: open economy (see Ratto et al., 2009), intermediate use in production structure, differentiated final goods production, government sector, investment frictions and labour market frictions. The labour market is modelled with an augmented search and matching framework based on Mortensen (1989) and Pissarides (1990) and accounts for labour market flows between employment and unemployment and endogenous job destruction rate (see van Roye, 2009). In the model we consider seven different sources (shocks) of macroeconomic disturbances which are explained in the following subsection. While the list does not cover all the possible sources of fluctuations that were at play during the Great Recession, we are able to explain most of the variations in the main macroeconomic variables, as discussed in section 3.

2.1 Model description

Household. We assume that the household consists of a continuum of individuals defined on the interval (0,1), who maximize expected utility $\tilde{U}_t$ from effective consumption $\tilde{C}_t$ of the form:

$$\tilde{U}_t = \frac{\tilde{C}_t^{1-\sigma} - 1}{1-\sigma} + \beta E_t\{\tilde{U}_{t+1}\}$$

Effective consumption is made up of market goods C_t and home goods H_t which are produced by unemployed U_t members of the household with efficiency set by parameter

b. The elasticity of substitution between the two types of consumption goods is governed by the parameter ϵ_{CH}. Since the amount of time that agents chose to devote to work is strongly dependent on the effectiveness of the home production parameter, we interpret this parameter as the labour supply shock.

$$\tilde{C}_t = (C_t^{\epsilon_{CH}} + H_t^{\epsilon_{CH}})^{\frac{1}{\epsilon_{CH}}}$$
$$H_t = b \times NE_t$$

We introduce heterogeneity of household members, which allows the endogenous job destruction to be implemented. Household members, indexed by $i \in (0,1)$, differ in their individual productivity, $A_t^i = e^{a_t^i}$, which we assume evolves according to:

$$a_t^i = a_{t-1}^i + \eta_t^i$$

where $\eta^i(o) \sim N(0, \sigma_A)$ is a normally distributed random variable. Individual productivity therefore follows a geometric random walk. In each period, after the realization of the individual productivity shock, firms and household members can decide to terminate or continue an individual job relationship ($N_t^i \in \{0,1\}$) based on its profitability for both sides and negotiate the wage W_t^i. The motion of individual productivity results in an aggregate distribution of productivity of the employed, which is approximated using Chebyshev polynomials. The exact implementation of and solution for this type of heterogeneity is explained in detail in Antosiewicz, Bukowski and Kowal (2011b).
The household income consists of wages $\int_0^1 W_t^i N_t^i di$, profits from firms Π_t and interest from bonds B_t. The expenditure side consists of consumption goods $P_t^C C_t$, lump sum taxes T_t and the quadratic cost of sending job offers Ξ_t with endogenous intensity e_t. The budget constraint of the household can be written as:

$$P_t^C C_t + T_t + \Xi_t = \Delta_t^B + \Pi_t + \Pi_t^B + \int_0^1 W_t^i N_t^i di.$$

where

$$\Delta_t^B = \left(B_{t-1}^H - \frac{B_t^H}{R_t^H}\right) + B_{t-1}^F \frac{q_t}{q_{t-1}} - \left(\frac{B_t^F}{R_t^F RP_t}\right)$$
$$\Xi_t = \left(\overline{c}_U \times (e_t - \overline{e}) + \psi_u \times (e_t - \overline{e})^2\right) \times NE_t$$

In the above, RP_t is a risk premium associated with investment in foreign bonds, while $\overline{e}$ is the steady state level of variable e.

Basic goods firm. Production in the model is a two-step process. In the first step the representative basic firm produces basic goods Y_t, using capital, labour and intermediate materials. In the second phase final good producers buy the product of the basic goods firm, and combine it with imported goods to produce final goods. The representative basic goods firm maximizes a discounted stream of profits $\tilde{\Pi}_t$:

$$\tilde{\Pi}_t = \Pi_t + E_t\{\Lambda_{t+1}\tilde{\Pi}_{t+1}\}$$

where $\Lambda_t = \beta \frac{\lambda_t}{\lambda_{t-1}}$ is the pricing kernel due to the household. The firm uses Cobb-Douglas technology to combine capital K_t and labour N_t:

$$Y_t^{NK} = K_{t-1}^{\alpha} \tilde{N}_t^{1-\alpha}$$

where α denotes the share of capital. The capital-labour composite goods Y_t^{NK} are combined with intermediate material Z_t using CES technology where the shares and elasticity are governed by parameters θ and ϵ_Z respectively.

$$Y_t = A^Y \times \left(\theta^{\frac{1}{\epsilon_Z}} (Y_t^{NK})^{\frac{\epsilon_Z - 1}{\epsilon_Z}} + (1-\theta)^{\frac{1}{\epsilon_Z}} (Z_t)^{\frac{\epsilon_Z - 1}{\epsilon_Z}}\right)^{\frac{\epsilon_Z}{\epsilon_Z - 1}}$$

where A^Y denotes the technology level and the technology shock. The accumulation of capital is subject to investment friction, the extent of which is set by parameter ϵ_K:

$$K_t = (1 - \frac{1}{\epsilon_K}\delta)K_{t-1} + \left(\frac{I_t}{K_{t-1}}\right)^{\epsilon_K} K_{t-1}$$

In order to hire workers, firms have to post vacancies V_t, incurring a unit cost of $\overline{\varpi}$. Since the amount of vacancies strongly depends on the cost of vacancies, we interpreted this parameter as the labour demand shock. Finally, the profit of the firm can be written as:

$$\Pi_t = P_t Y_t - P_t^Z Z_t - P_t^I I_t - \int_0^1 W_t^i N_t^i di - \overline{\varpi} V_t$$

Final goods firms We distinguish between the following final goods firms indexed by $f \in \mathcal{F}$: consumption, government, investment, intermediate materials and export goods. The production of final goods involves combining home produced basic goods $Y_t^{f,H}$ and imported basic goods $Y_t^{f,F}$ using the CES production function:

$$Y_t = \left((\theta_H^f)^{\frac{1}{\epsilon_f}} (Y_t^{f,H})^{\frac{\epsilon_f - 1}{\epsilon_f}} + (1-\theta_H^f)^{\frac{1}{\epsilon_f}} (Y_t^{f,F})^{\frac{\epsilon_f - 1}{\epsilon_f}}\right)^{\frac{\epsilon_f}{\epsilon_f - 1}}$$

where parameter θ_H^f sets the share of home produced goods and ϵ_f sets the elasticity. Final goods firms maximize one-period profits:

$$\Pi_t^f = P_t^f Y_t^f - P_t Y_t^{f,H} - P_t^F \times q_t \times Y_t^{f,F}$$

where q_t is the real foreign exchange rate.

Open economy. The open economy is modelled in a simplified way. Final goods firms are responsible for both imports and exports. We assume that the volume of exports depends on relative terms of trade and foreign demand Y^F, which is used as the foreign demand shock. Imports IM_t and exports EX_t are defined as:

$$IM_t = \sum_f IM_t^f \qquad IM_t^f = P_t^F \times q_t \times Y_t^{f,F}$$

$$EX_t = P_t \times EX_t^V \qquad EX_t^V = \left(\frac{P_t}{P_t^F q_t}\right)^{-\epsilon_F} \times Y^F$$

where parameter ϵ_F sets the elasticity of exports with respect to the terms of trade. The current account and capital account are given by:

$$CA_t = EX_t - IM_t$$

$$KA_t = B_{t-1}^F \frac{q_t}{q_{t-1}} - \frac{B_t^F}{R_t^F RP_t}$$

$$0 = CA_t + KA_t$$

with the last equation implicitly determining the real exchange rate.

Government. We assume that the government follows a simple fiscal rule under which it adjusts the amount of spending to deviations of GDP from its steady state. Spending is financed by lump-sum taxes T_t. This assumption implies that government debt is equal to zero, however due to the Ricardian equivalence in RBC models, it does not affect the results. This is summarized in the following two equations:

$$P_t^G G_t = \overline{G} \times \left(\frac{GDP_t}{GDP}\right)^{\epsilon_{GV}} \qquad\qquad T_t = P_t^G G_t$$

where $\overline{G}$ sets the steady state level of government spending and is used as the government spending shock. Moreover, we assume that a rise in government spending resulting from a government spending shock is used to subsidise company investment and household consumption, and is not spent on the public good. The subsidies affect the cost of the investment and consumption goods by $(1 - \tau_t^X), X \in \{I, C\}$, with τ_t^X set to match government subsidy spending to the subsidies received in each period.

Labour market. We assume a non-Walrasian labour market characterized by endogenous destruction and a search and matching mechanism. In each period the number of employed evolves according to:

$$N_t = (1 - \overline{\rho})(1 - s_t) \times \Big(N_{t-1} + M_{t-1}\Big) \tag{1}$$

where $\overline{\rho}$ and s_t denote the exogenous and endogenous destruction rates respectively. The number of new job matches M_t depends on the number of posted vacancies V_t and job offers $\widetilde{O}_t$ sent by non-employed job seekers NE_t.

$$M_t = \overline{\Upsilon} \widetilde{O}_t^{\psi} V_t^{1-\psi}, \tag{2}$$

Using this we can calculate the probability of finding a job and filling a vacancy as:

$$\Psi_t = \frac{M_t}{\widetilde{O}_t}, \qquad\qquad \Phi_t = \frac{M_t}{V_t}. \tag{3}$$

We assume that job seekers send job offers with intensity e_t, making the total number of sent job offers:

$$\widetilde{O}_t = e_t U_t. \tag{4}$$

Wages are negotiated individually between the worker and the firm based on the worker's individual productivity using Nash wage bargaining. Since wages only depend on individual productivity a, we can write a general wage function:

$$W_t(a) = \arg\max_{W_t(a)} \left(V_t^E(a) - V_t^U(a)\right)^{\xi} \times \left(V_t^F(a)\right)^{1-\xi}$$

where $V_t^E(a)$, $V_t^U(a)$ and $V_t^F(a)$ denote the value of employment for the worker, unemployment and the value of employment for the worker's firm with productivity equal to a. Parameter ξ denotes the worker's bargaining power and is also used as the wage bargaining shock. We assume that firms will endogenously sever a job relationship if its value is below a certain threshold $\tilde{c}$:

$$V_t^F(a) \leq \tilde{c}$$

Using the value $\bar{a}_t$ for which $V_t^F(\bar{a}_t) = \tilde{c}$ we can calculate the rate of endogenous job destruction. The parameter $\tilde{c}$ is also interpreted as the job destruction rate shock. The hazard rate of firing is determined by the endogenous and exogenous separation rates, whereas the hazard rate of hiring is defined simply as the probability of a worker finding a job.

Shocks. The shocks listed in the model description, which we denote by χ_t^X, whereby X indicates the relevant parameter, affect the parameters in a multiplicative way:

$$log(X_t) = log(\overline{X}) + \chi_t^X \tag{5}$$

where $\overline{X}$ is the steady state value of given parameter. All the shocks are assumed to be first order autoregressive processes:

$$\chi_t^X = \rho^X \chi_{t-1}^X + \varepsilon_t^X \tag{6}$$

where ε_t^X is a normally distributed random variable with mean 0 and standard deviation σ_X.

- foreign demand shock - Y^F,
- technology shock - A^Y,
- wage bargaining power shock - ξ,
- labour demand shock - $\overline{\varpi}$.
- labour supply shock - b,
- public consumption shock $\overline{G}$,
- job destruction rate shock -$\tilde{c}$,

2.2 Model estimation and parametrization

The model is calibrated and estimated separately for selected countries, resulting in models that differ only with regard to parameter values. The procedure uses the sample period from 1995 to 2013 of quarterly data for the following: real GDP, private consumption expenditure, investment expenditure, public consumption expenditure, exports, imports, foreign GDP, real hourly wage, employment rate, unemployment rate, hazard of employment to unemployment (firing) flows and hazard of unemployment to employment (hiring) flows.[5] Labour market flows are estimated using the methodology proposed by Elsby et al. (2008) which builds on Shimer (2007) but also allows a precise estimation of the flow probabilities outside of the flow's steady state. The variable foreign GDP is calculated for each country as the average GDP (in PPP) of its foreign trade partners, weighted by the structure of its exports. In order to obtain the cyclical component from the time series, we apply the Hodrick-Prescott filter in which we set the frequency of the extracted cyclical data to 60 quarters. This choice is motivated by the large, persistent fluctuations of the main macroeconomic variables that can be observed during the Great Recession. For example, using a cyclical frequency of 32 quarters for the unemployment rate in Spain results in almost the whole increase after 2008 being attributed to the trend variable, and the HP filtered cyclical component even falls below the trend in 2011. Extracting fluctuations of up to 60 quarters slightly alleviates this problem, and in the case of the Spanish unemployment rate approximately 1 percentage point more is attributed to the cyclical component.

[5]All data is taken from Eurostat, with the exception of the real hourly wage, which is taken from the OECD database.

The first step of the parametrization procedure is to set the parameters responsible for the steady state properties of the model, such as the employment rate and the shares of the GDP components or labour market flows. These values are calculated as averages from the corresponding time series or taken from Eurostat IO matrices. The second part consists of setting the parameters responsible for the dynamic properties of the model. This group consists of parameters describing the shock processes, elasticity and the degree of real frictions. These values are set using a Bayes estimation procedure which aims at matching the statistical moments of the model to the moments calculated from the HP-filtered cyclical component of the data. If we denote the parameters of the model as Γ, then the estimator of the parameters $\hat{\Gamma}$ can be formally written as:

$$\hat{\Gamma} = \arg\max_{\Gamma} L(\Gamma) \qquad L(\Gamma) = \sum_i \log \text{pdf}^{P_i}(\Gamma_i) + \sum_j \log \text{pdf}^{M_j}(M_j(\Gamma))$$

where pdf^{P_i} is the *a priori* distribution of the i-th parameter of the model and pdf^{M_j} is the distribution of the moment M_j. The *a priori* distribution of parameters is set in line with the literature. The distribution of the parameters controlling public consumption and foreign demand *a priori* was determined using the estimation results for the relevant data equations. Regarding statistical moments, we assume that pdf^{M_j} is normally distributed with mean equal to the particular moment calculated from the data. The moments that are included in the estimation procedure are: standard deviation of GDP, relative to GDP standard deviation and the correlation with GDP of employment, unemployment, wage, labour market flows and GDP components and the autocorrelation of GDP. When conducting counterfactual simulations, we set the parameters of the shock processes to common values using a panel estimation procedure. The estimated model parameters are shown in Table 4 in the appendix.

3 Results

3.1 Historical decompositions

We use the estimated models to perform two types of simulation experiments. The first consists of the historical decompositions of the main macroeconomic variables, conducted using a Kalman filter with respect to the shocks listed in subsection 2.1. We calculate the following contribution measures of particular shocks to the cyclical fluctuations of specific variables in different economies:

$$\kappa_j^i = \frac{cov[HD_j^i, z_j]}{var(z_j)} \qquad \kappa_j = \sum_i \kappa_j^i$$

where HD_j^i is the time series of the historical decomposition of the cyclical component for the j-th variable with respect to the i-th shock, and z_j is the empirical time series of the cyclical component of the j-th variable. The κ_j measures how the model fits the data. In the case of $\kappa_j = 1$, the model is able to fully replicate the evolution of variable j, while in the case of $\kappa_j > 1$ or $\kappa_j < 1$, the model predicts a higher or lower volatility of a particular variable than is observed in the data. Table 1 presents measures regarding how the model fits the selected variables, whereas Figures 1 to 7 plot the historical decompositions (subject to selected shocks) against the data for Greece, Italy, Portugal and Spain.[6] This

[6]Germany serves as a reference country for simulations in subsection 3.2 and is not shown on Figures 1-7. The results for Germany are available upon request.

allows us to identify the shocks which contributed most to the cyclical fluctuations in the countries studied, in particular during the Great Recession.[7]

Table 1: Model historical decomposition fit to the data for countries studied, by shock (in %)

shocks	foreign demand	productivity	bargaining power	labour demand	labour supply	government spending	job destruction	all
				GDP				
Greece	9	72	2	2	13	-2	3	99
Italy	31	66	2	1	1	0	2	102
Portugal	5	85	5	1	1	5	17	118
Spain	16	10	21	25	4	-4	40	113
Germany	30	58	3	0	0	-1	-1	87
				Employment				
Greece	2	20	4	7	35	0	11	80
Italy	3	0	2	14	10	1	23	52
Portugal	3	13	10	4	1	2	50	81
Spain	2	2	16	24	10	-2	47	97
Germany	2	10	10	8	6	0	27	61
				Unemployment				
Greece	5	17	8	7	34	0	18	89
Italy	2	10	9	17	10	2	44	93
Portugal	4	1	9	3	0	1	57	74
Spain	2	0	13	18	5	-3	47	80
Germany	3	13	12	17	14	1	43	102
				Employment to unemployment flows				
Greece	-2	-1	-33	-9	28	5	104	93
Italy	3	2	-28	-4	3	1	113	88
Portugal	2	7	-28	0	1	2	113	96
Spain	1	3	-43	-70	7	-1	200	96
Germany	5	1	-40	-31	9	3	143	88
				Unemployment to employment flows				
Greece	3	30	15	59	18	1	-40	86
Italy	-1	9	16	56	4	0	-19	66
Portugal	1	8	36	19	0	0	-15	48
Spain	2	1	90	103	11	-1	-113	92
Germany	2	20	50	55	6	-2	-55	76
				Wages				
Greece	-6	30	67	2	-8	2	1	89
Italy	4	-11	73	21	-11	3	22	98
Portugal	25	17	5	2	1	1	18	71
Spain	2	-6	10	15	0	3	7	32
Germany	5	-25	115	10	-9	1	1	98

Source: own calculations based on the DSGE model, quarterly data 1999-2013.

[7] To save space we focus on the historical decompositions of GDP, employment, unemployment, wages and labour market flows. The values of κ and figures for other variables are available upon request.

The model is able to explain between 87% to 118% of empirical GDP variation in the countries studied.[8] It identifies the two main determinants of GDP fluctuations, the productivity shock and the foreign demand shock. In Spain, and to lesser extent in Portugal, labour market shocks are also identified as important.[9] We find that during the Great Recession the negative productivity shock made a preeminent contribution to the decline in GDP, especially in the countries with a double-dip recession - Italy, Portugal and Spain. In Greece, the productivity shock was only dominant in the second stage of the crisis, initially the foreign demand shock was more dominant. In Italy and Portugal the strength of the foreign demand shock impact was unprecedented in the period studied (both in terms of the positive contribution during the boom and the negative effect during the crisis). Table 1 shows that government spending shocks were not significant determinants of GDP fluctuations. However, some impact is visible during the Great Recession (see Figure 2). The loose fiscal policy in Spain mitigated the economic slowdown after 2009 by nearly 2% of GDP. In other countries the impact was less. In the second stage of the crisis it declined in all countries. In Germany, GDP was mainly driven by productivity and foreign demand shocks.

The fit to data of the model's estimate of the labour market variables is also high.[10] We find that, contrary to GDP, productivity and foreign demand shocks were not the main determinants of labour market variables. Employment and unemployment were mainly determined by job destruction shocks which explain nearly 50% of employment and unemployment volatility in the countries studied. Noticeable but smaller impact was exerted by labour demand (Spain, Italy), bargaining power (Portugal, Spain) and labour supply (Greece) shocks. During the Great Recession, the decline in employment and rise in unemployment in all countries was mainly driven by job destruction shocks (see Fig. 3 and 4). The employment to unemployment flows were mainly driven by job destruction shocks, but their impact was mitigated by bargaining power shocks in Italy, Greece and Portugal, and by labour demand shocks in Spain. The unemployment to employment flows were mostly determined by labour demand shocks in Spain, Greece and Italy, and by bargaining power shocks in Portugal.[11] This was particularly the case during the Great Recession (see Fig. 6 and 7). The factors behind the wage volatility were more heterogenous. In Portugal foreign demand, productivity and job destruction shocks were of comparable importance. In other countries bargaining power shocks were dominant, followed by labour demand shocks in Italy and Spain, and productivity shocks in Greece. In Germany, the labour market shocks and flows were mainly driven by job destruction shocks. Labour demand and bargaining power shocks were of secondary importance. Bargaining power shocks were crucial for the evolution of wages.

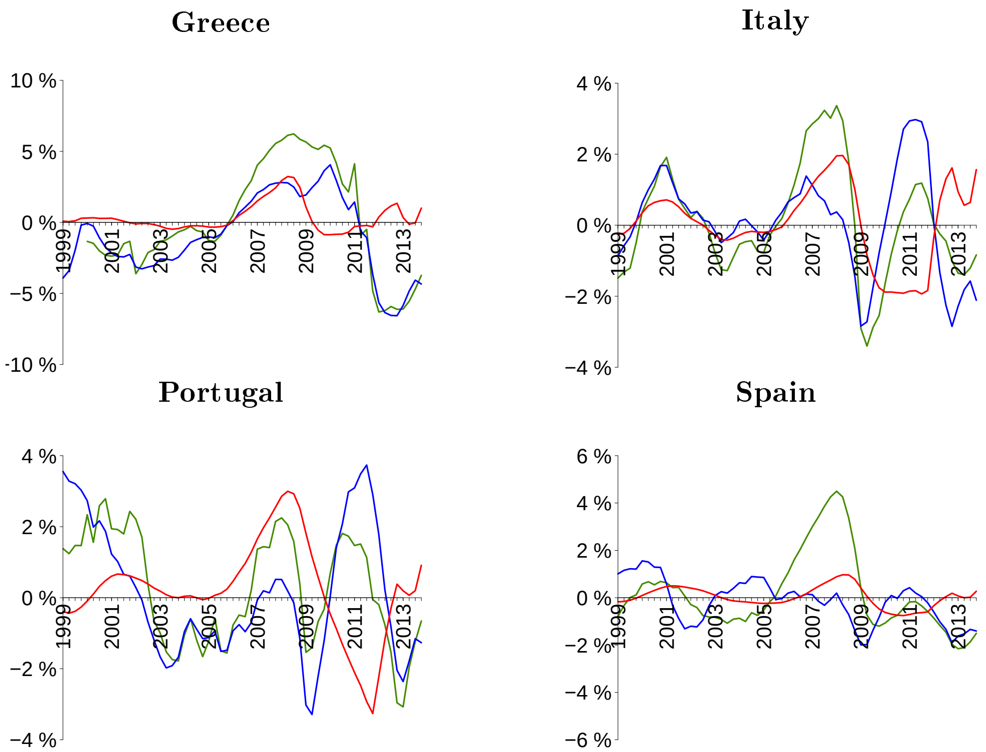
[8] A fit of over 100% means that the model implies a larger variance of the HP cyclical components of a variable than observed in the data.

[9] This is partly in line with Smets and Wouters (2005) who identified productivity and labour supply shocks as the main determinants of GDP variability. Smets and Wouters' (2005) model did not take into account foreign demand shocks.

[10] For employment, unemployment and labour market flows, we show deviations expressed as a share of the labour force in a given country.

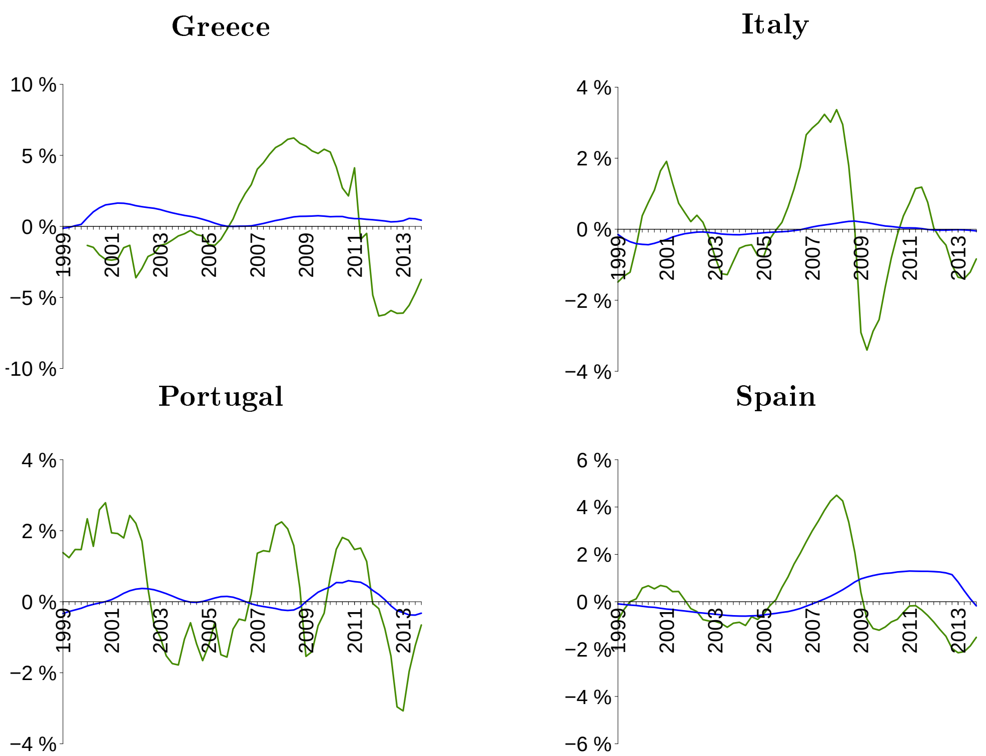
[11] Labour market flows are calculated using hazard rates of firing and hiring which are defined as the probability of losing (finding) a job in a quarter t, conditional on being employed (unemployed) in a quarter $t-1$, calculated in line with Elsby et al. (2008).

Figure 1: Historical decomposition of cyclical component of GDP with respect to productivity and foreign demand shock (in %).



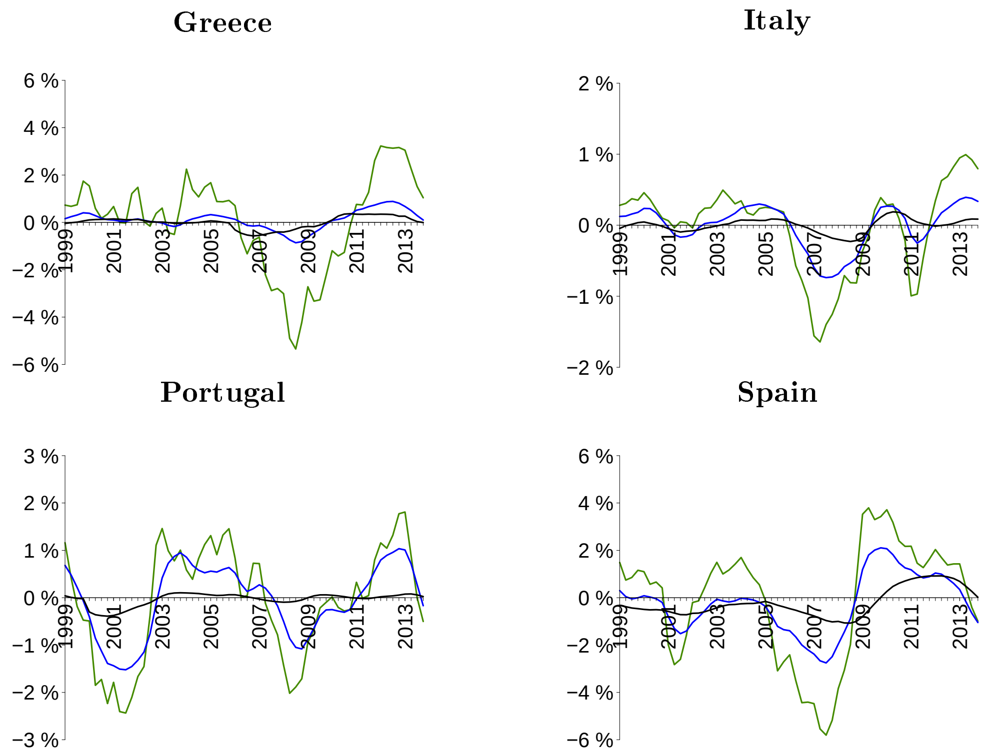
blue - contr. of productivity shock, red - contr. of foreign demand shock, green - data

Figure 2: Historical decomposition of cyclical component of GDP with respect to government spending shock (in %).



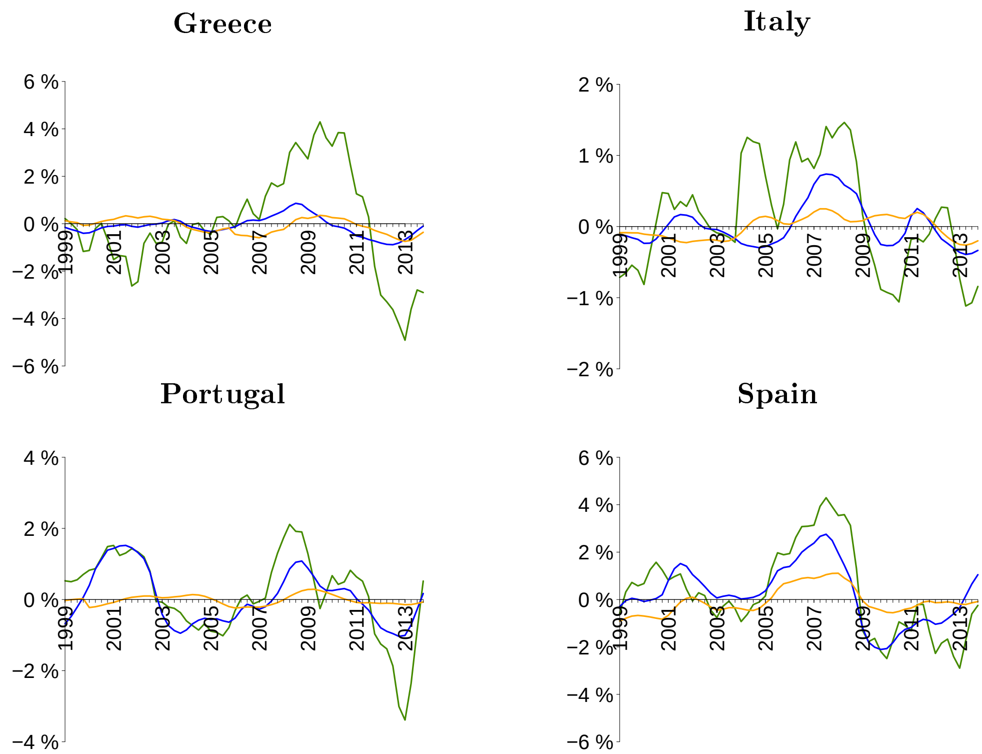
blue - contr. of government spending shock shock, green - data

Figure 3: Historical decomposition of cyclical component of unemployment with respect to job destruction and bargaining power shock (in %).



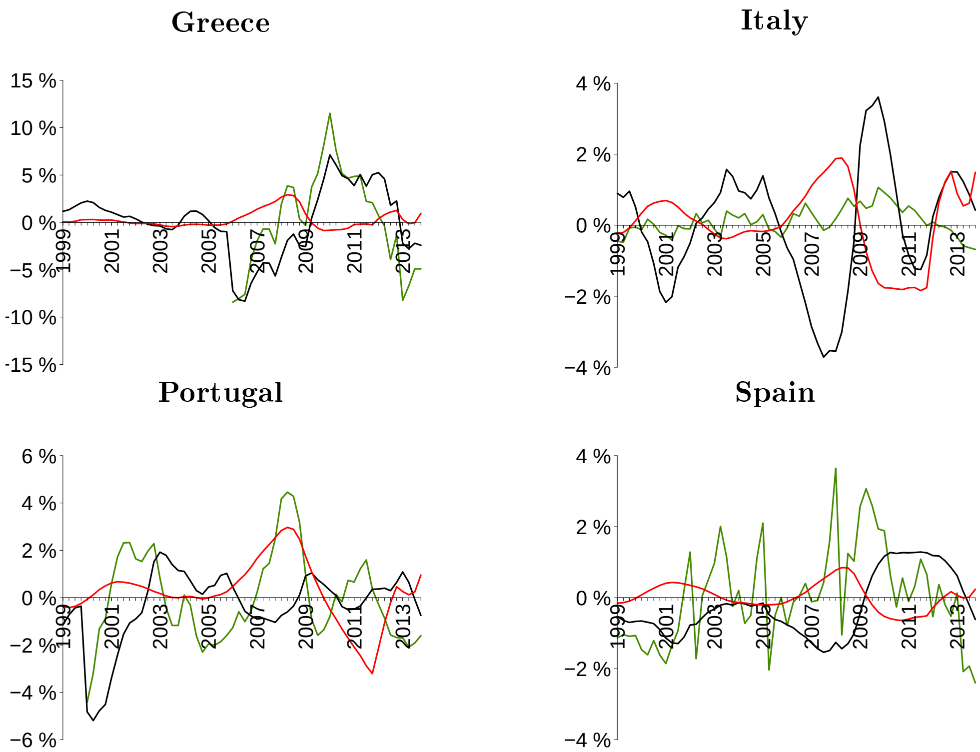
blue - contr. of job destruction shock, black - contr. of bargaining power shock, green - data

Figure 4: Historical decomposition of cyclical component of employment with respect to job destruction and labour demand shock (in %).



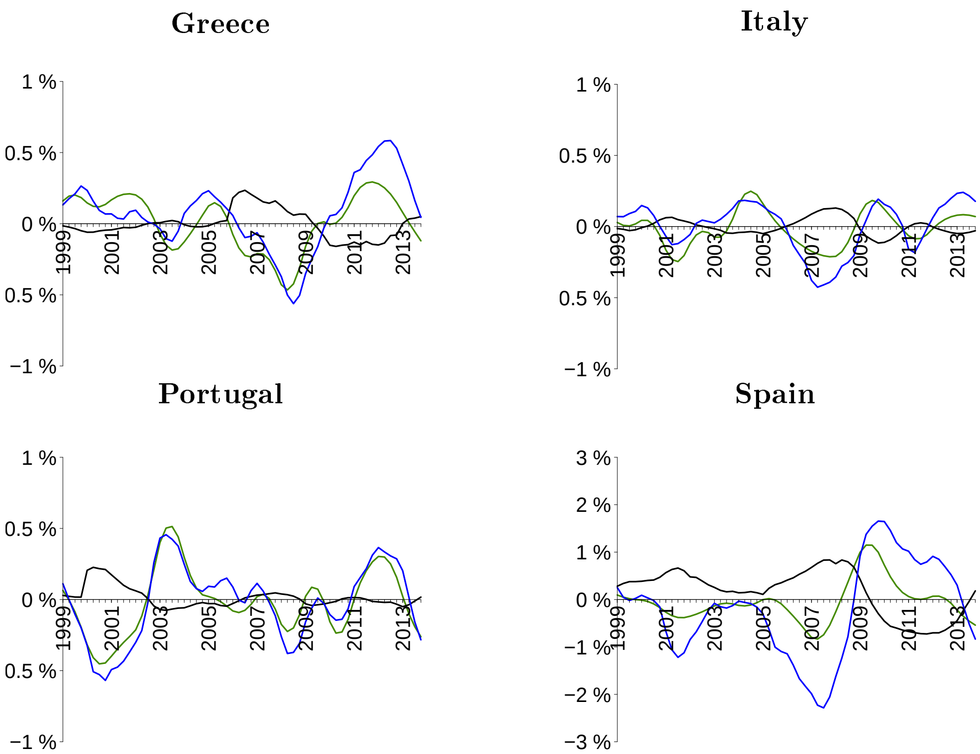
blue - contr. of job destruction shock, orange - contr. of labour demand shock, green - data

Figure 5: Historical decomposition of cyclical component of wage with respect to bargaining power and foreign demand shock (in %).



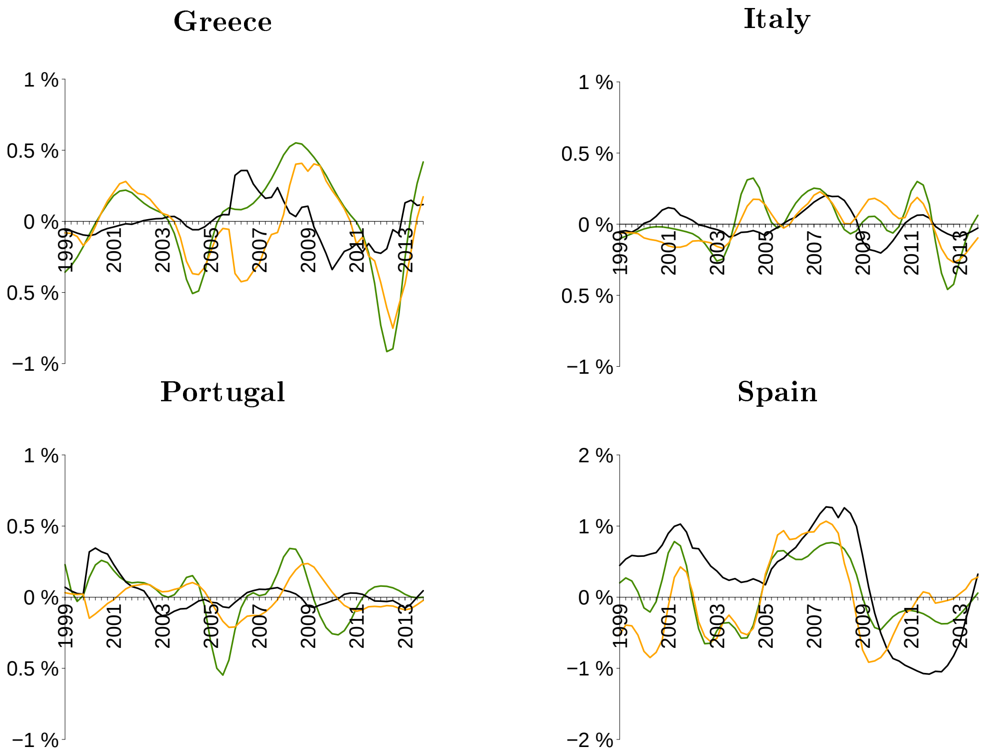
black - contr. of bargaining power shock, red - contr. of foreign demand shock, green - data

Figure 6: Historical decomposition of cyclical component of employment to unemployment flows wrt job destruction and bargaining power shock (in %).



black - contr. of bargaining power shock, blue - contr. of job destruction shock, green - data

Figure 7: Historical decomposition of cyclical component of unemployment to employment flows wrt bargaining power and labour demand shock(in %).



black - contr. of bargaining power shock, orange - contr. of labour demand shock, green - data

3.2 Counterfactual simulations

In this subsection we assess to what extent the performance of Southern European economies resulted from the country-specific shocks which affected them (the nature and strength of shocks), and to what extent from the country-specific absorption of shocks. We assume that the former is captured by the identified (filtered) disturbances, and the latter by the country-specific (estimated) parameters of the model. Germany, the largest EU economy with a labour market that was especially resilient during the Great Recession, is chosen as the reference country. For each economy we compare the country-specific response to its own shocks with a hypothetical response of the German economy to the same shocks. For this purpose, for each country we compare the historical decompositions, obtained from the country model, with a simulation resulting from applying the shocks filtered for a particular country to a model parameterised for Germany. Formally this can be expressed as following. Denote the predicted trajectory of variable j for country b, $y^b_{j,t}$ under shocks z^{b,X_t}, $X \in \mathcal{X}$, where $\mathcal{X}$ is the set of all shocks as:

$$\{y^b_{j,t}\}_{t\in T} = F\left(p_b, \{z^{b,X_t}\}_{t\in T}\right)$$

where p_b denotes the parameters estimated for the model of country b, and $F()$ represents the entire model. Following that, the hypothetical reaction of variable j for country b to the shocks calculated for country c can be written as:

$$\{y^{b,c}_{j,t}\}_{t\in T} = F\left(p_b, \{z^{c,X_t}\}_{t\in T}\right)$$

Each figure in this subsection presents two series: the historical decomposition of the relevant variable for a given country, $\{y^b_{j,t}\}_{t\in T}$), and a hypothetical simulation of this

variable, conducted with the German reference model but based on the history of shocks identified in a given country $\{y_{j,t}^{b,c}\}_{t \in T}$.[12] The difference between the two is a proxy of the impact of country-specific reaction to shocks.
Table 2 shows that all four Southern European countries would have experienced lower macroeconomic volatility if they had reacted to their country-specific shocks in the same way as the German economy would have. The difference is most pronounced in Spain (the standard deviation of the cyclical component of GDP would have amounted to 47% of the recorded value), and least pronounced in Italy (77%). All the countries studied would have experienced smaller fluctuations in the employment and unemployment rates, but the reduction in labour market volatility would have been much greater in Spain and Greece than in Italy and Portugal. Importantly, all the analysed economies would have exhibited greater volatility in real wages had they reacted to shocks like the German economy, the difference being most pronounced in Spain. However, some differences between the four countries did emerge.

Table 2: Standard deviations of cyclical component of selected macroeconomic variables - model prediction, counterfactual simulation and data (in %).

	Greece	Italy	Portugal	Spain
GDP				
German model	2.06	1.13	1.15	0.85
Country model	3.12	1.48	1.94	1.79
Data	3.75	1.39	1.53	1.53
Employment				
German model	1.02	0.65	1.04	1.04
Country model	1.62	0.63	1.13	1.96
Data	1.83	0.98	1.33	2.12
Unemployment				
German model	1.02	0.65	1.04	1.04
Country model	1.62	0.63	1.13	1.96
Data	1.93	0.61	1.29	2.47
Employment to unemployment flows				
German model	0.22	0.13	0.26	0.22
Country model	0.17	0.10	0.23	0.40
Data	0.17	0.11	0.21	0.38
Unemployment to employment flows				
German model	0.11	0.16	0.30	0.20
Country model	0.25	0.13	0.14	0.43
Data	0.30	0.16	0.25	0.47
Wages				
German model	3.36	1.06	3.55	4.05
Country model	3.15	0.91	3.06	1.01
Data	5.23	0.91	1.86	1.37

Source: own calculations based on DSGE model and Eurostat.

We find that if Spain had reacted to its shocks like Germany, volatility of employment and unemployment would be much lower. This would be partly due to the smaller scale of

[12] We focus on simulations of GDP, employment, unemployment, labour market flows and wages. Results for other variables are available upon request.

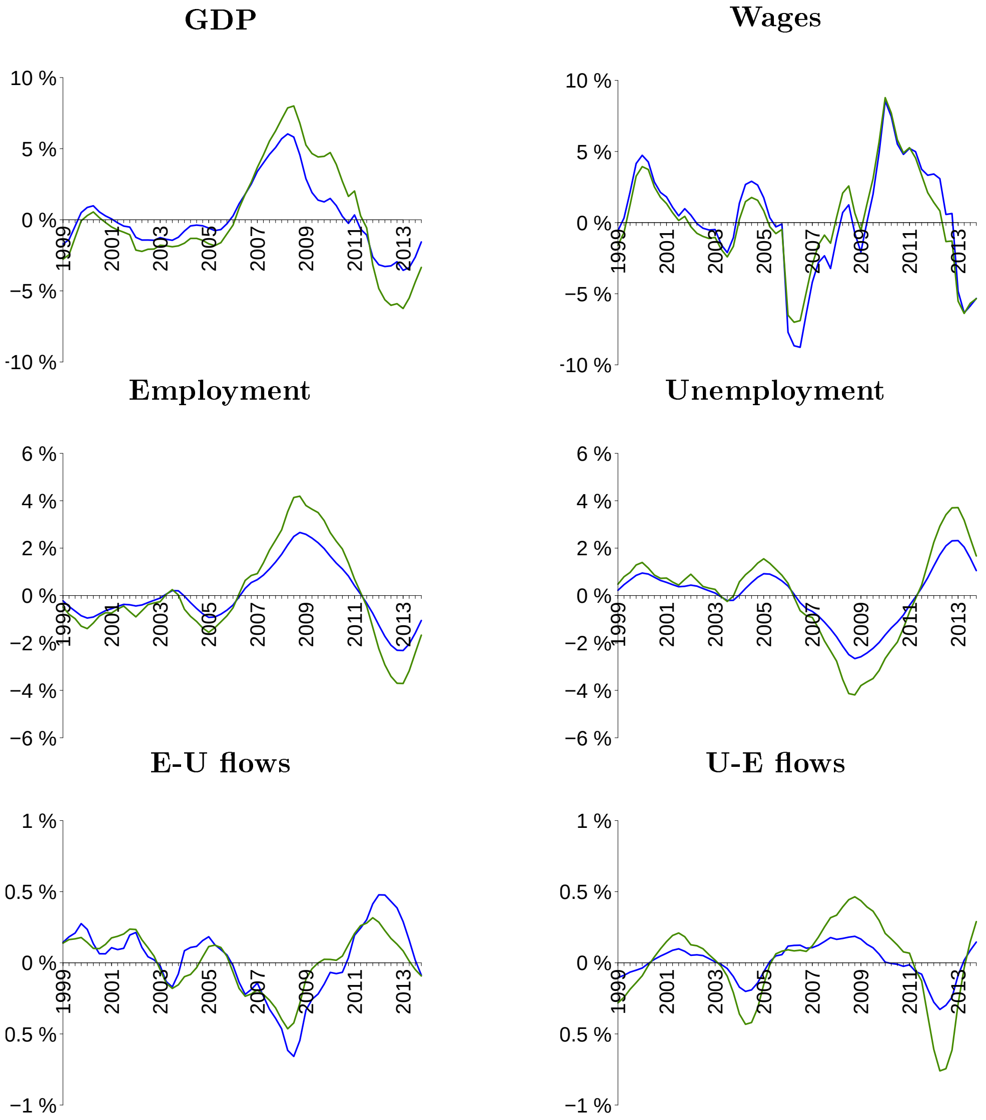
GDP fluctuations implied by the German model (the standard deviation of employment and unemployment, relative to GDP, in the counterfactual simulation), but would be also accompanied by much higher volatility of wages (both absolute and relative to GDP variation). This suggests that on the Spanish labour market, price (wage) adjustments are relatively smaller and quantity (employment and unemployment) adjustments are relatively higher than on the German labour market, as is illustrated by Figure 11. In general, the Spanish economy dealt worse with the absorption of shocks than the German economy would have. After 2009, even German absorption mechanisms would not have allowed Spain to avoid a slowdown, but the recession would have been, on average, by 0.4% of GDP less deep. Nevertheless, the response of the labour market to the same shocks would have been different in Germany - they would have had less impact on unemployment and employment, but would have led to much larger fluctuations in wages. Unemployment and firings would have been lower, whereas employment and hiring rates would have been higher. All these variables would have been less volatile. According to our model, if Germany had faced the same shocks as Spain did, from 2009-2013 the unemployment rate would have been on the average 0.7 percentage points lower, the total number of firings would have been 3% lower and the total number of hirings would have been 1% higher than in Spain. Costain et al. (2010) and Sala et al. (2012) have argued that the exceptionally high volatility of employment and unemployment in Spain can be attributed to the high number of temporary contracts, but our results show that wage adjustments could be another factor in play.

In Portugal the pattern is similar, albeit less pronounced. The model shows that if Germany had been affected by Portugal's shocks, it would not have experience a double-dip recession but rather a longer and shallower slowdown. Wages would have been lower from 2010, and the unemployment increase would have been smaller after 2012, leading to an unemployment rate lower by an average of 0.3 percentage points in 2012-2013 (and 0.1 in 2009-2013). On the other hand, firings and especially hirings would have been more volatile if Portugal had reacted to shocks like Germany would have (with total flows virtually unchanged). The same applies to labour market flows in Italy and Greece. Contrary to Spain, the other three Southern European countries stand out due to the low responsiveness of hirings and firings to macroeconomic shocks. Consequently, the high volatility of labour market flows in Spain might be related to the high number of temporary jobs (Costain et al. (2010), Sala et al. (2012)).

Figure 8 shows that the shocks which affected Greece, would have led to a decline in GDP in Germany of less than half the decline that was recorded in Greece, but it would still have been a noticeable recession. On the average in 2012-2013, GDP would have been 3.0% below the trend in the German model, compared to 5.2% in the Greek model with the same shocks. The drop in employment and spike in unemployment would have been significantly lower in Germany than they were in Greece (on the average of 1.1% of the labour force in 2012-2013). On the other hand, employment would have been lower and unemployment higher in Germany before the recession. Wages would have been more volatile in Germany, but the difference is much smaller than in the case of Spain. As a result we find that if Greece had reacted to shocks as Germany would have, the volatility of both employment and unemployment would have been lower, although this would not have been due to wage rigidities, but rather due the lower volatility of GDP and lower volatility of hirings.

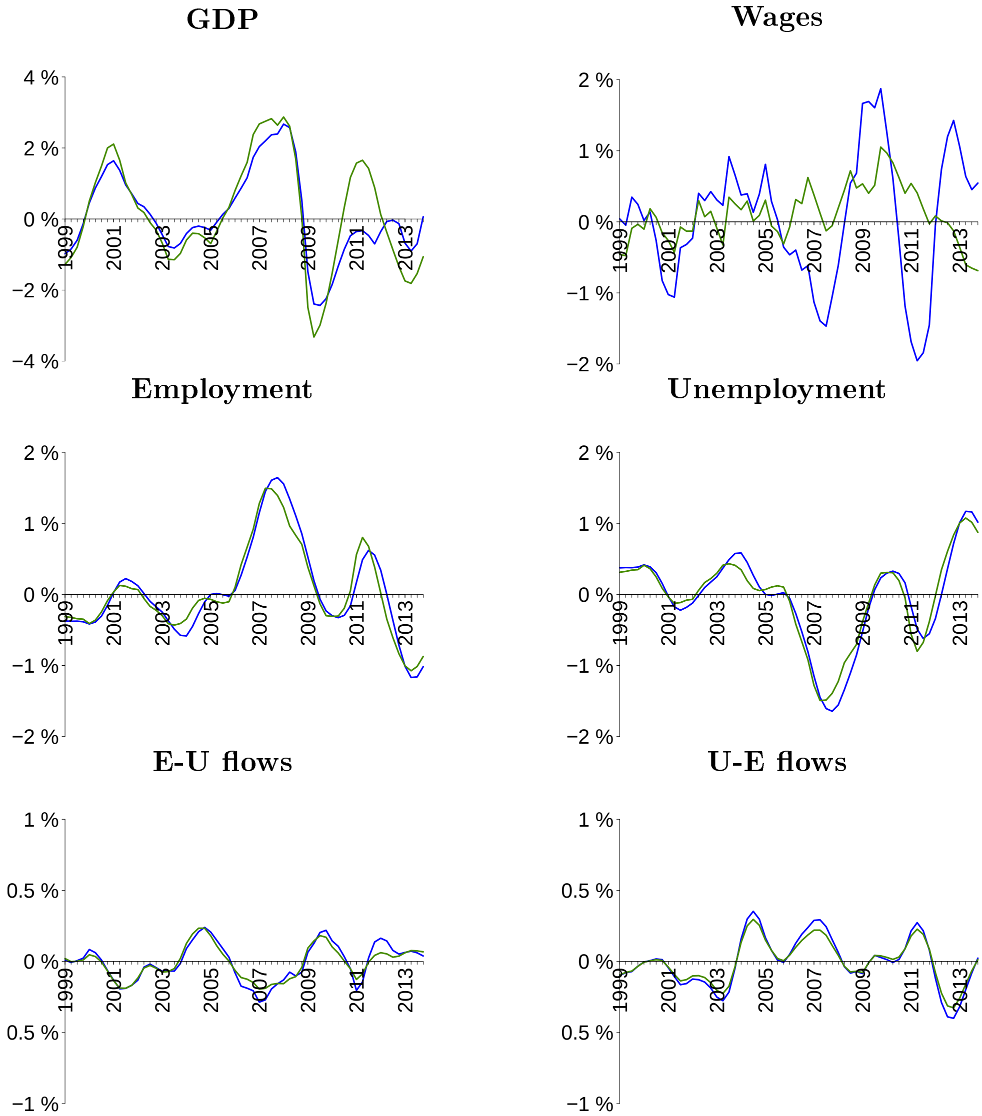
The Italian labour market has been the least volatile of the four Southern European ones studied (see Table 2). The simulation shows that GDP volatility would have been lower if Italy had reacted to shocks like Germany - similar to the other countries in the region - and instead of a double-dip recession there would have been a smaller but prolonged slowdown, like in Portugal. We find Italy to be the least responsive labour market of the countries studied - the absolute and relative volatility of all labour market variables would be higher in the German model with Italian shocks. During the Great Recession, employment in Germany would have been slightly higher (by 0.1% of the labour force in 2009-2013 on average), and both labour market flows would also have been higher (by 0.3% of the labour force in 2009-2013).

Figure 8: Comparison of Greece's capacity to absorb macroeconomic shocks against Germany.



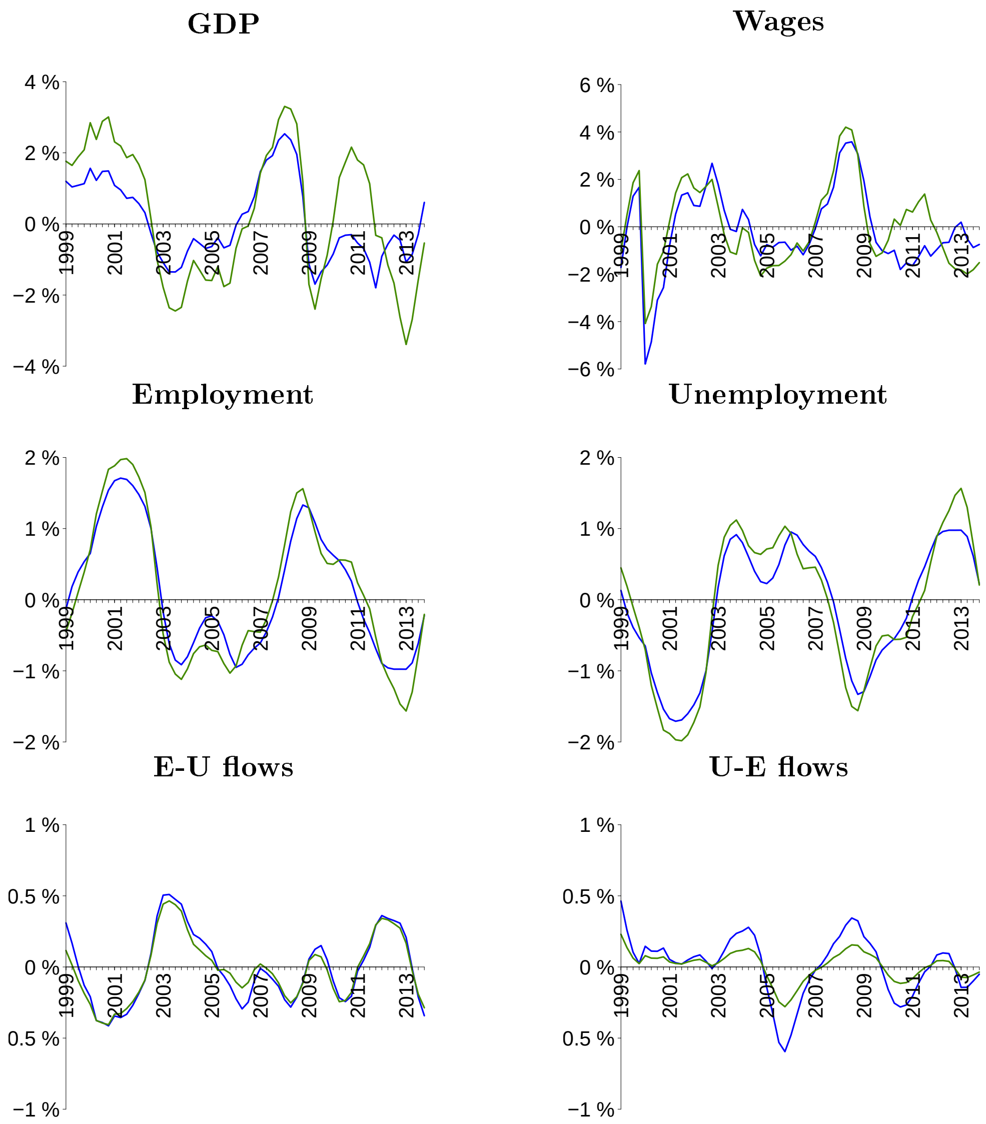
blue line - counterfactual simulation with German model, green line - decomposition with model for Greece

Figure 9: Comparison of the Italy's capacity to absorb macroeconomic shocks against Germany.



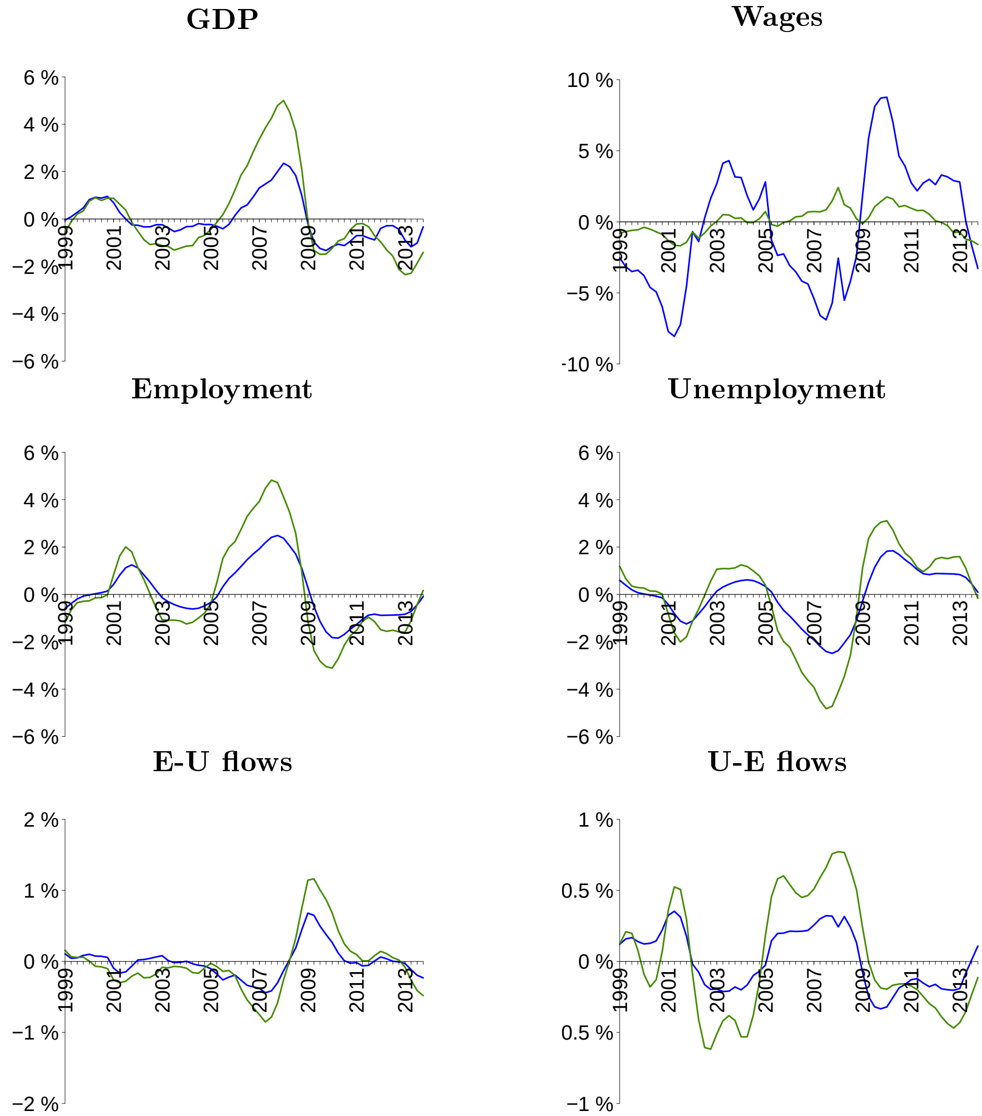
blue line - counterfactual simulation with German model, green line - decomposition with model for Italy

Figure 10: Comparison of Portugal's capacity to absorb macroeconomic shocks against Germany.



blue line - counterfactual simulation with German model, green line - decomposition with model for Portugal

Figure 11: Comparison of Spain's capacity to absorb macroeconomic shocks against Germany.



blue line - counterfactual simulation with German model, green line - decomposition with model for Spain

4 Conclusions

In this paper we use the DSGE model of real open economy with search and matching on the labour market to analyse the fluctuations of the macroeconomic and labour market variables in the Great Recession. We estimate models for four countries - Greece, Italy, Portugal and Spain - which are the main focus of the paper, and a reference country - Germany. The estimated models are able to replicate most of the variations observed in the data. We use a Kalman filter to identify the shocks responsible for macroeconomic fluctuations in the analysed economies. The internal productivity shock and the external demand shock are identified as the main determinants of GDP fluctuations. Spain stands out with a substantial contribution of labour demand and job destruction shocks to GDP fluctuations. Fiscal policy worked to offset the negative impact of the Great Recession in Spain and Portugal, but only to a small degree. The driving forces behind the labour market fluctuations were more diverse. Employment and unemployment were mainly driven by job destruction shocks, especially in Spain and Portugal, and some influence was also exerted by labour demand (Spain, Italy), bargaining power (Portugal, Spain) and labour supply (Greece) shocks. Firings were mainly driven by job destructions shocks, and hirings were driven by labour demand shocks. The evolution of wages was determined by various demand side shocks and bargaining power shocks.

Furthermore, we perform counterfactual simulations to study what the Great Recession in GIPS would have been like if all these countries reacted to their country-specific shocks like Germany - a benchmark for resilience to the Great Recession. We find that all the GIPS countries would experience lower volatility of GDP, but the labour market adjustments would be diverse. Spain and Italy constitute two extreme examples. Spain would have experienced much lower overall volatility of labour market indicators, and in the Great Recession unemployment and firings would have been lower, whereas employment and hirings would have been higher. It would also have experienced greater fluctuations of wages. On the other hand, Italy would have experienced higher volatility of all labour market indicators, including worker flows, if it had reacted to shocks like Germany. Greece and Portugal are located in between these two extremes. Portugal would have experienced less quantitative and more price adjustments on the labour market (similar to Spain, but to a lesser extent), but also higher flows (like Italy). In Greece, the fluctuations of employment and unemployment would be smaller, but as a result of the lower fluctuations of GDP and hirings, rather than larger fluctuations of wages.

Our results show that although the GIPS countries face the similar labour market challenges of high unemployment, their adjustments mechanisms are quite different and their policy agendas should reflect that. The high volatility of labour market variables and the significance of job destruction for GDP fluctuations in Spain stress the importance of quantitative labour market adjustments, likely related to the high rates of temporary employment and possible wage rigidities. This balance between wage and employment adjustments could have important consequences for the impact of recessions on societies, as the economies suffering from more job losses faced higher unemployment, a risk of poverty and social transfer spending. On the other hand, the focus in Greece should be on factors determining the elasticity of employment with respect to GDP, and in Italy on widespread rigidity - to cushion against the unemployment increase in the slowdown, as well as the increase in the risk of jobless growth.

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Appendix A

Table 4: Model parameters

parameter	interpretation	GR	IT	PT	ES	DE
α	share of capital	0.360	0.360	0.360	0.360	0.360
β	discount factor	0.990	0.990	0.990	0.990	0.990
$\overline{c}_U$	linear search cost	0.017	0.017	0.017	0.017	0.017
ψ_u	quadratic search cost	0.731	0.860	0.816	0.990	1.088
ϵ_{CH}	home market good elasticity	0.596	0.550	0.500	0.527	0.597
ϵ_K	investment friction	0.686	0.214	0.869	0.820	0.727
ϵ_Z	capital-labour material elasticity	0.146	0.331	0.028	0.015	0.306
ϵ_F	foreign GDP elasticity	2.019	4.804	5.544	5.658	0.945
ϵ_f	home foreign good elasticity	0.310	0.457	0.263	0.388	0.411
σ	intertemporal elasticity of consumption	1.500	1.500	1.500	1.500	1.500
ψ	matching function elasticity	0.202	0.390	0.637	0.415	0.355
Y^F	steady state export share	0.166	0.277	0.333	0.243	0.481
$\overline{G}$	steady state gov exp share	0.231	0.235	0.231	0.186	0.222
δ	capital depreciation rate	0.021	0.028	0.055	0.104	0.017
b	home production efficiency	0.561	0.498	0.521	0.516	0.473
θ_H^C	import share of consumption good	0.168	0.094	0.170	0.134	0.123
θ_H^G	import share of government good	0.005	0.004	0.016	0.024	0.020
θ_H^{INV}	import share of investment good	0.377	0.116	0.296	0.167	0.349
θ_H^{MAT}	import share of material good	0.270	0.247	0.368	0.233	0.235
$\overline{\rho}$	exogenous destruction rate	0.010	0.010	0.011	0.033	0.011
$\overline{\varpi}$	vacancy cost	0.459	0.559	0.499	0.206	0.542
ξ	worker bargaining power	0.685	0.650	0.717	0.692	0.688
$\rho_{\overline{G}}$	gov exp shock autocorrelation	0.241	0.241	0.241	0.241	0.241
ρ_{A^Y}	technology shock autocorrelation	0.288	0.288	0.288	0.288	0.288
ρ_{Y^F}	foreign demand shock autocorrelation	0.253	0.253	0.253	0.253	0.253
ρ_b	labour supply shock autocorrelation	0.207	0.207	0.207	0.207	0.207
$\rho_{\tilde{c}}$	job destruction shock autocorrelation	0.234	0.234	0.234	0.234	0.234
$\rho_{\overline{\varpi}}$	labour demand shock autocorrelation	0.251	0.251	0.251	0.251	0.251
ρ_ξ	wage bargaining shock autocorrelation	0.252	0.252	0.252	0.252	0.252
$\sigma_{\overline{G}}$	gov exp shock std. dev.	0.005	0.005	0.005	0.005	0.005
σ_{A^Y}	technology shock std. dev.	0.003	0.003	0.003	0.003	0.003
σ_{Y^F}	foreign demand shock std. dev.	0.006	0.006	0.006	0.006	0.006
σ_b	labour supply shock std. dev.	0.004	0.004	0.004	0.004	0.004
$\sigma_{\tilde{c}}$	job destruction shock std. dev.	0.012	0.012	0.012	0.012	0.012
$\sigma_{\overline{\varpi}}$	labour demand shock std. dev.	0.019	0.019	0.019	0.019	0.019
σ_ξ	wage bargaining shock std. dev.	0.012	0.012	0.012	0.012	0.012