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Fiscal retrenchments and the transmission mechanism of the sovereign risk channel for highly indebted countries☆

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ABSTRACT

We formalize sovereign and private sector default probabilities into a monetary model in order to test the hypothesis, which recently appeared in the literature, of whether the consideration of a sovereign risk channel affects the sign and size of output fiscal multipliers. The model is estimated for the most vulnerable Eurozone countries-characterized by high debt-to-GDP ratio-and stochastically simulated conditional on expenditure and revenue policy measures. We show that, conditional on specific fiscal shocks, the risk channel can operate in a pro-cyclical direction, amplifying the temporary contractionary effects of fiscal retrenchments. We show that both the relations between economic fundamentals and sovereign debt spreads and that between sovereign and credit spreads are weak. Therefore, the effectiveness of the risk channel for fiscal consolidations is small, irrespective of the direction of change in the sovereign default probability.

1. Introduction

We evaluate the empirical validity of the sovereign risk channel hypothesis and the related result of a likely emergence of expansionary fiscal contractions. The issue is of paramount importance for those countries characterized by a high degree of indebtedness, which exposes them to sovereign risk crises due to substantial deviations of sovereign bond rates and private lending rates from the risk-free policy rate. We test the model for those economies of the Eurozone with heterogeneously high degrees of indebtedness (i.e. Italy, Spain, Portugal, and Greece) that made them all very close to a sovereign risk crisis.

In the wake of the recent global recession, the unprecedented increase of sovereign debt in some OECD economies triggered a renewed interest in debt accumulation dynamics. This situation has been particularly worrying in the Eurozone, where markets doubted the sustainability of debt for those countries experiencing increased borrowing costs due to rising bond rates. In Europe, the perceived risks of contagion led both governments and supranational institutions to set up coordinated fiscal consolidation measures targeted to gain both solvency and control over strained public budgets. The effectiveness of these fiscal arrangements, partly backed by the hypothesis of expansionary fiscal contractions (Giavazzi & Pagano, 1996; Alesina & Ardagna, 2010), has received considerable interest in current macroeconomic research, even if it misses a widespread scientific consensus (Romer, 2010; Guajardo, 2014; Ramey, 2011).

Notably, the sovereign risk channel hypothesis, suggested by the quite strong unconditional correlation between government bond

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and private lending rate spreads observed during the crisis (Harjes, 2011; Corsetti, Kuester, Meier, & Müller, 2013), has provided further support to the idea of expansionary austerity. The economic argument is that a front-loaded fiscal retrenchment, by reducing the level of debt, can lead to a reduction in the sovereign default risk and thus in bond rates and private lending rates. The improved credit conditions to the private sector can stimulate a recovery, eventually reversing the negative effects of the fiscal contraction.

We extend a standard medium-scale monetary model to the consideration of both an open economy belonging to a monetary union and default probabilities on the side of both public and private borrowers. Our variant of the standard model features two critical innovations. The relation between sovereign default probability and interest rate spreads is modeled such that output, public debt, and the net foreign asset position (foreign debt) are the arguments of the sovereign default probability function. The private sector's default probability emerges within the theoretical apparatus characterizing the credit channel of monetary policy transmission (Bernanke et al., 1995). The open economy-monetary union model extension (Flotho, 2014) is thus implemented to capture the role of the net foreign asset position (NFA) dynamics among the fundamental drivers of sovereign risk. The choice of considering output within the triggers of default risk encounters theoretical and empirical justifications in the literature (Yeyati & Panizza, 2011; Mendoza, 2012; Juessen, Linnemann, & Shabert, 2014). Furthermore, it allows highlighting the close link between the size of the fiscal multipliers and the sign of the sovereign risk channel effects. In fact, when the former are sufficiently high, the debt-to-output ratio can increase following a fiscal contraction, leading to further deflationary pressure through increased bond and lending rate spreads.[1]

The model is estimated with Bayesian techniques on country-specific data. Based on the estimated parameterizations, we first detail the transmission mechanism of fiscal consolidations on interest rate spreads, and then evaluate the output multipliers of financially equivalent fiscal contractions affecting government consumption on the expenditure side, and labor income taxes on the revenue side.

Results show that *(i)* conditional on fiscal retrenchments implemented with expenditure cuts, the relatively high size of the short-term output multipliers implies that, despite the reduction of the debt level, a temporary but persistent increase in the debt-to-GDP ratio is observed, such that the risk channel tends to amplify the Keynesian effects of the fiscal contraction. In other words, it amplifies the transmission of shocks to aggregate demand. The improvement in the country's NFA position is not sufficient to reverse the former effect; *(ii)* conditional on labor tax increases, the risk channel operates in the predicted direction, given the reduction in the debt-to-GDP ratio and the improvement in the NFA position; *(iii)* irrespective of the direction of change in the sovereign default probability, the default risk channel is only marginally effective, because both the estimated relations-between fundamentals and spreads and between government and credit interest rate spreads-are weak.

Our paper relates to a large body of literature about the sovereign risk channel. *First*, it contributes to the literature on the determinants of sovereign risk, whose explanations based on movements in fundamentals (Barrios, Iversen, Lewandowska, & Setzer, 2009; Corsetti et al., 2013) are opposed to those favoring the idea of self-fulfilling debt crises (Bocola & Dovis, 2016; Beqiraj, Patella, Tancioni, Patella, & Tancioni, 2019; Patella & Tancioni, 2021). Even if descriptions of the role of non-fundamental factors in the emergence of credit spreads date back to Calvo (1998), more recent theoretical insights are provided by Broner, Erce, Martin, and Ventura (1998), Ayres, Navarro, Nicolini, and Teles (2018), and Lorenzoni and Werning (2019). *Second*, our investigation complements studies addressing the links between sovereign and private credit risk. Empirical evidence regarding the strong co-movements between sovereign and financial crises was provided by Diebold and Yilmaz (2009) and Reinart and Rogoff (2011) with aggregate macroeconomic data. On the theoretical terrain, Bocola (2016) investigated the impact of sovereign risk on banks' balance sheets, credit provision, and output losses. Faia (2017) modeled a more comprehensive set of sovereign risk mechanisms, featuring a balance sheet, a collateral, and a liquidity channel. Acharya, Drechsler, and Schnabl (2014), Farhi (2017), and Cooper and Nikolov (2018) analyzed the pass-through mechanics under the lens of banks bailouts incentives and costs.

Notwithstanding these relations to the literature, we have to stress that our investigation is restricted to the theoretical conceptualization and empirical evaluation of the risk channel hypothesis, thus of the role of fundamentals (generally conceived in terms of output and fiscal/debt outlook in the literature) for the pricing of public and credit debt obligations (Corsetti et al., 2013), and taking the perspective of financially stressed countries belonging to (and only partially interacting with) the Eurozone. This evaluation perspective is thus unable to provide a comprehensive description of the observed dynamics in sovereign and credit spreads. In particular, it cannot directly address monetary policy issues and the related market confidence switches, possibly leading to risks of contagion across countries.[2] This implies that a large fraction of the spreads' variability and the increasingly frequent episodes of stress in borrowing operations-emerged even under relatively stable macroeconomic fundamentals-is left unaddressed.

The paper is organized as follows. Section 2 reports some stylized facts about the risk channel. Section 3 describes the model, focusing in particular on the theoretical extensions implemented in the design of the financial sector. Section 4 provides the estimation and a discussion of simulation results, explaining the propagation mechanics. Section 5 concludes.

[1] The consideration of the debt level (Corsetti et al., 2013) would constrain the direction of change of the default probability to the one of the policy.

[2] The euro area's policy framework is characterized by the absence of an unconditional backstop mandate for the ECB, and by a consolidating fiscal space on the side of national governments. The lack of a "lender of last resort" mandate for the ECB implies the countries belonging to the euro-area issue debt in foreign currency. This unavoidably exposes fiscally fragile sovereigns to the risk of credibility and liquidity crises (De Grauwe, 2012). Moreover, since the creation of the EMU, born under the operation of the "dissuasive arm" of the Stability and Growth Pact in 1999, euro-area countries underwent three waves of fiscal retrenchments: the adoption of the six-pack in 2011; the Treaty on Stability, Coordination, and Governance in 2012 (known as Fiscal Compact); and of the two-pack in 2013. Within these institutional arrangements, market confidence can become fragile and subject to large and sharp reversals.

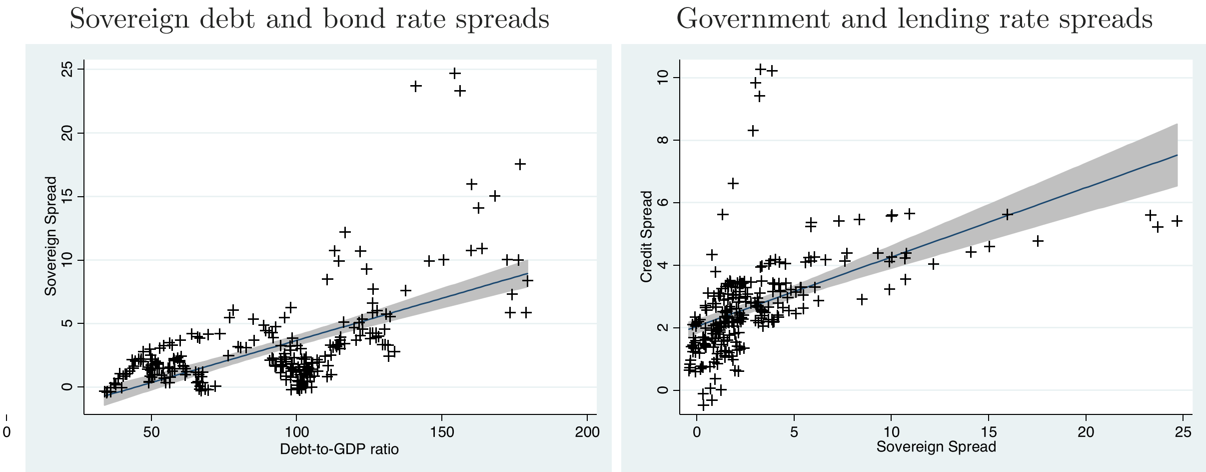

Fig. 1. *Risk channel hypothesis: sovereign debt and interest rate spreads - 1999q1-2014q3. Notes*: The scatter plots in the left graph consider the relation between the sovereign debt-to-GDP ratio and the sovereign debt interest rate spread, the latter defined as the interest rate differential between the 10-year government bond interest rate and the ECB's policy rate, for a selection of southern European countries (Italy, Spain, Portugal, and Greece). The scatter plots in the right graph relate the private credit rate spread (interest rate differential between the lending rate to non-financial corporations and the ECB's policy rate) to the sovereign debt spread.

2. Stylized facts

Here we provide some evidence considering euro-area countries characterized by a high degree of indebtedness, the key factor in determining the strength of the sovereign risk channel, through which higher public indebtedness adversely affects private-sector financing costs. We explore its implications for macroeconomic stability and fiscal stabilization policies. It is widely recognized that at least part of the movement in sovereign funding costs spills over private credit markets. Private credit spreads rise with sovereign risk because strained public finances raise the cost of financial intermediation. This assumption reflects the observation that as sovereign default looms, domestic firms face a higher risk of financial difficulties due to the risk of tax hikes, increases in tariffs, disruptive strikes, social unrest and general economic turmoil, all of which may raise the challenge of monitoring and enforcing loan contracts. A further cause of the risk nexus operates through the liquidity channel. Notably, a depreciation of sovereign assets eligible as collateral in a bank's balance sheets reduces its ability to re-finance its liquidity.

To form a first idea about the empirical relevance of the sovereign risk channel hypothesis in countries with heterogeneously high degrees of indebtedness, we consider four southern European countries belonging to the euro-area (Italy, Spain, Portugal, and Greece). Fig. 1 provides sample information about the key relations characterizing the transmission mechanisms, precisely the relation between the debt-to-output ratio and the sovereign interest rate spread, and that between the latter and the credit spread, both defined with respect to the European Central Bank's (ECB) marginal refinancing operations rate (the ECB's policy rate), which we take as the risk-free rate, consistently with the model's definitions. The sovereign interest rate is the 10-year government bond rate, and the credit rate is the banks' lending rate to non-financial corporations.[3]

The left panel of Fig. 1 shows a positive relationship between the debt-to-GDP ratio and the sovereign spread. This suggests that countries characterized by high indebtedness experience interest rate spreads on government bonds larger than others. Furthermore, the right panel of Figure 1 reports the relationship between the private and sovereign spreads. It shows a positive relationship between credit spreads and government bond spreads, suggesting the existence of a potential pass-through of the interest rate spread from the public to the private sector.

3. The model

We jointly consider a number of extensions to the standard medium-scale monetary model, characterized by the presence of nominal and real frictions in both the monopolistically competitive goods and labor markets (Christiano, Eichenbaum, & Evans, 2005; Smets, 2007). *First*, we allow for the co-existence of optimizing and liquidity-constrained households (Galı, López-Salido, & Vallés, 2007), to account for the substantial deviations from the permanent income hypothesis observed in empirical trials. *Second*, we introduce a monopolistically competitive credit sector (Curdia & Woodford, 2010), which is subject to costly Rotemberg pricing and

[3] Outside model consistency reasons, the preferred definition of risk (spreads) is based on the assumption that the now standard use of the maturity-matched German bund rate would not account for the evidence that German sovereign bonds cannot be conceived as risk-free assets over the entire time window considered in the analysis (Gilchrist, 2018). Moreover, this definition of spreads implies that the monetary policy stance-as captured by the dynamics of the reference ECB's interest rate instrument-enters the measure of risk considered in the model.

non-zero default probabilities for both public and private borrowers, such that a sovereign default risk channel emerges (Corsetti et al., 2013). *Third*, we consider a small open economy framework, developed along the lines of Adolfson, Laséen, Lindé, and Villani (2007) and Christiano, Trabandt, and Walentin (2011), adapted to a country belonging to a currency area with centralized monetary policy. As our empirical focus is on euro-area countries, we detail the basic feature of the European currency union, in which the central bank-modeled within the domestic economy-targets Eurozone inflation. The latter in turn partly depends on domestic inflation, given the country's relative weight in the currency area. The small open economy framework, in which the exogenous foreign sector (rest of the world) is described by a structural vector auto-regressive (SVAR) system, allows for the evaluation of the effects of the policies on the country's net foreign asset position. These effects are considered in the literature as an important trigger of default risk (Manasse, 2009; De Grauwe & Ji, 2013). *Fourth*, a simplified fiscal sector with exogenous government expenditures and distortionary labor income taxes allows the simulation of the effects of fiscal retrenchments implemented on both the expenditure and the revenue sides.

The major novelty in the design of the monopolistically competitive financial sector is thus the consideration of a non-zero default probability for both private sector and public sector borrowers, obtained by formalizing a cumulative distribution function relating the sovereign default probability to the debt and the NFA position to GDP ratios, and the private sector default probability to the sovereign default probability. Default risks determine sovereign and lending rate spreads through the consideration of a no-arbitrage condition between deposits (who pay back the risk-free policy rate) and domestic government debt bond holdings, and an optimality condition for credit institutions including the loss given default of the bank in the case of counterparty default, respectively.

Another peculiar feature of our model is the interaction between domestic and euro-area variables. This result is implicit to the centralized monetary policy-targeting euro-area inflation-in turn partially determined by domestic inflation. This modeling choice, which is relevant for the dynamics of the risk-free (policy) rate, activates a further interaction channel operating through the no-arbitrage condition between deposits and government bond holdings.

3.1. Default risks and the credit sector

We introduce non-zero default probabilities for both private and public sector borrowers, obtained by formalizing a cumulative distribution function relating the sovereign default probability to macroeconomic fundamentals, government debt, NFA position and real GDP. Sovereign risk variations affect the government bond interest rate spread through a no-arbitrage condition between bank deposits and domestic debt bond holdings. Sovereign risk, in turn, affects the private sector's default risk and the credit spread through an optimality condition for monopolistically competitive credit institutions including the loss given default of the bank in the case of counterparty default.

3.1.1. Sovereign default risk

We relate the sovereign default probability to three fundamental triggers addressed in the literature: *(i)* the level of government debt B_t; *(ii)* the NFA position A_t; and *(iii)* domestic output Y_t. The consideration of output among the triggers of the sovereign default probability allows for the empirical comparison of nested models in which the domestic and foreign debt levels are replaced by their ratios to GDP, an evaluation being considered at the estimation stage.[4] The inclusion of the NFA position among the triggers of sovereign risk is also justified by a stream of empirical literature showing that default episodes are often preceded by large imbalances in foreign indebtedness (Edwards, 1986; Manasse, 2009; De Grauwe & Ji, 2013).[5] Besides its empirical justifications, the choice of including GDP in the set of fundamentals has the advantage of leaving the relation between sovereign risk and fiscal retrenchments unrestricted, a result that would be ruled out by considering only B_t and A_t in the set of fundamental triggers. In fact, the inclusion of Y_t implies that both the size and sign of the default risk channel crucially depend on the size of the model's fiscal multipliers. When these multipliers are large enough, fiscal contractions can lead to increases in the debt-to-GDP ratio, thereby activating a default risk channel operating in an opposite (pro-cyclical) direction than what was predicted by the risk channel hypothesis.

Formally, the sovereign default probability is defined by the following cumulative density function:

$$p_t^g = 1 - \exp\left[-\varphi^g \left(\lambda_b B_t - \lambda_a A_t + \lambda_y Y_t \right) \right] \tag{1}$$

where φ^g is a scale parameter of the public sector default cumulative density function, λ_a,λ_b, and λ_y are elasticity parameters, such that $\partial p_t^{d,g}/\partial B_t > 0, \partial p_t^{d,g}/\partial A_t < 0$ and:

$$p_t^{d,g} = \begin{cases} 1 & if \quad \dfrac{B_t}{Y_t} = +\infty \cap \dfrac{A_t^-}{Y_t} = +\infty \\ 0 & if \quad \dfrac{B_t}{Y_t} = \dfrac{A_t}{Y_t} = 0 \end{cases}.$$

From the optimality condition for household's deposits and domestic bond holdings, the following no-arbitrage condition holds:

[4] This is consistent with a large empirical literature on the determinants of sovereign default risk, in which debt-to-GDP *ratios* are conceived as more appropriate measures of fiscal fragility, because of the relevance of macroeconomic dynamics for the ability of the government to service its debt levels (Yeyati & Panizza, 2011; Mendoza, 2012; Juessen et al., 2014).

[5] A fiscal retrenchment, by improving the NFA position through reduced imports, is likely to mitigate the financial pressure of international lenders.

$$R_t = \chi_t^{rg} R_t^g \left[\left(1 - p_{t+1}^{d,g}\right) + z^g p_{t+1}^{d,g} \right], \tag{2}$$

where z^g is the sovereign bond share of value recovered in the case of default–with $(1 - z^g)$ defining the size of the haircut–and χ_t^{rg} denotes a stochastic wedge capturing the "non-fundamental," or expectational, component in sovereign risk (Bocola & Dovis, 2016). Actually, the stochastic wedge χ_t^{rg} is introduced to capture, at the estimation stage, all the factors possibly affecting the sovereign spread outside fundamentals, such as monetary policy interventions, switches in market sentiments and confidence, and changes in rating agencies' opinions (Patella & Tancioni, 2021).

Given the above position, considering (2) and that $R_t^g = R_t q_t^b$, the interest rate spread on government bonds reads:

$$q_t^b = \frac{1}{\left[1 - (1 - z^g) p_{t+1}^{d,g}\right]}, \tag{3}$$

where the government bond interest premium q_t^b emerges as a result of a non-zero probability $p_t^{d,g}$ of sovereign debt default.

3.1.2. Financial intermediaries and private sector's default risk

Following Curdia and Woodford (2010), we assume that in each period t, (a continuum of) monopolistically competitive banks receive deposits $D_t(i)$from the households, and supply loans $L_t(i)$ to banks in the retail sector at the interest rate $R_t^l(i)$. Retail banks purchase differentiated loans from the monopolistically competitive banks and aggregate them in the single composite loan $L_t = \left[\int_0^1 L_t(i)^{(\chi_t^l - 1)/\chi_t^l} \right]^{\chi_t^l/(\chi_t^l - 1)}$. Loans are conceded at the lending rate $R_t^l(i)$to intermediate sector firms for anticipated wage payments $W_t(i) n_t(i)$. The term $\chi_t^l = \chi_t^l u_{l,t}$ in the composite loan denotes the stochastic loan demand elasticity (mark-up) in the credit sector. Intertemporal cost minimization implies that the optimal demand for loans is given by $L_t(i) = \left(R_t^l(i)/R_t^l\right)^{-\chi_t^l} L_t$.

At the end of each period, each monopolistically competitive bank pays back the risk-free interest-augmented initial deposits $R_t D_t(i)$and ownership profits Π_t^p to households, and maximizes its profit function period by period subject to the credit balance sheet constraint $D_{t+s}(i) = L_{t+s}(i) + Q_{t+s}(i)$. In its operation, the bank faces Rotemberg-type costs for adjusting the interest rate on loans:

$$\max_{D_t(i), R_t^l} E_t \sum_{s=0}^{\infty} \beta^s \frac{\Lambda_{t+s} P_t}{\Lambda_t P_{t+s}} \left\{ \left[1 - p_{t+s}^{d,p} (1 - z^p F\nu_{t+s})\right] R_{t+s}^l(i) L_{t+s}(i) - R_{t+s} D_{t+s}(i) \right.$$
$$\left. - \frac{\kappa_b}{2} \left(\frac{R_{t+s}^l(i)}{R_{t+s-1}^l(i)} - 1 \right)^2 L_{t+s}(i) \right\}$$

where $Q_t(i) = \phi^q D_t(i)$ and ϕ^q denote the level and the share of bank reserves, respectively, and κ_b is the lending rate adjustment cost parameter. The term z^p is the share of the Gordon's firm value $F\nu_t = \left[P_t^d Y_t - R_t^k K_t - W_t(i) n_t(i)\right] / \left[R_t^k - (\mu - 1)\right]$determining the bank's loss given default $(1 - z^p F\nu_t)$ in the case of counterparty default, where $P_t^d Y_t$ is the nominal output expressed in domestic prices P_t^d, and $R_t^k K_t$ denotes the return on installed capital K_t.

The co-movement between government bond and lending rates observed during the recent financial and debt crises indicates that the market valuation of sovereign debt assets can affect the private sector credit conditions (Harjes, 2011). Private sector losses on government bond holdings, as well as losses in outputs and profits, tend to increase the borrowing constraint (Corsetti et al., 2013). In order to capture this relation, we extend the standard monopolistically competitive credit sector to consider a default probability $p_t^{d,p}$ on the side of private sector's firms, described by the following cumulative density function:

$$p_t^{d,p} = \frac{1 - \exp\left[- \varphi^p p_t^{d,g} \right]}{1 - \exp\left\{ - \left[\varphi^p + 1 - p_t^{d,g} \right] \right\}}, \tag{4}$$

where φ^p is a scale parameter of the private sector default cumulative density function, such that:

$$p_t^{d,p} = \begin{cases} 1 & if \quad p_t^{d,g} = 1 \\ 0 & if \quad p_t^{d,g} = 0 \end{cases}.$$

Eq. (4) defines the degree to which the default probability on sovereign debt $p_t^{d,g}$ spills over the private sector.

From the optimality condition of the bank, the modified lending rate equation is obtained:

$$R_t^l(i) = \frac{1}{\left[1 - p_t^{d,p}(1 - z^p F\nu_t)\right]} \frac{1}{\chi_t^l - 1} \left\{ \chi_t^l R_t - \kappa_b \left[\left(\frac{R_t^l(i)}{R_{t-1}^l(i)} - 1 \right) \frac{R_t^l(i)}{R_{t-1}^l(i)} \right. \right.$$
$$\left. \left. - \beta \frac{P_t \Lambda_{t+1}}{P_{t+1} \Lambda_t} \left(\frac{R_{t+1}^l(i)}{R_t^l(i)} - 1 \right) \frac{R_{t+1}^l(i)}{R_t^l(i)} \frac{L_{t+1}(i)}{L_t(i)} \right] \right\},$$

It is noteworthy that the stochastic mark-up wedge χ_t^l, at the estimation stage, will capture any latent factor affecting the pass-through relation (Bocola, 2016).

The above equation highlights the main differences of our set-up with respect to standard credit sector frameworks. In the conventional monopolistically competitive credit sector model, the lending rate is exclusively determined by the mark-up over the risk-free interest rate and by its adjustment cost (e.g. Gerali, Neri, Sessa, & Signoretti, 2010). Instead, in our theoretical set-up, the lending rate includes, along with the mark-up on the risk-free interest rate and the adjustment cost, the private sector's default probability and the loss given default as main drivers of the lending rate dynamics. Note that the private sector does not default in equilibrium (Corsetti et al., 2013) even if, consistent with the empirical evidence, a non-zero probability of default affects the lending rate even at the steady state.

$$\frac{\overline{R}^l}{\overline{R}} = \frac{1}{1-\overline{p}^{d,p}(1-z^p\overline{F\nu})}\frac{\overline{\chi}^l}{(\overline{\chi}^l-1)}$$

where, $\overline{R}^l, \overline{R}, \overline{p}^{d,p}, \overline{F\nu}$, and $\overline{\chi}^l$ denote steady-state values.

3.2. Households

We consider a continuum of households indexed by $j\in[0,1]$, with a fraction ϕ^h having limited access to capital markets (Galı et al., 2007).[6] Ricardian households (superscript r) are assumed to maximize their lifetime utility function

$$\max_{C_t^r,B_t^r,B_t^{*r},K_t^{p,r},I_t^r,u_t^k} E_0\sum^{\infty}\chi_t^c\beta^t\left[\frac{C_t^{r\,1-\sigma_c}}{1-\sigma_c}-\chi_t^\beta\mu^{(1-\sigma_c)t}\frac{N_t^{1+\sigma_n}}{1+\sigma_n}\right], \tag{5}$$

where C_t^r is a composite consumption index, N_t is labor supply, and σ_c and σ_n are the consumption and labor supply curvature parameters, respectively. The terms χ_t^β and χ_t^n denote two preference shocks, the first to the intertemporal discount factor, and the second to labor disutility. The peculiar specification of the stochastic scaling factor of labor disutility is chosen to ensure balanced growth at the rate μ.

Each household purchases consumption and investment goods by means of after-tax labor incomes, capital incomes and dividends. The budget constraint for optimizers thus reads:

$$\begin{aligned} & C_t^r+I_t^r+\frac{B_t^r}{P_tR_t^g}+\frac{e_tB_t^{*r}}{P_tR_t^{g^*}\Phi_t}+\frac{D_t^r}{P_t} \\ & =\left[\left(1-p_t^{d,g}\right)+z^gp_t^{d,g}\right]\frac{B_{t-1}^r}{P_t}+\left(1-\tau_t^n\right)w_tN_t \\ & +\frac{R_{t-1}D_{t-1}^r}{P_t}+\frac{e_tB_{t-1}^{*r}}{P_t}+\frac{R_t^k}{P_t}K_{t-1}^r+\frac{\Pi_t^p\mu^t}{P_t}, \end{aligned} \tag{6}$$

where I_t^r is private investment, e_t is the currency union nominal effective exchange rate, and D_t^r/P_t denotes household's deposits to financial intermediaries in real terms. B_t^r and B_t^{*r} are domestic and foreign bond holdings held by Ricardian households, respectively, P_t is the consumption price index, R_t^k/P_t is the real return on capital K_t^r, and $\delta$is the capital depreciation rate. Labor income taxes scale the wage mass w_tN_t, where $w_t=W_t/P_t$ is the real wage, and $\Pi_t^p\mu^t/P_t$ are real dividends, where μdenotes trend growth of labor-augmenting productivity.

The term Φ_t in (6) denotes the risk premium on foreign bond holdings in the uncovered interest parity (UIP) equation $E_t(e_{t+1}/e_t) = R_t^g/\Phi_tR_t^{g^*}$(Adolfson et al., 2007), where:

$$\Phi_t=\exp\left[\left(R_t^{gez}-R_t^{g^*}\right)-\phi_aA_t^{ez}+\chi_t^\phi\right], \tag{7}$$

in which $A_t^{ez}=(A_t)^\omega(A_t^{ez^*})^{1-\omega}$ and $R_t^{gez}=(R_t^g)^\omega(R_t^{gez^*})^{1-\omega}$ denote the currency union's NFA position (reflecting cumulated net exports) and the average interest rate on euro-area government bonds, respectively. The variables $A_t, R_t^g, A_t^{ez^*}, R_t^{gez^*}$ denote the same variables for the domestic economy and the rest of the countries in the currency union, respectively, and $\omega$is the domestic economy's weight in the currency area. The parameter ϕ_a denotes the risk premium elasticity to the currency area NFA position and χ_t^ϕ is a risk premium shock.

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

$$K_t^r=\left(1-\delta\right)K_{t-1}^r+\chi_t^i\left[1-S\left(\frac{I_t^r}{I_{t-1}^r}\right)\right]I_t^r, \tag{8}$$

[6] The consideration of heterogeneous consumers, by introducing a direct link between current incomes and expenditure, enhances the empirical performances of the model.

where $S(I_t^r/I_{t-1}^r)$ defines the investment adjustment cost function (Smets, 2007), with curvature parameter ψ^i, and χ_t^i is an investment-specific shock.

Aggregate demand for consumption and investment goods $D_t = (C_t, I_t)$, is obtained as a constant elasticity of substitution index of domestically produced and imported goods, such that:

$$D_t = \left[(1-\nu)^{\frac{1}{\eta}}\left(D_t^d\right)^{\frac{\eta-1}{\eta}} + \nu^{\frac{1}{\eta}}\left(D_t^m\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}. \tag{9}$$

From households' cost minimization, $D_t^d = (1-\nu)\left[P_t^d/P_t\right]^{-\eta}D_t$ and $D_t^m = \nu\left[P_t^m/P_t\right]^{-\eta}D_t$ are the aggregate domestic and foreign produced (consumption and investment) goods, respectively, where νdenotes the import share parameter and $\eta$is the elasticity of substitution between domestic and imported goods. P_t^d and P_t^m denote the price indexes of domestic and imported goods, respectively, such that the consumption price index reads:

$$P_t = \left[(1-\nu)\left(P_t^d\right)^{1-\eta} + \nu\left(P_t^m\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{10}$$

For the fraction of non-Ricardian consumers, we follow Galı et al. (2007), assuming that constrained and unconstrained households have the same number of workers, $n_t = n_t^r = n_t^{nr}$ such that, from the budget constraint of the non-Ricardian household, the following consumption equation is obtained:

$$C_t^{nr} = \left(1-\tau_t^n\right)w_t N_t, \tag{11}$$

where it is evident that net income is entirely spent in consumption goods.

Consistent with a standard feature of medium-scale monetary models (e.g., Carty et al., 2005; Smets, 2007), we assume an imperfectly competitive labor market. The monopolistic union sets the wage W_t in order to maximize the following objective function:

$$\max_{\widetilde{W}_t(l)} E_t \sum_{j=0}^{\infty} (\beta\theta_w)^j \frac{\Lambda_{t+j}P_t}{\Lambda_t P_{t+j}}\left[\left(1-\tau_t^n\right)\widetilde{W}_t(l) + MRS_{t+j}\right]N_{t+j}^k(l)$$

subject to labor packers' demand for labor services

$$N_{t+j}^k(l) = \left(\frac{\widetilde{W}_t(l)}{W_{t+j}(l)}\right)^{-\frac{1+\lambda_w}{\lambda_w}} N_{t+j}^k$$

where $MRS_t = \partial\mathscr{L}(U_t, BC_t)/\partial N_t$ is the marginal rate of substitution, with $\mathscr{L}(U_t, BC_t)$ denoting the Lagrangian defined by the household utility, U_t, and the budget constraint BC_t, λ_w denotes the wage mark-up and $\theta_w$is the Calvo probabilitiy of keeping the wage fixed at the previous period's level.

3.3. Firms

3.3.1. Intermediate goods sector

Each intermediate firm operates in a perfectly competitive environment combining capital and labor. The production technology is as follows:

$$Y_t^i = \chi_t^a [K_t]^\alpha [\mu^t N_t]^{(1-\alpha)}, \tag{12}$$

where α is the output elasticity of capital and χ_t^a is a stochastic technology level.

The optimizing firm chooses the capital stock by solving the following maximization problem:

$$\max_{K_t, N_t} P_t^i Y_t - R_t^k K_t - R_t^t W_t N_t \text{s.t.}\left(12\right)$$

where P_t^i is the intermediate sector price index.

Since the wage bill $W_t N_t$ is anticipated by financial intermediaries, the cost of one unit of labor is $R_t^t W_t$, where:

$$R_t^t = \left[1 - p_t^{dp}\right]R_t^l + d_t^{cp}$$

denotes the effective interest rate and $d_t^{cp} = p_t^{dp}R_t^l$ is the cost of default per unit of borrowed labor. The above equation highlights that in our set-up the credit pass-through channel includes a further amplification mechanism, emerging from the private default probability entering the cost of borrowed labor.

3.3.2. Final goods sector

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. The characterization of the import–export relations between wholesale and retail sectors follows the standard set-up of open economy monetary models (e.g., Adolfson et al., 2007; Christiano et al., 2011).

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

Import wholesalers buy the homogeneous 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 $Y_t^m(i)$to produce the composite final good Y_t^m.

Export wholesalers buy the homogeneous 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 $Y_t^x(i)$to produce the composite final good Y_t^x.

We consider variable demand elasticity in the three final good sectors, indexed by $k = (d,m,x)$, by assuming a flexible variety aggregator G according to Kimball (1995) to allow for endogenous demand elasticity, a feature that has been shown to enhance the empirical performances of monetary models (Eichenbaum, 2007):

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

The domestic retailer's demand function reads:

$$Y_t^k(i) = Y_t^k G'^{-1}\left[\frac{P_t^k(i)}{P_t^k}\int_0^1 G'\left(\frac{Y_t^k(i)}{Y_t^k};\chi_t^{p,k}\right)\frac{Y_t^k(i)}{Y_t^k}di\right], \tag{13}$$

where $\chi_t^{p,k}$ denotes a mark-up shock.

The optimization problem of wholesale firms allowed to re-optimize their prices period by period reads:

$$\max_{\widetilde{P}_t^k(i)} E_t\sum_{j=0}^{\infty}\left(\beta\theta_p^k\right)^j\frac{\Lambda_{t+j}P_t}{\Lambda_t P_{t+j}}\left[\widetilde{P}_t^k(i) - MC_{t+j}^k\right]Y_{t+j}^k(i)\text{s.t.}(13),$$

where $MC_t^d = P_t^i, MC_t^m = e_tP_t^*$ and $MC_t^x = P_t^d/e_t$ are the nominal marginal costs of domestic, import and export wholesalers, respectively. $\left(\beta\theta_p^k\right)^j\Lambda_{t+j}P_t/\Lambda_tP_{t+j}$ denotes the firm's stochastic discount factor, where $\theta_p^k, k = (d,m,x)$, are the three sectors' Calvo probabilities of keeping the price fixed at the previous period's level.

3.4. Monetary and fiscal policies

The centralized monetary authority sets the nominal interest rate R_t by targeting currency area consumer prices inflation π_t^{ez}, defined by $\pi_t^{ez} = (\pi_t^c)^{\omega}(\pi_t^{ez*})^{1-\omega}$, where π_t^{ez*} denotes consumer prices inflation in the rest of the area, taken as exogenous. The policy instrument is adjusted gradually, giving rise to interest rate smoothing:

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\rho^R}\left[\left(\frac{\pi_t^{ez}}{\overline{\pi}^{ez}}\right)^{\psi_1}\right]^{1-\rho^R}e^{\chi_t^r},$$

where ρ^R is the autoregressive coefficient characterizing interest rate adjustments, ψdenotes the feedback coefficient to inflation π_t , and χ_t^r is the monetary policy shock.

Note that, in this setting, the central bank's feedback rule implies interaction between the domestic economy and euro-area. Depending on the relative weight $\omega$of the domestic economy in the currency union, such an interaction-for a given parameterization of the policy rule-dampens the degree of activism of the central bank, affecting the determination of the risk-free rate and of the sovereign and credit interest rates.

The government budget constraint, except for the emergence of the cost of default on sovereign bonds, is rather standard. In real terms it reads:

$$G_t + \phi^i Y_t + \left[\left(1 - p_t^{d,g}\right) + z^g p_t^{d,g}\right]\frac{B_{t-1}}{P_t} = \frac{B_t}{P_tR_t^g} - d_t^{c,g}\frac{B_{t-1}}{P_t} + \tau_t^n\int_0^1 w_t(i)n_t(i)di,$$

where $d_t^{c,g} = (1 - z^g)p_t^{d,g}$ is the unit cost of sovereign default and $G_t = G_{t-1}^{\rho_g}\exp(\varepsilon_{g,t})$ and $\tau_t^n = \tau_{t-1}^{n(\rho_{\tau^n})}\exp(\varepsilon_{\tau^n,t})$are the stochastic processes describing the exogenous government expenditure and labor income tax rate.

3.5. Model closure

Given the co-existence of intertemporally optimizing households $j \in [0, 1-\phi^h]$ and of rule-of-thumb households $j \in (1-\phi^h, 1]$, aggregate consumption C_t is given by:

$$C_t = \int_0^{1-\phi^h} C_t^r dj + \int_{1-\phi^h}^1 C_t^{nr} dj.$$

Since only Ricardian households hold bonds and accumulate capital, the other Ricardian-specific variables are aggregated as follows:

$$\Gamma_t = \int_0^{1-\phi^h} \Gamma_t^r dj \Gamma_t = \left[I_t, K_t, B_t, B_t^*\right]'.$$

Market clearing in the foreign bond market and the final goods market requires that, at the equilibrium, the following two equations for NFA and aggregate resources are satisfied:

$$\frac{e_t B_{t+1}^*}{\Phi_t R_t^* q_t^{b*}} = e_t P_t^x \left(C_t^x + I_t^x\right) - e_t P_t^* \left(C_t^m + I_t^m\right) + e_t B_t^* \tag{14}$$

and:

$$C_t^d + C_t^x + I_t^d + I_t^x + G_t + \frac{\kappa_b}{2}\left(\frac{R_{t+s}^l(i)}{R_{t+s-1}^l(i)} - 1\right)^2 L_{t+s}(i) \leqslant Y_t - a\left(u_t^k\right) K_{t-1}, \tag{15}$$

where $C_t^x + I_t^x = \left[P_t^x / P_t^*\right]^{-\eta^*} Y_t^*$ are total exports, with η^* denoting the foreign demand elasticity parameter (Armington elasticity).

The stationary representation of the model is obtained by scaling the real variables with respect to the trending technology process.

3.6. Foreign economy

Foreign (rest of the non-euro-area world) output (y_t^*), inflation (π_t^*), and short- and long-term interest rates($r_{s,t}^*$ and $r_{b,t}^*$) are exogenous with respect to the domestic economy and the currency union's variables in the theoretical model. Their evolution is described by an SVAR, where contemporaneous correlations are described by the structural error correlation matrix **B**. Formally:

$$\mathbf{A}(L)\begin{bmatrix} \pi_t^* \\ y_t^* \\ r_{s,t}^* \\ r_{b,t}^* \end{bmatrix} = \mathbf{B}\begin{bmatrix} \varepsilon_t^{\pi^*} \\ \varepsilon_t^{y^*} \\ \varepsilon_t^{r_s^*} \\ \varepsilon_t^{r_b^*} \end{bmatrix}, \mathbf{A}_0 = \mathbf{I}_4, \varepsilon_t \sim N(\mathbf{0}, \mathbf{I}_4) \tag{16}$$

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

The assumptions on **B** are consistent with the hypothesis that output and inflation do not respond contemporaneously to the other shocks in the system, and that the long-term interest rate is recursive with respect to the short-term rate.

4. Estimation and results

The model is applied to the data of four southern euro-area countries, Greece, Italy, Portugal and Spain, and estimated with the Bayesian method, such that four stand-alone small open economy models with country-specific parameterization emerge. Three nested model versions are estimated: the benchmark specification, in which the risk channel operates through variations in public debt, NFA and GDP (Model A); a specification in which GDP does not affect sovereign risk (i.e., only the *levels* of domestic and foreign debt are relevant-Model B); and a specification in which the risk channel is switched off (Model C). Based on the information provided by the estimated model's marginal data densities (MDD), Model A is empirically the best performing as compared to the alternative nested versions.[7]

Since a subset of the parameters' space is empirically unidentifiable even considering a large data set (Calvo, 2009; Iskrev, 2010; Koop, Pesaran, & Smith, 2013), we estimate only the sub-space containing empirically identifiable parameters. The latter is selected through the Iskrev (2010) analytical derivatives' method. The remaining parameters are fixed according to country-specific evidence

[7] See Table A.2 in appendix A2.

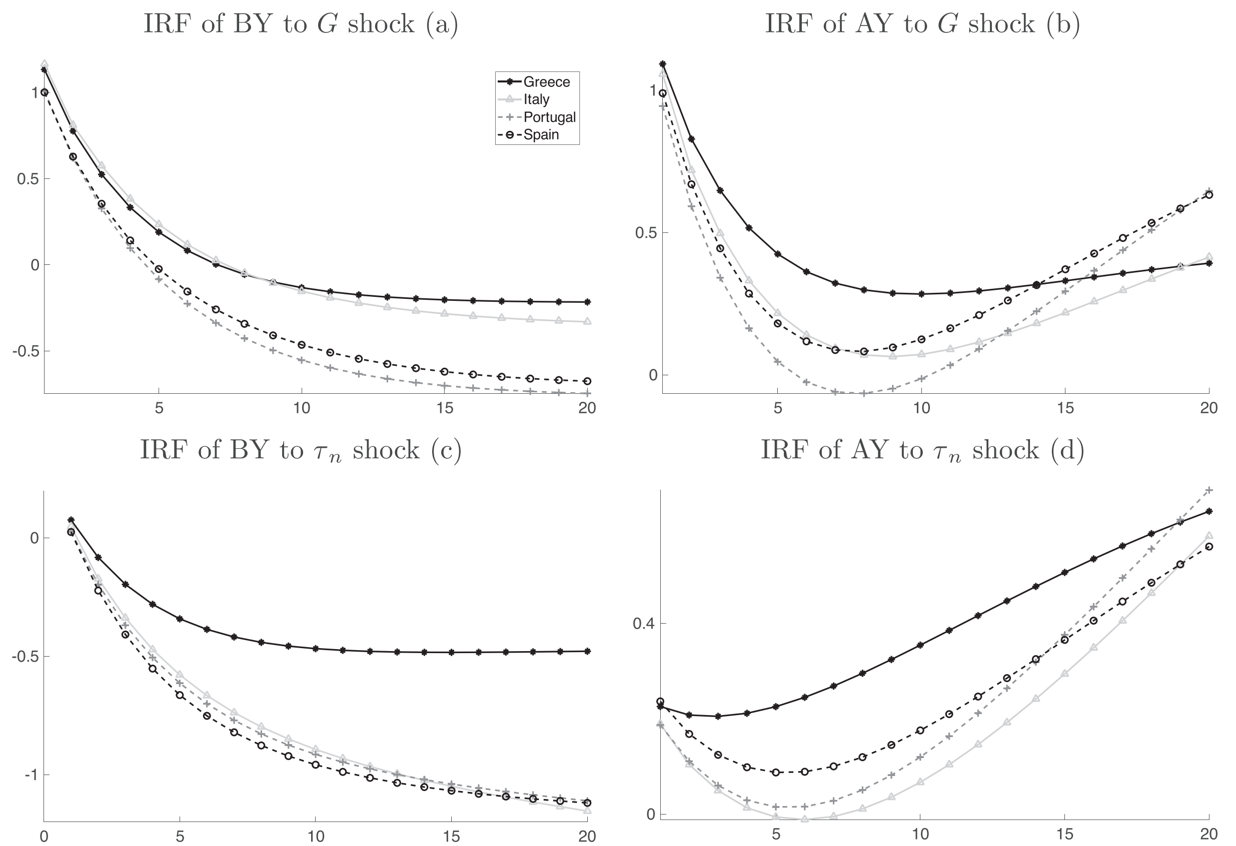

Fig. 2. *Response of fundamentals to a 1% GDP fiscal contraction. Notes*: Impulse responses (in quarters) of the debt to output ratio (B_t/Y_t) and of the net foreign asset to output ratio (A_t/Y_t) to a 1% GDP fiscal contraction (panels a-b: expenditure cut; panels c-d: labor income tax increase), obtained at the country-specific posterior mean estimates. The sovereign debt and the NFA to GDP ratio responses depict their percent deviation from the steady state, and the responses of the spreads are expressed in yearly basis point deviations from the respective steady state values.

and literature values.[8] Because of the limited sample size, a Bayesian estimator is used also for the foreign variables' SVAR, considering a modified Minnesota prior specification (Banbura, Giannone, & Reichlin, 2010). In appendix A1 we report the description of the data used in the estimates, where 16 observables are considered for each domestic economy. In appendix A2 prior beliefs and posterior distributions are considered: we impose 17 dogmatic priors to model parameters, 7 fixed to common values across countries and 10 considering country-specific evidence. The remaining model parameters are then estimated.

Posterior estimates add further cross-country structural heterogeneity to that implied by the country-specific dogmatic priors. Concerning the key parameters for the default probabilities, the scale parameter for the private sector's default probability φ^p is highly heterogeneous across countries, with estimates ranging from 0.19 (Italy) to 0.86 (Portugal). The elasticity of the sovereign default risk to public debt $(\lambda_b)$is below the prior in all countries, whereas that to NFA $(\lambda_a)$is generally above it, ranging between 0.58 (Italy) and 1.34 (Portugal). The estimates of the elasticity parameter to GDP range between -0.76 (Portugal) and -1.53 (Italy), signaling that variations in economic activity are the most important factor for the size of sovereign risk and spreads.

This is an important result for the main question of our paper: as long as debt ratios replace debt levels in the explanation of sovereign risk, the size of fiscal multipliers becomes of central importance for the direction in which the risk channel operates.

4.1. Results on the transmission mechanics of the risk channel

In this section, we provide a comparative analysis of the country-specific effects from the implementation of two financially equivalent contractionary fiscal policies: *(i)* a reduction in government consumption, and *(ii)* an increase in the labor income tax rate. These policies are evaluated by simulating the model stochastically and considering the parameterization obtained at the country-specific posterior mean estimates. The simulations are made comparable by calibrating the size of each policy shock to a 1% of GDP and by homogenizing their persistence considering a one-year average duration of the shock. In this simulation set-up, the comparability of results from the two shocks is ensured by the assumption of fully exogenous fiscal instruments.

[8] See Table A.2 in appendix A2.

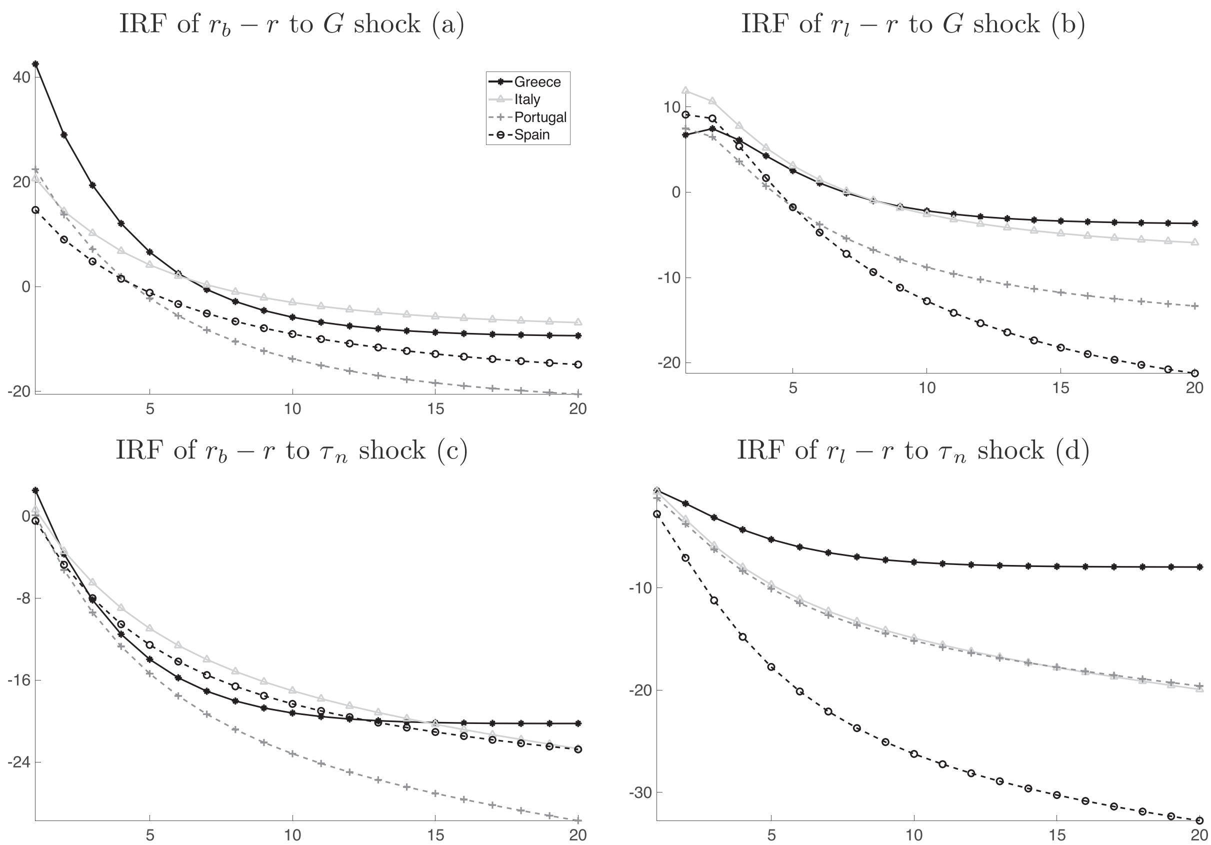

Fig. 3. *Response of sovereign debt and credit spreads a 1% GDP fiscal contraction. Notes*: Impulse responses (in quarters) of the sovereign debt interest rate spread ($r_t^g - r_t$) and of the credit interest rate spread ($r_t^l - r_t$) to a 1% GDP fiscal contraction (panels a-b: expenditure cut; panels c-d: labor income tax increase), obtained at the country-specific posterior mean estimates. Sovereign and credit interest rate spreads are expressed in yearly basis points.

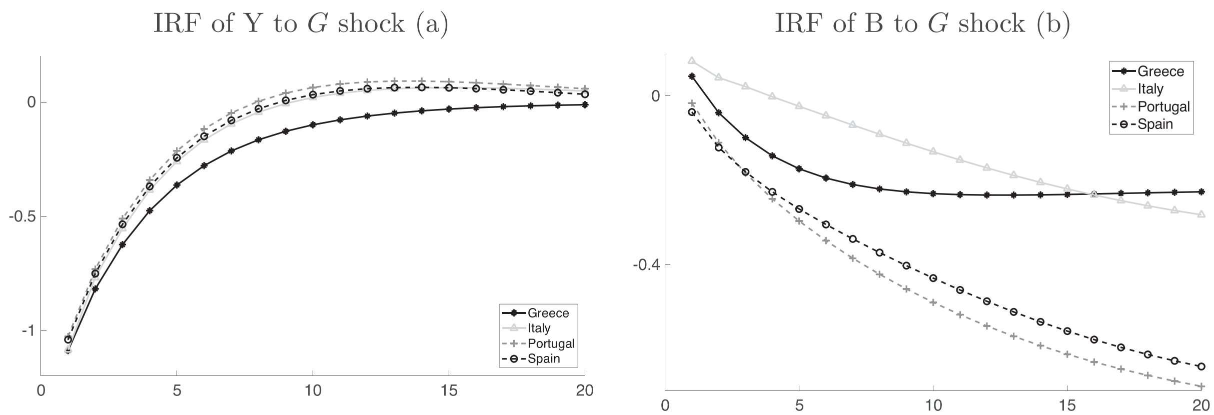

Fig. 4. *Response of output and debt to a 1% GDP fiscal contraction (expenditure cut). Notes*: Impulse responses (in quarters) of output and debt to a 1% GDP fiscal contraction (expenditure cut), obtained at the country-specific posterior mean estimates.

In order to get a first general picture of the basic mechanics of the risk channel emerging at the posterior parameterization, Fig. 2 reports the impulse responses of sovereign debt and NFA-to-GDP ratios (the fundamentals) to a 1% of GDP fiscal retrenchment implemented with expenditure cuts (panel a and b, respectively) and labor income tax rate increases (panel c and d, respectively). Fig. 3 reports the impulse responses for the sovereign and the credit interest rate spreads.

The transmission mechanics is as follows: given the fiscal retrenchment, a reduction in the debt level is obtained, irrespective of the fiscal instrument being considered (panel b in Figs. 4 and 5). The negative response of revenues, due to reduced labor incomes, does not

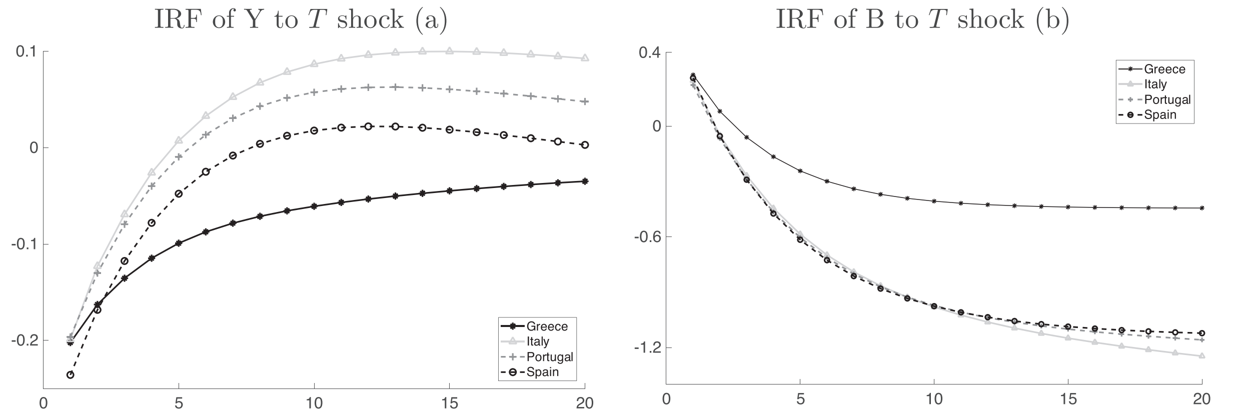

Fig. 5. *Response of output and debt to a 1% GDP fiscal contraction (tax increase)*. *Notes*: Impulse responses (in quarters) of output and debt to a 1% GDP fiscal contraction (labor income tax increase), obtained at the country-specific posterior mean estimates.

reverse the positive effects on the government budget. The NFA response is always positive, reflecting the improvement in the trade balance, due to the decrease in imports and the slight increase in exports, triggered by the contraction in domestic demand and the resulting internal deflation, respectively. Differences in responses mainly reflect the heterogeneity in trade elasticities and in the domestic, import and export Calvo coefficient estimates.

However, as the multipliers of the two fiscal instruments are different, the sign of debt-to-GDP ratio response is different when considering (financially equivalent) contractionary government consumption shocks as opposed to labor income tax shocks. These differences are discussed in more detail in the next sections.

4.1.1. Government expenditure cut

Considering the expenditure cut, the output response is negative and denotes an impact monetary multiplier slightly above unity in all countries (panel a in Fig. 4).[9] The contraction in output is higher than that in debt (panel b in Figure 4), such that the debt-to-GDP ratio temporarily increases (panel a in Figure 2). A moderate variability of the response is observed across countries, reflecting the low sensitivity of the expenditure multiplier to the country-specific parameterization. Government purchases, in fact, affect output directly, triggering only second-round effects on price and wage dynamics. The economic intuition for the positive response of the NFA-to-GDP ratio (panel b in Fig. 2) is immediate: the NFA level increases as a result of decreased domestic demand (imports) and increased competitiveness (stimulating exports) and output decreases because of the fiscal contraction.

The short-term response of the sovereign spread in all countries (panel a in Fig. 3) is the result of the contrasting influence of the two fundamental ratios on sovereign default risk. The positive response of the sovereign spread reaches a peak value on impact, ranging from more than 40 basis points (Greece) to 15 basis points (Spain), partly reflecting the size of the debt-to-GDP ratio responses. This signals that, given the estimated elasticities, the improved NFA positions are not enough to offset the pressure on sovereign default risk related to the increase in the debt-to-GDP ratios. The relatively high estimate for the elasticity of the default probability to foreign debt in Spain explains the smaller increase in the sovereign spread.

The lending rate spread temporarily increases in all countries (panel b in Fig. 3), even if by a smaller amount than the sovereign spread. A moderate reduction of the private borrowing cost is observed only after two years, once also the sovereign debt interest rate spread is back in the negative terrain. The size of the short term increase in the lending rate spread, estimated to range between 7 basis points (Greece) and 12 basis points (Italy), reflects the different estimates for the lending rate adjustment cost parameter in the different countries. In the longer term (five years), the lending rate spread reduction ranges from 4 basis points (Greece) and 21 basis points (Spain), mainly reflecting the different sovereign default elasticity to NFA.

The overall picture is that, conditional on a negative government consumption shock, the short-term effect of the default risk channel differs from that predicted by the theoretical literature (Corsetti et al., 2013Corsetti et al., 2013). The increase in the interest rate spreads tends to amplify the contractionary pressure directly stimulated by the fiscal retrenchment. However, consistent with time series evidence on government and lending interest rate differentials, the size of the increase in the firm borrowing cost is quite small, such that the fiscal multipliers are only marginally affected.[10]

4.1.2. Labor income tax increase

The multipliers of labor income taxes are much smaller.[11] than those emerging under a fiscal retrenchment implemented with

[9] These results are broadly consistent with the available European estimates (Coenen & Straub, 2005).
[10] In fact, by setting λ_b, λ_a, and λ_y to zero (as in Model C), only minor differences in fiscal multipliers are observed.
[11] This result is basically in line with the abundant SVAR-based empirical literature on fiscal multipliers since the seminal analysis of Blanchard and Perotti (2002)

expenditure cuts. The temporary nature of the shock implies a fractional transmission on domestic expenditure and output, with changes in the saving rate of unconstrained households absorbing a large part of the reduction in net incomes.

Because of the small multipliers (panel a in Fig. 5), the decrease in the debt level (panel b in Fig. 5) dominates the output contraction and a reduction of the debt-to-GDP ratio is observed even in the short run (panel c in Fig. 2). Internal demand contraction and the resulting deflation lead to an improvement in the trade balance, thus in the NFA-to-GDP ratio (panel d in Fig. 2). The latter is, however, smaller than that obtainable with expenditure cuts (panel b in Fig. 2), mainly because of the weaker output contraction.

The responses of the debt ratios, as well as the general macroeconomic response, are quite heterogeneous across countries, because of the different model structures. In the case of a labor tax rate increase, the transmission mechanism shows a closer link with the model parameterization, as it mainly operates indirectly, through the labor market adjustment, the link between current incomes and consumption (i.e., the fraction of spenders/savers), and the foreign sector variables' responses.

The favorable response of the default risk leads to lower public and private borrowing costs even in the short term (panels c and d in Fig. 3, respectively). However, the reduction of the spreads is relatively small. At the five-years' horizon, the expected reduction in the lending rate spread is between 7 basis points (Portugal) and 33 basis points (Spain). Even in this case, differences are mainly explained by the size of the sovereign default probability elasticity to the NFA position.

Contrary to the case of a fiscal retrenchment implemented through expenditure cuts, the tax rate increase is thus able to stimulate a short term reduction in public and private borrowing costs. However, given its small size, the relevance of the risk channel for macroeconomic dynamics and for the size of the fiscal multipliers is confirmed to be only marginal.

Overall, according to our analysis, there is no clear evidence of the existence of a risk channel driven by the dynamics of debt fundamentals, especially in the short term. The estimated fiscal multipliers are in fact aligned with those obtainable from equally parameterized country models in which the risk channel effects are eliminated.

For these reasons, we conjecture that the recent and recurrent surges in government bond and lending rate premia in the southern European countries considered in the analysis might be mainly attributed to factors that are only loosely related to the macroeconomic fundamentals generally conceived in the literature on the risk channel hypothesis. Additional sources of sovereign risk, possibly related to institutional factors that are unobservable in our setting, are likely playing a role. This conjecture is consistent with recent empirical literature showing that the role of fiscal fundamentals is only marginal, irrespective of the financial and macroeconomic regimes being in place (Bocola & Dovis, 2016; Ayres et al., 2018; Lorenzoni & Werning, 2019; Beqiraj et al., 2019; Patella & Tancioni, 2021).

5. Conclusions

The consideration of a default risk channel introduces interesting elements for the conduct of fiscal policy in highly indebted economies. In principle, for increasing levels of debt and for small-sized fiscal multipliers, a fiscal retrenchment can be expansionary, since the resulting improvement in fundamentals can trigger a reduction in sovereign and private default risks and thus in the private sector's borrowing costs.

Our analysis, developed at the country level for a selection of European economies characterized by high debt-to-output ratio, shows that, contrary to the theoretical prediction, the default risk channel does not operate. Conditional on fiscal retrenchments implemented with expenditure cuts, it rather operates in the opposite direction than predicted, because temporary but persistent increases in the debt-to-output ratio materialize. Consequently, in the short term, the sovereign and private default probabilities (and, thus, interest rates) tend to increase. The improvement in the net foreign asset position is not sufficient to stimulate a significant reduction in default probabilities and spreads able to reverse the former effects.

Conditional on fiscal retrenchments implemented on the side of labor tax revenues, a reduction in sovereign default risk can be observed. However, the degree to which the sovereign risk is estimated to be linked to fundamentals and spill over private sector risk is so weak that a reduction in the lending rate spread does not materialize. As long as the private sector lending rates provide a reliable approximation of the actual credit conditions, these results point to a limited effectiveness of the risk channel. As a result, the sign of the Keynesian tax multiplier is not reversed.

Consistent with the results of recent literature, other latent factors, possibly related to monetary/fiscal policy institutional arrangements and expectational factors, might be responsible for the larger fraction of the observed increases and variability in spreads. Our theoretical and empirical apparatus can deliver an evaluation of the empirical strength of the relation between macroeconomic fundamentals and the pricing of default risks, remaining unsuited to provide insights on the role of "non-fundamental triggers" of sovereign and credit risks. We intend to focusing on this intriguing issue in future research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Appendix

A.1. Data

For each domestic economy, 16 observables are considered for the estimates: (log differences of) real per capita GDP $\left(\Delta y_t^{obs}\right)$,

Table A.1
Dogmatic priors.

Parameter description		Source/Calibration	Greece	Italy	Portugal	Spain
z^g	Bond value given default	Greek haircut (Bocola (2016))		0.45		
χ^l	Credit demand elasticity	Carbó et al. (2009) , Weil (2013)	5.8	6	6.3	5.0
z^p	Gordon's firm value share	Carbó et al. (2000)	0.080	0.120	0.110	0.047
φ^g	Govt default scale	Gov. bond rate spread10^{-2}	0.18	0.11	0.15	0.14
λ_p^k	Mark-up	Smets (2007)		1.5;1.0 for$k = x$		
κ_ϵ^k	Kimball curvature	Smets (2007)		10.00		
δ	Capital depretation	Smets (2007)		0.025		
ϕ_a	Risk premium. elasticity	Schmitt-Grohé and Uribe (2003)		10^{-2}		
μ	Growth rate	Eurostat (2014)	0.07	0.04	0.14	0.22
β	Discount factor	Real interest rate	0.991	0.994	0.993	0.996
α	Output elast. of$K$	Investment-consumption/GDP	0.25	0.34	0.26	0.31
ω	Relative weigt in EZ	ECB, HICP*	0.026	0.177	0.021	0.120
ν	Import share	Import/GDP ratio	0.31	0.25	0.35	0.27
τ^n	Labor tax rate	Eurostat (2014)	0.33	0.42	0.23	0.32
g^y	Gov. cons/GDP	Eurostat (2014)	0.20	0.19	0.20	0.18

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 are denoted by $k = d, m, x$.
* : Harmonized Index of Consumer Prices

consumption (Δc_t^{obs}), investment $\left(\Delta i_t^{obs}\right)$, imports (Δm_t^{obs}), exports(Δx_t^{obs}), real wage $(\Delta w_t^{obs})$and public debt $\left(\Delta b_t^{obs}\right)$; the employment rate$(n_t^{obs})$; consumption $(\pi_t^{c,obs})$, import $(\pi_t^{m,obs})$, export $(\pi_t^{x,obs})$, and domestic sector $(\pi_t^{y,obs})$ price inflation; the nominal effective exchange rate (e_t^{obs}), the short-term interest rate, the 10-year government bond rate and the lending rate to non-financial corporations $(r_t^{obs}$, $r_{b,t}^{obs}$ and $r_{l,t}^{obs}$, respectively). To avoid stochastic singularity, 5 measurement errors are added to the 11 structural shocks in the model. These are the stochastic wedges for the CPI equation $(u_{cpi,t})$, for the import and export equations $(u_{m,t}$and$u_{x,t})$, the aggregate resources constraint $(u_{arc,t})$, and for the government budget constraint $(u_{b,t})$. Concerning the foreign sector SVAR, log differences of OECD area real output $(y_t^{*,obs})$, short-/long-term U.S. interest rates $(r_{s,t}^{*,obs}$ and $r_{b,t}^{*,obs})$, and foreign price inflation $\pi_t^{*,obs}$ are considered, such that 20 variables are used for each of the country-specific estimate. All data are taken from official sources, cover the period 1999:1–2017:4,[12] and are demeaned prior to estimation, in order to eliminate the observed deviations from balanced growth.

Formally, considering the vector of real per capita variables $\mathbf{x}_t^{'} = (y_t, c_t, i_t, m_t, x_t, w_t, y_t^*, b_t)$, of inflation rates $\pi_t^{'} = (\pi_t^c, \pi_t^m, \pi_t^x, \pi_t^y, \pi_t^*)$, of risk-free bond, and lending interest rates $\mathbf{r}_t^{'} = (r_t, r_{b,t}, r_{l,t}, r_t^*, r_{b,t}^*)$, the 20 measurement equations linking the linearized model variables to the respective observables read as follows:

$$\begin{bmatrix} \Delta\mathbf{x}_t^{obs} \\ u_t^{obs} \\ \pi_t^{obs} \\ \mathbf{r}_t^{obs} \\ e_t^{obs} \end{bmatrix} = \begin{bmatrix} \mathbf{x}_t - \mathbf{x}_{t-1} \\ u_t \\ \pi_t \\ \mathbf{r}_t \\ e_t + \log e \end{bmatrix}$$

A.2. Prior beliefs and posterior distributions

We impose 17 dogmatic priors to model parameters, 7 fixed to common values across countries, and 10 considering country-specific evidence. The remaining model parameters are estimated. The 7 exclusion restrictions for the identification of the foreign variables' SVAR add further dogmatic priors. Prior distributions for estimated parameters are common across countries and are specified following the usual practice: 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.

The credit sector markup $\chi_t^l/(\chi_t^l - 1)$is fixed considering sample evidence on the banking sector's Lerner index (Carbó, Humphrey,

[12] The choice of using a limited time span is made with the purpose of avoiding the potential estimation biases implied by the switch to the common currency in 1999. A detailed description of data sources and manipulations can be provided by the authors upon request.

Table A.2
Prior distributions and posterior mean estimates.

	Description	Prior		Posterior mean			
			Mean (s.d.)	Greece [c.i.]	Italy [c.i.]	Portugal [c.i.]	Spain [c.i.]
λ_b	Default risk elast. to b_t	$\mathscr{N}$	0.50	0.11	0.04	0.19	0.07
			(0.30)	[0.02 – 0.20]	[0.01 – 0.08]	[0.04 – 0.31]	[0.16 – 0.12]
λ_a	Default risk elast. to a_t	$\mathscr{N}$	0.50	0.97	0.58	1.34	1.18
			(0.30)	[0.24 – 1.64]	[0.12 – 1.34]	[0.60 – 2.04]	[0.50 – 1.81]
λ_y	Default risk elast. to y_t	$\mathscr{N}$	0.00	−1.45	−1.53	−0.76	−1.07
			(1.00)	[− 2.61 – −0.25]	[− 3.20 – −0.48]	[− 2.03 – 0.44]	[− 1.93 – −0.14]
φ^p	Priv. default scale par.	$\mathscr{N}$	1.00	0.23	0.19	0.86	0.68
			(0.50)	[0.09 – 0.35]	[0.10 – 0.38]	[0.48 – 1.21]	[0.38 – 0.00]
κ_b	Lending rate adj. cost	$\mathscr{G}$	3.00	5.80	3.80	3.34	6.45
			(1.50)	[3.52 – 8.04]	[2.38 – 5.15]	[1.82 – 4.69]	[4.57 – 8.36]
σ_c	Consumption curv.	$\mathscr{N}$	2.00	1.56	2.43	2.13	2.37
			(0.10)	[1.19 – 1.91]	[2.14 – 2.75]	[1.83 – 2.43]	[2.10 – 2.64]
ϕ^h	Fraction of non Ricardian	$\mathscr{B}$	0.30	0.23	0.23	0.24	0.35
			(0.10)	[0.16 – 0.29]	[0.17 – 0.29]	[0.17 – 0.31]	[0.28 – 0.43]
η	Armington elast. domestic	$\mathscr{G}$	1.50	0.83	2.29	1.90	1.78
			(0.40)	[0.58 – 1.07]	[1.99 – 2.59]	[1.62 – 2.10]	[1.61 – 1.94]
η^*	Armington elast. foreign	$\mathscr{G}$	1.50	2.26	1.01	0.59	0.54
			(0.40)	[1.44 – 3.05]	[0.58 – 1.43]	[0.34 – 0.83]	[0.31 – 0.75]
ψ^i	Investment adj. cost cur.	$\mathscr{G}$	5.00	4.09	7.12	5.40	7.07
			(1.00)	[2.84 – 5.29]	[4.39 – 8.89]	[4.10 – 6.75]	[5.25 – 8.80]
θ_p^d	Calvo domestic sector	$\mathscr{B}$	0.50	0.89	0.79	0.77	0.70
			(0.10)	[0.85 – 0.93]	[0.74 – 0.83]	[0.72 – 0.83]	[0.66 – 0.74]
θ_p^m	Calvo import sector	$\mathscr{B}$	0.50	0.54	0.70	0.70	0.70
			(0.10)	[0.48 – 0.61]	[0.65 – 0.75]	[0.65 – 0.75]	[0.66 – 0.75]
θ_p^x	Calvo export sector	$\mathscr{B}$	0.50	0.88	0.86	0.81	0.94
			(0.10)	[0.83 – 0.92]	[0.82 – 0.85]	[0.76 – 0.86]	[0.93 – 0.95]
θ_w	Calvo wage	$\mathscr{N}$	0.50	0.66	0.63	0.58	0.50
			(0.10)	[0.56 – 0.76]	[0.56 – 0.71]	[0.48 – 0.68]	[0.42 – 0.59]
ρ^R	Interest rate smoothing	$\mathscr{B}$	0.75	0.87	0.84	0.83	0.86
			(0.10)	[0.84 – 0.90]	[0.81 – 0.87]	[0.80 – 0.86]	[0.84 – 0.89]
ψ_1	Feedback MP inflation	$\mathscr{N}$	1.50	1.51	1.46	1.46	1.52
			(0.20)	[1.36 – 1.67]	[1.30 – 1.61]	[1.31 – 1.61]	[1.37 – 1.67]
Model A LDD				3867.77	4610.11	4576.03	4665.49
Model B LDD				3865.82	4600.70	4574.69	4663.72
Model C LDD				3863.63	4591.97	4518.47	4635.97

Notes: N, B, and G denote the Normal, the Beta, and the Gamma distributions, respectively. Posterior mean estimates are obtained with 250000 Metropolis–Hastings replications on two parallel chains.

Maudos, & Molyneux, 2009; Weil, 2013); the share of the Gordon's firm value z^p is chosen to match an average loss given default of 0.61 (Carty, Gates, & Gupton, 2000);z^g is fixed to match a haircut share of 0.55 (Bocola, 2016); and the scale parameter of the government default probability cumulative density function, φ^g, is fixed by targeting the spread between the government bond rate and the risk-free rate observed in the sample considered in the estimates.

The remaining financial sector parameters are estimated. In the absence of commonly accepted results in the literature, diffuse priors are used, such that the posterior estimates will be dominated by the conditional distribution (likelihood). Specifically, the elasticity parameters λ_a and λ_b are assumed to be normally distributed with mean 1 and s.d. 0.5 and a very diffuse prior with zero mean and unit standard deviation is adopted for the default probability elasticity to GDP, λ_y. The latter assumption implies that sovereign and private risk premia, at the prior parameterization, do not depend on the level of economic activity (Corsetti et al., 2013). The scale parameter of the private default probability cumulative density function, φ^p, is assumed to be normally distributed with mean 1 and standard deviation 0.5, consistent with a full pass-through prior. Finally, the lending rate adjustment cost parameter κ_b is assumed to be gamma-distributed with mean 3 and standard deviation 1.5 (Galı et al., 2010).

Prior elicitation for the remaining model parameters is aligned to that commonly adopted in the literature, such that the relevant sources and targets are only briefly summarized in Table A.1, reporting the common and country-specific dogmatic priors, whereas prior distributions for the estimated parameters are summarized in Table A.2.

The prior opinions for the autoregressive coefficients of the 10 persistent shock processes (i.e., $\rho_a, \rho_c, \rho_n, \rho_{inv}$ $\rho_{uip}, \rho_{rg}, \rho_m, \rho_x, \rho_{rl}$ and ρ_{arc}) are described by a weakly informative beta-distributed prior with mean 0.5 and standard deviation 0.15. For the standard errors of the innovations, we assume a prior mean of 0.01 with two degrees of freedom for all shocks.

The elicitation of priors for the foreign variables' SVAR follows the modified Minnesota prior suggested by Banbura et al. (2010). Accordingly, priors are specified under the assumption of independent first-order autoregressive processes, with standard deviations decreasing in the power of the SVAR's lag order i (net of an overall 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 are approximated by the residuals of univariate auto regressive estimates. Formally, the prior for the coefficients of the fifth-order SVAR (16) are specified as follows:

$$E\left[(\mathbf{A}_i,\mathbf{B})_{mn}\right] = \begin{array}{l} \vartheta \text{ for } i=1, m=n \\ 0 \text{ otherwise} \end{array}, V\left[(\mathbf{A}_i,\mathbf{B})_{mn}\right] = \begin{array}{l} \dfrac{\lambda^2}{i^2} \text{ for } m=n \\ \dfrac{\lambda^2}{i^2}\dfrac{\sigma_m^2}{\sigma_n^2} \text{ otherwise} \end{array}, \tag{17}$$

where the values for the coefficients $\vartheta$are obtained from the estimates of the independent first-order autoregressive processes.

Table A2 summarizes the priors and the posterior estimates for the structural parameters.[13] The posterior log-marginal data densities of the three nested model specifications (Table A2-bottom) signal that the risk channel is empirically relevant and that debt *ratios* are the relevant triggers of sovereign default risk.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.najef.2021.101400.

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[13] For expositional convenience, the estimates of the stochastic components' coefficients, identification checks and detailed estimation results are available upon request.

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