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Abstract

Two labor market targeted fiscal policies, a hiring subsidy and a wage subsidy for new hires of labor, are evaluated, and their macroeconomic effects compared with those of standard fiscal instruments. The analyses are based on an extension of a monetary, open economy, search and matching model in which a distinction between the wage negotiated by newly hired workers and incumbents is introduced. The model is estimated with Bayesian techniques using data for high unemployment countries of the EZ periphery (Greece, Ireland, Italy, Portugal and Spain). Posterior simulations show that, the labor market policies are not superior to standard fiscal expansions in stimulating a timely response of economic activity, and their output and employment-enhancing effects are dominant only in the long term and at the Greece and Portugal estimates. The consideration of a liquidity trap environment marginally reinforces these results, showing that expansionary policy actions triggering a deflation can be procyclical when the interest rate zero-lower-bound binds.

JEL Classification: E62, H25, H30, J20, C11

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Key Words: wage and hiring subsidies, newly hired workers, search and matching, fiscal multiplier, zero lower bound, Bayesian estimation.

Introduction

The recent labor market (LM) evolution in the "periphery" of the Euro-zone (EZ), characterized by unprecedented levels of unemployment and youth unemployment rates on average well above 40%, is receiving increasing attention from European economic institutions and governments. The social and political implications of such a LM performance, basically mirroring the longest and deepest economic downturn even registered since harmonized data began to be recorded, are currently seen as the main threat to the entire European project, making the employment issue one of the declared major European policy challenges. The acknowledgement of the severity of this problem led to formal commitments for action, resulting in a renewed European Employment Strategy (EES), strengthened with the launch of the Employment Package (EP) in April 2012 and, for a more specific target, with the endorsement of the Youth Guarantee (YG) in April 2013, a set of measures targeted to the youth unemployment issue in the most problematic Member States[3].

From the perspective of a macroeconomic analyst, the EP and YG-related measures can be categorized in three main - economically relevant - policy goals: *i)* the reduction of the hiring cost, to enhance the job creation process[4]; *ii)* the reduction of the firing cost, to increase LM flexibility[5]; *iii)* increase the efficiency of the matching process[6]. Will these policies actually work?

Recent developments in the macroeconomic modelling of monetary economies with frictions, and in particular those addressing the role of imperfect labor markets, provide some guidance in these evaluations. Zanetti (2011), proposes a search and matching model calibrated to UK data to analyze the business cycle implications of unemployment benefits and firing costs. More in the specific of policy evaluation, Faia et al. (2013), by calibrating an open economy labor selection model featuring hiring and firing costs to European data, compare the size of the fiscal multiplier resulting from hiring subsidies and short-time work to the fiscal multipliers emerging with equally financed more traditional policies, such as government spending and tax shocks. Both contributions show that LM institutions and policies play a role in macroeconomic dynamics and that LM-targeted fiscal instruments can be an effective tool in the management of the short term employment fluctuations.

The economic argument supporting these conclusions is that structural LM policies lead

[3]Some of the policy recommendations within the EP and the YG have already been adopted by the peripheral EZ countries. Greece, Italy, Portugal and Spain have all changed individual dismissal rules, and the collective bargaining regulation has been relaxed in Greece and Spain in favor of company-level renewable agreements. Salary increases have been capped or suspended in all countries of the EZ periphery, whilst hiring and wage (or social contribution) subsidies for new hires of labor have been introduced in Greece and Italy. Other measures are expected to be adopted within the implementation of the YG programme, or through the prospective bilateral Contractual Arrangements with the EU, an instrument expected to support the requesting country with policy guidance and financial help in change of structural reforms.

[4]Targeted hiring subsidies, the reduction of the labor tax wedge, wage subsidies for new hires of labor, subsidization of traineeship and apprentienship programmes are the measures devoted to this objective.

[5]The reform of the labor market regulation in the direction of increased internal flexibility, reduced firing costs and width of the collective bargaining process is recommended for the fulfillment of this goal.

[6]In this case the suggested policies include the investment in public employment services to improve the shared information on job opportunities, the anticipation of skill and qualification needs, the cross-border mobility, investments in vocational training and targeted lifelong learning.

to consistent improvements on both the demand and supply sides of the economy: on the one hand, the employment expansion stimulated by the reduced labor cost increases the level of economic activity; on the other hand, the resulting internal deflation triggers both an interest rate reduction, that stimulates domestic expenditure, and an increase in the price competitiveness of the home economy, leading to increased net foreign demand. Compared to more standard expansionary fiscal policies, the LM-targeted fiscal instruments thus appear robust to the usual criticism addressing the inflationary and distortionary effects of the traditional fiscal measures.

There are however some important questions that need further inspection. *First*, as long as the LM policies are often targeted to specific sub-groups of the labor force (as it is with some EP and YG-related measures), focusing on policies that affect the general cost of labor can lead to a misleading approximation of the effects of the actual measures within the programmes. *Second*, since policies are targeted to and adopted by specific member countries, it is unclear to what degree a model calibrated to the data of a single country, or to average European data, can approximate the expected effects from the implementation of the same measures in structurally different economic realities. *Third*, as with standard fiscal policies, the efficacy of LM-targeted policies may crucially depend on their interaction with the monetary policy regime, as evidenced by a recent and large body of literature. Christiano et al. 2011a, Eggertsson 2011a, b, Eggertsson and Krugman 2012 show that the size of the fiscal multipliers is dampened by the actual strength of the counteracting monetary policy response, generally modeled as targeting inflation and output stabilization. Analyses that do not consider empirically relevant monetary policy reaction rules[7], or the possibility that the fiscal stimulus takes place during a strong recession, i.e. in a neighborhood of a liquidity trap, may produce outcomes that, even if theoretically consistent, can result empirically irrelevant.

The novel contribution of our analysis is that we jointly address these three critical points from both the theoretical and empirical perspectives. We evaluate the country-specific effects on economic activity and employment resulting from the adoption of two selective LM-targeted structural measures well rooted in the EP-YG programmes: a hiring cost subsidy and a wage subsidy targeted to new hires of labor[8]. The expected effects of the LM policies are then compared to those obtainable from financially equivalent fiscal policies based on government consumption, transfers and investment shocks on the expenditure side, and on labor, consumption, business profits and capital gains tax shocks on the revenue side.

The different policy options are evaluated using an extended search and matching monetary model estimated with Bayesian techniques on a large set of data for five major EZ peripheral countries, i.e. Greece, Ireland, Italy, Portugal and Spain (the PIIGS). Policy simulations consider both a standard environment in which the domestic economies operate at their full potential and a non standard liquidity-trap environment, with a binding zero lower bound for the nominal interest rate (ZLB). The consistency of the latter scenario with the EZ economic

[7]The empirical literature shows that the behavior of the monetary authority is highly inertial, such that the couteracting monetary policy response has moderate effects in the short term Smets and Wouters 2007, Christiano et al. 2011b).

[8]In this respect, the proposed analysis can be considered as an extension of the one in Zanetti (2011), focusing on the role of unemployment benefits and firing "taxes", and in Faia et al. (2013), analyzing the size of the fiscal stimulus from hiring subsidies and short-term work relative to other fiscal instruments.

situation is questionable, but likely. The nominal policy rate is still positive in the EZ, but very close to the zero, such that further real interest rate cuts are highly improbable, especially if we consider the below-target price dynamics and the lack of credible policy commitments to inflate the economy[9]. In this respect, our analysis both extends and specifies that proposed by Eggertsson et al. (2014), who show that, considering a monetary model calibrated to average EZ data, a permanent reduction in product and LM markups, can have contractionary short term effects when the economy is in a liquidity trap[10].

The model adopted in our analyses is extended in the design of the LM structure by considering a distinction between incumbent workers and new entrants in the search and matching framework, such that both government hiring and wage subsidies for newly hired workers can be consistently introduced within the policy instruments set. This modification affects both the job creation condition and the Nash bargained wage intertemporally, thus unions/firms are non-neutral in wages/labor costs with respect to new labor hire choices. Outside this modification, the design of the non Walrasian LM basically follows Diamond (1982), Mortensen and Pissarides (1994), and Pissarides (2000) for the introduction of hiring costs and matching frictions, and Gertler et al. (2008) and Gertler and Trigari (2009) for the representation of the staggered Nash-wage bargaining between unions and firms.

The model considers some additional features that are functional to the analysis. The small open economy framework, developed along the lines of Adolfson et al. (2007) and Christiano et al. (2011b), in which the foreign sector is described by a structural vector auto-regressive system (SVAR) estimated with Bayesian techniques, allows the evaluation of the effects of the policies on foreign competitiveness and net exports. The rich specification of the fiscal sector, in which we consider unemployment benefits, hiring subsidies and wage subsidies in addition to the standard fiscal instruments describing the expenditure and revenues sides of fiscal models, allows the consideration of a number of alternative fiscal policies. The consideration of a wedge between short and long-term interest rates allows the representation of an interest rate differential between policy and government bond rates that can affect the dynamics of real variables. Moreover, we assume that the public capital stock and investment flow are chosen by a maximizing fiscal player targeting the distance between output and the government financial need.

Our results show that, even if the LM fiscal measures are an effective tool in stimulating a non jobless expansion, their superiority to alternative and more standard expansionary fiscal policies is questionable. The LM policies are expected to produce highly heterogeneous effects across countries, depending on the estimated country-specific model structure. Moreover, the expansionary effects on output and employment take place only in the medium to long-run, whilst the short-term effects on economic activity are contractionary for all countries but Greece. The comparative analysis shows that, outside Greece and Portugal and irrespective of the time horizon being considered, a standard expansionary policy based on government consumption dominates any other equally financed fiscal intervention.

The analysis shows that these outcomes are explained by three main hindrance factors in

[9]The persistent economic stagnation, the ongoing fiscal consolidation processes and the declared commitment to a continuation of these policies, rule out the feasibility, or credibility, of any inflationary commitment.

[10]Outside the differences in model specification,tThe main distinctive point of our analysis is that we evaluate the effects of two specific LM structural policies considering estimated country-specific parameterizations.

the propagation mechanics of the policies: *First,* the high degree of nominal wage rigidity and the role played by the union's relative power in the intertemporal bargaining over the present and expected gains from government subsidization reduce the size of the initial real wage contraction. *Second*, the inertial behavior of the monetary authority response, i.e. the degree to which the interest rate accommodates the internal deflation, leads to a temporary increase in the real interest rate, thus to reduced consumption and investments. *Third*, the high degree of both nominal and real rigidities rules out a timely response of the real variables once the real interest rate response is back in the negative terrain.

The consideration of a deep recession characterized by a binding ZLB highlights the role played by the monetary policy regime. Results show that, in this situation, the effectiveness of policies based on reduced marginal costs and internal deflations is further weakened and delayed, because of the impossibility of accommodating the deflation with a relevant nominal interest rate drop. Such an outcome holds both for the two specific LM-targeted fiscal policies, confirming Eggertsson et al. (2014) results on the procyclical effects of structural policies. On the contrary, and in line with the results of a recent literature (Christiano et al. 2011a, b, Eggertsson and Krugman 2012), the efficacy of standard inflationary fiscal measures, as are the policies based on increased government expenditure, is increased by the dampened counteracting response of monetary policy.

The paper is organized as follows: Section one describes the model, focusing in particular on the theoretical extensions implemented in LM design. Section two provides the details of the Bayesian estimation of the country-specific models. Here we describe the data and their transformations, we address issues of empirical identification, the calibration and the elicidation of priors for the structural model and the Bayesian SVAR parameters, and discuss the posterior estimates. Section three describes the simulation results, explaining the propagation mechanics in the standard time and binding ZLB environments. Section four concludes.

1 The model

We introduce a number of extensions to the now standard set-up of the NK-DSGE model, characterized by the presence of nominal and real frictions in both good and labor markets (Christiano et al. 2005, Smets and Wouters 2007). *First*, we consider a small open economy framework, developed along the lines of Adolfson et al. (2007) and Christiano et al. (2011b), in which the foreign sector is exogenous with respect the domestic economy and its evolution is described by a structural vector auto-regressive system (SVAR). *Second*, we adopt a rich specification of the fiscal sector, only marginally resembling that proposed in Drautzburg and Uhlig (2011), in which we consider unemployment benefits, hiring subsidies and wage subsidies in addition to the standard fiscal instruments characterizing the expenditure and revenues sides of fiscal models. *Third*, we develop a detailed representation of the non Walrasian LM, basically following Diamond (1982), Mortensen and Pissarides (1994), and Pissarides (2000) for the introduction of hiring costs and matching frictions, and Gertler et al. (2008) and Gertler and Trigari (2009) for the representation of the staggered Nash-wage bargaining between unions and firms.

The model thus considers four agents: firms (domestic, import sector and export sector), households (unions), the fiscal policy maker and the monetary authority.

As stressed in the introductory section, the major novelty in the design of the LM structure is the introduction in the model of both government wage and hiring subsidies for newly hired workers, obtained by considering a distinction between incumbent workers and new entrants in the search and matching framework. This modification affects both the job creation condition and the Nash bargained wage, such that unions/firms are non-neutral in wages/labor costs with respect to new labor hire choices.

1.1 The labor market

The matching process is described by a standard Cobb-Douglas matching technology:

$$m_t = \sigma_m \upsilon_t^{\sigma_n} u_t^{1-\sigma_n} \tag{1}$$

where σ_m is the matching efficiency parameter, υ_t is the number of vacancies and $u_t = 1 - n_{t-1}$ denotes the unemployment rate once the labor force stock has been normalized to one. The chosen timing in the unemployment relation shows that individuals entering the labor force stock activate their job search immediately, whilst workers that loss their job in t are not able to search for a new one in the same period of the separation event. Given the job filling rate $q_t = m_t/\upsilon_t$ and the job finding rate $s_t = m_t/u_t$, the LM tightness can equivalently be defined as $\theta_t = \upsilon_t/u_t$ or $\theta_t = s_t/q_t$.

Under the assumption of exogenous separation, the employment law of motion is described by the following dynamic equation

$$n_t = (1-\rho)\, n_{t-1} + m_t \tag{2}$$

where ρ is the separation rate.

1.2 The household

1.2.1 The optimizing household

We consider a continuum of Ricardian households indexed by $j \in [0,1]$ that have access to a complete set of contingent claims, suggested by Galí et al. (2007). This hypothesis ensures that households are homogeneous with respect to consumption and asset holdings choices, thus the notation can be simplified by dropping the j-index. The representative household is assumed to maximize the following lifetime utility function:

$$\max_{C_t^r, B_t^r, B_t^{*r}, K_t^{p,r}, I_t^r, u_t^k} E_0 \sum_{t=0}^{\infty} \beta^t \left[\xi_t^c \frac{(C_t^r - h\widetilde{C}_{t-1})^{1-\sigma_c}}{1-\sigma_c} - \chi_t \int_0^1 n_t \, di \right] \tag{3}$$

where C_t^r is a composite consumption index, $h\widetilde{C}_{t-1}$ denotes external habits σ_c is the consumption curvature parameter and $0 \leq n_t \leq 1$ denotes the fraction of household members who are employed. ξ_t^c and χ_t are two preference shocks which are assumed to follow the i.i.d. processes

$\xi_t^c = e^{\varepsilon_{\xi^c,t}}$ and $\chi_t = \chi\mu^{(1-\sigma_c)t}\xi_t^n$, respectively, where $\xi_t^n = e^{\varepsilon_{\xi^n,t}}$[11].

Each household purchases consumption and investment goods by means of after tax labor and capital incomes, after tax unemployment benefits, dividends and government transfers. The budget constraint is thus given by:

$$
\begin{aligned}
&(1+\tau_t^c)C_t^r + I_t^r + \frac{B_t^r}{P_t R_t^e} + \frac{e_t B_t^{*r}}{P_t R_t^{e*}\Phi(\frac{A_t}{Y_t}, \frac{e_t}{e_{t-1}}, R_t^{e*} - R_t^e, \widetilde{\phi}_t)} \\
= \;& TR_t^r + \frac{B_{t-1}^r}{P_t} + \frac{e_t B_{t-1}^{*r}}{P_t} + (1-\tau_t^n)\int_0^1 \left[\frac{w_t(i)}{P_t} n_t(i) + b_t^u(1-n_t(i))\right] di \\
&+ \left\{(1-\tau_t^k)\left[\frac{R_t^k}{P_t}u_t^k - a(u_t^k)\right] + \delta\tau_t^k\right\} K_{t-1}^{p,r} + \frac{\Pi_t^p \mu^t}{P_t}
\end{aligned}
\tag{4}
$$

where I_t^r is private investment, $A_t = \frac{e_t B_{t+1}^*}{P_t}$ is the aggregate net foreign asset position of the domestic economy and e_t is the nominal effective exchange rate. B_t^r and B_t^* denote domestic and foreign bond holdings, respectively, P_t is the consumption price index and $R_t^e = R_t q_{b,t}$, $R_t^{e*} = R_t^* q_{b,t}^*$ are the domestic and foreign interest rates on government bonds, where R_t, R_t^* denote the respective policy rates and $q_{b,t}$, $q_{b,t}^*$ are the home and foreign spreads on government bond, respectively. The domestic spread is assumed to follow the AR(1) process $q_{b,t} = \overline{q}_b^{1-\rho_{q_b}} q_{b,t-1}^{\rho_{q_b}} e^{\varepsilon_{q_b,t}}$, whilst the foreign spread is defined within the SVAR system for the foreign variables. $\frac{R_t^k}{P_t}$ is the real return on capital $K_t^{p,r}$, u_t^k and $a\left(u_t^k\right)$ denote the utilization rate and its adjustment cost[12], respectively, and δ is the private capital depreciation rate. $\frac{w_t(i)}{P_t}$ is the real wage and $\frac{\Pi_t^p \mu^t}{P_t}$ define real dividends, where μ denotes the long-run trend growth of labor-augmenting productivity. Government transfers TR_t^r, unemployment benefits $b_t^u = b^u \mu^t$[13] and the tax rates on consumption τ_t^c, on labor income τ_t^n and on capital τ_t^k complete the budget constraint of the Ricardian household. The term $\Phi_t = \Phi(\frac{A_t}{Y_t}, \frac{e_t}{e_{t-1}}, R_t^{e*} - R_t^e, \widetilde{\phi}_t)$ in (4) denotes the risk premium on foreign bond holdings in the modified uncovered interest parity (UIP) equation $E_t\left(\frac{e_{t+1}}{e_t}\right) = \frac{R_t^e}{\Phi_t R_t^{e*}}$, i.e.:

$$
\Phi_t = \exp[-\widetilde{\phi}_a\left(\frac{A_t}{Y_t} - \frac{A}{Y}\right) - \widetilde{\phi}_r\left(R_t^{e*} - R_t^e\right) + \widetilde{\phi}_s\left(1 - \frac{e_t}{e_{t-1}}\right) + \widetilde{\phi}_t]
\tag{5}
$$

where $\widetilde{\phi}_t$ is a time varying shock to the risk premium, which is assumed to follow the AR(1) stochastic process $\widetilde{\phi}_t = \widetilde{\phi}_{t-1}^{\rho_{\widetilde{\phi}}} e^{\varepsilon_{\widetilde{\phi},t}}$ and $\widetilde{\phi}_a$, $\widetilde{\phi}_s$ and $\widetilde{\phi}_r$ are positive elasticities. Our specification ensures the satisfaction of the usual equilibrium requirements (Lundvik 1992, Schmitt-Grohé and Uribe 2001) and adds some flexibility to alternative modified UIP equations adopted in the literature (e.g. Adolfson et al. 2008 and Christiano et al. 2011b). The log-linear representation of the modified UIP is the following:

[11] The peculiar specification of the stochastic scaling factor of labor disutility χ_t is chosen to ensure balanced growth.

[12] The function $a\left(u_t^k\right)$ is assumed to be strictly increasing and convex, with curvature parameter ψ^k. The utilization rate relates effective to physical capital in a standard fashion, i.e. $K_t^r(i) = K_{t-1}^{p,r}(i)u_t(i)$.

[13] In order to ensure long-run balanced growth, b_t^u is assumed to grow at the labor augmenting productivity growth rate μ.

$$E_t\left(\Delta e_{t+1}\right)=\widetilde{\phi}_s\Delta e_t+\left(1-\widetilde{\phi}_r\right)\left(R^e_t-R^{e*}_t\right)+\widetilde{\phi}_a\left(A_t-Y_t\right)-\widetilde{\phi}_t$$

were the parameter $\widetilde{\phi}_s$ defines the autoregressive behavior of the expected change in the nominal exchange rate and $\widetilde{\phi}_r \geq 0$ denotes the elasticity to the interest rate differential on bond holdings, allowing for the emergence of the "forward premium puzzle" (for $\widetilde{\phi}_r > 1$), i.e. the negative correlation between interest rate differentials and expected exchange rate variations often observed in empirical trials[14].

The law of motion of physical capital is described by the following equation:

$$K^{p,r}_t=(1-\delta)K^{p,r}_{t-1}+q_{i,t}\left[1-S(\frac{I^r_t}{I^r_{t-1}})\right]I^r_t \tag{6}$$

where $S(\frac{I^r_t}{I^r_{t-1}})$ defines the private investment adjustment cost function, with curvature parameter ψ^i, and $q_{i,t}$ is an investment-specific shock, which is assumed to follow the i.i.d. stochastic process $q_{i,t}=e^{\varepsilon_{q_i,t}}$.

Aggregate demand for type X_t goods, $X_t=(C_t,I_t)$, is obtained as a CES index of domestically produced and imported goods, such that:

$$X_t=\left[(1-\nu)^{\frac{1}{\eta}}\left(X^d_t\right)^{\frac{\eta-1}{\eta}}+\nu^{\frac{1}{\eta}}\left(X^m_t\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{7}$$

where, from households' cost minimization, $X^d_t\,(1-\nu)\left(\frac{P^d_t}{P_t}\right)^{-\eta}X_t$ and $X^m_t=\nu\left(\frac{P^m_t}{P_t}\right)^{-\eta}X_t$ are, respectively, the aggregate available domestic and foreign produced goods, ν denotes the import share parameter and η is the elasticity of substitution between domestic and imported goods. P^d_t and P^m_t denote the price indexes of domestic and imported goods, respectively, such that:

$$P_t=\left[(1-\nu)\left(P^d_t\right)^{1-\eta}+\nu\left(P^m_t\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{8}$$

From the first order condition (F.O.C.) for consumption, the following consumption Euler equation is obtained:

$$C^r_t-hC^r_{t-1}=\left[\beta R^e_t\frac{P_t}{P_{t+1}}\frac{(1+\tau^c_t)}{(1+\tau^c_{t+1})}\frac{\xi^c_{t+1}}{\xi^c_t}\right]^{-\frac{1}{\sigma_c}}\left(C^r_{t+1}-hC^r_t\right) \tag{9}$$

1.2.2 The rule-of-thumb household

We assume that Ricardian and non Ricardian households have the same number of workers,hence:

$$n_t=n^r_t=n^{nr}_t \tag{10}$$

[14]In the modified UIP adopted in Adolfson et al. (2008) the autoregressive component is not independent on the elasticity to the interest rate differential, and the chosen prior does not allow for a direct emergence of the forward premium puzzle. Compared to the specification adopted in Christiano et al. (2011b), our modified UIP adds the autoregressive component.

From the budget constraint of the non Ricardian household, the resulting consumption equation is as follows:

$$C_t^{nr} = \frac{1}{(1+\tau_t^c)}\left[Tr_t^{nr} + (1-\tau_t^n)\frac{w_t\,(i)}{P_t}n_t\,(i) + (1-\tau_t^n)b_t^u(1-n_t\,(i))\right] \tag{11}$$

where it is evident that rule-of-thumbers spend all their net income (from labor, government transfers and unemployment benefits) in consumption goods.

1.2.3 Workers value functions

Let $W_t(w_t\,(i))$ be the worker value of being matched to a job evaluated at the wage $w_t\,(i)$ and U_t be the value of being unemployed at time t. Assuming that the probabilities of wage reoptimization can be different for incumbent workers and hires of new labor, the value of the employment/unemployment states are the following:

$$\begin{aligned} W_t(w_t\,(i)) &= (1-\tau_t^n)\frac{w_t\,(i)}{P_t} - \frac{\chi_t}{\Lambda_t} \\ &+ \beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}\left[(1-\rho)\left[\gamma_w W_{t+1}(w_t\,(i)) + (1-\gamma_w)W_{t+1}(w_{t+1}^*\,(i))\right] + \rho U_{t+1}\right]\right\} \end{aligned} \tag{12}$$

$$U_t = (1-\tau_t^n)b_t^u + \beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}\left[s_{t+1}\left(\theta_w W_{t+1}(w_t) + (1-\theta_w)W_{t+1}(w_{t+1}^*)\right) + (1-s_{t+1})U_{t+1}\right]\right\} \tag{13}$$

where $W_t(w_t) = \int_0^1 W_t(w_t\,(i))m_t\,(i)\,/m_t\;di$ denote the average value of employment, $m_t\,(i)$ is the total matches at time t at firm i, γ_w and θ_w are the Calvo parameters defining the probability of being unable to re-optimize the wage in $t+1$ for incumbent workers and for newly matched workers, respectively. Λ_t is the Lagrange multiplier. From equations (12) and (13) the net value of being employed, i.e. the worker' surplus $W_t(w_t\,(i)) - U_t$, is obtained.

1.3 The intermediate goods sector

Each intermediate firm (i) operates in a perfectly competitive environment. The production technology is as follows:

$$Y_t^i(i) = \xi_t^a\left[\frac{K_{t-1}^g}{\int_0^1 Y_t^i(j)dj}\right]^{\frac{\xi}{1-\xi}}\left[K_t(i)\right]^\alpha\left[\mu^t n_t(i)\right]^{(1-\alpha)} \tag{14}$$

where K_t^g is public capital, α and ξ are the output elasticity of private and public capital, respectively, and $\xi_t^a = \xi_{t-1}^{a^{\rho_{\xi^a}}} e^{\varepsilon_{\xi^a,t}}$ is an AR(1) process defining the evolution of total factor productivity.

The optimizing firm chooses the optimal quantity of capital by solving the following maximization problem:

$$\max_{K_t(i)} P_t^i\,(i)\,Y_t(i) - R_t^k\,(i)\,K_t(i) \quad \text{s.t. } (14)$$

whose re-arranged F.O.C. yields:

$$R_t^k(i) = \alpha P_t^i(i)\frac{Y_t^i(i)}{K_t(i)} \tag{15}$$

where $P_t^i(i)$ is the intermediate sector price index.

A distinction between job values to the firm of newly hired and incumbent workers is introduced. Such a distinction, which - to our knowledge - is new to the literature on models with search and matching frictions, is necessary to evaluate the relative efficacy of two LM-targeted fiscal instruments: hiring and wage government subsidies. The former basically consists in a reduction of the cost of hiring per vacancy, $\kappa(1-\varphi_t^h)$, the latter in a reduction of the wage cost $(1-\varphi_t^w)w_t(i)$ for new hires of labor, where κ is the hiring cost and φ_t^h, φ_t^w are the hiring and wage subsidies, respectively. Note that in this setting the government wage subsidy for new hires of labor can be considered equivalent to a selective fiscal instrument affecting the direct taxation on the labor income of newly hired workers.

Let $J_t^n(w_t(i))$ and $J_t^o(w_t(i))$ be the values to the firm of a job evaluated at the wage w_t for a newly hired and an incumbent worker, respectively:

$$\begin{aligned} J_t^n(w_t(i)) &= (1-\tau_t^p)\left[\zeta_t - (1-\varphi_t^w)\frac{w_t(i)}{P_t^d}\right] \\ &\quad +(1-\rho)\beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}\left[\gamma_w J_{t+1}^o(w_t(i)) + (1-\gamma_w)J_{t+1}^o(w_{t+1}^*(i))\right]\right\} \end{aligned} \tag{16}$$

and:

$$J_t^o(w_t(i)) = (1-\tau_t^p)(\zeta_t - \frac{w_t(i)}{P_t^d}) + (1-\rho)\beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}\left[\gamma_w J_{t+1}^o(w_t(i)) + (1-\gamma_w)J_{t+1}^o(w_{t+1}^*(i))\right]\right\} \tag{17}$$

where P_t^d is the domestic price index, τ_t^p denotes the business profits tax rate and $\zeta_t = (1-\alpha)P_t^i Y_t/n_t$ the marginal productivity of labor. By re-arranging equations (16) and (17) yields an alternative specification of $J_t^n(w_t(i))$:

$$J_t^n(w_t(i)) = J_t^o(w_t(i)) + (1-\tau_t^p)\varphi_t^w\frac{w_t}{P_t} \tag{18}$$

Equation (18) shows that the standard case in the literature, in which the firm does not consider a distinction in the job values of incumbent and newly hired workers, is restored for $\varphi_t^w = 0$.

Given the positions above, the value of a vacancy is the following:

$$J_t^v(i) = -\kappa(1-\varphi_t^h) + q_t\left[\theta_w J_t^n(w_{t-1}(i)) + (1-\theta_w)J_t^n(w_t^*(i))\right] \tag{19}$$

which resolves in a standard vacancy value equation for $\varphi_t^h = 0$ and $J_t^n(w_t(i)) = J_t^o(w_t(i)) = J_t(w_t(i))$, i.e. for $\varphi_t^w = 0$.

By imposing the free entry condition, such that $J_t^v(i) = 0$, and considering that a fraction of the hiring and wage cost is financed by the government with subsidies, i.e. $\varphi_t^h > 0$, $\varphi_t^h > 0$, the vacancy posting condition is the following:

$$\frac{\kappa(1-\varphi_t^h)}{q_t} = [\theta_w J_t^n(w_{t-1}(i)) + (1-\theta_w) J_t^n(w_t^*(i))]$$
$$= [\theta_w J_t^o(w_{t-1}(i)) + (1-\theta_w) J_t^o(w_t^*(i))] + (1-\tau_t^p)\varphi_t^w \left[(1-\theta_w)\frac{w_t^*(i)}{P_t^d} + \theta_w \frac{w_{t-1}(i)}{P_t^d}\right] \tag{20}$$

where an alternative expression in terms of $J_t^o(w_t(i))$ is provided for analytical convenience. Note that equation (20) resolves in a standard vacancy posting condition for $\varphi_t^h = 0$ and $\varphi_t^w = 0$. Considering the recursive solution of the value to the firm of an incumbent job position (17), the vacancy posting condition (20) becomes:

$$\begin{aligned}
\frac{\kappa(1-\varphi_t^h)}{q_t} = {} & (1-\tau_t^p)(P_t^i \zeta_t - \frac{w_t^*(i)}{p_t^d}) + (1-\rho)\beta E_t \left[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{\kappa(1-\varphi_{t+1}^h)}{q_{t+1}}\right] \\
& + E_t \left\{(1-\tau_{t+1}^p)\left(\frac{w_{t+1}^*(i)}{p_{t+1}^d} - \frac{w_t^*(i)}{p_t^d}\right)\right\} \sum_{j=1}^{\infty} \frac{\Lambda_{t+1}}{\Lambda_t} [(1-\rho)\beta\gamma_w]^j \\
& - \frac{\theta_w}{\gamma_w} E_t \left\{(1-\tau_{t+1}^p)\left(\frac{w_{t+1}^*(i)}{p_{t+1}^d} - \frac{w_t(i)}{p_t^d}\right) \sum_{j=1}^{\infty} \frac{\Lambda_{t+1}}{\Lambda_t} [(1-\rho)\beta\gamma_w]^j \right\} \\
& + \theta_w \left\{(1-\tau_t^p)\left(\frac{w_t^*(i)}{p_t^d} - \frac{w_{t-1}(i)}{p_{t-1}^d}\right) E_t \sum_{j=0}^{\infty} \frac{\Lambda_{t+1}}{\Lambda_t} [(1-\rho)\beta\gamma_w]^j \right\} \\
& - (1-\rho)\beta E_t \left\{\frac{\Lambda_{t+1}}{\Lambda_t}(1-\tau_{t+1}^p)\varphi_{t+1}^w \left[\theta_w \frac{w_t(i)}{p_t^d} + (1-\theta_w)\frac{w_{t+1}^*(i)}{p_{t+1}^d}\right]\right\} \\
& + (1-\tau_t^p)\varphi_t^w \left[\theta_w \frac{w_{t-1}(i)}{p_{t-1}^d} + (1-\theta_w)\frac{w_t^*(i)}{p_t^d}\right]
\end{aligned} \tag{21}$$

Compared to the job creation condition in the standard search and matching set-up, equation (21) shows that the wage subsidy influences vacancy posting intertemporally. Present vacancies posted are positively related to the present wage subsidy φ_t^w (last row of equation 21) and negatively related to the loss opportunity of the gains from wage subsidies due to future job openings (second last row of equation 21). The latter loss is proportional to the fraction of surviving workers $(1-\rho)$, i.e. those jobs that will not benefit from the government wage subsidy in the next period, thus the positive contemporaneous effects, other things being equal, are always dominant. Present and future hiring subsidies φ_t^h affect vacancy posting directly. For $\varphi_t^h = 0$ and $\varphi_t^w = 0$, equation (21) resolves in the standard vacancy posting condition.

1.4 Nash wage bargaining

We do not consider a separate Nash wage bargaining scheme for incumbent and newly hired workers on the grounds that the separation rate is exogenous and unions are assumed to be representative of both types of labor. In other terms, since firing is not a control variable for the domestic intermediate firm, an optimal firing strategy distinguishing between incumbents and newly hired workers cannot be implemented[15]. A unique wage is thus Nash-bargained by maximizing the product:

$$\max_{w_t^*} \left[W_t(w_t^*(i)) - U_t\right]^{\varsigma} J_t(w_t^*(i))^{1-\varsigma} \tag{22}$$

where the parameter ς denotes the union's relative bargaining power and $J_t(w_t^*)$ denotes the aggregate job value to the firm, i.e.:

$$J_t(w_t^*(i)) = \int_0^1 J_t(w_t^*(i), j)\, dj = \int_0^{\phi_t^o} J_t^o(w_t^*(i))\, dj + \int_{\phi_t^o}^1 J_t^n(w_t^*(i))\, dj \tag{23}$$

where $\phi_t^o = (1-\rho)\, n_{t-1}/n_t$ is the share of incumbent workers.

Considering equations (22) and (23) the following F.O.C. is obtained:

$$(1-\varsigma)(1-\tau_t^p)\left[W_t(w_t^*(i)) - U_t\right] = \varsigma(1-\tau_t^n)\left[J_t^o(w_t^*(i)) + (1-\phi_t^o)(1-\tau_t^p)\varphi_t^w w_t^*(i)\frac{1}{p_t^d}\right] \tag{24}$$

By substituting the value functions in (24), after some algebra, the equation for the individual real wage is obtained:

$$\begin{aligned}
w_t^*(i) \;=\; & \vartheta_t\left\{\varsigma\left[\zeta_t + (1-\phi_t^o)\varphi_t^w\frac{w_t^*(i)}{p_t^d}\right] + (1-\varsigma)\left(b_t^u + \frac{\chi_t}{\Lambda_t}\right)\right\} + \vartheta_t(1-\varsigma) \\
& E_t\left\{T_{t+1}^n\left[\Delta w_{t+1}^*(i) - \frac{\theta_w}{\gamma_w}\frac{s_{t+1}}{1-\rho}(w_{t+1}^*(i) - w_t(i))\right]\sum_{j=1}^{\infty}\frac{\Lambda_{t+j}}{\Lambda_t}\left[(1-\rho)\beta\gamma_w\right]^j\right\} \\
& +\vartheta_t\varsigma E_t\left\{\left[T_{t+1}^p - \frac{\theta_w}{\gamma_w}\left[T_{t+1}^p - S_{t+1}T_{t+1}^n\right]\right]\Delta\frac{w_{t+1}^*(i)}{p_{t+1}^d}\sum_{j=1}^{\infty}\frac{\Lambda_{t+j}}{\Lambda_t}\left[(1-\rho)\beta\gamma_w\right]^j\right\} \\
& +\frac{1}{(1-\tau_t^p)}\vartheta_t\varsigma(1-\rho)\beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}\frac{\kappa(1-\varphi_{t+1}^h)}{q_{t+1}}\left[1 - S_{t+1}\frac{T_{t+1}^n}{T_{t+1}^p}\right]\right\} + \vartheta_t\varsigma\beta \\
& E_t\left\{(1-\rho-s_{t+1})\varphi_{t+1}^w\frac{\Lambda_{t+1}}{\Lambda_t}T_{t+1}^n\left[\left[1-\theta_w-\left(1-\phi_{t+1}^o\right)\right]\frac{w_{t+1}^*(i)}{p_{t+1}^d} + \theta_w\frac{w_t(i)}{p_t^d}\right]\right\} \\
& -\vartheta_t\varsigma(1-\rho)\beta E_t\left\{\frac{\Lambda_{t+1}}{\Lambda_t}T_{t+1}^p\varphi_{t+1}^w\left[(1-\theta_w)\frac{w_{t+1}^*(i)}{p_{t+1}^d} + \theta_w\frac{w_t(i)}{p_t^d}\right]\right\}
\end{aligned} \tag{25}$$

where $S_t = (1-\rho-s_t)/(1-\rho)$, $\vartheta_t \equiv 1/\left[1-\varsigma\left(1-1/p_t^d\right)\right]$, $T_t^i = (1-\tau_t^i)/(1-\tau_{t-1}^i)$, for $i=(n,p)$, $p_t^d = P_t^d/P_t$, and $w_t(i)$ is the average real wage:

$$w_t(i) = \frac{m_t}{n_t}\left[\theta_w w_{t-1}(i) + (1-\theta_w)w_t^*(i)\right] + \frac{(1-\rho)\, n_{t-1}}{n_t}\left[\gamma_w w_{t-1}(i) + (1-\gamma_w)w_t^*(i)\right]$$

[15]Note that the consideration of an endogenous specification of the firing process along the lines proposed byf the recent literature on search and matching models (Krause and Lubik 2007, Faia et al. 2013) would not change the theoretical consistency of our hypothesis. In fact, in these models the endogenous separation rate is in general conditioned to an exogenous, job-specific, stochastic productivity process, such that the endogeneity would not introduce an additional type-specific control variable to the firm.

Equation (25) shows that, in the presence of a wage subsidy φ_t^w, the real wage is directly related to the marginal product of labor ζ_t, as in the standard model, to the present government wage subsidy for new hires of labor $(1-\phi_t^o)\varphi_t^w w_t^*(i)/p_t^d$, and to the future wage subsidy. The latter affects the present real wage from the perspective of both the firm and the worker expected gains from the measures: *i*) from the perspective of firm's expected gain, the last row of equation (25) shows that the bargained real wage is negatively related to the anticipation of the loss of future (after tax) *firm* gains from wage subsidies, proportional to the fraction of continuing jobs $1-\rho$ - i.e. those not benefiting from wage subsidization - and to the union's relative bargaining power ς, denoting the workers share; *ii*) from the perspective of the workers expected gain, the second last row of equation (25) shows that the anticipation of the loss of future (after tax) *worker* gains from wage subsidies, again proportional to both the fraction of continuing jobs $1-\rho$ and to the relative bargaining power ς, increases the bargained wage, whilst an incentive to reduce the bargained wage comes from the anticipation of the shared (after tax) *worker* gains from the wage subsidization of future hires of new labor s_{t+1}

For reasonable values of the exogenous separation rate ρ and of the union's relative bargaining power ς, the firm's intertemporal incentive to reduce the present bargained wage dominates the union's net intertemporal incentive to increase it, because of the consideration of the gains from the subsidization of future hires of labor, as evident in the terms s_{t+1} and $-\left(1-\phi_{t+1}^o\right)w_{t+1}^*(i)/p_{t+1}^d$ in the second last row of equation (25). Other things being equal, the wage contraction is thus directly related to the size of the separation rate ρ and to the union's relative bargaining power ς. Moreover, the staggered bargaining perspective assumed here allows to highlight that the expected wage subsidy affects the real wage considering the probability of a new hire of labor to re-negotiate the wage.

The introduction of a hiring subsidy φ_t^h negatively affects the present real wage as it directly reduces the expected hiring costs. Considering a firm negotiating a real wage, the incentive for a reduction comes from the anticipation of the loss opportunity of a future reduction in the hiring cost.

Note that, for $\varphi_t^h=0$ and $\varphi_t^w=0$, equation (25) resolves in the standard real Nash wage equation.

1.5 The final goods sector: wholesalers and retailers in the domestic, import and export sectors

For expositional convenience, a joint description of the structure of the final good sector, composed of domestic, import and export wholesalers and retailers, is provided.

Domestic wholesale firms buy the homogenous good Y_t^i from domestic intermediate good producers at the price P_t^i, and differentiate the homogeneous product into $Y_t^d(i)$ using a linear technology. Wholesalers sell their goods under monopolistic competition to domestic retailers, who use the differentiated goods $Y_t^d(i)$ to produce the composite final good Y_t^d.

Wholesale firms in the import sector buy the homogenous good Y_t^* from foreign retailers at the foreign price P_t^*, and obtain a differentiated good $Y_t^m(i)$. Wholesale importing firms sell their goods under monopolistic competition to import retailers who use the differentiated goods $Y_t^m(i)$ to produce the composite final good Y_t^m.

Finally, wholesale export firms buy the homogenous good Y_t^d from domestic retailers at the price P_t^d and produce a differentiated good $Y_t^x(i)$ using a linear technology. Wholesalers in the export sector sell their goods under monopolistic competition to export retailers, who use the differentiated goods $Y_t^x(i)$ to produce the composite final good Y_t^x.

We allow for variable demand elasticity in the three sectors, indexed by $k = (d, m, x)$, by assuming a flexible variety aggregator à la Kimball (1995):

$$\left[\int_0^1 G\left(\frac{Y_t^k(i)}{Y_t^k}; \lambda_{p,t}^k\right) di\right] = 1$$

such that the domestic retailers demand function for differentiated goods is:

$$Y_t^k(i) = Y_t^k G'^{-1}\left[\frac{P_t^k(i)}{P_t^k}\varkappa_{p,t}^k\right] \tag{26}$$

where:

$$\varkappa_{p,t}^k \equiv \int_0^1 G'\left(\frac{Y_t^k(i)}{Y_t^k}; \lambda_{p,t}^k\right)\frac{Y_t^k(i)}{Y_t^k} di$$

The optimization problem of wholesalers firms that are allowed to re-optimize their prices reads:

$$\max_{\widetilde{P}_t^k(i)} E_t \sum_{j=0}^{\infty}\left(\beta\xi_p^k\right)^j \frac{\Lambda_{t+j}P_t}{\Lambda_t P_{t+j}}\left[\widetilde{P}_t^k(i) - MC_{t+j}^k\right] Y_{t+j}^k(i)$$
$$\text{s.t. } (26)$$

where $MC_t^d = P_t^i$, $MC_t^m = e_t P_t^*$ and $MC_t^x = P_t^d / e_t$ are the nominal marginal costs of the domestic, import sector and export sector wholesalers, respectively. The term $\left(\beta\xi_p^k\right)^j \Lambda_{t+j}P_t/\Lambda_t P_{t+j}$ denotes the stochastic discount factor of the firm, where ξ_p^k is the Calvo probability of price adjustment (Calvo 1983) and $\lambda_{p,t}^k = e^{\varepsilon_{p,t}^k}$ are *i.i.d.* stochastic processes defining the time-varying markups[16]. Note that we do not take into account indexation mechanisms in order to allow an interpretation of the (observed) frequency of price changes in terms of (theoretical) price re-optimization[17].

The first order condition for the optimality problem above is given by:

$$E_t \sum_{j=0}^{\infty}\left(\xi_p^k\beta\right)^j \frac{\Lambda_{t+j}P_t}{\Lambda_t P_{t+j}} Y_{t+j}^k(i)\left[\widetilde{P}_t^k(i) + \left(\widetilde{P}_t^k(i) - MC_{t+s}^k(i)\right)\frac{1}{G'^{-1}\left(\nu_t^k\right)}\frac{G'\left(\theta_{t+j}^k\right)}{G''\left(\theta_{t+j}^k\right)}\right] = 0 \tag{27}$$

[16] We assume i.i.d. mark-up shocks in order to enhance the identifiability of the price equations. For a more in dept explanation of this point, see the estimation section below and Giuli and Tancioni (2012).

[17] Under the hypothesis of indexation, prices are changed period by period, ruling out any intepretation of the observed frequencies of price changes in terms of frequencies of price re-optimizations.

where $\theta_t^k = G'^{-1}\left(\nu_t^k\right)$, $\nu_t^k = \frac{P_t^k(i)}{P_t^k}\varkappa_{p,t}^k$, and the aggregate domestic price indexes read:

$$P_t^k = \left(1 - \xi_p^k\right) P_t^k(i) G'^{-1}\left[\frac{P_t^k(i)}{P_t^k}\varkappa_{p,t}^k\right] + \xi_p^k P_{t-1}^k G'^{-1}\left[\frac{P_{t-1}^k}{P_t^k}\varkappa_{p,t}^k\right] \tag{28}$$

1.6 Government policies

1.6.1 The monetary authority

The Central Bank sets the nominal interest rate $R_t \equiv 1 + r_t$ according to a contemporaneous rule considering inflation, output and output growth deviations from the respective steady state values. The policy instrument is adjusted gradually, giving rise to interest rate smoothing:

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\rho^R}\left[\left(\frac{\pi_t}{\overline{\pi}}\right)^{\psi_1}\left(\frac{Y_t}{\overline{Y}}\right)^{\psi_2}\right]^{1-\rho^R}\left(\frac{Y_t}{Y_{t-1}}\right)^{\psi_3} + \epsilon_t^r \tag{29}$$

where ρ^R defines the degree of interest rate smoothing, ψ_1, ψ_2, ψ_3, are the feedback coefficients to CPI inflation π_t[18], the output level Y_t, and output growth, respectively. The stochastic term ϵ_t^r denotes the monetary policy shock, which is assumed to be white noise $\epsilon_t^r = e^{\varepsilon_t^r}$. Similar to money-growth rules, implementation of this policy rule does not require knowledge about the natural rate of interest or of the level of potential output, both of which are unobserved[19].

The fact that the countries being considered in this study all joined a common currency and a centralized monetary policy since 1999 (2001 for Greece) implies that, at the estimation stage, a regime break has to be taken into account. To implement such a structural break, we will consider a permanent observed exogenous shock acting as a multiplicative regime-shift dummy variable on all the four monetary policy coefficients.

1.6.2 The fiscal authority

By expressing government consumption, government transfers, hiring subsidies and unemployment benefits in terms of domestic goods, the government budget constraint in real terms

[18] CPI inflation is obtained as a weighted average considering domestic and imported price variations, i.e.: $\pi_t = \left[(1-\nu)\left(p_t^d \pi_t^d\right)^{1-\eta} + \nu\left(p_t^m \pi_t^m\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}$.

[19] The hypothesis that the central bank targets trend output instead of the output that would have prevailed in the absence of nominal rigidities has been adopted in the empirical literature (e.g. Del Negro et al. 2007; Adolfson et al. 2007) and is consistent with the main objective of our analysis, which is basically empirical.

reads:

$$\frac{P_t^d}{P_t}\left[G_t + I_t^g + \varphi_t^h \kappa \upsilon_t + (1-\tau_t^n)\, b_t^u \int_0^1 (1-n_t(i))\; di\right] + TR_t + \frac{B_{t-1}}{P_t} + (1-\tau_t^p)\,\varphi_t^w\,(1-\phi_t^o)$$
$$\int_0^1 \left[\theta_w w_{t-1}(i) + (1-\theta_w)\, w_t^*(i)\right]\; di = \frac{B_t}{P_t R_t q_t^b} + \tau_t^c C_t + \tau_t^n \int_0^1 w_t(i)\, n_t(i)\; di$$
$$+\tau_t^k\left[r_t^k u_t^k - a(u_t^k) - \delta\right] K_{t-1}^{p,r} + \tau_t^p \int_0^1 \left[\zeta_t - w_t(i)\right]\; di \tag{30}$$

where $G_t = G_{t-1}^{\rho_g} Y_t^{(1-\rho_g)\eta_{gy}} D_t^{\eta_{gd}} e^{\varepsilon_{g,t}}$ and $TR_t = TR_{t-1}^{\rho_{tr}} Y_t^{(1-\rho_{tr})\eta_{try}} D_t^{\eta_{trd}} e^{\varepsilon_{tr,t}}$ are the partial adjustment stochastic processes for government expenditures for consumption and transfers, respectively, where D_t denotes the government financial need and $\varepsilon_{g,t}$, $\varepsilon_{tr,t}$ are *i.i.d.* shocks. Finally, φ_t^h and φ_t^w denote the expenditure for hiring and wage subsidies, respectively, described by the partial adjustment processes $\varphi_t^h = \varphi_{t-1}^{h^{\rho_{\varphi^h}}} u_t^{(1-\rho_{\varphi^h})\eta_{\varphi^h}} e^{\varepsilon_{\varphi^h,t}}$ and $\varphi_t^w = \varphi_{t-1}^{w^{\rho_{\varphi^w}}} u_t^{(1-\rho_{\varphi^w})\eta_{\varphi^w}} e^{\varepsilon_{\varphi^w,t}}$.

From government budget constraint (30) the financial need D_t is obtained:

$$D_t \equiv \frac{P_t^d}{P_t}\left[G_t + I_t^g + \varphi_t^h \kappa \upsilon_t + (1-\tau_t^n)\, b_t^u \int_0^1 (1-n_t(i))\; di\right] + TR_t + \frac{B_{t-1}}{P_t} + (1-\tau_t^p)$$
$$\varphi_t^w (1-\phi_t^o) \int_0^1 \left[\theta_w w_{t-1}(i) + (1-\theta_w)\, w_t^*(i)\right]\; di - \overline{\tau}_t^p \int_0^1 \left[\zeta_t - w_t(i)\right]\; di$$
$$-\overline{\tau}_t^c C_t - \overline{\tau}_t^n \int_0^1 w_t(i)\, n_t(i)\; di - \overline{\tau}_t^k \left[r_t^k u_t^k - a(u_t^k) - \delta\right] K_{t-1}^p \tag{31}$$

A fraction ψ_τ of D_t is financed with distortionary taxation on consumption, labor income, capital and on business profits, such that:

$$\psi_\tau (D_t - D) = (\overline{\tau}_t^p - \tau^p) \int_0^1 \left\{\zeta_t - w_t(i) + \varphi_t^w (1-\phi_t^o)\left[\theta_w w_{t-1}(i) + (1-\theta_w)\, w_t^*(i)\right]\right\}\; di$$
$$+ (\overline{\tau}_t^c - \tau^c)\, C_t + (\overline{\tau}_t^n - \tau^n) \int_0^1 \left[w_t(i)\, n_t(i) + b_t^u (1-n_t(i))\right]\; di$$
$$+ \left(\overline{\tau}_t^k - \tau^k\right) K_{t-1}^p \left[r_t^k u_t^k - a\left(u_t^k\right) - \delta\right] \tag{32}$$

whilst the remaining fraction is financed by issuing government bonds:

$$\frac{B_t - B}{P_t R_t^e} = (1-\psi_\tau)(D_t - D) \tag{33}$$

We assume that the different tax rates are partially adjusted[20] by choosing the vector of

[20]By denoting with $f(D_t) = \tau_t^i$, $i = c, n, k, p$, the partial adjustment is obtained by assuming the following conditional process for the tax rates: $\tau_t^i = \tau_{t-1}^{i^{\rho_{\tau^i}}} f(D_t)\, e^{\varepsilon_t^i}$, where ε_t^i are *i.i.d.* tax rates shocks.

government tax instruments $\boldsymbol{\omega} = \left[\omega^c \omega^n \omega^k \omega^p\right]'$, where $\omega^c + \omega^n + \omega^k + \omega^p = 1$.

$$\omega^c \psi_\tau \left(D_t - D\right) = \left(\overline{\tau}_t^c - \tau^c\right) C_t \tag{34}$$

$$\omega^n \psi_\tau \left(D_t - D\right) = \left(\overline{\tau}_t^n - \tau^n\right) \int_0^1 \left[w_t\left(i\right) n_t\left(i\right) + b_t^u (1 - n_t\left(i\right))\right] \, di \tag{35}$$

$$\omega^k \psi_\tau \left(D_t - D\right) = \left(\overline{\tau}_t^k - \tau^k\right) \frac{k_{t-1}^p}{\mu} \left[r_t^k u_t^k - a\left(u_t^k\right) - \delta\right] \tag{36}$$

$$\omega^p \psi_\tau \left(D_t - D\right) = \left(\overline{\tau}_t^p - \tau^p\right) \int_0^1 \left\{\zeta_t - w_t\left(i\right) + \varphi_t^w \left(1 - \phi_t^o\right) \left[\theta_w w_{t-1}\left(i\right) + \left(1 - \theta_w\right) w_t^*\left(i\right)\right]\right\} \, di \tag{37}$$

where $\overline{\tau}_t^i$, $i = c, n, k, p$, denotes the systematic component on the revenue side, which relates to the stochastic tax rate considering a first order autoregressive stochastic wedge $\eta_t^{\tau^i}$ denoting the discretionary component, such that $\tau_t^i = \overline{\tau}_t^i \eta_t^{\tau^i}$, with $\eta_t^{\tau^i} = \eta_{t-1}^{\tau^i \rho_{\tau^i}} e^{\varepsilon_{\tau^n,t}}$.

An optimal rule is considered for government investment expenditures. The fiscal authority is assumed to choose the public capital stock K_t^g and public investment I_t^g by maximizing the distance between output Y_t and the financial need, i.e.:

$$\max_{K_t^g, I_t^g} E_t \sum_{j=t}^{\infty} \beta^{t+j} \frac{\Lambda_{t+j}}{\Lambda_t} \left[Y_{t+j} - D_{t+j}\right]$$

$$\begin{aligned} \text{s.t. } Y_t &= (\xi_t^a)^{(1-\xi)} (K_{t-1}^g)^{\xi} (K_t)^{\alpha(1-\xi)} \left[\mu^t n_t\right]^{(1-\alpha)(1-\xi)} \\ K_t^g &= (1 - \delta^g) K_{t-1}^g + q_t^{i^g} \left[1 - S^g\left(\frac{I_t^g}{I_{t-1}^g}\right)\right] I_t^g \end{aligned}$$

where δ^g is the public capital depreciation rate and $S^g(\frac{I_t^g}{I_{t-1}^g})$ denotes the government investment adjustment cost function, with curvature parameter ψ^{ig}. The first order conditions for government capital and investment are, respectively:

$$\beta E_t \left[\left(1 - \delta^g\right) \Lambda_{t+1}^{k^g} q_t^{k^g} + \Lambda_{t+1} \xi (\xi_{t+1}^a)^{(1-\xi)} (K_t^g)^{\xi - 1} (K_{t+1})^{\alpha(1-\xi)} \left(\mu^{t+1} n_{t+1}\right)^{(1-\alpha)(1-\xi)}\right] - \Lambda_t^{k^g} = 0$$

$$\beta E_t \left[q_{t+1}^{i^g} \Lambda_{t+1}^{k^g} S^{g\prime}\left(\frac{I_{t+1}^g}{I_t^g}\right)\left(\frac{I_{t+1}^g}{I_t^g}\right)^2\right] + \Lambda_t^{k^g} q_t^{i,g} \left[1 - S^g\left(\frac{I_t^g}{I_{t-1}^g}\right) - S^{g\prime}\left(\frac{I_t^g}{I_{t-1}^g}\right)\left(\frac{I_t^g}{I_{t-1}^g}\right)\right] - \frac{P_t^d}{P_t} \Lambda_t = 0$$

where $\Lambda_t^{k^g}$ is the shadow price of government capital and $q_t^{i^g} = q_{t-1}^{i^{g \rho_{i^g}}} e^{\varepsilon_{i^g,t}}$ is a stochastic process for the government investment-specific shock.

1.7 Model closure

Given the presence of intertemporally optimizing households $j \in [0, 1 - \phi^h]$ and of rule-of-thumb households $j \in (1 - \phi^h, 1]$, aggregate vector variable variable $\Phi_t = [C_t, TR_t]'$ is given by:

$$\Phi_t = \int_0^1 \Phi_t(j)\ dj = \int_0^{1-\phi^h} \Phi_t^r\ dj + \int_{1-\phi^k}^1 \Phi_t^{nr}\ dj$$

where, given $d = TR_t^{nr}/TR_t^r$, the fraction of government transfers to Ricardian and non Ricardian households are, respectively: $TR_t^r(i) = \frac{TR_t}{1+\phi^h(d-1)}$ and $TR_t^{nr}(i) = \frac{dTR_t}{1+\phi^h(d-1)}$.

Since only Ricardian households hold bonds and accumulate capital, aggregate variables are related to the vector of Ricardian-specific variables as follows:

$$\Phi_t = \int_0^{1-\phi^h} \Phi_t^r\ dj$$

for $\Phi_t = [I_t, K_t^p, K_t, B_t, B_t^*]'$.

Market clearing for the foreign bond market and the final goods market requires that at the equilibrium the following two equations for net foreign assets evolution and aggregate resources are satisfied:

$$\frac{e_t B_{t+1}^*}{\Phi_t R_t^* q_t^{b*}} = e_t P_t^x (C_t^x + I_t^x) - e_t P_t^* (C_t^m + I_t^m) + e_t B_t^* \quad (38)$$

and:

$$C_t^d + C_t^x + I_t^d + I_t^x + G_t + I_t^g \leq Y_t - a\left(u_t^k\right) K_{t-1}^p - \kappa_t \upsilon_t \quad (39)$$

where $C_t^x + I_t^x = \left[\frac{P_t^x}{P_t^*}\right]^{-\eta_*} Y_t^*$ are total exports with η_* denoting the foreign demand elasticity parameter[21].

The stationary representation of the model is obtained by scaling the real variables with respect to the trending technology process. The scaled model is then log-linearized around the deterministic steady state, taking into account that the presence of a deterministic term in the productivity growth process affects the coefficients of the dynamic equations.

The resulting log-linearized model is composed of 51 structural equations and of 23 shock processes, of which seven are assumed to be first order autoregressive and the remaining 16 are assumed to be *i.i.d.*. The economic relations are described by 63 structural parameters (including the fiscal and monetary policy rule coefficients), whilst the stochastic component of the model is defined by 30 coefficients (23 for the standard deviations of shocks and seven for the autoregressive coefficients)[22].

[21] At the estimation stage we will also consider an additive stochastic process ϱ_t in the aggregate resources constraint, i.e. a first order autoregressive measurement error $\varrho_t = \varrho_{t-1}^{\rho_\varrho} e^{\varepsilon_{\varrho,t}}$. Such a shock is generally considered in the empirical literature in order to enhance the estimates when these include output and all its components appearing in the model.

[22] We denote as structural parameters those defining preferences, technology, elasticities, real and nominal rigidities in the good and labor markets, as well as the coefficients describing the monetary and fiscal policy reaction rules. The seven autoregressive coefficients are those describing the memory of the technology process around the deterministic trend, of the structural shock on government investments, on exports, the home bias, the uncovered interest parity, the long-term interest rate spread and the memory of a measurement error included in the aggregate constraint.

1.8 The foreign economy

Foreign output (y_t^*), inflation (π_t^*), short and long-term interest rates $\left(r_{s,t}^* \text{ and } r_{l,t}^*, \text{ respectively}\right)$ are exogenous to the variables of the small domestic economy and their evolution is described by a fourth-order structural Bayesian B-VAR, where contemporaneous correlations are defined by the structure of the stochastic component matrix $\mathbf{B}$. Formally:

$$\mathbf{A}(L)\begin{bmatrix}\pi_t^* \\ \Delta y_t^* \\ r_{s,t}^* \\ r_{l,t}^*\end{bmatrix} = \mathbf{B}\begin{bmatrix}\varepsilon_t^{\pi^*} \\ \varepsilon_t^{y^*} \\ \varepsilon_t^{r_s^*} \\ \varepsilon_t^{r_l^*}\end{bmatrix}, \quad \mathbf{A}_0 = \mathbf{I}_4, \quad \boldsymbol{\varepsilon}_t \sim N(\mathbf{0}, \mathbf{I}_4) \tag{40}$$

$$\mathbf{B} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix}, \quad \mathbf{BB}' = \boldsymbol{\Omega}$$

The assumptions on the contemporaneous correlations matrix $\mathbf{B}$ are consistent with the hypothesis that output and inflation do not respond contemporaneously to the other shocks in the system (Adolfson et al. 2008)[23], and that the long-term interest rate is post-recursive with respect to the short-term interest rate.

The SVAR system adds four linear stochastic equations to the economic and stochastic relations of the domestic economy model, resulting in a total of 78 equations and 27 shocks.

2 Bayesian estimation

The rich parameterization of the model precludes the estimation of the entire parameter space, because of the poor empirical identifiability of medium and large scale DSGE models (Canova and Sala 2009, Iskrev 2010a,b, Koop et al. 2011). Even if log-linearized around the deterministic steady state, these structures are in fact characterized by relevant nonlinearities in parameter convolutions, such that the likelihood generated by the model can be uninformative, i.e. multimodal or flat with respect to some parameter values. On these premises, only the subset of the parameter space that satisfies the theoretical and empirical identification conditions is estimated using the Bayesian method, whilst for the remaining subset we adopt dogmatic priors specified according to the available country-specific evidence and to conventional calibration values.

A Bayesian approach is adopted also for the estimation of the foreign variables SVAR, in this case considering a partially modified Minnesota priors specification approach. The choice of using the Bayesian method for the estimation of the SVAR is based on recent results showing its good properties both within sample and in terms of minimization of the predictive variance of the resulting model (Banbura et al. 2010).

[23] Consistently with the results in Adolfson and Lindé (2011), the over-identifying restriction that output does not respond contemporaneously to the price shock is not rejected by the data at the standard 5% criterion.

2.1 Data issues and measurement equations

To enhance the empirical identification of the widest fraction of the structural parameters space, we use a large set of domestic and foreign quarterly variables to estimate the country-specific models.

Considering the domestic economies, 21 observables are considered: (log differences of) of real per capita GDP[24] $\left(\Delta y_t^{obs}\right)$, consumption $\left(\Delta c_t^{obs}\right)$, investment $\left(\Delta i_t^{obs}\right)$, imports $\left(\Delta m_t^{obs}\right)$, exports$\left(\Delta x_t^{obs}\right)$, the real wage $\left(\Delta w_t^{obs}\right)$, real government expenditures for consumption $\left(\Delta g_t^{obs}\right)$, investment $\left(\Delta i_t^{g,obs}\right)$ and transfers $\left(\Delta tr_t^{obs}\right)$; the direct tax rate on labor income $\left(\tau_t^{n,obs}\right)$, on business profits $\left(\tau_t^{p,obs}\right)$, on capital $\left(\tau_t^{k,obs}\right)$ and the indirect tax rate on consumption $\left(\tau_t^{c,obs}\right)$; the unemployment rate $\left(u_t^{obs}\right)$, the (quarterly) rates of change of the price deflators for consumption $\left(\pi_t^{c,obs}\right)$, import $\left(\pi_t^{m,obs}\right)$, export $\left(\pi_t^{x,obs}\right)$ and for the domestic sector $\left(\pi_t^{y,obs}\right)$; the nominal effective exchange rate $\left(e_t^{obs}\right)$, the (quarterly) short and long-term interest rate $\left(r_{s,t}^{obs}\right.$ and $r_{l,t}^{obs}$, respectively$\left.\right)$, the latter approximated by the 10-years government bond rate. Because of the lack of time series data for hiring and wage subsidies $\varphi_t^h$and φ_t^w, the partial adjustment processes defining their evolution over time are pinned down at the estimation stage. All real variables are referred to the base-year 2005.

Considering the variables for the foreign sector, the log difference of real output $\left(y_t^{*,obs}\right)$ is obtained from the real world output index (base-year 2005) and short and long-term interest rates $\left(r_{s,t}^{*,obs}\right.$ and $r_{l,t}^{*,obs}$, respectively$\left.\right)$ are obtained as weighted averages of the corresponding figures for the US and the EMU area, with weights given by the relative importance of the two economic areas in domestic capital movements. The foreign price deflator $\left(\pi_t^{*,obs}\right)$ is obtained from the real effective exchange rate definition equation using observed data on domestic inflation, the nominal and the real effective exchange rates. A total of 25 variables is thus considered in the country-specific estimates[25].

All data are taken from official sources and cover the period 1980:1-2012:4[26]. Real variables of the private domestic sector, their deflators and the nominal short and long-term interest rates are taken from the OECD-Economic Outlook database. Nominal and real effective exchange rate indexes, defined at the base-year 2005, and real world output index (2005 = 100) are taken from the IMF-International Financial Statistics database. Data for government expenditures and revenues are, for the quarterly frequency, from the IMF Government Financial Statistics database and, for the yearly frequency, from the OECD-Tax Statistics database and from the IMF Finance Statistics Yearbook [27].

[24] Per capita variables are obtained considering the labor force as the normalizing variable.

[25] To the best of our knowledge, the use of such a high number of observables in the estimates is unprecedented in the literature on empirical DSGE models.

[26] Because of the lack of quarterly time series prior to 1990 for Ireland and to 2000 for Greece, quadratic interpolation methods are applied to yearly observations to obtain the quarterly figures 1980:1-1989:4 and 1980:1-1999:4 for Ireland and Greece, respectively.

[27] Even in this case, since quarterly data are available only after 1999:1, adjustments to changing definitions and quadratic interpolation methods are applied to yearly observations in order to obtain the quarterly frequency for the preceding time span. A detailed description of the data manipulation is provided in a technical appendix of the paper, available upon request from the authors

Before linking the observed variables to the theoretical counterparts, some of the latter are transformed in order to get full consistency with the statistical definitions. In particular, the transformations take into account that, differently to the statistical aggregates, consumption and investment in the theoretical model are composites of domestic and imported goods and output also includes the hiring cost and that related to changes in the capital utilization rate.

Further transformations are needed in order to make the data consistent with the theoretical steady states and in particular with the model property of balanced growth (μ), a theoretical prediction which is not supported by the evidence in all the countries being considered, in particular for export and import shares. More specifically, the positive/negative excess trends in real variables are removed by considering sample deviations from the steady state output growth rate μ in the measurement equations of all the real variables in the system, such that the theory-consistent stationary great ratios are restored.

Formally, considering the vector of real per capita variables $\mathbf{x}_t = (c_t,\, i_t,\, m_t,\, x_t,\, w_t,\, g_t,\, i_t^g,\, tr_t,\, y_t^*)$, of tax rates $\boldsymbol{\tau}_t = \left(\tau_t^n,\, \tau_t^p,\, \tau_t^k,\, \tau_t^c\right)$, of inflation rates $\boldsymbol{\pi}_t = (\pi_t^c,\, \pi_t^m,\, \pi_t^x,\, \pi_t^y,\, \pi_t^*)$, of short and long-term interest rates $\mathbf{r}_{s,t} = \left(r_{s,t},\, r_{s,t}^*\right)$ and $\mathbf{r}_{l,t} = \left(r_{l,t},\, r_{l,t}^*\right)$, the 25 measurement equations linking the linearized model variables to the respective observables read as follows:

$$\begin{bmatrix} \Delta y_t^{obs} \\ \Delta \mathbf{x}_t^{obs} \\ \boldsymbol{\tau}_t^{obs} \\ u_t^{obs} \\ \boldsymbol{\pi}_t^{obs} \\ \mathbf{r}_{s,t}^{obs} \\ \mathbf{r}_{l,t}^{obs} \\ e_t^{obs} \end{bmatrix} = \begin{bmatrix} \widetilde{y}_t - \widetilde{y}_{t-1} + \log \mu \\ \widetilde{\mathbf{x}}_t - \widetilde{\mathbf{x}}_{t-1} + \log \mu + \log \boldsymbol{\mu}_{xy} \\ \widetilde{\boldsymbol{\tau}}_t + \boldsymbol{\tau} \\ \widetilde{u}_t + u \\ \widetilde{\boldsymbol{\pi}}_t + \log \boldsymbol{\pi} \\ \widetilde{\mathbf{r}}_{s,t} - \log \overline{\boldsymbol{\beta}}^{(.,*)} + \log \boldsymbol{\pi}^{(c,*)} \\ \widetilde{\mathbf{r}}_{l,t} - \log \overline{\boldsymbol{\beta}}^{(.,*)} + \log \boldsymbol{\pi}^{(c,*)} + \mathbf{q}_b^{(.,*)} \\ \widetilde{e}_t + \log e \end{bmatrix} \tag{41}$$

where the coefficients μ_{xy} denote the excess trend (or excess growth rate) of each observed generic real per capita variable in $\mathbf{x}_t^{obs}$ from the real per capita GDP growth rate, μ. $\boldsymbol{\tau}$, $-\log \overline{\boldsymbol{\beta}}$, $\boldsymbol{\pi}$, $\mathbf{q}_b$ and s denote the (steady state) tax rates, the domestic and foreign real interest rates, the inflation rates, the domestic and foreign long-term interest rate spreads, and the nominal effective exchange rate, respectively, and u denotes the steady state unemployment rate.

2.2 Calibrated parameters

Calibrated values are chosen taking into account both sample and extraneous evidence when informative for the theoretical parameters, and conventional values when such information is missing. At the estimation stage, a standard vacancy posting condition and real wage equation are assumed, such that the parameters defining the partial adjustment processes of hiring and wage subsidies φ_t^h and φ_t^w are not considered.

We impose 24 dogmatic priors on the 60-dimensional structural parameters space. Absent country-specific information, 11 structural parameters are fixed to common values across countries. These are the steady-state mark-up coefficients λ_p^d, λ_p^m and λ_p^x, fixed to the conventional value of 1.2, consistent with prior demand elasticities for domestic, import and export sector firms equal to 6, the Kimball endogenous demand elasticity parameters κ_ϵ^d, κ_ϵ^m and κ_ϵ^x, fixed to the conventional value of 10 (Eichenbaum and Fisher 2007, Smets and Wouters 2007), the parameter defining the fraction of newly hired workers that are unable to re-optimize the wage period by period θ_w, fixed to 0.5, consistent with the hypothesis of a two quarters average duration of the new wage contract, the parameter defining the fraction of government transfers to Ricardian and non Ricardian households d, fixed to 1, consistent with an hypothesis of equally distributed transfers, the exchange rate sensitivity to the net foreign assets to GDP ratio $\widetilde{\phi}_a$, fixed to the arbitrary small value of 1^{-328} and the private and government capital depreciation rates, δ and δ^g, respectively, both fixed to the conventional value of 0.025.

The remaining 13 dogmatic priors for structural parameters are fixed considering country-specific evidence. These are the trend growth parameter μ, fixed considering the sample growth rate of per capita GDP, the discount factor β, calibrated considering the country-specific trend growth and the average real interest rate, the home bias parameter $(1-\nu)$, fixed according to the country-specific sample evidence on the import share, the separation rate ρ, fixed to the country estimates provided by Hobijn and Sahin (2009), the parameter defining the frequency of wage re-optimization of incumbent workers γ_w, fixed to the country estimates provided in Druant et al. (2012), and the parameter defining the unemployment benefit b^u, fixed according to the country-specific replacement rates provided in the OECD-LFS data base (Christoffel et al. 2009). The output elasticity of private capital α, the matching efficiency parameter σ_m and the labor disutility scale parameter χ are calibrated such that the labor share, the unemployment rate and the job finding rate steady-state values evaluated at the prior parameterization match the sample counterparts for each country[29]. Country-specific sample evidence on average tax rates (Eurostat 2013) is used to fix the steady state revenue parameters τ^n, τ^p, τ^k and τ^c.

Finally, the coefficients in the system of measurement equations (41), i.e. those in the vector of deviations from GDP trend $\boldsymbol{\mu}_{xy}$, in the vectors of tax rates $\boldsymbol{\tau}$, of inflation rates $\boldsymbol{\pi}$, of domestic and foreign real interest rates and bond rate spreads, $-\log\overline{\boldsymbol{\beta}}$ and $\mathbf{q}_b$, respectively, and the long-run nominal effective exchange rate e, are fixed to the respective sample means.

The seven exclusion restrictions for the identification of the foreign variables' SVAR, i.e. the zero restriction for b_{12}, b_{13}, b_{14}, b_{21}, b_{23}, b_{24} and b_{34} add further seven dogmatic priors. Table 1 summarizes the common and country-specific dogmatic priors adopted for the structural parameters in model estimation.

[*INSERT TABLE 1 ABOUT HERE*]

2.3 Priors for estimated parameters

The subset of (35) structural model parameters who is not affected by evident identification problems, the 29 coefficients defining the stochastic component (the *i.i.d.* hiring and wage

[28] Such a small value ensures the satisfaction of the stability conditions (Lundvik 1992, Schmitt-Grohé and Uribe 2001) while minimizing the exchange rate persistence induced by its "technical" relation with the NFA evolution.

[29] Sample data for the job finding rate are obtained by elaborating the information in the OECD Labor Force Survey data-base series "Unemployment by duration".

subsidy shocks are pinned down at the estimation stage) and the 73 coefficients of the SVAR (nine for the unrestricted elements of the $\mathbf{B}$ matrix and 64 for the vector autoregressive component) are estimated with the Bayesian method[30].

Outside the Calvo price parmeters, the prior distributions are common across countries and are specified following the standard practice: *i)* the shape of the probability density functions is the gamma and the inverted gamma for parameters theoretically defined over the $\mathbb{R}^+$ range, the beta for parameters defined in a $[0-1]$ range and the normal for priors on parameters theoretically defined over the $\mathbb{R}$ range; *ii)* prior means and standard deviations are defined on the basis of sample information (when available), or considering the results of previous analyses[31]. In order to enhance the estimation of parameters subject to weak empirical identifiability, informative priors are adopted such that a certain degree of curvature in the log-kernel is obtained.

The prior means for the Calvo parameters of the domestic, import and export sectors, (ξ_p^d, ξ_p^d ξ_p^d, respectively) are specified according to the country-specific micro-evidence provided in Druant et al. (2012)[32], i.e. 0.71 for Greece, 0.75 for Ireland, 0.69 for Portugal and 0.70 for Italy and Spain. Since the available information does not distinguish across sectors, we adopt a relatively high value for the prior standard deviation, fixed to 0.1. A weak gamma-distributed prior with mean 1.5 and standard deviation 0.4 is adopted for the import and export Armington elasticities η and η^* (Adolfson et al. 2008, Christiano et al. 2011b).

Considering the modified UIP equation, the autoregressive coefficient $\widetilde{\phi}_s$ is assumed to be beta-distributed with prior mean 0.5 and prior s.d. 0.15, whilst for the country risk adjustment coefficient $\widetilde{\phi}_r$ we basically follow Christiano et al. (2011b), assuming a diffuse gamma distribution with prior mean 1.25 and prior s.d. 0.5.

The private and public investment adjustment cost parameters ψ^i and ψ^{ig} are assumed to be normally distributed around a prior mean of 5 with a prior s.d. of 2, and the utilization rate curvature parameter ψ^k is assumed to be beta-distributed with prior mean 0.5 and prior s.d. 0.15 (Christiano et al. 2011b).

Concerning the preference parameters, the consumption curvature parameter σ_c is assumed to be normally-distributed with a prior mean of 2 and a prior s.d. of 0.1, whilst the external habits parameter is assumed to be beta-distributed and centered around 0.7 with a prior s.d. of 0.1. The prior for the fraction of liquidity constrained households is rather diffuse, with mean 0.25 and s.d. 0.10[33].

[30] Operationally, posterior modes are obtained by maximizing the log-posterior kernel (resulting from the prior distribution and the conditional distribution approximated by the Kalman filter) with respect to the model parameters, and posterior distributions are obtained from the Metropolis-Hastings Monte Carlo Markov chain (MCMC) numerical integration algorithm. Two chains of 500k iterations are considered.

[31] The standard practice of considering results from previous studies is not free of limitations, since the validity domain of prior evidence is not independent of the model being considered.

[32] The Kimball curvature, Calvo and mark-up (or demand elasticity) parameters are not separately identifiable, as testified by the results of preliminary identification checks at the prior values (Iskrev 2010a,b). We adopt the standard practice of fixing the Kimball and mark-up parameters to ensure the empirical identification of the estimated Calvo parameters.

[33] The preference parameters, even if separately identifiable in our setting, are not fully variation-free. The choice of a relatively tight prior for the consumption curvature parameter enhances the identifiability of the other parameters.

Considering the LM-specific parameters, a relatively weak beta-distributed prior with mean 0.5 and s.d. 0.15 is assumed for the matching function share parameter σ_n and the union's relative bargaining power parameter ς. The prior for the hiring cost parameter κ is assumed to be gamma-distributed with mean 0.05 and s.d. 0.01, a prior mean value consistent with a hiring cost to GDP ratio $\frac{\kappa v}{Y}$ close to 1%.

Concerning the monetary policy parameters, the interest rate smoothness coefficient ρ^R is assumed to be beta-distributed with prior mean 0.75 and prior s.d. 0.1, the inflation response parameter ψ_1 is assumed to be normally distributed with prior mean 2 and s.d. 0.2, whilst the output and output growth sensitivity parameters ψ_2 and ψ_3 are assumed to be beta-distributed with prior means (s.d.) of 0.1 (0.05) and 0.25 (0.1), respectively. The four shift parameters accounting for the monetary policy structural break in the smoothness coefficient and in the feedback coefficients are assumed to be normally distributed with zero prior mean and s.d. equal to 0.2.

Considering the fiscal policy parameters, a beta-distributed prior with mean 0.75 and s.d. 0.15 is adopted for the autoregressive components ρ_{τ^c}, ρ_{τ^n}, ρ_{τ^k} and ρ_{τ^k} in the tax rates partial adjustment equations, and ρ_g, ρ_{tr} in the government consumption and transfers equations, respectively. For the coefficients denoting the sensitivity of these expenditure components to output, η_{gy} and η_{try}, an informative and normally distributed prior with mean 1 and s.d. 0.1 is adopted, consistent with the hypothesis of long-run balanced growth of public expenditures. A weakly informative beta-distributed prior with mean 0.05 and s.d. 0.02 is chosen for the parameters η_{gd} and η_{trd}, defining the sensitivity of public consumption and transfers to the government financial need. The latter prior is equivalent to that chosen for the sensitivity of the tax rates to the financial need ψ_τ, basically following the calibration value adopted in Drautzburg and Uhlig (2011). Finally, a weakly informative beta-distributed prior with mean 0.25 and s.d. 0.10 is adopted for the tax instruments ω^c, ω^n and ω^k, whilst ω^p is restricted to be equal to $1 - \left(\omega^c + \omega^n + \omega^k\right)$.

Considering the stochastic component of the models, the prior opinions for the autoregressive coefficients of the seven persistent shock processes (i.e., ρ_{ξ^a}, ρ_{i^g}, $\rho_{\tilde{\phi}}$, ρ_{q_b}, ρ_{ϱ}, ρ_ν and ρ_x) are commonly described by a weakly informative beta-distributed prior with mean 0.75 and s.d. 0.15[34]. For the standard errors of the 25 innovations, we assume a prior mean of 0.01 with two degrees of freedom for all shocks, except for those multiplying convolutions of parameters whose values are outside the $[10^{-1},\ 10]$ range, that are scaled accordingly.

The prior opinions on the estimated structural parameters are summarized in the first column of the result Table 2 (panels a-e).

The elicidation of priors for the foreign variables' SVAR is based on the partially modified Minnesota priors approach (Doan et al. 1984, Litterman 1986, Sims and Zha 1998) suggested by Banbura et al. (2010). Accordingly, priors are specified consistently with the hypothesis of independent AR(1) processes (random walks for variables close to non-stationarity), with prior variabilities decreasing in the power of the lag order of the SVAR i (net of an overall

[34]The autoregressive coefficients ρ_ν and ρ_x denote the persisitency of the stochastic component in the import and export equations, respectively. The first component defines a stochastic home bias parameter, and the second a stochastic elasticity of substitution between foreign and domestic goods. The two stochastic components enter the log-linear representation of the model additively, such that they do not influence the empirical identifiability of the preference parameters.

shrinkage parameter λ, calibrated according to the number of variables in the system) and scaled considering the variables' error variance ratios σ_m^2/σ_n^2, the latter approximated by the estimated residuals of univariate autoregressive representations. Formally, the prior moments for the 73 coefficients of the fourth-order SVAR (40) are specified as follows:

$$E\left[(\mathbf{A}_i,\mathbf{B})_{mn}\right]=\begin{array}{l}\vartheta \text{ for } i=1,\ m=n\\ 0 \text{ otherwise}\end{array},\quad V\left[(\mathbf{A}_i,\mathbf{B})_{mn}\right]=\begin{array}{l}\frac{\lambda^2}{i^2} \text{ for } m=n\\ \frac{\lambda^2}{i^2}\frac{\sigma_m^2}{\sigma_n^2} \text{ otherwise}\end{array} \tag{42}$$

where the values for the first-order autoregressive coefficients ϑ are obtained from the estimates of independent AR(1) processes.

2.4 Posterior mean estimates

Table 2*a*-*b*-*c*-*d*-*e* report the prior and the posterior mean estimates. Panel *a, b* and *c* contain the estimates of 37-dimensional parameters space for the model economy, the monetary policy and the fiscal policy coefficients, respectively. Panel *d* and *e* report the estimates of the 30 parameters defining the persistence and size of the 25 exogenous stochastic components, respectively[35].

According to the estimated posterior mode standard deviations and the implied pseudo t-values, the structural parameter estimates all appear significant for each of the countries being considered. Concerning the stationary disturbances, we obtain a high degree of autocorrelation for all the autoregressive shock processes. The exogenous innovations are all significant according to their standard errors.

The posterior mean values for the model economy parameters are generally close to the respective modal values and indicate reasonable estimates based on our prior opinions and results in the literature. Evident exceptions are the unconventionally high posterior estimates obtained for the private and public capital adjustment cost parameters ψ^i and ψ^{ig}, on average more than the double of the prior mean value, implying milder investment and capital responses than those obtainable under standard calibration values.

The curvature parameter for the capital utilization rate ψ^k is estimated to be very high and distant from the prior for Greece (0.99), Italy (0.96), Spain (0.94), quite high for Portugal (0.70), whilst it is not far from the prior in the case of Ireland (0.57). These numbers are expected to be reflected in differences the country-specific model dynamics, since a higher curvature parameter indicates less room for quick adjustments of the utilization rate of capital, thus more persistence.

[*INSERT TABLE 2a ABOUT HERE*]

[35] Mode checks and multivariate M-H convergence plots signal that the estimation process performs correctly for all countries. The mode estimates intersect the log posterior kernel at its maximum for all parameters. The multivariate diagnostics signal that the estimates are stable both within (over replications) and particularly between chains. Posterior densities confirm these encouraging indications, signalling a close to normal shape and a reasonable distance from prior densities. These results are available upon request from the authors.

A relevant degree of cross-country heterogeneity is obtained also with respect to the parameter defining the fraction of liquidity constrained households ϕ^h, estimated to be quite high for Portugal (0.46) and Italy (0.39), and quite low for Greece (0.1) and Spain (0.17). These differences are expected to affect the size of the fiscal policy multipliers, as long as a higher degree of rule-of-thumb behavior is reflected in a more direct link between current income and private consumption, i.e. in the breakdown of Ricardian equivalence.

The posterior estimates of the Calvo parameters in the domestic, import and export sectors, ξ_p^d, ξ_p^m and ξ_p^x, respectively, are somewhat higher than the prior opinions based on survey evidence and the conventional values used in the literature. The high posterior estimates basically reflect the flat slope of the NKPCs, which is more pronounced than that implied by the joint consideration of the Calvo frequency micro-estimates and of the conventional calibration values for the mark-up (or elasticity) parameters[36].

The estimated Armington elasticities η and η^* are generally smaller than the prior and denote a differentiated pattern across countries. A similar consideration holds true for the risk premium parameter $\widetilde{\phi}_r$, which is estimated to be slightly above unity for Italy and Ireland only, ruling out a direct emergence of the forward premium puzzle in the remaining countries.

The estimates of the LM-specific parameters show some variability across countries, in particular for the union's relative bargaining power parameter ς, estimated to be higher than the conventional value of 0.5 for Portugal (0.83), Greece (0.77), and Ireland (0.7), and lower for Italy (0.26) and Spain (0.47). The posterior mean estimates for the hiring cost parameter κ and the matching function share parameter σ_n are not distant from priors.

[*INSERT TABLE 2b ABOUT HERE*]

[*INSERT TABLE 2c ABOUT HERE*]

Considering the estimated monetary policy coefficients adjusted for the break implied by the shift to the single currency, relevant differences emerge across countries. The size of the policy rate response to inflation close to a conventional parameterization for Greece (1.65) and Ireland (1.38), and quite low for the remaining countries (between 1.02 and 1.13). Joint with the estimated high degrees of inertial behavior (the coefficient ρ^R is always well above 0.8), these results indicate, with the exception of Greece, a mild monetary policy response to variations in inflation and output, potentially dampening its counter-cyclical effects under standard fiscal expansions and its pro-cyclical effects in the case of structural policies targeted to a reduction of the labor cost and inflation.

It is interesting to note that the posterior estimates of the four shift parameters accounting for the monetary policy structural break are negative and sizeable in all countries being considered, signalling that the shift to a common currency and a centralized authority targeting

[36] Such a result shows that, for the countries considered in this study, the introduction of endogenous demand elasticities does not solve the micro-macro dichotomy in the estimate of the NKPC slope coefficients (Eichenbaum and Fisher 2007).

average EZ inflation and output has implied a reduced degree of monetary policy activism with respect to the single economies' macroeconomic developments[37].

[*INSERT TABLE 2d ABOUT HERE*]

Finally, the posterior estimates for the fiscal policy coefficients confirm the high degree of inertia on both the expenditure and the revenue sides, with estimated autoregressive coefficients well above the conventional calibration value of 0.9 (Perotti 2005). It is interesting to note that, except Greece, the posterior estimates for the parameter denoting the sensitivity of the tax rates to the government financial need ψ_τ, even if low and distant from the prior, are basically consistent with the Galì and Perotti (2003) estimates for OECD countries. The estimated sensitivities of government consumption and transfers to the financial need (η_{gd} and η_{trd}, respectively) are on average higher and more heterogeneous across countries, with a size ranging from 0.01 for Spain to 0.11 for Ireland. The parameter defining the link between long-run expenditure and output levels (η_{gy} and η_{try}) are always not significantly different from unity, such that the hypothesis of balanced growth in the fiscal variables cannot be rejected.

[*INSERT TABLE 2e ABOUT HERE*]

3 Policy simulations

In this section we provide a comparative analysis of the country-specific expected effects from the implementation of the two alternative LM targeted policies. These are obtained by simulating the model considering the parameterization obtained at the country-specific posterior mean estimates.

The policy simulation exercise is developed along two main lines: *i)*.a persistent, albeit not permanent, reduction in the labor cost of newly hired workers through transitory wage subsidies, financed with public resources equivalent to 1% of GDP; *ii)* a transitory reduction in hiring costs through structural LM reforms, for an equivalent amount of resources. The persistence coefficients of the shocks are set to 0.75, consistent with a one year average duration of the policy shock.

Even though the mathematical implementation of measure *ii)* is straightforward in our model, its calibration to the resources being devoted is highly problematic. In order to circumvent these implementation problems, and possibly optimistically, we assume that, given the estimated equilibrium hiring cost parameter (which is not observed), the structural measures are expected to induce a reduction of this specific cost on impact for an amount equivalent to the public financing of the measure.

We assume that the measures are backed by national resources, so that they necessarily imply fiscal financing, i.e, public budget and debt variations through tax rate and expenditure changes, expenditure restructuring and bonds issuing. In order to enhance the understanding

[37] Detailed results on the monetary policy break estimates are reported in a technical appendix available upon request from the authors.

of the simulation results, we only consider the estimated systematic components in the revenue equations, i.e., the specific elasticity of tax rates to the financial need, whilst the expenditure side is assumed to be fully exogenous by setting the elasticities of the expenditure components to the financial need and to GDP to zero.

The results from the LM-targeted policy simulations are then compared with those obtainable from the implementation of equally financed fiscal policy measures based on increased expenditures in government consumption, transfers and investments and on decreased tax pressure on labor incomes, business profits, capital gains and consumption. The different simulations are made comparable by calibrating the size of each policy shock to be equivalent to a 1% of GDP on impact and by homogenizing their persistence to the one adopted for the simulation of the LM-targeted fiscal measures.

The same policy simulations are then repeated considering that the economies are operating in a liquidity trap. To implement such an environment, we calibrate a negative preference shock implying an eight-quarters period non positive equilibrium interest rate for each country, and impose the zero-lower-bound (ZLB) condition.

3.1 The effects of the policies in standard times

Figure 1 depicts the expected effects from government wage subsidization of new hires of labor in the PIIGS. Since the model dynamics activated by a government hiring subsidy shock is not qualitatively different, the impulse responses of a hiring cost subsidization policy are not reported and summary results are reproduced in Table 3. Output and unemployment responses are reproduced in panels *a* and *b*. These are normalized such that the GDP response has an interpretation in terms of the dynamic monetary fiscal multiplier (i.e. the expected monetary variation in GDP from a 1 euro budget variation), whilst the unemployment rate response has an interpretation in terms of percent variation in the unemployment rate.

[*INSERT FIGURE 1 ABOUT HERE*]

A first outcome that merits to be highlighted is the very high variability of results over time and across countries for both measures, signalling the operation of very different transmission mechanisms. Two points are common to both the LM-targeted measures: first, the short term (4 to 6 quarters) effect on output is negative for all countries (on impact, between -1.4 for Portugal and -0.14 for Spain) but Greece (0.41 on impact) and that on unemployment is negligible; second, the measures are expected to produce positive effects on output and employment only in the medium to long-term (on average 19 quarters, i.e. nearly five years). Considering the hiring subsidy, the peak output multiplier and the peak percent reduction in unemployment range, respectively, from a maximum of 4 and -2.4% for Greece, to a minimum of approximately 0.3 for the output multiplier and of -0.2% for unemployment in Italy. Qualitatively similar results are obtained for the wage subsidy, for which the highest peak effects are again obtained for Greece (3.9 the output peak multiplier, -2.3% maximum unemployment reduction), and the lowest for Italy.

The negative output response observed in all countries but Greece on impact is mainly related to the delayed real wage contraction, due to the nominal wage rigidity, and to the temporary increase in the real interest rate, due to the weak monetary policy reaction to the deflation stimulated by the real wage contraction. The resulting increase in the real interest rate leads to a temporary drop in private expenditures (consumption and investment), whilst the dampened real wage contraction, which is not compensated by a quick and significant increase in employment, tends to depress private consumption in the fraction of liquidity constrained households. The positive net export response stimulated by the devaluation of the real exchange rate is not sufficient to outweigh the contraction in the internal demand components. The fact that Greece is the country for which the strongest real wage contraction and the highest degree of monetary policy activism are obtained explains great part of the fact that for this country the expansionary effects take place even on impact, consistently with the result and the mechanics discussed in Faia et al. (2013)[38].

Panels *c*-*f* of Figure 2 report the percent variations of the real wage, the real interest rate, of private expenditures and of net exports to a wage subsidy shock. The induced real wage contraction is at the root of the transmission mechanisms of the policies being considered. The size and the persistence of this effect depend on the estimated parameterization of equation (25), in which the relevance of the degree of nominal wage rigidity, as well as the contemporaneous and intertemporal relations in the wage bargaining process are highlighted.

Considering the introduction of a wage subsidy, the first row of equation (25) shows that, for a given degree of nominal wage rigidity, the bargained real wage is directly related to the present wage subsidy, weighted by the fraction of new hires of labor. The contemporaneous effects are thus dominated by the intertemporal effects, driving the bargained wage in the opposite direction. In fact, and as expected from the discussion in section (2.4), given the country-specific calibrated values for the separation rate ρ, and the estimated union's relative bargaining power parameter ς, the firm's intertemporal incentive to reduce the present bargained wage always dominates the union's net intertemporal incentive to increase it. The different real wage responses in the countries being considered basically reflect the cross-country heterogeneity in these two LM parameters and the different degrees of nominal wage rigidity.

Considering the introduction of a hiring subsidy, the mechanics of the wage contraction is immediately evident in the third last row of equation (25), showing that the subsidy reduces the present bargained real wage because of the anticipation of the loss opportunity of a future reduction in the hiring cost.

The delayed output and employment peak effects of the LM-targeted policies are due to, on the one hand, the high degree of both nominal and real rigidities and, on the other, to the inertial behavior of the monetary authority. The nominal wage rigidity dampens the speed of the wage contraction, as well as the estimated high degrees of price rigidity, that reduces the size and delays the resulting price deflation.

On the real terrain, the estimated high degrees of external habits h introduce a strong memory component in private consumption behavior, which is not compensated by a sufficiently quicker response of private and public investment, because of the high private and

[38] We have verified that, by setting the inflation response coefficient to 1.2 in the Taylor rule and lowering the estimated elasticity of import to the value being estimated for the export elasticity (0.67), the responses of output and employment are more aligned with those obtained for the other countries. The output impact response becomes negative, whilst the peak output and unemployment multipliers are strongly reduced (1.4 and -0.97%)

public capital adjustment costs (defined by the estimated size of parameters ψ^i and ψ^{ig}), and of the degree of rigidity in varying its utilization.rate (defined by the estimated size of parameter ψ^k).

Concerning the relative effects of the two LM policies, the simulations indicate that, except Greece, the expected effects from the introduction of hiring subsidies are slightly stronger than those from an equally financed wage subsidization (Table 3). This result is due to the higher real wage contraction stimulated by the hiring cost subsidy shock.

Table 3 shows that, compared to more standard expansionary fiscal policies increasing public spending or reducing the tax pressure, the LM-targeted policies prove less efficient in providing a timely (impact) stimulus to economic activity in all countries being considered. Except Greece and Portugal, the fiscal multipliers are maximized both on impact and at the peak response with a government consumption shock. Even considering a purely wasteful government consumption expenditure, for these countries the range of values for the estimated impact and peak monetary multipliers are within 1 and 1.6.

[*INSERT TABLE 3 ABOUT HERE*]

It is interesting to compare the effects from hiring costs and newly hired workers' wage subsidization with those from a labor tax reduction. The latter induces a positive peak output response on impact in all economies, even if the size of the multiplier is highly heterogeneous across countries, basically reflecting the estimated fraction of liquidity constrained households[39]. The reason for the quicker effects is that, since the tax cut affects the (larger) fraction of incumbent workers, the reduction in the labor tax pressure immediately increases the current after tax real income, stimulating consumption in the fraction of liquidity constrained households and labor supply. The increase in labor supply tends to counterbalance the inflationary pressure activated by the increased private consumption expenditure. Thus, because of the resulting economic expansion, private investment also increases. The negative net export response, due to the slightly reduced competitiveness of the domestic production from increased domestic prices, is not sufficient to reverse the sign of the response in output.

The impact reduction in unemployment stimulated the LM-targeted measures (Table 4) never dominates that obtainable from the alternative measures, whilst the expected peak effects are stronger than those obtainable in the short term with a government consumption expansion for Greece and Portugal only, and substantially weaker for the remaining countries.

The main responsible for the relatively high values of the government consumption employment multiplier is again the estimated inertial behavior of monetary policy. When faced with an expansionary and inflationary policy, the smoothed response of the nominal interest rate tends to downsize the counteracting effects of the monetary policy stabilization response, whilst it provides weak accommodation to policies relying mainly on the dynamics activated by wage and price deflations, as it is in the case of the wage and hiring costs subsidization

[39] The fraction of rule-of-thumb households is in fact estimated to be particularly low for Greece and Spain, reflecting the low correlation between private consumption and current net incomes in the sample. Considering the recent evolution of the Greek and Spanish economies, it is highly probable that the fraction of liquidity contrained households increased strongly. We have verified that, by including a dummy variable controlling for the recessionary periods, the estimated degree of liquidity constraints increases by 0.14 points for Spain and 0.18 points for Greece.

policies.

To summarize: *i)* the LM-targeted policies lead in general to a higher degree of heterogeneity of results across countries than that resulting from standard fiscal policies (in particular government consumption expenditures); *ii)* aside Greece and Portugal in the medium to long run, their growth-enhancing effects are always inferior than those obtainable from government consumption expenditure shocks; *iii)* the employment effects can be superior than those of the alternative fiscal policies, but their potential is reached only with a significant delay.

These results signal that, even if the LM-targeted policies reduce the labor cost both directly and indirectly, whereas standard fiscal expansions based on government expenditure lead to an increase in the real wage that tends to counterbalance the employment-enhancing effects of the economic expansion, these mechanisms are not strong enough to make the LM-targeted policies a set of instruments to be always preferred to more standard fiscal policies, especially under a business cycle management perspective.

It is worth highlighting that, under the small open economy assumption adopted in this study, the estimated effects of the LM-targeted policies are likely to be maximized, since we cannot control for the situation in which the same policy is adopted in the foreign economy. It would be interesting to evaluate to which degree their generalized adoption in a highly integrated single currency area has the same efficacy.

[*INSERT TABLE 4 ABOUT HERE*]

3.2 The effects of the policies in a liquidity trap

The analysis developed so far has shown that the relative efficacy of the alternative measures in the different countries depends both on the different degrees of nominal and wage rigidity and on the interaction between fiscal and monetary policy regimes. In particular, an aggressive monetary policy increases the expected effects of policies targeted to induce a price deflation through the reduction of the labor cost, and dampens those of policies stimulating the general economic activity, because of their inflationary implications.

The fact that the LM-targeted fiscal policies being evaluated are expected to be implemented in economies operating well below their potential and with virtually zero policy rates, as is the case of the countries considered in this study, suggests to extend the analysis to the situation of a binding ZLB. In these circumstances, a deflationary policy cannot be accommodated by the automatic response of the monetary authority, since the nominal interest rate cannot be reduced further (Eggertsson et al. 2014). On the contrary, an expansionary and inflationary fiscal policy, until it does not succeed in taking the economy out of the liquidity trap, will not face the same counteracting effects originating in the stabilizing response of the monetary policy during standard times (Christiano et al. 2011a, Eggertsson 2011a,b, Eggertsson and Krugman 2012). Tables 5 and 6 replicate, for a below potential-liquidity trap economic environment, the information on the fiscal multipliers and on the employment effects of the alternative policies provided by Tables 3 and 4. Since strongly negative output multipliers are often found, one row reporting the peak negative multiplier is added in Table 5.

The consideration of a liquidity trap environment clearly affects the efficacy of the LM-targeted fiscal policies. Considering the hiring cost subsidization policy, the short-term output multipliers are negative in all countries but Greece, and the module of their size increased (between -0.3 for Spain and -2.2 for Portugal), whilst the long-term peak output multipliers are slightly decreased and delayed further (between 0.2 for Italy and 3.9 for Greece). Qualitatively similar results are obtained considering the subsidization of the wage of the new hires of labor, for which the short term multipliers are again negative and their module increased in size in all countries but Greece (between -0.3 for Italy and -1.7 for Portugal), whilst in the long run their peak values are basically unchanged as compared to the normal times simulation, (between 0.3 for Italy and 3.8 for Greece).

The short term employment effects - evaluated at the binding ZLB - are weakened in all countries (and reversed in sign for Italy and Spain) whilst the long-run peak unemployment response, whose size is basically unaffected since the economy has recovered from the liquidity trap, is in general delayed further as compared to the standard time simulations.

As evident in Figure 2, in which the impulse responses of output and unemployment to a wage subsidy shock are reported together with those of the real wage, the real interest rate and of the relative contributions of private expenditures and net exports to the output response, the transmission mechanism explaining these results is the same described for the simulations assuming a not binding ZLB environment. Even in this case, the subsidization policy generates a deflation through the real wage contraction. The main difference here is that, for the eight periods in which the ZLB binds, the monetary authority cannot accommodate the policy with a nominal interest rate reduction, such that the resulting increase in the real interest rate is of the same size of the price deflation. The transitory but sizeable negative output response amplifies the real wage contraction and the deflation during the liquidity trap period.

As the economy recovers, the monetary authority decreases the policy rate by a larger amount than in a not binding ZLB environment, because of the stronger deflation, and firms are willing to hire more workers, because of the stronger real wage contraction. This justifies the expansion following the transitory but persistent depression activated by the LM policies, such that the long run effects are basically unaffected.

Notwithstanding the amplified and delayed output responses, and with the exception of Greece and Portugal, the LM-targeted policies are confirmed to be inferior to a fiscal policy expansion based on government consumption. Interestingly, the output and employment effects of fiscal expansions based on government expenditures are only marginally increased when the ZLB binds. This result, which is apparently in contrast with part of the recent literature on the efficacy of fiscal policy, is due to the fact that our simulations are based on estimated country-specific monetary reaction rules, pointing to a very low degree of policy activism even in normal times. As a result, the fact that with a binding ZLB the counteracting response of the monetary authority does not take place immediately, does not make a big difference with respect to its operation in normal times. In both cases, the real interest rate tends to decrease with the increased inflation, adding a positive private expenditure response to the government stimulus.

[*INSERT TABLE 5 ABOUT HERE*]

[*INSERT TABLE 6 ABOUT HERE*]

[*INSERT FIGURE 2 ABOUT HERE*]

It is also interesting to note that, differently from a results, under a binding ZLB, fiscal expansions based on tax rate cuts are not counterproductive in the short term. This difference in results is due to the fact that the apparently surprising outcomes in Eggertsson (2011a) are obtained in a simplified model setting assuming full Ricardian equivalence, whilst the presence of liquidity constrained households in our setting is not consistent with this hypothetical model feature. To clarify its relevance, consider the propagation mechanism activated by a labor tax cut. On the one hand, it increases the after tax current income, leading to both increased labor supply and to increased consumption demand in the fraction of liquidity constrained households, if present. On the other hand, the increased labor supply induces a real wage and thus marginal cost contraction, activating a deflationary pressure. Since we consider and estimate that a fraction of households are liquidity constrained in all countries, the positive income effects on expenditure dominate those related to the deflation and the resulting expected real interest rate increase, an outcome which is ruled-out under full Ricardian equivalence[40].

4 Conclusions

We develop, estimate and simulate a model characterized by a detailed representation of the non Walrasian LM. We introduce both government hiring and wage subsidies for newly hired workers, obtained by considering a distinction between incumbent workers and new entrants in the search and matching framework, in order to formalize a modification affecting both the job creation condition and the Nash bargained wage, such that unions/firms are non-neutral in wages/labor costs with respect to new hires of labor.

The analysis, developed at the country-level for a selection of peripheral EZ economies (the PIIGS), is based on the simulation of the country-specific response of output and employment to a general hiring shock and a wage subsidy shock targeted to new hires of labor only, and on their comparison with the expected effects from financially equivalent fiscal policies affecting government expenditure and revenues. Results show that, contrary to some conclusions in the recent literature and the policy recommendations within the European EP and YG programmes, the LM-targeted fiscal measures, in a short term perspective, are not superior to more standard fiscal instruments in the management of the business cycle. The analysis also indicates that, even in a longer term perspective and aside Greece and Portugal, the output multiplier of government consumption is higher than that from hiring costs and newly hired workers' subsidization. Considering the employment effects, these policies prove to be clearly superior to more standard fiscal expansions only in the long term and at the Greece

[40] In his comment to the Eggertsson's (2011a) paper, Christiano (2011) provides some useful insights and identifies two major ingredients for the deflationary pressure to emerge following a tax cut: *i)* the persistence of the deflationary pressure, i.e. the presence of relevant price rigidities; *ii)* the sensitivity of expenditures to the real interest rate, i.e. the empirical relevance of the Euler consumption equation. Our results, emerging in an extended structural model setting estimated on country data, provide evidence againts Eggertsson's theoretical result, giving an empirical assesment of both key factors.

and Portugal model parameter estimates.

The consideration of a liquidity trap environment tends to reinforce these conclusions only marginally, as both output and employment multipliers of government expenditures are slightly increased. On the contrary - and with the exception of Greece - the output multiplier of the LM-targeted measures are clearly negative in the short term, and their peak effects are reached with an increased delay as compared with the standard environment simulations.

These results basically highlight the importance of the fiscal-monetary policy coordination in the business cycle management, an option which might be out of reach during a deep recession.

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TABLE 1 - DOGMATIC PRIORS: STRUCTURAL PARAMETERS

Parameter	Description	Greece	Ireland	Italy	Portugal	Spain
β	Discount factor	0.994	0.997	0.996	0.999	0.995
α	Output elasticity of private capital	0.265	0.200	0.333	0.210	0.265
δ	Private capital depreciation rate	0.025	0.025	0.025	0.025	0.025
δ^g	Government capital depreciation rate	0.025	0.025	0.025	0.025	0.025
ν	Import share	0.206	0.656	0.210	0.262	0.202
ρ	Separation rate	0.028	0.042	0.021	0.039	0.061
σ_m	Matching efficiency	0.410	0.300	0.360	0.310	0.500
χ	Labor disutility scale	0.500	1.400	1.150	0.300	1.000
b^u	Unemployment benefit	0.650	0.650	0.630	0.720	0.610
γ_w	Calvo incumbent workers	0.750	0.800	0.850	0.770	0.750
θ_w	Calvo new workers	0.500	0.500	0.500	0.500	0.500
φ^j	Labor subsidies	0.000	0.000	0.000	0.000	0.000
τ^c	Consumption tax rate	0.163	0.220	0.174	0.180	0.140
τ^k	Capital tax rate	0.289	0.289	0.336	0.316	0.293
τ^n	Labor income tax rate	0.309	0.280	0.386	0.255	0.332
τ^p	Business tax rate	0.200	0.125	0.314	0.315	0.300
λ_p^i	Price markups	1.200	1.200	1.200	1.200	1.200
κ_ϵ^i	Demand elasticity	10.00	10.00	10.00	10.00	10.00
μ	Growth rate	0.999	1.007	1.002	1.003	1.002
$\widetilde{\phi}_a$	Exchange rate elasticity to net asset	0.001	0.001	0.001	0.001	0.001
d	Relative government transfers share	1.000	1.000	1.000	1.000	1.000

Notes: The parameters related to "great ratios" and other observable quantities related to steady state values are calibrated considering that the time unit is a quarter. The sector specific parameters denoted by i = d, m, x are assumed, as for the wage and hiring subsidy j = w, h, to be of equal value.

TABLE 2a - PRIOR DISTRIBUTIONS AND POSTERIOR MEAN ESTIMATES: MODEL ECONOMY

	Prior distribution		Posterior mean				
	Density	Mean (s.d.)	Greece [c.i.]	Ireland [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
ξ_p^d	$\mathcal{G}$	0.69 − 0.75*	0.896	0.899	0.889	0.859	0.857
		(0.10)	[0.873 − 0.918]	[0.881 − 0.917]	[0.880 − 0.897]	[0.840 − 0.877]	[0.845 − 0.871]
ξ_p^m	$\mathcal{G}$	0.69 − 0.75*	0.895	0.900	0.845	0.930	0.845
		(0.10)	[0.856 − 0.938]	[0.877 − 0.922]	[0.816 − 0.875]	[0.912 − 0.947]	[0.811 − 0.880]
ξ_p^x	$\mathcal{G}$	0.69 − 0.75*	0.822	0.800	0.802	0.833	0.792
		(0.10)	[0.778 − 0.867]	[0.768 − 0.835]	[0.761 − 0.844]	[0.791 − 0.887]	[0.748 − 0.839]
σ_c	$\mathcal{N}$	2.00	1.946	1.865	1.854	2.002	1.837
		(0.10)	[1.787 − 2.102]	[1.699 − 2.033]	[1.712 − 1.995]	[1.857 − 2.163]	[1.659 − 2.014]
h	$\mathcal{B}$	0.70	0.773	0.856	0.767	0.750	0.773
		(0.10)	[0.732 − 0.815]	[0.816 − 0.894]	[0.726 − 0.807]	[0.702 − 0.799]	[0.715 − 0.841]
ϕ^h	$\mathcal{B}$	0.25	0.105	0.197	0.395	0.458	0.175
		(0.10)	[0.059 − 0.156]	[0.078 − 0.307]	[0.306 − 0.483]	[0.363 − 0.554]	[0.093 − 0.257]
η	$\mathcal{G}$	1.50	0.887	1.052	0.455	0.667	0.788
		(0.40)	[0.735 − 1.045]	[0.642 − 1.450]	[0.321 − 0.592]	[0.484 − 0.845]	[0.632 − 0.953]
η^*	$\mathcal{G}$	1.50	0.659	0.801	0.892	0.677	0.588
		(0.40)	[0.546 − 0.767]	[0.656 − 0.957]	[0.773 − 1.006]	[0.546 − 0.809]	[0.451 − 0.716]
$\widetilde{\phi}_s$	$\mathcal{B}$	0.50	0.589	0.942	0.946	0.818	0.885
		(0.15)	[0.495 − 0.684]	[0.902 − 0.983]	[0.909 − 0.984]	[0.739 − 0.903]	[0.816 − 0.952]
$\widetilde{\phi}_r$	$\mathcal{G}$	1.25	0.682	0.928	1.030	0.814	0.824
		(0.50)	[0.598 − 0.763]	[0.883 − 0.975]	[0.987 − 1.072]	[0.744 − 0.888]	[0.758 − 0.898]
ψ^i	$\mathcal{N}$	5.00	12.93	8.065	11.50	9.007	8.986
		(2.50)	[10.25 − 15.57]	[5.445 − 10.56]	[9.47 − 13.59]	[6.978 − 10.98]	[7.040 − 10.93]
ψ^{ig}	$\mathcal{N}$	5.00	12.65	12.16	14.94	5.237	12.95
		(2.50)	[9.91 − 15.37]	[9.327 − 15.03]	[12.51 − 17.43]	[3.027 − 7.450]	[10.22 − 15.62]
ψ^k	$\mathcal{B}$	0.50	0.996	0.567	0.965	0.700	0.944
		(0.15)	[0.993 − 0.999]	[0.426 − 0.709]	[0.953 − 0.979]	[0.639 − 0.764]	[0.916 − 0.973]
σ_n	$\mathcal{B}$	0.50	0.565	0.463	0.630	0.493	0.566
		(0.10)	[0.427 − 0.704]	[0.362 − 0.572]	[0.499 − 0.757]	[0.477 − 0.510]	[0.423 − 0.716]
ς	$\mathcal{B}$	0.50	0.769	0.697	0.263	0.835	0.469
		(0.10)	[0.716 − 0.822]	[0.608 − 0.788]	[0.178 − 0.349]	[0.784 − 0.890]	[0.362 − 0.574]
κ	$\mathcal{G}$	0.05	0.045	0.042	0.035	0.060	0.037
		(0.01)	[0.031 − 0.058]	[0.026 − 0.058]	[0.023 − 0.045]	[0.051 − 0.069]	[0.025 − 0.049]

Notes: N and B are Normal and Beta distributions, respectively. Posterior mean estimates for the model economy parameters are obtained with 250000 M-H replications on two parallel chains. * denotes the range of values for the country-specific values Druant et al. (2012).

TABLE 2b - PRIOR DISTRIBUTIONS AND POSTERIOR MEAN ESTIMATES: MONETARY AUTHORITY

	Prior distribution		Posterior mean				
	Density	Mean (s.d.)	Greece [c.i.]	Ireland [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
ρ^R	$\mathcal{B}$	0.75	0.884	0.951	0.910	0.834	0.913
		(0.10)	[0.865 – 0.902]	[0.923 – 0.974]	[0.893 – 0.927]	[0.812 – 0.856]	[0.899 – 0.927]
ψ_1	$\mathcal{N}$	2.00	1.77	1.378	1.136	1.134	1.027
		(0.20)	[1.538 – 1.996]	[1.019 – 1.716]	[1.041 – 1.225]	[1.091 – 1.178]	[0.884 – 1.165]
ψ_2	$\mathcal{B}$	0.10	0.067	0.112	0.016	0.020	0.043
		(0.05)	[0.038 – 0.093]	[0.038 – 0.180]	[0.005 – 0.027]	[0.007 – 0.032]	[0.020 – 0.065]
ψ_3	$\mathcal{B}$	0.25	0.066	0.126	0.130	0.067	0.165
		(0.10)	[0.029 – 0.098]	[0.093 – 0.158]	[0.102 – 0.157]	[0.043 – 0.091]	[0.121 – 0.208]

Notes: N and B are Normal and Beta distributions, respectively. Posterior mean estimates for the monetary authority parameters are obtained with 250000 M-H replications on two parallel chains.

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TABLE 2c - PRIOR DISTRIBUTIONS AND POSTERIOR MEAN ESTIMATES: FISCAL AUTHORITY

	Prior distribution		Posterior mean				
	Density	Mean	Greece	Ireland	Italy	Portugal	Spain
		(s.d.)	[c.i.]	[c.i.]	[c.i.]	[c.i.]	[c.i.]
ω^c	$\mathcal{B}$	0.25	0.311	0.419	0.204	0.366	0.208
		(0.10)	[0.170 − 0.461]	[0.324 − 0.521]	[0.103 − 0.298]	[0.253 − 0.479]	[0.123 − 0.287]
ω^n	$\mathcal{B}$	0.25	0.382	0.408	0.261	0.257	0.154
		(0.10)	[0.221 − 0.545]	[0.276 − 0.562]	[0.103 − 0.410]	[0.130 − 0.380]	[0.053 − 0.251]
ω^k	$\mathcal{B}$	0.25	0.310	0.175	0.078	0.373	0.041
		(0.10)	[0.165 − 0.448]	[0.098 − 0.291]	[0.025 − 0.130]	[0.274 − 0.470]	[0.016 − 0.067]
ψ_τ	$\mathcal{B}$	0.05	0.004	0.022	0.018	0.013	0.016
		(0.02)	[0.002 − 0.005]	[0.015 − 0.027]	[0.012 − 0.024]	[0.010 − 0.015]	[0.011 − 0.020]
ρ_{τ^c}	$\mathcal{B}$	0.75	0.980	0.974	0.964	0.929	0.978
		(0.15)	[0.962 − 0.999]	[0.956 − 0.995]	[0.925 − 0.998]	[0.886 − 0.975]	[0.962 − 0.997]
ρ_{τ^n}	$\mathcal{B}$	0.75	0.981	0.988	0.989	0.983	0.980
		(0.15)	[0.968 − 0.995]	[0.978 − 0.998]	[0.980 − 0.998]	[0.973 − 0.994]	[0.964 − 0.998]
ρ_{τ^k}	$\mathcal{B}$	0.75	0.983	0.976	0.974	0.947	0.983
		(0.15)	[0.964 − 1.000]	[0.963 − 0.989]	[0.957 − 0.991]	[0.899 − 0.994]	[0.972 − 0.995]
ρ_{τ^p}	$\mathcal{B}$	0.75	0.985	0.971	0.948	0.986	0.972
		(0.15)	[0.973 − 0.999]	[0.949 − 0.994]	[0.920 − 0.977]	[0.972 − 0.999]	[0.951 − 0.993]
ρ_g	$\mathcal{B}$	0.75	0.969	0.952	0.984	0.991	0.989
		(0.15)	[0.937 − 0.999]	[0.927 − 0.979]	[0.972 − 0.998]	[0.985 − 0.998]	[0.980 − 0.998]
ρ_{tr}	$\mathcal{B}$	0.75	0.947	0.954	0.988	0.917	0.987
		(0.15)	[0.925 − 0.973]	[0.936 − 0.971]	[0.978 − 0.998]	[0.870 − 0.965]	[0.978 − 0.997]
η_{gy}	$\mathcal{N}$	1.00	1.002	0.943	1.016	1.024	1.027
		(0.10)	[0.843 − 1.168]	[0.774 − 1.109]	[0.848 − 1.186]	[0.863 − 1.186]	[0.853 − 1.187]
η_{try}	$\mathcal{N}$	1.00	1.006	1.037	1.010	1.016	1.006
		(0.10)	[0.841 − 1.175]	[0.879 − 1.199]	[0.850 − 1.175]	[0.858 − 1.181]	[0.838 − 1.173]
η_{gd}	$\mathcal{B}$	0.05	0.036	0.035	0.014	0.036	0.010
		(0.02)	[0.020 − 0.052]	[0.016 − 0.052]	[0.007 − 0.021]	[0.025 − 0.046]	[0.006 − 0.013]
η_{trd}	$\mathcal{B}$	0.05	0.059	0.113	0.014	0.019	0.016
		(0.02)	[0.021 − 0.094]	[0.081 − 0.145]	[0.008 − 0.019]	[0.010 − 0.028]	[0.011 − 0.021]

Notes: N and B are Normal and Beta distributions, respectively. Posterior mean estimates for the fiscal authority parameters are obtained with 250000 M-H replications on two parallel chains.

TABLE 2d - PRIOR DISTRIBUTIONS AND POSTERIOR MEAN ESTIMATES: COEFICIENTS OF SHOCKS

	Prior distribution		Posterior mean				
	Density	Mean (s.d.)	Greece [c.i.]	Ireland [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
ρ_{ξ^a}	$\mathcal{B}$	0.75	0.980	0.938	0.910	0.948	0.915
		(0.15)	[0.971 − 0.989]	[0.922 − 0.955]	[0.890 − 0.931]	[0.930 − 0.958]	[0.902 − 0.928]
ρ_{i^g}	$\mathcal{B}$	0.75	0.873	0.993	0.154	0.261	0.788
		(0.15)	[0.825 − 0.921]	[0.989 − 0.998]	[0.059 − 0.245]	[0.126 − 0.389]	[0.706 − 0.864]
$\rho_{\tilde{\phi}}$	$\mathcal{B}$	0.75	0.836	0.891	0.898	0.926	0.879
		(0.15)	[0.772 − 0.903]	[0.848 − 0.932]	[0.874 − 0.923]	[0.908 − 0.947]	[0.849 − 0.909]
ρ_{q_b}	$\mathcal{B}$	0.75	0.874	0.916	0.889	0.854	0.906
		(0.15)	[0.847 − 0.900]	[0.876 − 0.956]	[0.863 − 0.914]	[0.827 − 0.882]	[0.883 − 0.929]
ρ_{ϱ}	$\mathcal{B}$	0.75	0.990	0.934	0.918	0.899	0.930
		(0.15)	[0.980 − 0.999]	[0.905 − 0.964]	[0.895 − 0.941]	[0.856 − 0.945]	[0.912 − 0.950]
ρ_{ν}	$\mathcal{B}$	0.75	0.974	0.976	0.916	0.957	0.929
		(0.15)	[0.957 − 0.991]	[0.964 − 0.990]	[0.894 − 0.939]	[0.929 − 0.988]	[0.907 − 0.951]
ρ_{x}	$\mathcal{B}$	0.75	0.990	0.976	0.895	0.960	0.908
		(0.15)	[0.989 − 0.995]	[0.962 − 0.992]	[0.867 − 0.923]	[0.914 − 0.992]	[0.882 − 0.932]

Notes: B represents the Beta distribution. Posterior mean estimates for the AR(1) coeficients of shocks are obtained with 250000 M-H replications on two parallel chains.

TABLE 2e - PRIOR DISTRIBUTIONS AND POSTERIOR MEAN ESTIMATES: S.D. OF SHOCK PROCESSES

	Prior distribution		Posterior mean				
	Density	Mean (s.d.)	Greece [c.i.]	Ireland [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
$\varepsilon_{\tau^n,t}$	$\mathcal{G}^{-1}$	0.01	0.009	0.004	0.005	0.005	0.004
		(2.00)	[0.008 – 0.010]	[0.004 – 0.005]	[0.004 – 0.005]	[0.005 – 0.006]	[0.004 – 0.004]
$\varepsilon_{\tau^p,t}$	$\mathcal{G}^{-1}$	0.01	0.013	0.006	0.014	0.014	0.020
		(2.00)	[0.012 – 0.015]	[0.006 – 0.007]	[0.012 – 0.015]	[0.013 – 0.016]	[0.018 – 0.022]
$\varepsilon_{\tau^k,t}$	$\mathcal{G}^{-1}$	0.01	0.021	0.021	0.020	0.013	0.009
		(2.00)	[0.019 – 0.024]	[0.019 – 0.023]	[0.018 – 0.022]	[0.012 – 0.015]	[0.008 – 0.010]
$\varepsilon_{\tau^c,t}$	$\mathcal{G}^{-1}$	0.01	0.003	0.004	0.003	0.004	0.004
		(2.00)	[0.003 – 0.004]	[0.004 – 0.005]	[0.002 – 0.003]	[0.004 – 0.005]	[0.003 – 0.004]
$\varepsilon_{g,t}$	$\mathcal{G}^{-1}$	0.01	0.025	0.028	0.019	0.025	0.011
		(2.00)	[0.022 – 0.027]	[0.025 – 0.031]	[0.017 – 0.021]	[0.022 – 0.028]	[0.010 – 0.012]
$\varepsilon_{tr,t}$	$\mathcal{G}^{-1}$	0.01	0.080	0.027	0.014	0.021	0.012
		(2.00)	[0.072 – 0.088]	[0.024 – 0.030]	[0.013 – 0.015]	[0.019 – 0.023]	[0.011 – 0.013]
$\varepsilon_{i^g,t}$	$\mathcal{G}^{-1}$	0.1	0.125	0.182	0.973	0.580	0.125
		(2.00)	[0.097 – 0.152]	[0.147 – 0.216]	[0.813 – 1.132]	[0.326 – 0.830]	[0.094 – 0.155]
$\varepsilon_{\xi^a,t}$	$\mathcal{G}^{-1}$	0.01	0.012	0.016	0.010	0.010	0.009
		(2.00)	[0.010 – 0.013]	[0.014 – 0.018]	[0.009 – 0.011]	[0.009 – 0.011]	[0.008 – 0.010]
$\varepsilon_{r,t}$	$\mathcal{G}^{-1}$	0.01	0.003	0.005	0.002	0.002	0.003
		(2.00)	[0.003 – 0.003]	[0.004 – 0.005]	[0.002 – 0.002]	[0.002 – 0.002]	[0.003 – 0.003]
$\varepsilon_{p,t}^d$	$\mathcal{G}^{-1}$	0.5	3.334	3.099	1.584	0.887	0.728
		(2.00)	[1.945 – 4.627]	[1.992 – 4.05]	[1.288 – 1.856]	[0.649 – 1.122]	[0.576 – 0.871]
$\varepsilon_{p,t}^m$	$\mathcal{G}^{-1}$	0.5	7.335	2.430	2.599	1.284	3.478
		(2.00)	[2.134 – 12.019]	[1.379 – 3.405]	[1.608 – 3.571]	[0.672 – 1.924]	[1.998 – 4.933]
$\varepsilon_{p,t}^x$	$\mathcal{G}^{-1}$	0.5	3.118	1.028	1.423	1.754	1.615
		(2.00)	[1.57 – 4.620]	[0.649 – 1.399]	[0.844 – 2.048]	[0.794 – 2.794]	[0.939 – 2.445]
$\varepsilon_{q_b,t}$	$\mathcal{G}^{-1}$	0.01	0.004	0.004	0.002	0.002	0.002
		(2.00)	[0.004 – 0.004]	[0.004 – 0.004]	[0.002 – 0.002]	[0.002 – 0.002]	[0.002 – 0.002]
$\varepsilon_{q_i,t}$	$\mathcal{G}^{-1}$	0.5	0.269	0.498	0.210	0.250	0.204
		(2.00)	[0.210 – 0.324]	[0.329 – 0.657]	[0.172 – 0.250]	[0.191 – 0.309]	[0.156 – 0.247]
$\varepsilon_{\widetilde{\phi},t}$	$\mathcal{G}^{-1}$	0.01	0.004	0.003	0.002	0.002	0.003
		(2.00)	[0.002 – 0.006]	[0.002 – 0.004]	[0.002 – 0.003]	[0.001 – 0.002]	[0.002 – 0.003]

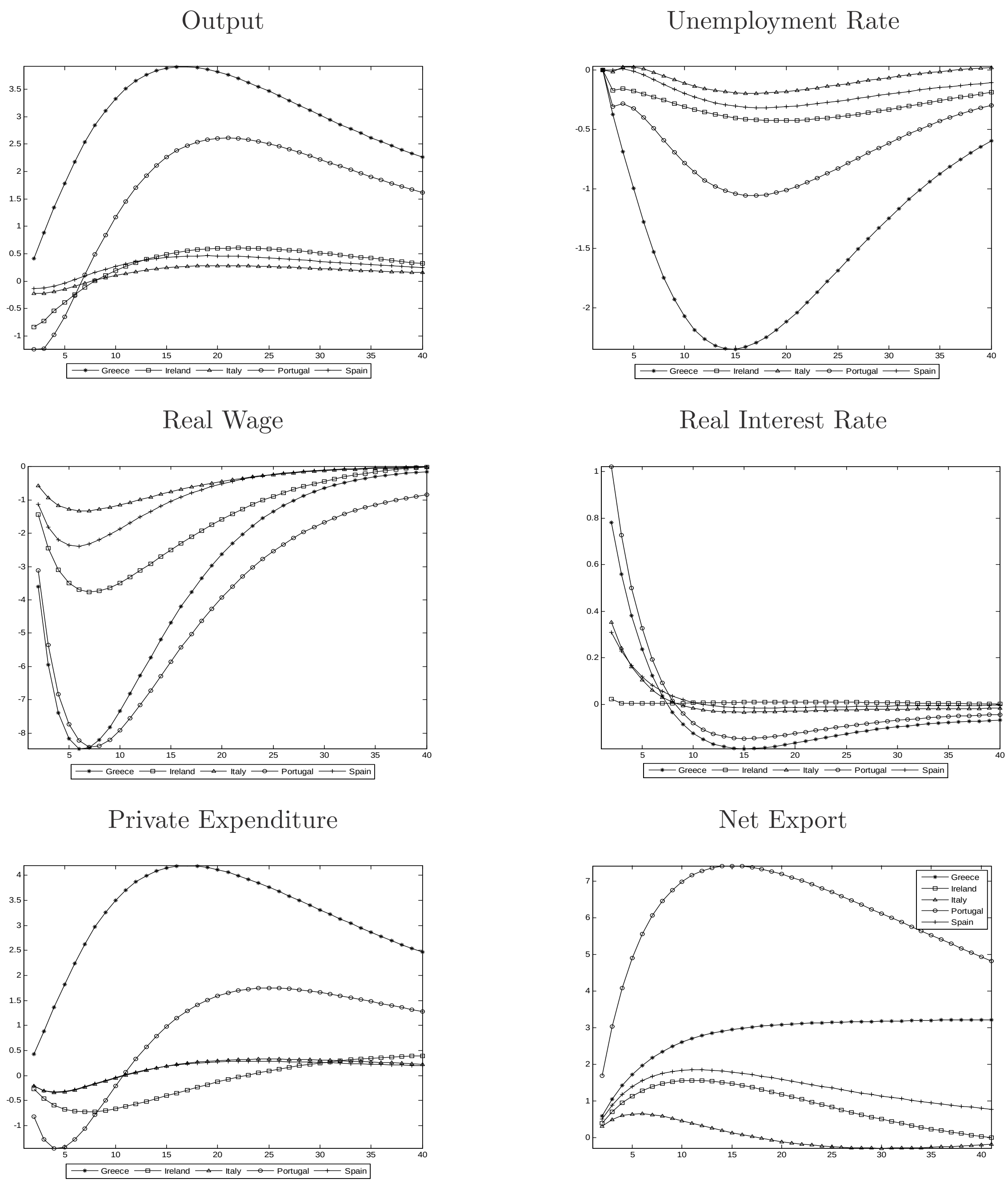
Notes: G represents the Gamma distribution. Posterior mean estimates for the standard deviation.of shock processes are obtained with 250000 M-H replications on two parallel chains.

TABLE 2e - (CONTINUED)

	Prior distribution			Posterior mean			
	Density	Mean (s.d.)	Greece [c.i.]	Ireland [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
$\varepsilon_{\xi^c,t}$	$\mathcal{G}^{-1}$	0.01	0.112	0.181	0.097	0.146	0.058
		(2.00)	$[0.086 - 0.137]$	$[0.128 - 0.231]$	$[0.073 - 0.120]$	$[0.111 - 0.181]$	$[0.043 - 0.074]$
$\varepsilon_{\xi^n,t}$	$\mathcal{G}^{-1}$	0.01	0.076	0.037	0.012	0.050	0.022
		(2.00)	$[0.060 - 0.091]$	$[0.029 - 0.045]$	$[0.011 - 0.014]$	$[0.042 - 0.057]$	$[0.019 - 0.025]$
$\varepsilon_{x,t}$	$\mathcal{G}^{-1}$	0.01	0.038	0.025	0.030	0.025	0.035
		(2.00)	$[0.034 - 0.042]$	$[0.023 - 0.028]$	$[0.027 - 0.033]$	$[0.022 - 0.028]$	$[0.031 - 0.039]$
$\varepsilon_{cpi,t}$	$\mathcal{G}^{-1}$	0.01	0.010	0.009	0.006	0.004	0.009
		(2.00)	$[0.009 - 0.011]$	$[0.008 - 0.010]$	$[0.006 - 0.007]$	$[0.003 - 0.004]$	$[0.008 - 0.010]$
$\varepsilon_{\nu,t}$	$\mathcal{G}^{-1}$	0.01	0.031	0.032	0.029	0.024	0.033
		(2.00)	$[0.027 - 0.034]$	$[0.029 - 0.035]$	$[0.026 - 0.032]$	$[0.021 - 0.026]$	$[0.029 - 0.037]$
$\varepsilon_{\varrho,t}$	$\mathcal{G}^{-1}$	0.01	0.009	0.013	0.007	0.008	0.007
		(2.00)	$[0.008 - 0.010]$	$[0.012 - 0.015]$	$[0.006 - 0.008]$	$[0.007 - 0.009]$	$[0.006 - 0.008]$
$\varepsilon^*_{dp,t}$	$\mathcal{G}^{-1}$	0.005	0.006	0.006	0.006	0.006	0.006
		(2.00)	$[0.006 - 0.007]$	$[0.006 - 0.007]$	$[0.006 - 0.007]$	$[0.006 - 0.007]$	$[0.006 - 0.007]$
$\varepsilon^*_{y,t}$	$\mathcal{G}^{-1}$	0.005	0.006	0.006	0.006	0.006	0.006
		(2.00)	$[0.005 - 0.006]$	$[0.005 - 0.006]$	$[0.005 - 0.006]$	$[0.005 - 0.006]$	$[0.005 - 0.006]$
$\varepsilon^*_{r,t}$	$\mathcal{G}^{-1}$	0.005	0.002	0.002	0.002	0.002	0.002
		(2.00)	$[0.002 - 0.002]$	$[0.002 - 0.002]$	$[0.002 - 0.002]$	$[0.002 - 0.002]$	$[0.002 - 0.002]$
$\varepsilon^*_{rl,t}$	$\mathcal{G}^{-1}$	0.005	0.001	0.001	0.001	0.001	0.001
		(2.00)	$[0.001 - 0.001]$	$[0.001 - 0.001]$	$[0.001 - 0.001]$	$[0.001 - 0.001]$	$[0.001 - 0.001]$

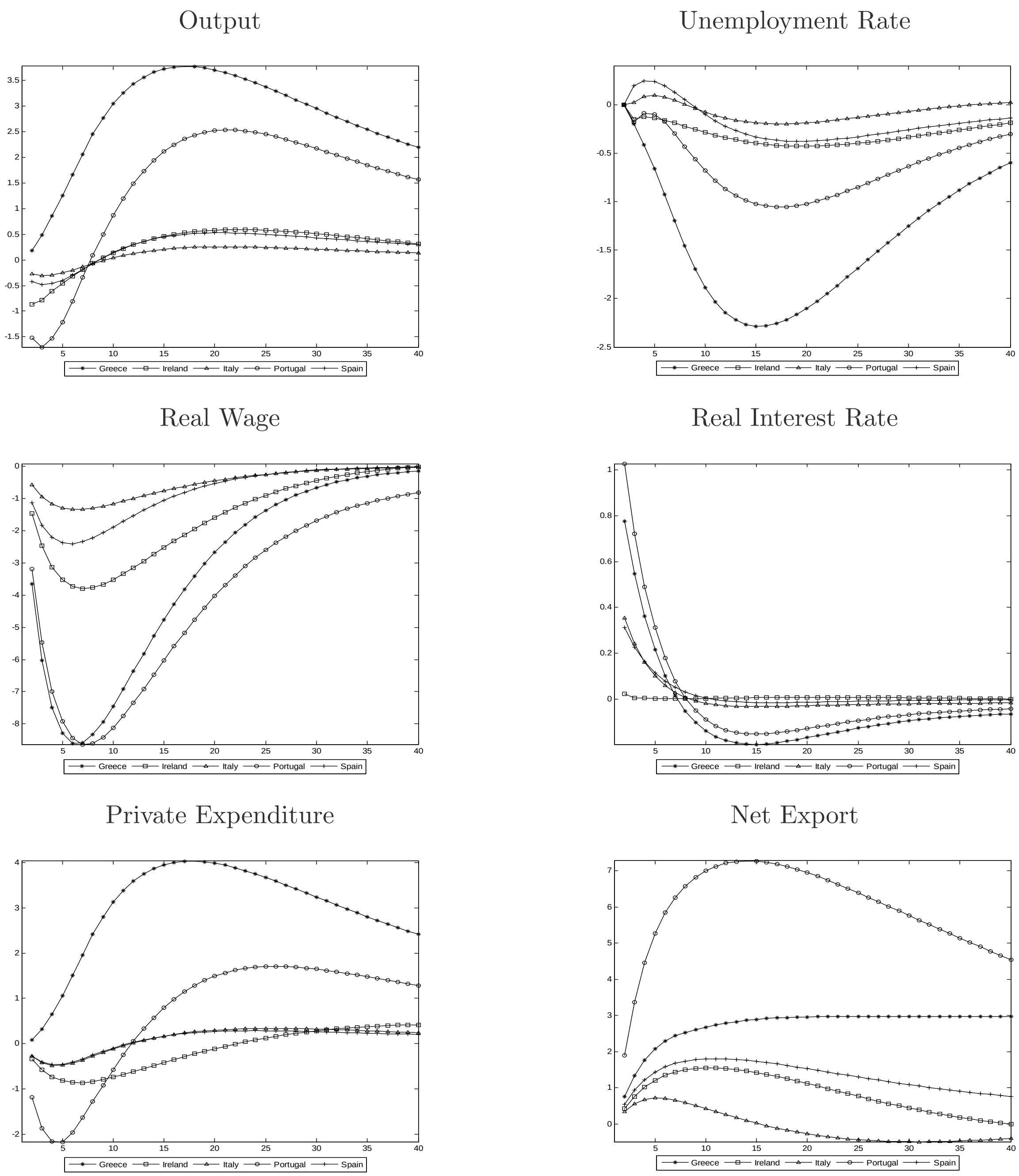
Notes: G represents the Gamma distribution. Posterior mean estimates for the standard deviation of shock processes are obtained with 250000 M-H replications on two parallel chains.

FIGURE 1 - WAGE SUBSIDIZATION OF NEWLY HIRED WORKERS - NORMAL TIMES



Notes: Impulse response of output (Y_t), unemployment (u_t), real wage (w_t), real interest rate (R_t), private expenditure (C_t) and net export ($X_t - M_t$) to a one percent shock in wage subsidization of newly hired workers in the periphery of the eurozone. Impulse responses in standard times are obtained at the posterior mean estimate.

FIGURE 2 - WAGE SUBSIDIZATION OF NEWLY HIRED WORKERS - ZLB BINDS FOR 8 PERIODS



Notes: Impulse response of output (Y_t), unemployment (u_t), real wage (w_t), real interest rate (R_t), private expenditure (C_t) and net export ($X_t - M_t$) to a one percent shock in wage subsidization of newly hired workers in the periphery of the eurozone. Impulse responses when ZLB binds for 8 periods are obtained at the posterior mean estimate.

TABLE 3 - FISCAL MULTIPLIERS - STANDARD TIMES

Instrument	Multiplier	Greece	Ireland	Italy	Portugal	Spain
Hiring subsidy	Impact	0.41	−0.96	−0.25	−1.43	−0.17
	Peak (quarter)	4.02 (15)	0.72 (21)	0.31 (19)	2.94 (20)	0.58 (18)
Wage subsidy	Impact	0.41	−0.83	−0.22	−1.24	−0.14
	Peak (quarter)	3.91 (16)	0.60 (21)	0.28 (19)	2.61 (20)	0.46 (18)
Gov. consumption	Impact	1.00	1.55	0.98	1.28	0.99
	Peak (quarter)	1.00 (1)	1.55 (1)	0.98 (1)	1.28 (1)	0.99 (1)
Gov. transfers	Impact	0.06	0.09	0.26	0.36	0.12
	Peak (quarter)	0.06 (1)	0.09 (1)	0.26 (1)	0.36 (1)	0.12 (1)
Gov. investment	Impact	0.22	0.23	0.14	0.50	0.16
	Peak (quarter)	0.51 (6)	0.38 (4)	0.31 (5)	1.01 (5)	0.34 (5)
Wage.tax	Impact	0.09	0.10	0.35	0.44	0.16
	Peak (quarter)	0.09 (1)	0.10 (1)	0.35 (1)	0.44 (1)	0.16 (1)
Profit.tax	Impact	0.00	-0.02	−0.01	0.00	−0.01
	Peak (quarter)	0.01 (16)	0.02 (22)	0.01 (17)	0.01 (22)	0.02 (16)
Capital gains.tax	Impact	0.01	0.01	0.02	0.02	0.01
	Peak (quarter)	0.03 (6)	0.02 (4)	0.04 (5)	0.04 (5)	0.03 (5)
Consumption.tax	Impact	0.13	0.10	0.26	0.41	0.18
	Peak (quarter)	0.15 (2)	0.10 (1)	0.26 (1)	0.41 (1)	0.18 (2)

Notes: Fiscal multipliers on output (Y_t) in standard times for the PIIGS countries are reported for different potential government instruments. In order to get a clear view, not only for their value on impact, the peak of fiscal multipliers and the time, in brackets, in whitch it is realized is also reported.

TABLE 4 - UNEMPLOYMENT EFFECTS - STANDARD TIMES

Instrument	Multiplier	Greece	Ireland	Italy	Portugal	Spain
Hiring subsidy	Impact	−0.38	−0.20	-0.01	−0.34	0.01
	Peak (quarter)	−2.42 (13)	−0.51 (18)	−0.21 (16)	−1.19 (16)	−0.39 (17)
Wage subsidy	Impact	−0.37	−0.17	-0.01	−0.30	0.00
	Peak (quarter)	−2.35 (14)	−0.42 (18)	−0.19 (16)	−1.06 (16)	−0.31 (17)
Gov. consumption	Impact	−0.74	−0.76	−0.76	−0.45	−0.74
	Peak (quarter)	−0.74 (1)	−0.76 (1)	−0.76 (1)	−0.45 (1)	−0.74 (1)
Gov. transfers	Impact	−0.05	−0.04	−0.20	−0.13	−0.09
	Peak (quarter)	−0.05 (1)	−0.04 (1)	−0.20 (1)	−0.13 (1)	−0.09 (1)
Gov. investment	Impact	−0.16	−0.14	−0.11	−0.21	−0.12
	Peak (quarter)	−0.27 (5)	−0.17 (4)	−0.16 (4)	−0.36 (5)	−0.17 (4)
Wage.tax	Impact	−0.06	−0.05	−0.27	−0.15	−0.12
	Peak (quarter)	−0.06 (1)	−0.05 (1)	−0.27 (1)	−0.15 (1)	−0.12 (1)
Profit.tax	Impact	0.00	0.00	0.00	0.00	0.00
	Peak (quarter)	−0.01 (14)	−0.02 (19)	−0.01 (15)	0.00 (18)	−0.02 (14)
Capital gains.tax	Impact	−0.01	−0.01	−0.01	−0.01	−0.01
	Peak (quarter)	−0.02 (5)	−0.01 (4)	−0.02 (4)	−0.02 (5)	−0.02 (5)
Consumption.tax	Impact	−0.10	−0.05	−0.21	−0.15	−0.13
	Peak (quarter)	−0.10 (2)	−0.05 (1)	−0.21 (1)	−0.15 (1)	−0.13 (1)

Notes: Fiscal multipliers on unemployment (u_t) in standard times for the PIIGS countries are reported for different potential government instruments. In order to get a clear view, not only for their value on impact, the peak of fiscal multipliers and the time, in brackets, in whitch it is realized is also reported.

TABLE 5 - FISCAL MULTIPLIERS - ZLB BINDS FOR 8 PERIODS

Instrument	Multiplier	Greece	Ireland	Italy	Portugal	Spain
Hiring subsidy	Impact	0.02	−1.00	0.59	−1.88	−0.24
	Peak + (quarter)	3.89 (16)	0.70 (21)	0.24 (21)	2.82 (20)	0.55 (19)
	Peak - (quarter)	–	−1.00 (1)	−0.61 (2)	−2.18 (2)	−0.28 (2)
Wage subsidy	Impact	0.18	−0.87	−0.27	−1.52	−0.42
	Peak + (quarter)	3.78 (16)	0.59 (21)	0.26 (20)	2.53 (20)	0.53 (19)
	Peak - (quarter)	–	−0.87 (1)	−0.30 (2)	−1.70 (2)	−0.48 (2)
Gov. consumption	Impact	1.01	1.56	0.99	1.29	1.02
	Peak (quarter)	1.01 (1)	1.56 (1)	0.99 (1)	1.29 (1)	1.02 (1)
Gov. transfers	Impact	0.07	0.09	0.26	0.37	0.13
	Peak (quarter)	0.07 (1)	0.09 (1)	0.26 (1)	0.37 (1)	0.13 (1)
Gov. investment	Impact	0.22	0.24	0.15	0.51	0.17
	Peak (quarter)	0.52 (5)	0.41 (4)	0.32 (5)	1.04 (5)	0.37 (5)
Wage tax	Impact	0.09	0.10	0.35	0.44	0.17
	Peak (quarter)	0.09 (1)	0.10 (1)	0.35 (1)	0.44 (1)	0.17 (1)
Profit.tax	Impact	0.06	0.02	-0.25	0.00	-0.16
	Peak (quarter)	0.51 (17)	0.02 (1)	0.26 (18)	0.01 (4)	0.38 (17)
Capital gains tax	Impact	0.01	0.01	0.02	0.02	0.01
	Peak (quarter)	0.03 (6)	0.02 (4)	0.04 (5)	0.04 (5)	0.03 (5)
Consumption tax	Impact	0.14	0.10	0.27	0.41	0.19
	Peak (quarter)	0.16 (2)	0.10 (1)	0.27 (1)	0.41 (1)	0.20 (2)

Notes: Fiscal multipliers on output (Y_t) in ZLB times for the PIIGS countries are reported for different potential government instruments. In order to get a clear view, not only for their value on impact, the peak of fiscal multipliers and the time, in brackets, in whitch it is realized is also reported.

TABLE 6 - UNEMPLOYMENT EFFECTS - ZLB BINDS FOR 8 PERIODS

Instrument	Multiplier	Greece	Ireland	Italy	Portugal	Spain
Hiring subsidy	Impact	−0.09	−0.17	0.26	−0.14	0.06
	Peak (quarter)	−2.35 (14)	−0.51 (19)	−0.19 (17)	−1.19 (17)	−0.39 (17)
Wage subsidy	Impact	−0.20	−0.15	0.03	−0.18	0.20
	Peak (quarter)	−2.28 (14)	−0.42 (19)	−0.19 (16)	−1.05 (16)	−0.37 (18)
Gov. consumption	Impact	−0.75	−0.77	−0.77	−0.46	−0.76
	Peak (quarter)	−0.75 (1)	−0.77 (1)	−0.77 (1)	−0.46 (1)	−0.76 (1)
Gov. transfers	Impact	−0.05	−0.04	−0.21	−0.13	−0.09
	Peak (quarter)	−0.05 (1)	−0.04 (1)	−0.21 (1)	−0.13 (1)	−0.09 (1)
Gov. investment	Impact	−0.16	−0.15	−0.12	−0.22	−0.13
	Peak (quarter)	−0.28 (5)	−0.18 (4)	−0.17 (4)	−0.37 (5)	−0.19 (5)
Wage tax	Impact	-0.06	-0.05	-0.28	-0.16	-0.12
	Peak (quarter)	−0.06 (1)	−0.05 (1)	−0.28 (1)	−0.16 (1)	−0.12 (1)
Profit tax	Impact	-0.05	0.00	0.00	0.00	0.02
	Peak (quarter)	-0.41 (15)	0.01 (19)	-0.21 (16)	−0.01 (18)	-0.26 (16)
Capital gains tax	Impact	-0.01	-0.01	-0.01	-0.01	−0.01
	Peak (quarter)	−0.02 (5)	−0.01 (4)	−0.02 (4)	−0.02 (5)	−0.02 (5)
Consumption tax	Impact	-0.10	-0.06	-0.21	-0.15	-0.14
	Peak (quarter)	−0.11 (2)	−0.06 (1)	-0.21 (1)	−0.15 (1)	−0.14 (2)

Notes: Fiscal multipliers on unemployment (u_t) in zlb times for the PIIGS countries are reported for different potential government instruments. In order to get a clear view, not only for their value on impact, the peak of fiscal multipliers and the time, in brackets, in whitch it is realized is also reported.

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