Labour market fluctuations in GIPS – shocks vs adjustments

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Abstract

Purpose – The purpose of this paper is to identify factors behind cyclical fluctuations and differences in adjustments to shocks in Greece, Italy, Portugal and Spain (GIPS) and a reference country – Germany. The authors try to answer the question whether the GIPS countries could have fared differently in the Great Recession if they reacted to shocks affecting them like a resilient German economy would have.

Design/methodology/approach – The authors use a DSGE model of real open economy with search and matching on the labour market and endogenous job destruction, estimated separately for each country. The authors calculate impulse response functions, historical decompositions and perform counterfactual simulations of the response of the German model to the sequence of shocks identified for each of GIPS.

Findings – The authors find that all GIPS countries were more vulnerable to productivity and foreign demand shocks than Germany. They would have experienced lower macroeconomic volatility if they reacted to their shocks like Germany. Employment (unemployment) rates in GIPS would have been less volatile and higher (lower) during the Great Recession, especially in Spain and Greece. Real wage volatility would have been higher, especially in Spain and Portugal.

Originality/value – The trade-off between unemployment and wage adjustments *vis-à-vis* Germany was the largest in Spain, which also would have experienced lower variability of job separations and hirings. The evolution of the labour market in Greece and Portugal was driven rather by its higher responsiveness to GDP fluctuations than in Germany, whereas Italy emerges as the least responsive labour market within GIPS.

Keywords Unemployment, Great Recession, DSGE models, Rigidities

Paper type Research paper

1. Introduction

The Great Recession was extraordinary in its reach, depth and durability of the economic slowdown and labour market deterioration. Greece, Italy, Portugal and Spain (GIPS) were especially affected. Between 2008 and 2013 real GDP in Greece declined by 24.6 per cent, in Italy by 7.4 per cent, in Portugal by 6.8 per cent and in Spain by 6.7 per cent. 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. Greece was the most affected with regard to both GDP and unemployment, but unemployment rate in Spain started rising earlier and reached a similar level. Bachmann *et al.* (2015) report that in these two countries employment to unemployment flow rates rose and unemployment to employment flow rates declined more than in the EU on average during the crisis. In Portugal and Italy both worker flow rates increased moderately. Labour market slack exerted pressure on wage adjustments. OECD (2014) argued that downward real wage adjustments have become more frequent but nominal wage floors have become more binding, the latter stressed by Schmitt-Grohé and Uribe (2013). Among GIPS, real wage adjustments were largest in Greece (between 2008 and 2013 real average hourly wages declined by 17.1 per cent) and in Portugal (decline by 10.0 per cent). In Spain and Italy real wages kept growing and between 2008 and 2013 increased by 14.4 and 13.6 per cent, respectively. At the same time, Germany suffered a recession in 2008 but rebounded and

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unemployment rate kept declining, and employment and wages kept rising (Figure 1), while job separations declined and hirings rose (Bachmann *et al.*, 2015).

The developments of output, unemployment, wages and labour market flows during the Great Recession have been documented in the literature, but studies analysing them jointly in the general equilibrium framework and identifying the role played by different shocks are scarce, especially for Europe. Christiano *et al.* (2015) and Furlanetto and Groshenny (2016) use DSGE models for the US labour market, Pierluigi *et al.* (2014) apply VAR to the six largest Euro area countries in a VAR framework (but do not account for flows). This paper aims at filling this gap. We focus on GIPS countries and study the factors behind fluctuations on their labour markets during the Great Recession using a DSGE model for an open economy with labour market frictions. We estimate the model separately for each of these economies and for a reference country – Germany, which we selected because during the Great Recession it stood out as a resilient labour market and can be treated as a realistic best-case template for adapting to shocks (Rinne and Zimmermann, 2013; Zimmermann, 2013). We identify shocks which drove fluctuations in particular countries and differences in country-specific responses to them, in order to single-out shocks which GIPS were most vulnerable to, in comparison to Germany. We also attempt to answer the question to what extent developments in GIPS were due to idiosyncratic disturbances, and to what extent they were due to a country-specific ability to absorb shocks.

Such questions have been mainly studied econometrically by, e.g. Layard *et al.* (1991), Blanchard and Wolfers (2000), Nickell *et al.* (2005), Bassanini and Duval (2006), Bukowski *et al.* (2013), while DSGE applications have been rare. Our approach follows, e.g. Smets and Wouters (2005), who compare shocks and frictions in the US and Euro area business cycles, Christoffel *et al.* (2009) who analyse the dependencies between the labour market features and monetary policy outcomes in the Euro area, and Bentolila *et al.* (2012) who study the effects of

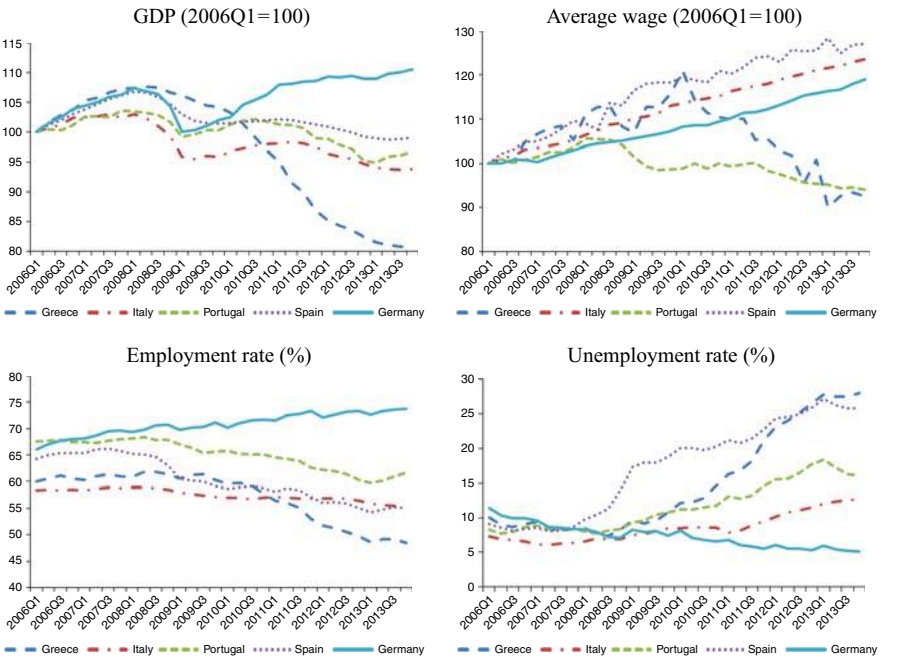


Figure 1.
Great recession in GIPS and Germany

Source: Own elaboration on Eurostat and OECD data

an increase of dismissal costs in Spain to French levels on worker turnover and unemployment. Contrary to Smets and Wouters (2005) and Christoffel *et al.* (2009), we use a real open-economy model, since our focus is on individual countries instead of larger economic areas. Our model also features a more elaborate labour market. Contrary to Bentolila *et al.* (2012), we use general instead of partial equilibrium and study several countries.

We use the model to conduct three types of analyses. Following Smets and Wouters (2005) and Christoffel *et al.* (2009), we calculate historical decompositions for the 1999-2013 period and identify shocks which were main determinants of business cycle fluctuations in each country. Next, we compare the country-specific impulse response functions (IRF) to the shocks identified as main drivers of fluctuations. The last exercise consists of simulating the response of the German model to the sequence of shocks identified for each of the GIPS countries. We compare country-specific adjustments in the GIPS countries with hypothetical "German-like" adjustments to the same shocks. We decompose the fluctuations in GIPS countries into a part which would have also occurred in Germany (contribution of shocks), and a part that would have not (contribution of country-specific adjustments in the struggling GIPS countries *vis-à-vis* resilient Germany). These counterfactual simulations constitute a generalisation of Bentolila *et al.* (2012) approach whose simulations rely on variations in the value of a single parameter[1]. Our ambition is to look at the overall labour market adjustment patterns, in particular during the Great Recession. We quantify hypothetical scenarios to understand better how much of the economic malaise in GIPS, with a particular attention paid to labour market, could have been realistically spared, and what would be the trade-offs associated with different (German) adjustment pattern. These patterns likely to reflect country-specific sets of institutions and structural factors, which in turn are being likely to be intertwined and formed jointly in particular countries (Eichhorst *et al.*, 2010; Betcherman, 2012). This is reflected in our choice of simulation strategy – since parameters for a given country are estimated jointly and are not independent from each other, we opt for analysing reactions of two models, and hence on overall adjustments in a general equilibrium. To the best of our knowledge, such counterfactual simulations are a novel approach in the literature[2].

Our main finding is that all GIPS countries would have experienced lower macroeconomic volatility if they had reacted to their country-specific shocks in the same way as Germany would have. However, they would not have avoided a substantial slowdown during the Great Recession. GIPS countries, especially Spain and Greece, would also have recorded smaller fluctuations in employment and unemployment rates. At the same time, all GIPS would have exhibited greater volatility in real wages. We find that wage flexibility in Southern Europe, inferred from responsiveness of wages to bargaining power shocks, was lower than in Germany. We find that the trade-off between unemployment and wage adjustments *vis-à-vis* Germany was most pronounced in Spain. Spain would also have experienced much lower variability of job separations and hirings had it reacted to shocks like Germany would have. This feature can be related to high incidence of temporary contracts in Spain, which contributes to high responsiveness of job separations to GDP changes, as shown by Costain *et al.* (2010), Bentolila *et al.* (2012) and Sala *et al.* (2012). Evolution of unemployment in Greece and Portugal can be rather traced back to higher responsiveness of their labour markets to GDP fluctuations than in Germany. Italy turns out the least responsive labour market among GIPS. If it reacted to shocks like Germany in the Great Recession, it would experience both higher labour market flows and employment.

The paper is structured as follows. In Section 2, we present the model, solution and estimation methodology. In Section 3, we present historical decompositions and differences in IRF. In Section 4, we discuss the results from counterfactual simulations. Section 5 provides the conclusion.

2. Methodology

This section presents an open-economy DSGE model with labour market frictions modelled in search and matching framework (Mortensen, 1989; Pissarides 1990) with endogenous job destruction (Tortorice, 2013). We consider seven macroeconomic and labour market shocks chosen in line with the study of Smets and Wouters (2003) and Christoffel *et al.* (2009).

2.1 Model description

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

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

Effective consumption consists of market goods C_t and home goods H_b which are produced by unemployed U_t members of the household with efficiency set by parameter b:

$$\tilde{C}_t = \left(C_t^{\epsilon_{CH}} + H_t^{\epsilon_{CH}}\right)^{\frac{1}{\epsilon_{CH}}} \tag{2}$$

$$H_t = b \times U_t \tag{3}$$

The elasticity of substitution between the two types of goods is set by ϵ_{CH}. Since the amount of time that agents chose to devote to work is strongly dependent on the value of b, we use this parameter as the labour supply shock. We introduce heterogeneity of employed household members in order to implement endogenous separation rate. Employed differ in their individual productivity, $A_t^i = e^{a_t^i}$, which we assume evolves according to:

$$a_t^i = a_{t-1}^i + \eta_t^i \tag{4}$$

where $\eta^i(o) \sim N(0, \sigma_A)$ is a normally distributed random variable. In each period, after the realisation 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 and negotiate wage W_t^i. The implementation of this heterogeneity is explained in detail in the study of Antosiewicz and Suda (2015); however, the main idea is similar to standard endogenous separation rate models (Van Roye and Wesselbaum, 2009; Trigari, 2009; Tortorice, 2013).

The household income consists of wages $\int_0^1 W_t^i N_t^i \, di$, profits from firms Π_t and interest from home B_t and foreign bonds B_t^F. The expenditure side consists of consumption goods $P_t^C C_t$ less government subsidy τ_t^C, lump-sum taxes T_t and the cost of sending job offers Ξ_t with endogenous intensity e_t. The budget constraint of the household can be written as:

$$P_t^C C_t\left(1-\tau_t^C\right) + T_t + \Xi_t = \Delta_t^B + \Pi_t + \int_0^1 W_t^i N_t^i di \tag{5}$$

where:

$$\Delta_t^B = \left(B_{t-1}^H - \frac{B_t^H}{R_t^H}\right) + B_{t-1}^F \frac{q_t}{q_{t-1}} - \left(\frac{B_t^F}{R_t^F R P_t}\right) \tag{6}$$

$$\Xi_t = \left(\bar{c}_U \times (e_t - \bar{e}) + \psi_u \times (e_t - \bar{e})^2\right) \times U_t \quad (7)$$

RP_t is a risk premium associated with investment in foreign bonds (Senhadji, 1994), while $\bar{e}$ 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 step, 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 maximises a discounted stream of profits $\tilde{\Pi}_t$:

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

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

$$Y_t^{NK} = K_{t-1}^{\alpha}\left(\int_0^1 A_t^i N_t^i di\right)^{1-\alpha}$$

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:

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

where A^Y denotes the technology level and the technology shock. The accumulation of capital is subject to investment friction (Lucas and Prescott, 1971), the extent of which is set by parameter ϵ_K:

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

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 use this parameter as the labour demand shock. Finally, the profit of the firm can be written as:

$$\Pi_t = P_t Y_t - P_t^Z Z_t - P_t^I I_t\left(1 - \tau_t^I\right) - \int_0^1 W_t^i N_t^i di - \overline{\varpi} V_t, \quad (8)$$

where τ_t^I is government subsidy for investment, which is described later.

Final goods firms. The basic good is purchased by final good firms indexed by $f \in \mathcal{F}$: consumption, government, investment, intermediate materials and exporters, who combine it with imported goods $Y_t^{f,F}$:

$$Y_t^f = \left(\left(\theta_H^f\right)^{\frac{1}{\epsilon_f}}\left(Y_t^{f,H}\right)^{\frac{\epsilon_f - 1}{\epsilon_f}} + \left(1 - \theta_H^f\right)^{\frac{1}{\epsilon_f}}\left(Y_t^{f,F}\right)^{\frac{\epsilon_f - 1}{\epsilon_f}}\right)^{\frac{\epsilon_f}{\epsilon_f - 1}} \quad (9)$$

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

$$\Pi_t^f = P_t^f Y_t^f - P_t Y_t^{f,H} - P_t^F \times q_t \times Y_t^{f,F} \quad (10)$$

where q_t is the real foreign exchange rate. The following market clearing condition holds:

$$Y_t = \sum_{f \in \mathcal{F}} Y_t^{f,H} \tag{11}$$

Open economy. We build an open-economy model in which the domestic economy faces exogenous foreign demand (Ratto *et al.*, 2009). 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:

$$IM_t = \sum_f IM_t^f \quad IM_t^f = P_t^F \times q_t \times Y_t^{f,F} \tag{12}$$

$$EX_t = P_t \times EX_t^V \quad EX_t^V = \left(\frac{P_t}{P_t^F q_t}\right)^{-\epsilon_F} \times Y^F \tag{13}$$

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:

$$CA_t = EX_t - IM_t \tag{14}$$

$$KA_t = B_{t-1}^F \frac{q_t}{q_{t-1}} - \frac{B_t^F}{R_t^F RP_t} \tag{15}$$

$$0 = CA_t + KA_t \tag{16}$$

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 is summarised in the following two equations:

$$P_t^G G_t = \overline{G} \times \left(\frac{\text{GDP}_t}{\text{GDP}}\right)^{\epsilon_{GV}} \quad T_t = P_t^G G_t \tag{17}$$

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 characterised by endogenous destruction and a search and matching mechanism. In each period the number of employed evolves according to:

$$N_t = (1-\overline{\rho})(1-s_t) \times (N_{t-1} + M_{t-1}) \tag{18}$$

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 sent by unemployed:

$$M_t = \overline{\Upsilon}(e_t U_t)^{\psi} V_t^{1-\psi} \tag{19}$$

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

$$\Psi_t = \frac{M_t}{e_t U_t}, \quad \Phi_t = \frac{M_t}{V_t}. \tag{20}$$

Wages are negotiated individually between the worker and the firm based on the worker's individual productivity using Nash wage bargaining:

$$W_t(a) = \arg \max_{W_t(a)} \left(V_t^E(a) - V_t^U\right)^{\xi} \times \left(V_t^F(a) - J_t\right)^{1-\xi} \tag{21}$$

where $V_t^E(a)$ and V_t^U denote the value of employment and unemployment for the worker while $V_t^F(a)$ and J_t denote the value of employment and of posting a vacancy for a firm. Parameter ξ denotes the worker's bargaining power and is also used as the wage bargaining shock. The value functions have the following form:

$$V_t^E(a) = W_t(a) + \beta E_t\left((1-\rho)(1-s_t)\left(V_{t+1}(a') - V_t^U\right) + V_{t+1}^U\right) \tag{22}$$

$$V_t^U = b - \Xi_t(e_t) + \beta E_t\left(\Phi_t V_{t+1}^E(a^0) + (1-\Phi_t)V_{t+1}^U\right) \tag{23}$$

$$V_t^F(a) = X_t - W_t(a)\beta E_t\left((1-\rho)(1-s_t)V_{t+1}^F(a')\right) \tag{24}$$

$$J_t = -\overline{\varpi} + \beta \Psi_t E_t\left((1-\rho)(1-s_{t+1})V_{t+1}^F(a^0)\right) \tag{25}$$

where a' is a random variable which denotes next period productivity conditional on a, and X_t is marginal productivity wrt labour. We assume that labour market entrants draw their initial productivity from Normal distribution denoted by a^0. The amount of vacancies posted by firms is given by the free entry condition $J_t = 0$, while search intensity is given by the condition $((\partial V_t^U)/(\partial e))(e) = 0$. We assume that firms will endogenously sever a job relationship if its value is below a certain threshold $\tilde{c}$:

$$V_t^F(a) \leqslant \tilde{c} \tag{26}$$

Using the value $\overline{a}_t$ for which $V_t^F(\overline{a}_t) = \tilde{c}$ we can calculate the rate of endogenous job destruction. The parameter $\tilde{c}$ is also used 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:

$$\log(X_t) = \log\left(\overline{X}\right) + \chi_t^X \tag{27}$$

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

$$\chi_t^X = \rho^X \chi_{t-1}^X + \varepsilon_t^X \tag{28}$$

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 – $\overline{G}$; and
- job destruction rate shock – $\tilde{c}$.

Solution method. The solution of the model is standard and consists of solving for the non-stochastic steady state and calculating a linear approximation around it. The dynamics of the model are solved according to the method described by Sims (2002).

2.2 Model estimation and parametrisation

The model is calibrated and estimated separately for every country, resulting in models that differ only with regard to parameter values. We use quarterly data from the 1995-2013 period for: real GDP, private consumption expenditure, investment expenditure, public consumption expenditure, exports, imports, foreign GDP, real hourly wage, employment rate, unemployment rate, employment to unemployment flows (job separations) and unemployment to employment flows (hirings)[3]. Labour market flows are estimated with the methodology of Elsby *et al.* (2008) as hazard rates of firing and hiring, i.e. the probability of losing (finding) a job in a quarter t, conditional on being employed (unemployed) in a quarter $t-1$. 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. To obtain the cyclical component from the time series, we apply the Hodrick-Prescott filter in which the frequency of the extracted cyclical data is set 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[4].

A summary of model parameters is presented in Table AI. The first step consists of setting parameters responsible for calibrating the steady state properties of the model, such as employment rate, shares of the GDP components and labour market flows. The target values are calculated as averages from the corresponding time series or taken from Eurostat IO matrices. Two parameters values, namely, the discount rate β and Cobb-Douglas production function parameter α are taken as standard from the literature. The second step consists of setting the parameters responsible for the dynamic properties of the model. This group consists of parameters describing the shock processes, elasticities, the degree of real frictions and search and vacancy costs. These values are set using a Bayesian 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:

$$\hat{\Gamma} = \arg \max_{\Gamma} L(\Gamma) \quad L(\Gamma) = \sum_i \log \text{ pdf}^{P_i}(\Gamma_i) + \sum_j \log \text{ pdf}^{M_j}\left(M_j(\Gamma)\right) \tag{29}$$

where pdf^{P_i} is the a priori distribution of the ith parameter of the model and pdf^{M_j} is the distribution of the moment M_j. The a priori distribution of parameters is assumed to be normal with mean and standard deviation set to allow for a fairly large degree of flexibility for

the estimation procedure. For labour market matching function parameters which are bounded to the unit interval we assume a mean of 0.5 and standard deviation 0.3. For parameters that cannot be pinned down empirically, such as the cost of search, vacancy posting cost and investment friction, we arbitrarily set the mean and allow for a large standard deviation. Distribution for remaining elasticities is set in line with the literature. For parameters describing shock processes we assume high autocorrelation and a mean of 1 per cent for the standard deviation, with the exception of the distribution of the parameters controlling public consumption and foreign demand, which were determined using estimation results for the relevant data equations. After individual country estimation, we set the parameters of the shock processes to common values using a panel estimation procedure. 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.

3. Differences of GIPS *vis-à-vis* Germany

Table AI presents the estimated parameters of country models. From the viewpoint of cyclical volatility of labour market variables, the following parameters are particularly interesting:

- quadratic search cost – the higher the parameter, the lower the volatility of search effort of households and in turn the lower labour market volatility – is the highest in Germany and the lowest in Greece;
- vacancy cost – the higher the parameter, the lower the labour market volatility – is the highest in Italy followed by Germany, and the lowest in Spain;
- matching function elasticity – the higher the parameter, the higher the volatility of unemployment and employment – is the highest in Spain, and the lowest in Portugal;
- exogenous destruction rate – the higher the parameter, the higher the labour market volatility[5] – is by far the highest in Spain and comparable in other countries;
- foreign GDP elasticity – the higher the parameter, the higher the volatility of GDP (and lower resilience to foreign demand shocks) – is the highest in Spain and Portugal, and the lowest in Germany; and
- home foreign good elasticity – the higher the parameter, the lower the volatility of GDP – is the highest in Italy and Germany, and the lowest in Portugal.

Next, we use the estimated models to quantify the differences in reactions to shocks in the analysed countries. To this aim we calculate IRF and historical decompositions conditional on a history of shocks identified by models for each country. The former allows for a comparison of reactions of various economies to identical unit shocks. The latter allows identification of shocks which were most important for the cyclical fluctuations in particular countries in 1999-2013. For each economy, the contribution of shock i to fluctuations of variable j is calculated as follows:

$$\kappa_j^i = \frac{\text{cov}\left[HD_j^i,\ z_j\right]}{\text{var}\left(z_j\right)} \quad \kappa_j = \sum_i \kappa_j^i \tag{30}$$

where HD_j^i is the time series of the historical decomposition of variable j cyclical component with respect to shock i, and z_j is the variable j cyclical component in the data for a given country.

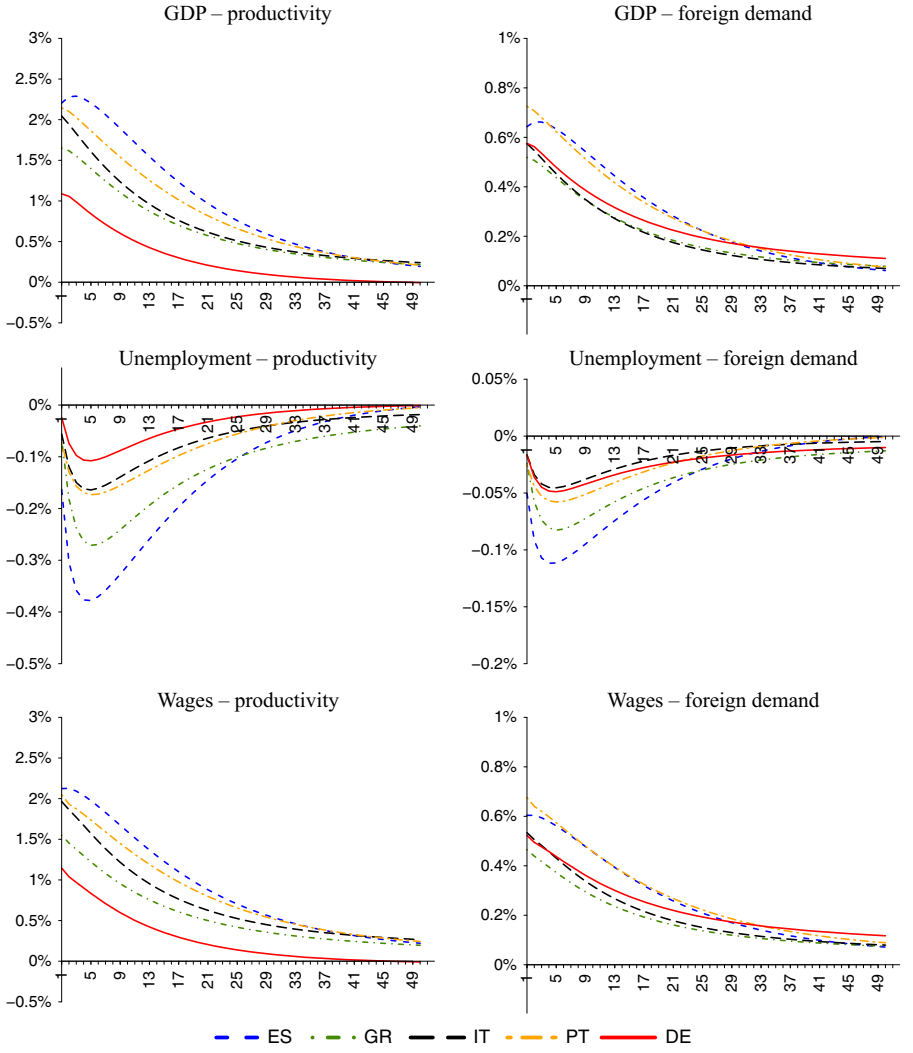
The κ_j measures how the model fits the data in a given country. If $\kappa_j = 1$, the model is able to exactly replicate the evolution of variable j, in the case of $\kappa_j > 1$ or $\kappa_j < 1$, it predicts, respectively, a higher or lower volatility of a particular variable than observed in the data. Moreover, the Appendix contains plots of the estimated shocks for the analysed countries.

Historical decompositions (Table I) suggest that productivity and foreign demand shocks were the main determinants of GDP fluctuations in all countries studied[6]. The resilience to productivity shocks in GIPS economies was lower than in Germany (Figure 2). The impact of (unit) productivity shock on GDP was much stronger in GIPS countries (maximum deviation ranging from 1.7 per cent in Greece to 2.3 per cent in Spain, total deviation over 50 quarters – from 31.7 pp. in Greece to 48.7 pp. in Spain) than in Germany (1.3 per cent and

Shocks	Foreign demand	Productivity	Bargaining power	Labour demand	Labour supply	Government spending	Job destruction	All shocks
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
Job separations								
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
Hirings								
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

Note: The values of κ for other variables are available upon request
Source: Own calculations based on the DSGE model, quarterly data 1999-2013

Table I.
Model historical decomposition fit to the data, by country and shock (in %)



Note: In %, or pp. of labour force in the case of unemployment

Figure 2. Model impulse response functions of GDP, unemployment and wages to productivity and foreign demand shocks

13.6 pp., respectively). The response of GDP to a foreign demand shock was less differentiated between countries and weaker than the response to a productivity shock (ranging from 0.5 per cent maximum and 10.0 pp. total deviation in Greece to respectively 0.7 per cent and 14.2 pp. in both Portugal and Spain). The responses of wages to productivity and foreign demand shocks were analogous to those of GDP, albeit smaller. Productivity shock had stronger and more persistent impact on unemployment in GIPS countries than in Germany. Spain stood out with the strongest response of unemployment (maximum absolute deviation of 0.4 per cent of labour force) and Greece with most persistent (total absolute deviation of 7.3 pp.) while Germany had much weaker reactions (0.1 per cent maximum and 1.7 pp. total in absolute terms). The same was true for the impact of foreign demand shock on unemployment, although the impact in Italy was weaker than in Germany.

In all countries labour market fluctuations were determined mainly by shocks specific to that market. Employment and unemployment were driven mostly by job destruction shocks which explain nearly 50 per cent of unemployment volatility in all countries except Greece. Noticeable but smaller impact was exerted by labour demand (Spain, Italy), bargaining power (Portugal, Spain) and labour supply (Greece) shocks (Table I). Spain exhibited the strongest responses of unemployment to job destruction (maximum of 0.3 per cent of labour force and total of 3.8 pp.) and labour demand (0.1 per cent maximum and total of 2.0 pp.) shocks (Figure 3). Greece also showed high responsiveness of unemployment to labour demand shocks (0.1 per cent maximum and 1.7 pp. total), while Portugal exhibited relatively persistent response of unemployment to job destruction

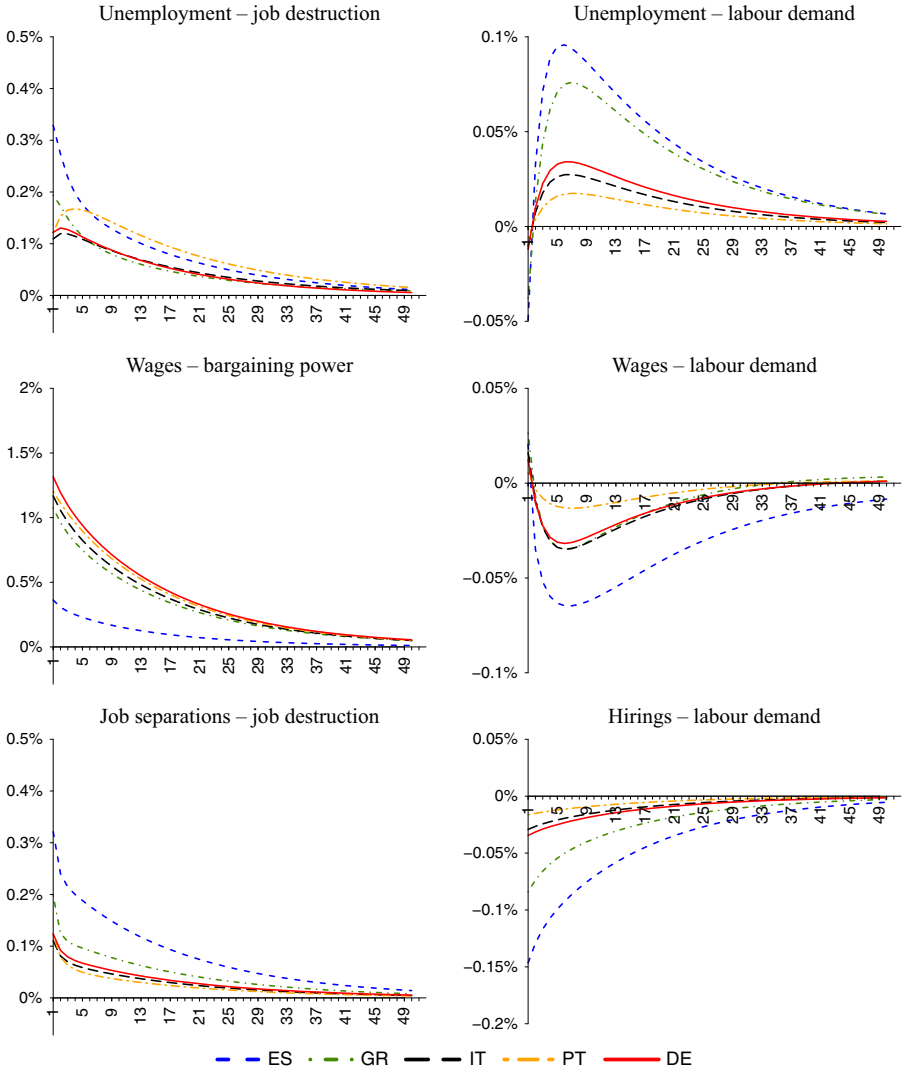


Figure 3.
Model impulse response functions of labour market variables to selected shocks

Note: In %, or pp. of labour force in the case of unemployment and flows

shocks (total impact of 3.9 pp.). Germany and Italy displayed small responses of unemployment to these two shocks[7].

On the other hand, Germany exhibited the highest responsiveness of wages to bargaining power shocks (1.3 per cent maximum and 18.7 pp. total deviation), while Spain stood out with the lowest (0.4 per cent, 4.4 pp.). We interpret this responsiveness as a proxy for wage flexibility, and we find it was the highest in Germany and by far the lowest in Spain[8]. Bargaining power shocks were crucial for the evolution of wages, except for Portugal where foreign demand, productivity and job destruction shocks were of comparable importance (Table I). The second most potent shock explaining the evolution of wages was labour demand shock in Germany, Italy and Spain, and productivity shock in Greece. However, the response of wages to labour demand shock was small. It was strongest in Spain (maximum absolute response 0.06 per cent, total 1.8 pp.) and weakest in Portugal (0.01 per cent, 0.2 pp.), while the Italy, Greece and Germany had similar reactions.

Job separations in all countries were driven mainly by job destruction shocks, but their impact was mitigated by bargaining power shocks, and labour demand shocks in Germany and Spain (Table I). Hirings were mostly determined by labour demand shocks in Germany, Greece, Italy and Spain, and by bargaining power shocks in Portugal. Spain exhibited the highest responsiveness of separations to job destruction shocks (maximum 0.3 per cent of labour force and 4.3 pp. total), as well as of hirings to labour demand shocks (maximum 0.2 per cent and 2.0 pp. total), followed by Greece (Figure 3). The other three countries reacted to such shocks to a lower extent.

4. Counterfactual simulations

Section 3 identified cross-country differences in reactions to independent, unit shocks. However, in reality economies were affected by country-specific realisation of several shocks occurring simultaneously. In this section, we assess to what extent the performance of GIPS can be explained by the country-specific shocks which hit them (the nature and size of shocks), and to what extent by the country-specific absorption of shocks, in particular, their lower resilience *vis-à-vis* Germany. We assume that the former is captured by the identified (filtered) disturbances, and the latter by the country-specific (estimated) parameters of the model. Thus, for each GIPS economy we compare the country-specific response to its own shocks (historical decomposition obtained from the country model) with a hypothetical response of Germany to the same shocks (simulation of shocks filtered for a particular country with 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 follows:

$$\left\{y^b_{j,t}\right\}_{t \in T} = F\left(p_b, \left\{z^{b,X_t}\right\}_{t \in T}\right) \tag{31}$$

where p_b denotes the parameters estimated for the model of country b, and $F()$ represents the entire model. The hypothetical reaction of variable j for country b to the shocks filtered for country c is calculated as:

$$\left\{y^{b,c}_{j,t}\right\}_{t \in T} = F\left(p_b, \left\{z^{c,X_t}\right\}_{t \in T}\right) \tag{32}$$

The difference between $\{y^b_{j,t}\}_{t \in T}$ and $\{y^{b,c}_{j,t}\}_{t \in T}$ is a proxy of the impact of country-specific reaction to shocks in GIPS.

We find that all GIPS countries would have experienced lower macroeconomic volatility if they reacted to their country-specific shocks in the same way as the German economy would have (Table II)[9]. The difference is most pronounced in Spain (the standard deviation

	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
Job separations				
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
Hirings				
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

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

of the cyclical component of GDP would have amounted to 47 per cent of the recorded value), and least pronounced in Italy (77 per cent). All GIPS countries would have also 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. All GIPS economies would have exhibited greater volatility of real wages, the difference being most pronounced in Spain. However, some differences between the four Southern European countries emerge, especially with respect to the labour market patterns of the boom and bust cycle of the 2000s.

We find that Germany would generally have dealt better with the absorption of Spanish shocks than Spain did. Although Germany would not have avoided a slowdown after 2009, it would have been on average by 0.4 per cent of GDP less deep. Volatility of employment and unemployment would have been much lower (standard deviation would be 1.0 per cent instead of 1.6 per cent) – partly due to lower GDP volatility implied by the German model (2.1 per cent vs 3.1 per cent), which translates into lower volatility of employment and unemployment, and partly due to much higher volatility of wages in the German model (both in absolute terms, 3.4 per cent vs 3.1 per cent, and relatively to GDP volatility). Job separations and hirings would also have been less volatile (0.2 per cent vs 0.4 per cent for both flows). Figure 4 confirms that Spanish shocks in Germany would have had less impact on unemployment and employment, but would have led to much larger fluctuations in wages. On average, in 2009-2013, unemployment rate would have been lower (by 0.7 pp.), as would job separations (by 3 per cent). Employment rate and hirings would have been higher (by 0.7 pp. and 1 per cent, respectively). Costain *et al.* (2010) and Sala *et al.* (2012) have

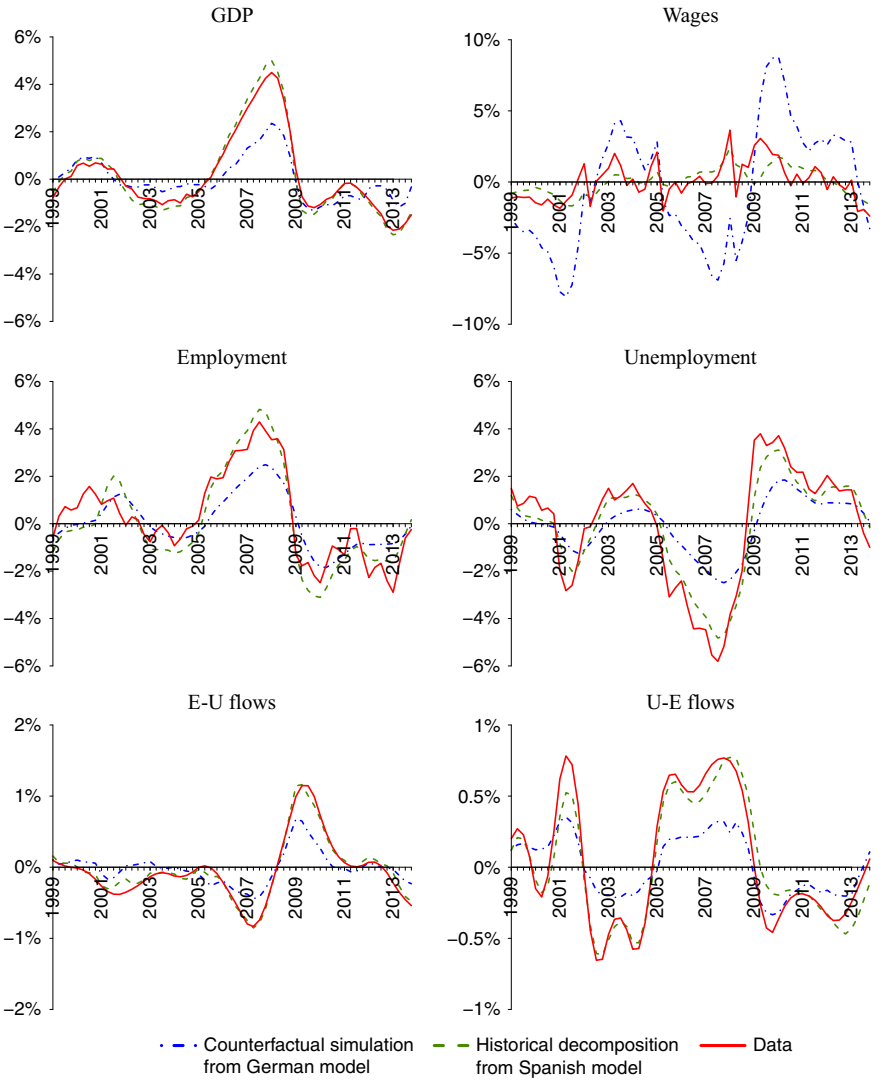


Figure 4.
Comparison of Spain's capacity to absorb macroeconomic shocks against Germany

argued that the exceptionally high volatility of employment, unemployment and labour market flows in Spain can be attributed to the high incidence of temporary contracts. Our results show that rigid wage adjustments could be another factor in play[10].

In Portugal, the pattern was similar, albeit less pronounced. 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 (Figure 5). Volatility of GDP would have been lower (standard deviation 1.2 per cent vs 2.0 per cent), as would employment and unemployment (1.0 per cent vs 1.1 per cent). Wages would have been more volatile (3.6 per cent vs 3.1 per cent), and would have been lower after 2010 (by 4 per cent on average in 2009-2013). Unemployment would have increased less after 2012, so the unemployment rate would have been lower by an average of 0.3 pp. in 2012-2013 (by 0.1 in 2009-2013). Job separations and hirings would have

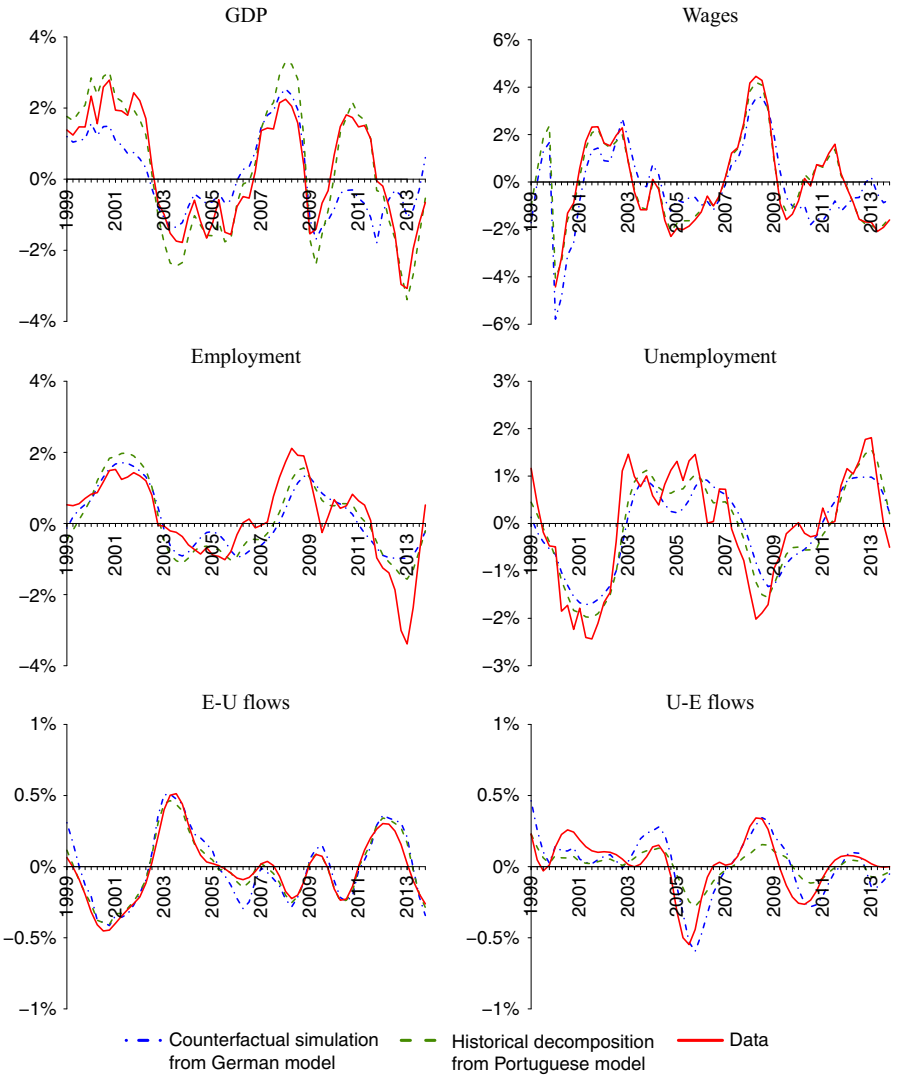


Figure 5.
Comparison of Portugal's capacity to absorb macroeconomic shocks against Germany

been more volatile (0.3 per cent vs 0.1 per cent and 0.3 per cent vs 0.2 per cent, respectively), while average flows in 1999-2013 would have been 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 separations and hirings to macroeconomic shocks.

The shocks which affected Greece would have led to lower volatility of GDP in Germany (standard deviation 2.1 per cent vs 3.1 per cent), as well as employment and unemployment (1.0 per cent vs 1.6 per cent). Still, GDP would have been much more volatile than in other GIPS countries which shows that shocks affecting Greece were especially powerful. In 2012-2013, the decline in GDP would have been lower in Germany (on the average 3.0 per cent below the trend) than that recorded in Greece (5.2 per cent), but it still would

have been a noticeable recession (Figure 6). The drop in employment and spike in unemployment would also have been significantly lower (on the average by 1.1 per cent of the labour force in 2012-2013). On the other hand, employment would have been lower and unemployment higher in Germany before the Great Recession (on the average by 0.9 per cent of the labour force in 2006-2009). Wages would have been more volatile in Germany (3.4 per cent vs 3.1 per cent), but the change is smaller than in case of Spain. Thus, weaker fluctuations of employment and unemployment would have been mainly due to lower volatility of GDP and lower volatility of hirings (0.1 per cent vs 0.3 per cent), instead of wage rigidities which affected Spain.

In Italy, GDP volatility would also have been lower if Italy had reacted to shocks like Germany (standard deviation 1.1 per cent vs 1.5 per cent) and instead of a double-dip

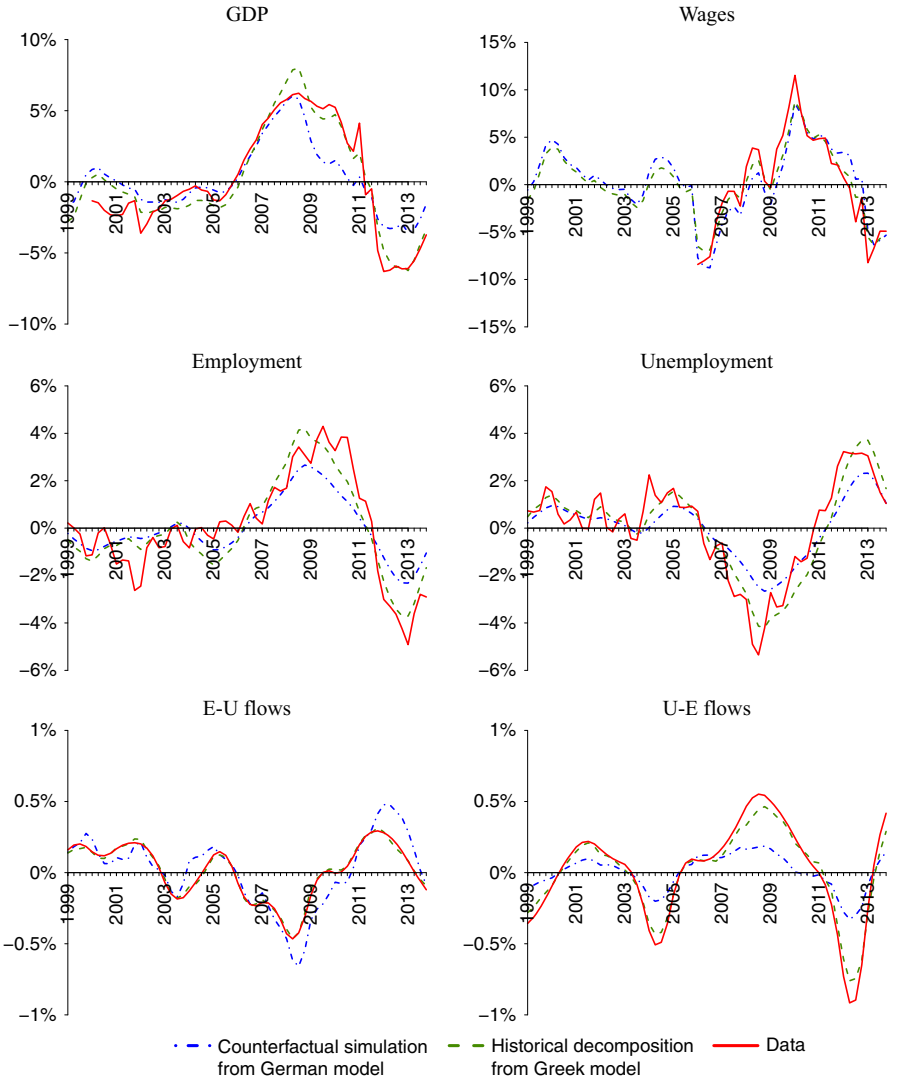


Figure 6.
Comparison of Greece's capacity to absorb macroeconomic shocks against Germany

recession there would have been a smaller but prolonged slowdown, like in Portugal (Figure 7). Italy emerges to have the least responsive labour market of the countries studied – the absolute and relative-to-GDP volatility of all labour market variables would have been slightly higher in Germany if it was affected by Italian shocks (Table II). During the Great Recession, employment in Germany would have been slightly higher (by 0.1 per cent of the labour force in 2009-2013 on average), as would also have been labour market flows (by 0.3 per cent of the labour force in 2009-2013).

5. Conclusions

In this paper, we use a DSGE model of real open economy with labour market frictions to analyse fluctuations of macroeconomic and labour market variables in GIPS, and a

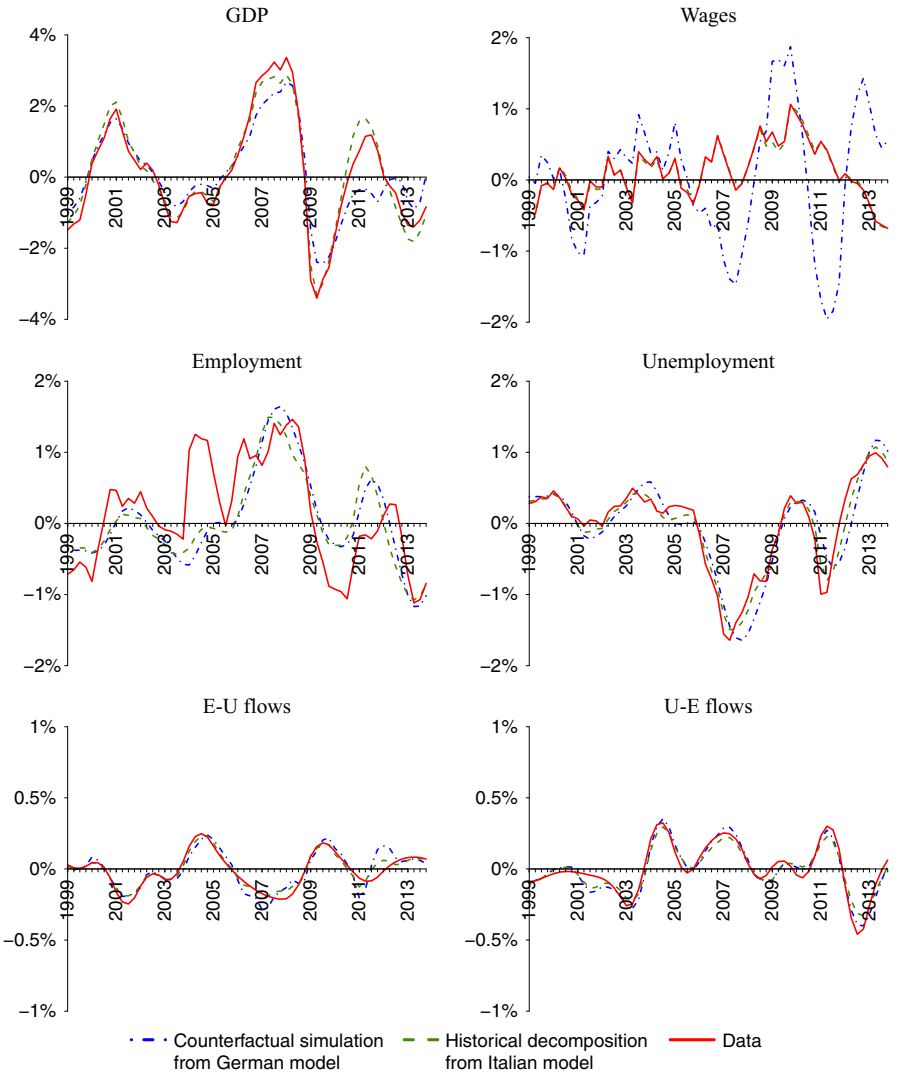


Figure 7.
Comparison of the Italy's capacity to absorb macroeconomic shocks against Germany

reference country – Germany. We aim to contribute to the literature focussed on cyclical co-developments of output, unemployment and wages by using a model in general equilibrium framework that accounts for labour market flows and allows for identification of country-specific adjustments to shocks. We estimate the model separately for each country and find that GIPS countries were more vulnerable to productivity and foreign demand shocks than Germany. We identify these two shocks as main determinants of GDP fluctuations. Spain and Portugal were more responsive to both productivity and foreign demand shocks than Italy and Greece, and also exhibited stronger quantitative adjustments to job destruction and labour demand shocks, which are identified as main driving forces behind employment and unemployment fluctuations. The responsiveness of wages to bargaining power shocks was lower in GIPS, which we interpret as lower real wage flexibility in GIPS than in Germany.

In terms of model parameters, the higher macro-resilience of German economy can be attributed to its relatively low elasticity to foreign GDP fluctuations and high home foreign good elasticity, as well as labour market-related parameters – relatively low job destruction rate, and relatively high quadratic search cost and high vacancy costs – which jointly contribute to relatively low variability of employment and unemployment. On the other hand, Spain stood out with relatively high foreign GDP elasticity, high job destruction rate and matching function elasticity and low search and vacancy costs, which contributed to high variability of employment and unemployment.

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. We find that all GIPS countries would have experienced lower volatility of GDP, but labour market adjustments would have been 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 labour market indicators, including worker flows, if it 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 have been smaller, but as a result of lower fluctuations of GDP and hirings, rather than larger fluctuations of wages. All GIPS countries would have higher employment and lower unemployment during the Great Recession, if they were able to react to shocks affecting them like Germany would have.

Our results show that GIPS countries would not have been able to avoid a recession if they reacted to shocks like Germany, but in each of them it would have been less severe and unemployment growth would have been smaller. From the perspective of policy responses to business cycle, the higher vulnerability of GIPS to a comparable foreign demand or productivity shocks suggest that responses of monetary or fiscal policies in GIPS should be relatively stronger than in Germany. In the light of the common monetary policy in the Eurozone, our finding stresses the need for prudent fiscal policy, which would create space for larger responses to shocks in GIPS.

What is more, we find that adjustment mechanisms on the GIPS labour market are quite diverse and we think that policy agendas should reflect that. Boeri and Jimeno (2015) argue that so far the EU policy coordination and conditionality during the Great Recession and the Euro area debt crisis failed to account properly for the interactions between shocks and country-specific labour market institutional frameworks. The high volatility of labour market variables and the significance of job destruction for GDP fluctuations in Spain suggest that labour market adjustments were mainly quantitative. We find a similar,

but less pronounced pattern in Portugal. The policy agenda in these countries should tackle high and volatile job separations rates, likely related to high incidence of temporary contracts and labour market duality, and low wage flexibility, likely related to the collective bargaining system characterised by a high degree of price indexation (Font *et al.*, 2015) and automatic extension of agreements to all firms and workers (Bentolila *et al.*, 2010). The focus in Greece should be on factors determining the (so far high) elasticity of employment with respect to GDP (potentially regulations hindering internal firm flexibility in adjusting hours and content of jobs, Eichhorst *et al.*, 2010), whereas in Italy on factors behind low responsiveness of labour market to output – which cushions the unemployment increase after adverse shocks, but creates a risk of jobless growth. The introduction of Italian Graded Security Contract (*Contratto a Tutele Crescenti*) in 2015 is an example of a reform addressing this issue (Boeri *et al.*, 2015).

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Notes

1. The counterfactual simulations conducted by Christoffel *et al.* (2009) are different and consist of comparing IRFs for a range of values of a single parameter.
2. Conceptually similar approach was used by, e.g. OECD (2015) who analyses how wage inequalities would change in the OECD countries if country-specific skills distributions, returns to skills and skills uses would be replaced by average OECD patterns. However, we use the dynamic macroeconomic setting.
3. All data from Eurostat, except the real hourly wage from the OECD database.
4. For example, 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 is below the trend in 2011. Extracting fluctuations of up to 60 quarters alleviates this problem.
5. Although this parameter mainly calibrates steady state employment.
6. They jointly explain over 80 per cent of GDP fluctuations in all countries except Spain, where labour market shocks are also important for GDP fluctuations. Smets and Wouters (2005) found productivity and labour supply shocks as the main determinants of GDP variability in Euro area, but their model did not account for foreign demand shocks.
7. Germany had 0.1 per cent maximum and 2.3 pp. total response to job destruction shock, 0.03 per cent and 0.7 pp. to labour demand shock, respectively. Italy had 0.1 per cent maximum and 2.5 pp. total response to job destruction shock, 0.03 per cent and 0.6 pp. to labour demand shock, respectively.
8. Christoffel *et al.* (2009) find that bargaining shocks explain a significant share of fluctuations of wages, output and inflation in Euro area and argue that such shocks contain valuable information for the central bank for evaluating inflation and output dynamics. This corroborates interpretation of responsiveness to these shocks as proxy for wage flexibility in the flexible wage setting.

9. We focus on GDP, employment, unemployment, labour market flows and wages. Results for other variables are available upon request.

10. In line with Font *et al.* (2015) who show that cyclicality of real wages in Spain was especially low in recessions. Higher levels of unemployment did not translate into additional real wage adjustments when the economy was contracting, while lower levels of unemployment during expansions have incremental effects on wage elasticity.

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Appendix

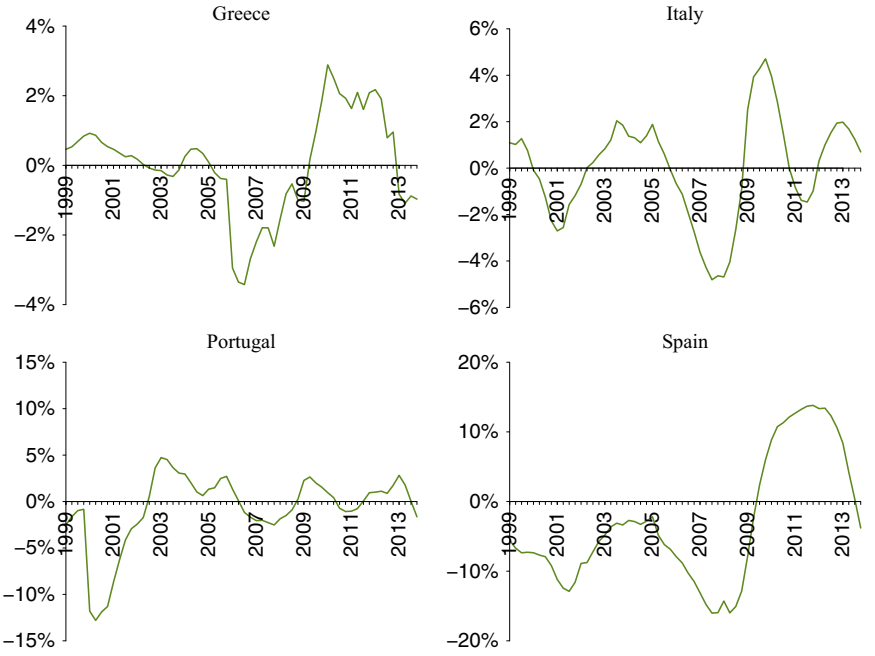

Figure A1. Estimated path of bargaining power shock (in %)

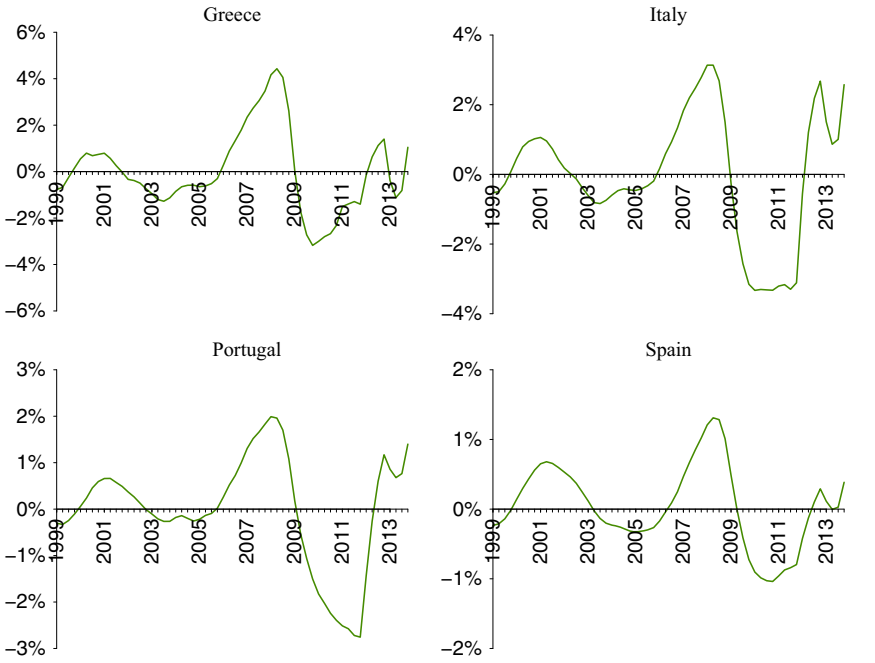

Figure A2.
Estimated path of foreign demand shock (in %)

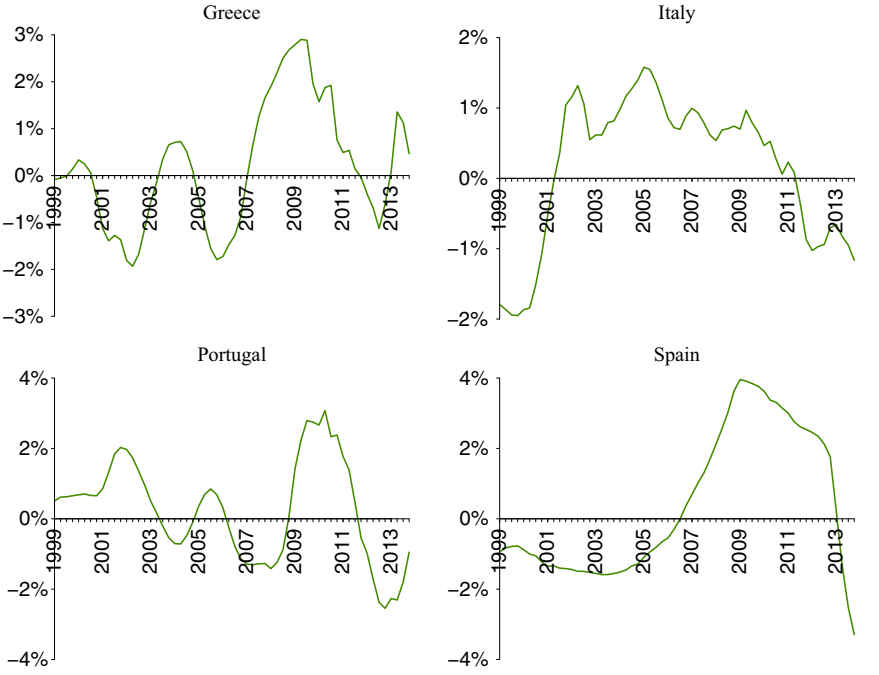

Figure A3.
Estimated path of government spending shock (in %)

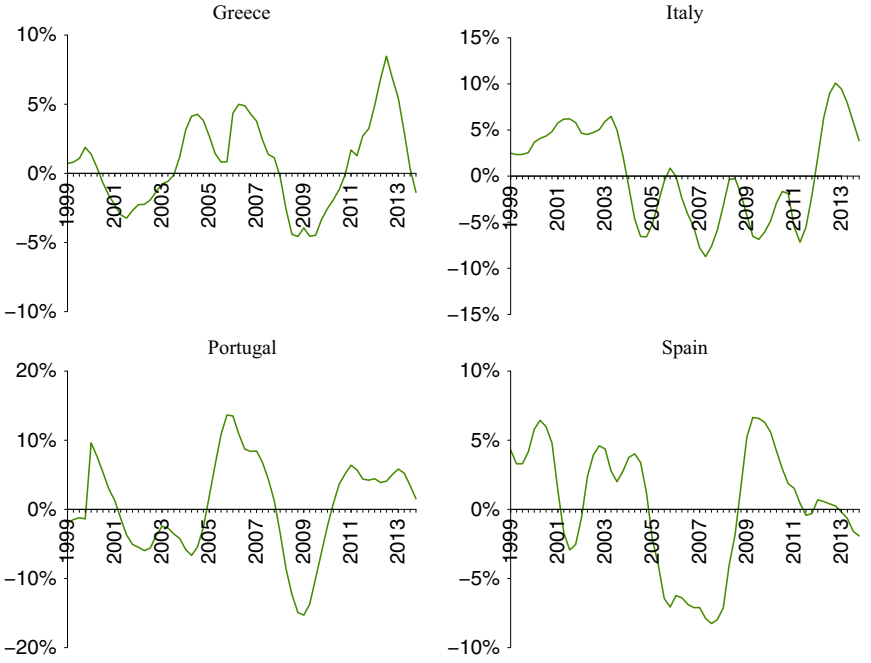

Figure A4.
Estimated path of labour demand shock (in %)

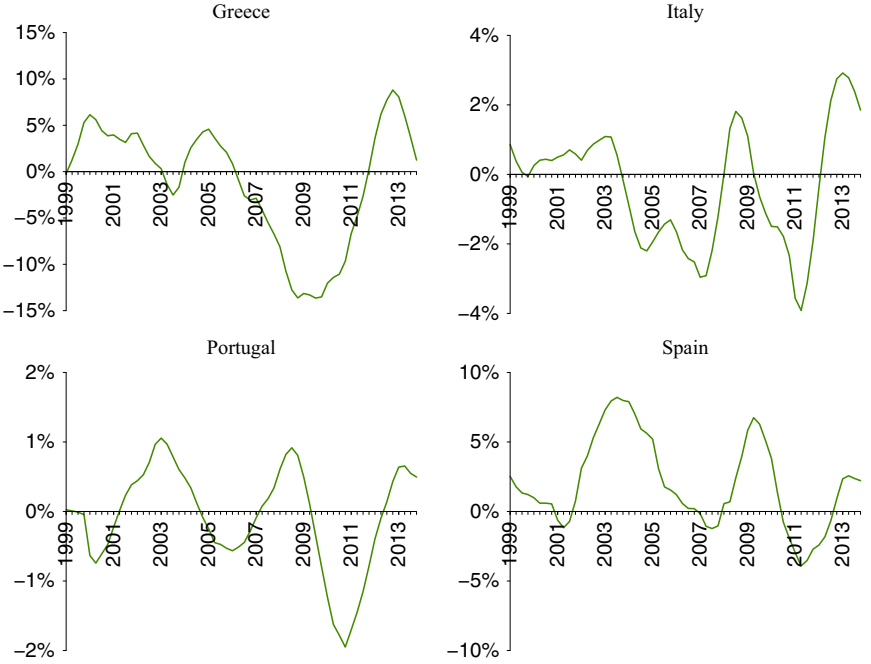

Figure A5.
Estimated path of labour supply shock (in %)

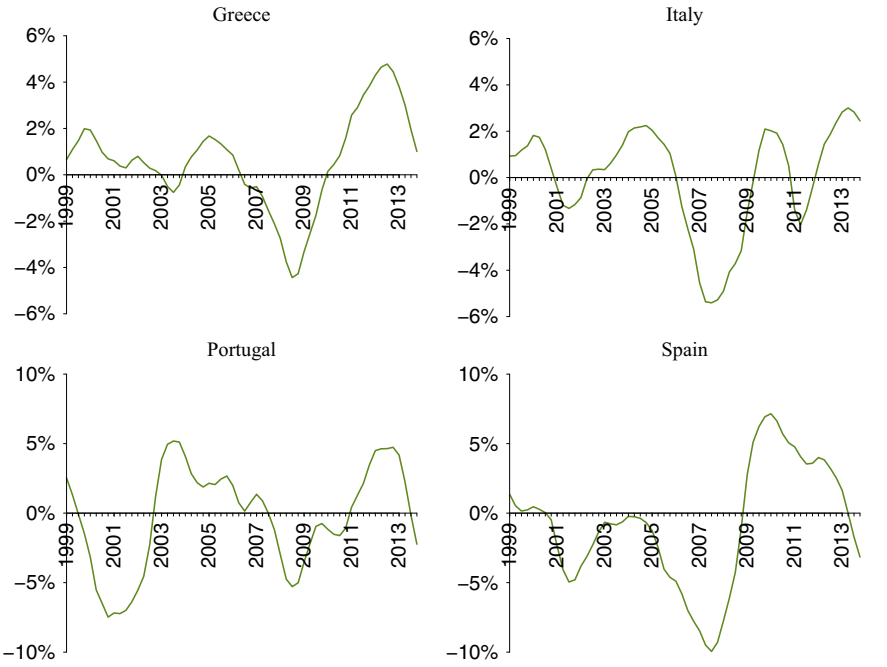

Figure A6.
Estimated path of job destruction shock (in %)

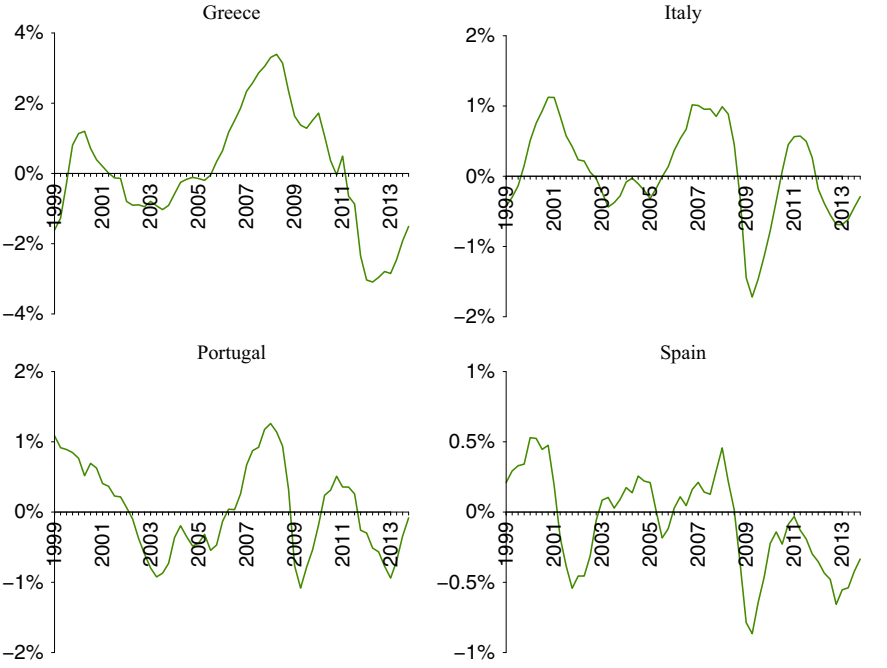

Figure A7.
Estimated path of productivity shock (in %)

Parameter	Calibration target of parameter	GR	IT	PT	ES	DE	Prior	
Calibrated parameters								
$\overline{Y^F}$	Steady state export share	0.166	0.277	0.333	0.243	0.481	–	–
$\overline{G}$	Steady state government export share	0.231	0.235	0.231	0.186	0.222	–	–
δ	Steady state investment	0.021	0.028	0.055	0.104	0.017	–	–
b	Steady state employment	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	–	–
$\overline{\rho}$	Outflows from employment	0.010	0.010	0.011	0.033	0.011	–	–
Parameters set exogenously								
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	–	–
Estimated parameters							Mean	SD
$\overline{c}_U$	Linear search cost	0.017	0.017	0.017	0.017	0.017	0.017	0.01
ψ_u	Quadratic search cost	0.731	0.860	0.816	0.990	1.088	1	1
ϵ_{CH}	Home market good elasticity	0.596	0.550	0.500	0.527	0.597	0.3	0.5
ϵ_K	Investment friction	0.686	0.214	0.869	0.820	0.727	0.9	1
ϵ_Z	Capital-labour material elasticity	0.146	0.331	0.028	0.015	0.306	0.3	0.2
ϵ_F	Foreign GDP elasticity	2.019	4.804	5.544	5.658	0.945	5	5
ϵ_f	Home foreign good elasticity	0.310	0.457	0.263	0.388	0.411	0.5	4
ψ	Matching function elasticity	0.202	0.390	0.637	0.415	0.355	0.5	0.3
ξ	Worker bargaining power	0.685	0.650	0.717	0.692	0.688	0.5	0.3
$\overline{\varpi}$	Vacancy cost	0.459	0.559	0.499	0.206	0.542	0.5	0.5
$\rho_{\overline{G}}$	Government export shock autocorrelation	0.942	0.942	0.942	0.942	0.942	*	*
ρ_{A^Y}	Technology shock autocorrelation	0.917	0.917	0.917	0.917	0.917	0.96	0.2
ρ_{Y^F}	Foreign demand shock autocorrelation	0.936	0.936	0.936	0.936	0.936	*	*
ρ_b	Labour supply shock autocorrelation	0.957	0.957	0.957	0.957	0.957	0.96	0.2
$\rho_{\tilde{c}}$	Job destruction shock autocorrelation	0.945	0.945	0.945	0.945	0.945	0.96	0.2
$\rho_{\overline{\varpi}}$	Labour demand shock autocorrelation	0.937	0.937	0.937	0.937	0.937	0.96	0.2
ρ_{ξ}	Wage bargaining shock autocorrelation	0.936	0.936	0.936	0.936	0.936	0.96	0.2
$\sigma_{\overline{G}}$	Government export shock SD	0.005	0.005	0.005	0.005	0.005	*	*
σ_{A^Y}	Technology shock SD	0.003	0.003	0.003	0.003	0.003	0.01	0.1
σ_{Y^F}	Foreign demand shock SD	0.006	0.006	0.006	0.006	0.006	*	*
σ_b	Labour supply shock SD	0.004	0.004	0.004	0.004	0.004	0.01	0.1
$\sigma_{\tilde{c}}$	Job destruction shock SD	0.012	0.012	0.012	0.012	0.012	0.01	0.1
$\sigma_{\overline{\varpi}}$	Labour demand shock SD	0.019	0.019	0.019	0.019	0.019	0.01	0.1
σ_{ξ}	Wage bargaining shock SD	0.012	0.012	0.012	0.012	0.012	0.01	0.1

Note: *These values were set by estimation of relevant data equations separately for each country

Table AI.
Model parameters

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