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The Balance Sheet Channel of Fiscal Policy: Sovereign Exposure and Credit to Firms in the European Periphery *

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Abstract

This paper provides empirical evidence on the balance sheet channel of fiscal policy in peripheral European economies. Our findings using a Panel VAR reveal that shifts in financial institutions' balance sheets following a debt-financed fiscal expansion reduce credit provision and investment in these countries. Moreover, the analysis indicates that economies with higher sovereign exposure experience more severe credit crunches and investment declines. To explore the underlying mechanisms, we employ a DSGE model that incorporates banks as primary holders of sovereign debt. The model shows that sovereign exposure amplifies the negative effects on credit supply, lowering investment and capital formation.

Keywords: Bayesian estimation, panel VAR, sign restrictions, DSGE, bank-sovereign exposure, fiscal policy, crowding out, euro area periphery.

JEL Classification: C11, C33, E32, E44, E62, F45, G21, H63.

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1 Introduction

This paper contributes to the growing body of research examining the relationship between sovereign debt, financial intermediation, and private credit allocation in Europe. The intricate relationship between elevated sovereign debt and financial stability has been a persistent concern in Europe, particularly since the Global Financial Crisis (GFC). Although the Euro area's aggregate debt-to-GDP ratio has receded from its pandemic high, several economies continue to grapple with substantial public debt levels due to persistent primary deficits (ECB (2024)). This ongoing fiscal fragility, coupled with the market's constrained capacity to absorb increasing public debt issuance, remains a critical consideration. As central banks progressively unwind their balance sheets, attention is shifting back to commercial banks as primary holders of sovereign debt. This re-emergence of banks in such a dominant role, exacerbated by recent discussions surrounding a substantial expansion of public debt to finance initiatives like the *ReArm Europe Plan/Readiness 2030*, intensifies concerns regarding its potential implications for credit supply, investment, and broader financial stability.

A consequence of the elevated sovereign debt burden is the reinforced interdependence between domestic banks and their respective national fiscal authorities, often termed the 'bank-sovereign nexus' or 'doom loop'. Financial institutions have markedly increased their holdings of government debt, leading to a pronounced *home bias*, with a preference for holding domestic sovereign bonds over foreign ones. This trend is particularly evident in peripheral European economies, specifically Greece, Ireland, Italy, Portugal, and Spain (GIIPS), where domestic banks' exposure to sovereign bonds has remained high, despite policy initiatives aimed at promoting diversification (ECB, 2020). This dynamic underscores the need to re-evaluate the mechanisms through which sovereign debt accumulation influences private credit supply and investment dynamics, particularly given the inherent risks of this deep interdependence.

Starting from this premise, this paper examines how public debt dynamics influence the real economy through the balance sheet channel of fiscal policy through financial institutions. Specifically, we address two core research questions. Firstly, we investigate the immediate and lagged effects of debt-financed government spending expansion on credit supply and investment in the European periphery, assessing potential asymmetries in the responses across these countries. Second, we dig into the underlying mechanisms driving these responses, with a particular focus on how the banking sector's role as a primary holder of sovereign bonds directly influences both private credit supply and capital formation.

To answer our first question, we employ a Structural Bayesian Panel Vector Autoregression (PVAR) model, identified via sign restrictions (Uhlig, 2005). This framework allows us to examine the effects of debt-financed fiscal shocks on a range of real and financial variables, while accounting for inherent cross-country heterogeneity in fiscal transmission dynamics. Our empirical findings reveal that, under a debt-financed shock, the balance sheet re-composition of financial institutions negatively affects credit provision to firms and investment across the GIIPS countries. We further disentangle these effects at the individual country level, consistently finding more pronounced credit crunches in economies with greater pre-existing exposure to sovereign debt holdings on their bank balance sheets. For our second question, we employ a standard general equilibrium model that incorporates debt securities into bank intermediation. This theoretical framework helps explore the hypothesis that banks with high domestic public debt exposure reduce corporate lending. The model suggests that increased sovereign debt holdings following a fiscal expansion lead to credit displacement and reduced capital formation, consistent with our empirical findings.

The combination of increased public debt and the significant exposure of domestic banks to sovereign bonds has created notable challenges for real economic activity. Elevated levels of sovereign debt held by European domestic banks have been consistently linked to a reduction in credit supply to the private sector and, consequently, decreased investment. In Europe, the post-GFC period witnessed a surge in debt issuance by fiscal authorities, alongside a corresponding rise in sovereign debt holdings by domestic financial institutions (see e.g. Bocola, 2016; Bolton and Jeanne, 2011; Gennaioli et al., 2018). Simultaneously, a substantial body of literature documents a significant contraction in new credit to non-financial corporations (NFCs) during this precise period (see e.g. Broner et al., 2014; Crosignani, 2017; Gennaioli et al., 2014). This credit contraction had palpable real economic effects, most notably manifested through reduced capital formation (see e.g. Acharya et al., 2014; Balduzzi et al., 2018; Cingano et al., 2016). This issue holds particular relevance in the European context, where NFCs rely heavily on bank loans as their primary source of external financing (see Altavilla et al. (2019); Reichlin (2014)). The diversion of bank capital towards sovereign bonds, whether driven by regulatory incentives, perceived safety, or simply a lack of alternative profitable lending opportunities, directly impacts the flow of funds to productive private sector investments.

Sovereign debt exposures, therefore, remain a critical channel through which fiscal policy propagates through the financial system, with the potential to amplify credit crunches and ultimately shape real economic outcomes. Empirical evidence suggests that increases in bank credit to the private sector are positively associated with real GDP and private investment growth (Antoshin et al. (2017)). However, persistently high levels of public debt in Europe have been associated with a decline in private investment (see e.g. Afonso and Jalles, 2015; Demirel et al., 2017; Picarelli et al., 2019), raising serious concerns about the long-term implications for economic activity. As investment decisions are closely tied to credit availability and affordability, a comprehensive understanding of the interplay between public debt, private credit, and investment dynamics is essential for effective policymaking aimed at fostering sustainable economic growth.

This paper contributes to the literature on the macro-financial transmission of fiscal policy in three main ways: First, we propose and quantify a balance sheet channel of fiscal policy, where debt-financed government spending affects credit supply and investment through changes in banks' holdings of sovereign debt. Focusing on peripheral European economies in the aftermath of the GFC, we show that public debt accumulation reshapes bank balance sheets, crowds out private lending, and ultimately reduces investment. While previous micro-level studies have documented the adverse effects of sovereign exposures on bank credit provision and raising lending costs (Altavilla et al. (2017); Popov and Van Horen (2014); Blundell-Wignall and Slovik (2010)), particularly for riskier borrowers such as small and young firms (De Marco (2019)), these studies typically rely on partial equilibrium settings and cannot capture the broader macroeconomic implications. Further empirical evidence from the European debt crisis shows that large amounts of sovereign debt held by domestic banks led to a reallocation of lending away from the private sector (Broner et al., 2014), reducing firm-level investment, employment, and overall economic activity (Acharya et al., 2018; Bottero et al., 2020). Furthermore, Bofondi et al. (2018) and Cingano et al. (2016) provide evidence that the contractions of credit supply were more pronounced in countries with a lower capitalisation of the banking sector and higher exposure to sovereign risk. These micro-level analyses, while illuminating at the bank-firm level, often face limitations in capturing economy-wide general equilibrium effects and the feedback loops between the banking sector and the broader macroeconomy. Our paper addresses this by integrating these granular insights into a macro-financial framework, allowing us to quantify the aggregate impact of sovereign exposure.

Second, our empirical analysis improves upon standard fiscal VAR approaches by explicitly incorporating macro-financial linkages. While the existing literature largely focuses on a narrow set of macroeconomic variables such as output, government spending, and taxes (e.g., Blanchard and Perotti (2002); Perotti (2005); Favero (2002); Fatás and Mihov (2001)), it often neglects the financial sector's role in fiscal policy transmission. Identification strategies in this literature include recursive schemes or sign restrictions, initially proposed for monetary policy shocks (Faust (1998); Uhlig (2005)) and later extended to fiscal settings (Caldara and Kamps (2008); Mountford and Uhlig (2009); Dungey and Fry (2009); Eller et al. (2017); Inchauspe (2021); Ando et al. (2025)). Our VAR design extends these frameworks by incorporating financial sector variables, capturing relevant macro-financial linkages essential for analysing the effects of financial sector exposure to debt-financed government expansions. Closely related macro-level evidence is provided by Liaqat (2019), who uses panel SVARs to show that higher sovereign debt levels reduce private investment across 127 countries. For Europe, Podstawski and Velinov (2018) and Palmen (2020) highlight the importance of sovereign risk in driving credit market outcomes in peripheral economies. However, unlike these studies, which emphasise the sovereign risk channel, our contribution lies in isolating the exposure channel, identifying how public debt accumulation, even in the absence of heightened sovereign risk, can generate substantial real effects through balance sheet recomposition.

Third, we employ a standard DSGE model with credit market frictions on both the demand side (borrowing-constrained firms) and supply side (banks facing capital requirements), and allow banks to hold government bonds in their balance sheets. This framework is designed to explore a counterfactual scenario in which sovereign debt is not held by domestic banks, enabling an assessment of how credit and investment dynamics would evolve in the absence of sovereign exposure. Despite extensive research on the sovereign debt–banking nexus, most studies emphasise risk channels, leaving important gaps in understanding the role of sovereign exposure itself. Compared to models emphasising sovereign risk (e.g., Pariès et al. (2023); Bocola (2016)), our DSGE approach focuses on the consequences of sovereign exposure in an environment without explicit default risk. Although we do not model risk explicitly, our results show that even in the absence of default risk, large sovereign debt holdings by banks can generate real effects by crowding out private credit and investment through balance sheet reallocation. That said, one could argue that sovereign risk operates through capital outflows, which may trigger sudden stops and increase the home bias of sovereign debt in bank portfolios, further reinforcing the link between sovereigns and financial institutions.[1] Our work also aligns with the DSGE literature examining sovereign debt holdings and resulting credit crunches, including Brzoza-Brzezina and Makarski (2011), who use a general equilibrium model tailored for Poland, and Broner et al. (2014), who use a growth model to explain how domestic debt holdings in European periphery banks can crowd out investment. Additionally, Kirchner and van Wijnbergen (2016) use a structural calibrated model integrating debt-financed fiscal policy and financial intermediation with financial frictions. Our paper builds on these standard approaches but incorporates financial frictions on both the credit demand and supply sides. We extend a workhorse DSGE framework, drawing from Kamber and Thoenissen (2013), by introducing a fiscal authority and embedding government securities directly into the balance sheets of financial intermediaries. This approach offers a framework to analyse the role of sovereign exposure in peripheral economies and to assess how financial frictions shape the transmission of debt-financed fiscal policy through the banking system.

The remainder of this paper is structured as follows: Section 2 presents the empirical findings on the balance sheet channel of fiscal policy using a Bayesian Panel VAR. Section 3 provides a description of the DSGE model, offering a theoretical rationale for the mechanisms identified in the empirical analysis. Section 4 reconciles the theoretical framework with empirical findings. Section 5 concludes.

2 Empirical Evidence from a Bayesian Panel VAR Approach

We employ a Bayesian panel VAR model estimated using Gibbs sampling methods. The analysis focuses on quarterly data from 2003Q1 to 2019Q4, covering the five peripheral European countries: Greece, Ireland, Italy, Portugal and Spain (GIIPS).[2] In its general form, the model

[1]There is broad consensus in the literature that, following the global financial crisis, peripheral European countries experienced a sharp decline in capital inflows (see, e.g., Murai and Schnabl (2021); Kraus et al. (2019); Gros and Alcidi (2015); Merler and Pisani-Ferry (2012)), while core countries attracted capital flows by being perceived as "safe-haven". Prior to the crisis, these inflows had supported government spending and bank lending through loans, investments, and bond purchases. However, as concerns over rising public debt and political instability mounted, investors began to withdraw and ceased purchasing government bonds. This abrupt reversal significantly increased the exposure of the domestic banking sector to sovereign debt in GIIPS economies.

[2]The timeframe for the study is determined by the availability of data on domestic sovereign debt holdings by domestic banks, representing the longest series available for the panel of countries since the establishment of the monetary union.

includes N countries, with n endogenous variables, m exogenous variables and p lags over T periods. For each country i, the model is defined as:

$$x_{it} = \sum_{k=1}^{p} A_i^k x_{i,t-k} + C_i z_t + \epsilon_{it} \quad ; \quad \epsilon_{it} \sim \mathcal{N}(0, \Sigma_i) \tag{1}$$

where x_{it} is the vector containing the n endogenous variables for country i at time t, Ai^k is the matrix of dynamic coefficients, z_t is the vector of exogenous variables including the constant, C_i captures the impact of exogenous variables on the endogenous, and ϵ_i is the vector of residuals. Following the fiscal VAR by Blanchard and Perotti (2002), the model includes government expenditure, taxes and output all in real terms and additional financial variables to capture fiscal effects on financial institutions. The model includes a constant and the volatility index VIX as exogenous variables, with the latter capturing global financial market uncertainty and its spillover effects on domestic dynamics. The country-specific vector of endogenous variables x_{it} is defined as:

$$x_{it} = [g_{it}, y_{it}, t_{it}, \Delta b_{it}^g, sdh_{it}, l_{it}^{NFC}, cob_{it}, I_{it}]' \tag{2}$$

total government expenditure is denoted by g_{it}, y_{it} denotes output, t_{it} corresponds to government taxes, Δb_{it}^g is net government borrowing, sdh_{it} captures the domestic sovereign debt held by the domestic banking sector, l_{it}^{NFC} measures credit extended to non-financial corporations, cob_{it} reflects the real cost of borrowing for non-financial corporations, and I_{it} denotes investment.[3] All variables are expressed in real terms and as percentage deviations from their respective trends, with the exception of the real cost of borrowing, which is expressed as a percentage. Appendix A.1 provides detailed information on data sources, variable transformations, and the methods used for cyclical component extraction.

We employ a sign restriction approach to identify a debt-financed government expansion.[4] To improve the isolation of the shock of interest, we identify a richer set of structural shocks within the VAR. This helps ensure that the estimated debt-financed fiscal expansion is not capturing other fiscal, macroeconomic or financial shocks. This shock is defined as a discretionary increase in government spending that is not followed by higher tax revenues, but instead financed through additional government borrowing, part of which is absorbed by the domestic banking sector. To recover this shock, we impose a positive sign restriction on government spending, borrowing,

[3]Although foreign financing can play an important role in GIIPS economies, we do not include a separate variable for foreign sovereign debt holdings in the VAR. Domestic and foreign holdings together account for total sovereign debt outstanding, and movements in the two series largely reflect reallocation across holders. Including both variables would therefore introduce strong collinearity. Since the focus of the paper is the domestic bank balance sheet channel, we use domestic bank holdings as the relevant exposure variable, while foreign holdings mainly represent its counterpart.

[4]The literature has extensively employed SVARs to study fiscal policy effects under different identification schemes: Favero (2002) and Fatás and Mihov (2001) rely primarily on recursive ordering for shock identification, while Blanchard and Perotti (2002) and Perotti (2005) achieve identification by using institutional knowledge on fiscal policy decision lags and explicit elasticity estimates of fiscal variables to economic activity. Moreover, sign restrictions applied to fiscal VARs have been employed by Caldara and Kamps (2008), Mountford and Uhlig (2009), and Dungey and Fry (2009), with more recent applications including Inchauspe (2021), Eller et al. (2017), and Ando et al. (2025).

and sovereign debt holdings on impact, while requiring tax revenues to remain unchanged for two consecutive quarters. The restriction that tax revenues do not respond for two quarters reflects the idea that discretionary spending increases are initially financed through borrowing rather than contemporaneous taxation, helping distinguish debt-financed fiscal expansions from tax-financed spending shocks. The restriction is imposed only over a short horizon in order to capture the initial implementation of the fiscal policy intervention while allowing fiscal variables to adjust endogenously thereafter. Importantly, our identification does not rely on the exact length of this restriction window, and the results remain robust to alternative horizons.[5] We further identify a tax-financed fiscal expansion, in which government spending and tax revenues increase simultaneously to isolate the debt-financed fiscal shock. Government borrowing and sovereign debt holdings are restricted not to respond on impact following the shock.[6]

Our identification strategy follows the methodology established in Mountford and Uhlig (2009) and Canova and Pappa (2011), and is extended to account for macro-financial interactions. Table 1 presents the full set of sign restrictions used to identify each shock in the system.[7] To ensure that fiscal shocks are not confounded with broader macroeconomic or financial disturbances, we impose orthogonality to three additional structural shocks: a business cycle shock, a credit demand shock, and a credit supply shock. The business cycle shock, as defined in the aforementioned studies, is characterised by joint increases in output, tax revenues, government spending, and investment, consistent with procyclical dynamics. Orthogonality is enforced by explicitly breaking this co-movement pattern; for instance, the tax-financed fiscal expansion imposes a negative response in investment, contrasting with the positive investment response under the business cycle shock. Credit demand and supply shocks are included to account for macro-financial linkages, as the model is designed to capture the interaction between fiscal and financial variables. These shocks are identified through opposing movements in the cost of borrowing and credit volumes: the credit demand shock features joint increases in both variables, while the credit supply shock is defined by a fall in borrowing costs and a rise in credit volumes. Crucially, both credit shocks are restricted to have no contemporaneous effect on sovereign debt holdings, ensuring that financial sector conditions are isolated from fiscal financing channels. Overall, this identification strategy is designed to recover fiscal shocks that reflect policy interventions rather than endogenous responses to cyclical or financial conditions.

In our analysis, we abstract from modelling the consumption response, as it lies outside

[5]The restriction window follows the logic of Mountford and Uhlig (2009), although we adopt a shorter two-quarter horizon to avoid overly restrictive assumptions. Figure A.1 reports results when the tax restriction is imposed only on impact and when it is extended to four quarters. In both cases, the estimated impulse responses remain very similar to the baseline specification, with median responses lying close to the baseline estimates and well within the corresponding confidence bands.

[6]A common alternative to identifying fiscal shocks is the Blanchard–Perotti approach, which relies on institutional timing restrictions in the fiscal equations. As a robustness check, we implement this identification relying on elasticities by Mourre et al. (2019). The resulting impulse responses are qualitatively similar to those obtained under the baseline specification and are reported in Figure A.1.

[7]Sign restrictions are imposed on the impulse responses generated from the posterior distribution of the VAR parameters, and only draws that satisfy the full set of restrictions over the specified horizon are retained for inference.

Table 1: Sign Restrictions Used to Identify Structural Shocks

Shock	g	t	Δb^g	sdh	y	l^{NFC}	cob	I
Fiscal								
Debt-fin. fiscal exp.	+	0^a	$+^a$	+	*	*	*	*
Tax-fin. fiscal exp.	+	+	0	0	*	*	*	-
Macro-financial								
Business cycle	+	+	*	*	+	*	*	+
Credit demand shock	*	*	*	0	*	+	+	*
Credit supply shock	*	*	*	0	*	+	−	*

Note: Signs indicate the imposed restrictions for each shock in the SVAR model. A "+" ("–") denotes a positive (negative) response, "0" indicates no response, and " $*$ " denotes an unrestricted response. All restrictions apply on impact. Restrictions marked with (a) are additionally imposed for the two quarters following the shock.

the primary scope of this study. Instead, we focus on accounting for macro-financial linkages, particularly the role of the banking sector in shaping investment dynamics. We acknowledge that while the theoretical literature on fiscal policy shocks, modelled using general equilibrium frameworks, has developed along two main lines: one aligning with real business cycle models and the other incorporating nominal rigidities[8], these approaches overlook the interactions between fiscal policy, the banking sector exposure to sovereign debt and the impact through credit markets. In our empirical analysis, we abstain from incorporating consumption and instead emphasise how these macro-financial interactions influence credit provision and firms' investment decisions.

Our empirical analysis focuses on the balance sheet reallocation channel through which banks' exposure to sovereign debt affects credit and investment. Accordingly, the results should be interpreted as evidence consistent with an exposure-based transmission mechanism conditional on observed financial conditions.[9] In the following subsection, we present the results for the debt-financed government expansion under two different estimations. First, we show a pooled estimation, which evaluates the effects of a fiscal expansion across the sample of peripheral countries. Next, we apply a random effects model to analyse individual country dynamics within the panel VAR framework. Both estimations are carried out using Bayesian techniques to estimate model parameters and derive impulse response functions.[10] To ensure the reliability

[8] The first, aligned with the real business cycle literature, suggests government spending increases lead to decreases in private consumption and real wages, while employment rises. In contrast, the second branch, supported by models with nominal rigidities like Galí et al. (2007), shows that government spending can raise private consumption, real wages, and employment.

[9] To ensure that the results are not driven by changes in sovereign risk conditions, we additionally control for country-level sovereign CDS spreads. The results remain qualitatively similar when CDS spreads are included in the specification. The corresponding estimates are reported in Figure A.2.

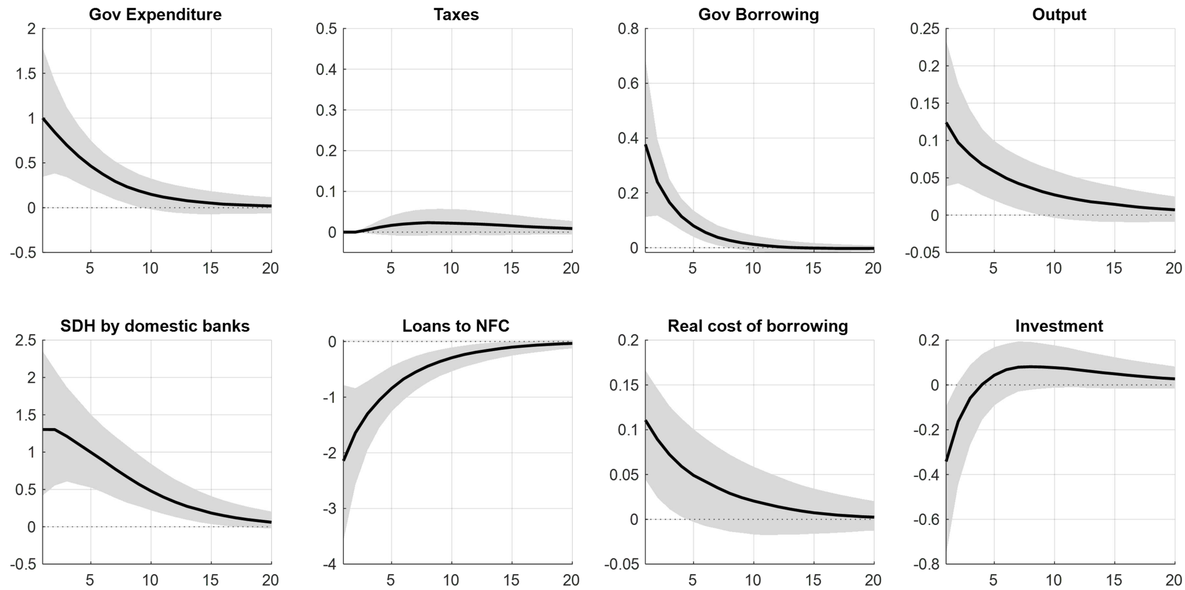
[10] It is important to note that, in the Bayesian PVAR with hierarchical priors (random effects), dynamic coefficients are allowed to vary across units. In contrast, pooled estimation assumes that the matrix of dynamic coefficients is homogeneous across units. Consequently, the aggregation of individual impulse responses or coefficients from the random effects model does not reproduce the results obtained under pooled estimation. Readers should be aware that the pooled and random effects estimators differ in nature: the former imposes homogeneity, while the latter allows for partial heterogeneity through hierarchical shrinkage (see Canova and Ciccarelli (2009);

of the estimates, we check that all models in this section satisfy the stability condition, confirming that no roots are outside the unit circle.

2.1 Responses to a Debt-Financed Fiscal Expansion in Peripheral European Economies

We start by employing a pooled estimation for the panel of peripheral countries to analyse the effect of a debt-financed government spending shock. The pooled estimator of the model is obtained by relaxing the properties of cross-subsectional heterogeneity in eq. 1, where the matrix of dynamic coefficients A_i^k is assumed to be homogeneous across units and $\Sigma_{ii} = \mathbf{E}(\epsilon_i \epsilon_i') = 0$ for $i \neq j$ takes the form of Σ^c diagonal elements of the matrix ($\Sigma_t = I_n \otimes \Sigma^c$). The estimation of the coefficients β and Σ^c are obtained through Bayesian techniques following a Normal-Wishart identification strategy.[11] The model employs one lag, selected based on the highest log marginal data density across specifications with varying lag lengths. We also consider alternative specifications with additional lags and find results remain qualitatively unchanged.

Figure 1: Response to a government spending shock in the pooled EU periphery countries



Median responses (solid line) normalised to a 1-unit increase in government spending on impact, under a pooled estimator based on 5,000 iteration runs (after a burn-in of 1,000 iterations). The y-axis depicts the median responses in percentage deviations from trend, with the 68% credible intervals represented by the shaded gray area. The cost of borrowing, defined as a rate, is expressed in percentage points. The horizontal axis indicates the time in quarters.

Figure 1 presents the impulse responses that illustrate the dynamic effects of a government

Canova and Ciccarelli (2013)). Therefore, differences between the two approaches are to be expected.

[11]The prior for β is assumed to be a multivariate normal and the prior for the variance-covariance matrix Σ^c is inverse Wishart, where the residual variance terms for each of the n endogenous variables $(\sigma_1^2, \sigma_2^2, \sigma_3^2, \sigma_4^2, \sigma_5^2)$ are obtained from a pooled sample of the N countries. We set the overall tightness parameter $\lambda_1 = 0.1$ and the lag decay parameter $\lambda_3 = 2$.

spending shock in the pooled sample of EU periphery countries. The figures report the median responses to a government spending shock normalised to unity on impact, with 68% credible intervals represented by the shaded area. Government borrowing increases, peaking in the early quarters, with the median response reaching about 0.4 percent deviation from trend on impact before gradually converging back to its steady-state level. Taxes appear largely unresponsive, despite being restricted from reacting only during the first two quarters following the shock. Furthermore, output responds positively on impact (0.12 percent), indicating a short-term stimulus effect of government spending. At the same time, domestic banks' sovereign debt holdings (SDH) increase, highlighting the role of financial intermediaries in absorbing newly issued government debt. In particular, SDH rises by around 1.2 percent deviations from trend on impact and remains persistent, dissipating only after approximately 15 quarters, which suggests that government debt stays on banks' balance sheets for a prolonged period. The fiscal expansion appears to generate crowding-out effects in private credit markets, as evidenced by a decline in loans to non-financial corporations. This decline occurs alongside an increase in the real cost of borrowing, indicating tighter financial conditions following the rise in public sector debt. Additionally, the contraction in lending and the higher cost of borrowing point to a reduction in credit supply. Furthermore, investment declines by approximately 0.4 percent relative to trend following the shock, before gradually stabilising, consistent with crowding-out effects.

Our results suggest the presence of balance sheet restructuring in the financial sector. Namely, when financial intermediaries are unable to obtain additional resources to purchase government debt, they reallocate funds from other assets, such as corporate lending, which ultimately leads to lower investment. The extent to which this mechanism operates may vary across countries, depending on their access to external capital markets to finance bond issuance by domestic fiscal authorities. As previously discussed, following the global financial crisis, GIIPS economies experienced a sharp reversal in capital inflows, in contrast to core European countries, which acted as safe havens and attracted capital (Murai and Schnabl (2021); Kraus et al. (2019); Gros and Alcidi (2015); Merler and Pisani-Ferry (2012)). As a result, these economies experienced increased exposure to sovereign debt in their domestic banking sectors. However, even among GIIPS economies, country-specific characteristics, particularly in their credit markets, can lead to heterogeneous responses to fiscal shocks. As such, the effects of fiscal policy are likely to differ across these countries, due to structural differences in financial markets and broader economic conditions.

We thus examine the asymmetric effects on credit to firms and investment across the pool of countries by analysing the individual dynamics in peripheral European economies. We allow for cross-subsectional heterogeneity in the PVAR model by relying on a random coefficient estimator with hierarchical priors. Under this estimator the matrix of dynamic coefficients in eq. 1, A_i^k is assumed to be country specific and $\Sigma_{ii,t} = \mathbf{E}(\epsilon_{it}\epsilon_{is}') = 0$ for $i \neq j$ and takes the form of Σ_i diagonal elements of the matrix ($\Sigma = I_n \otimes \Sigma_i$). This imposes country-specific heterogeneity in the impact coefficients and residuals in the panel, which should be assumed if the purpose is to allow each country to respond differently to fiscal shocks. In compact form and stacked over T

periods, eq. 1 is defined as:

$$X_i = \bar{X}_i \beta_i + \epsilon_i \tag{3}$$

where X_i is a vector of order nTx1, the matrix $\bar{X}_i$ is of order nTx $n(np+m)$ capturing the lagged values of the endogenous and exogenous variables. The vector β_i is of order $n(np+m)$x1 containing the transpose of row j of the endogenous $A_i^{k(j)}$ and exogenous coefficients $C_i^{(j)}$, and the vector of residuals ϵ_i is of order nTx1. The random effects model states that for each country i, the vector β_i is such that:

$$\beta_i = b + b_i \tag{4}$$

where b is the vector of order npx1 and b_i is treated as random for the country i with mean zero and a constant variance. This thus implies :

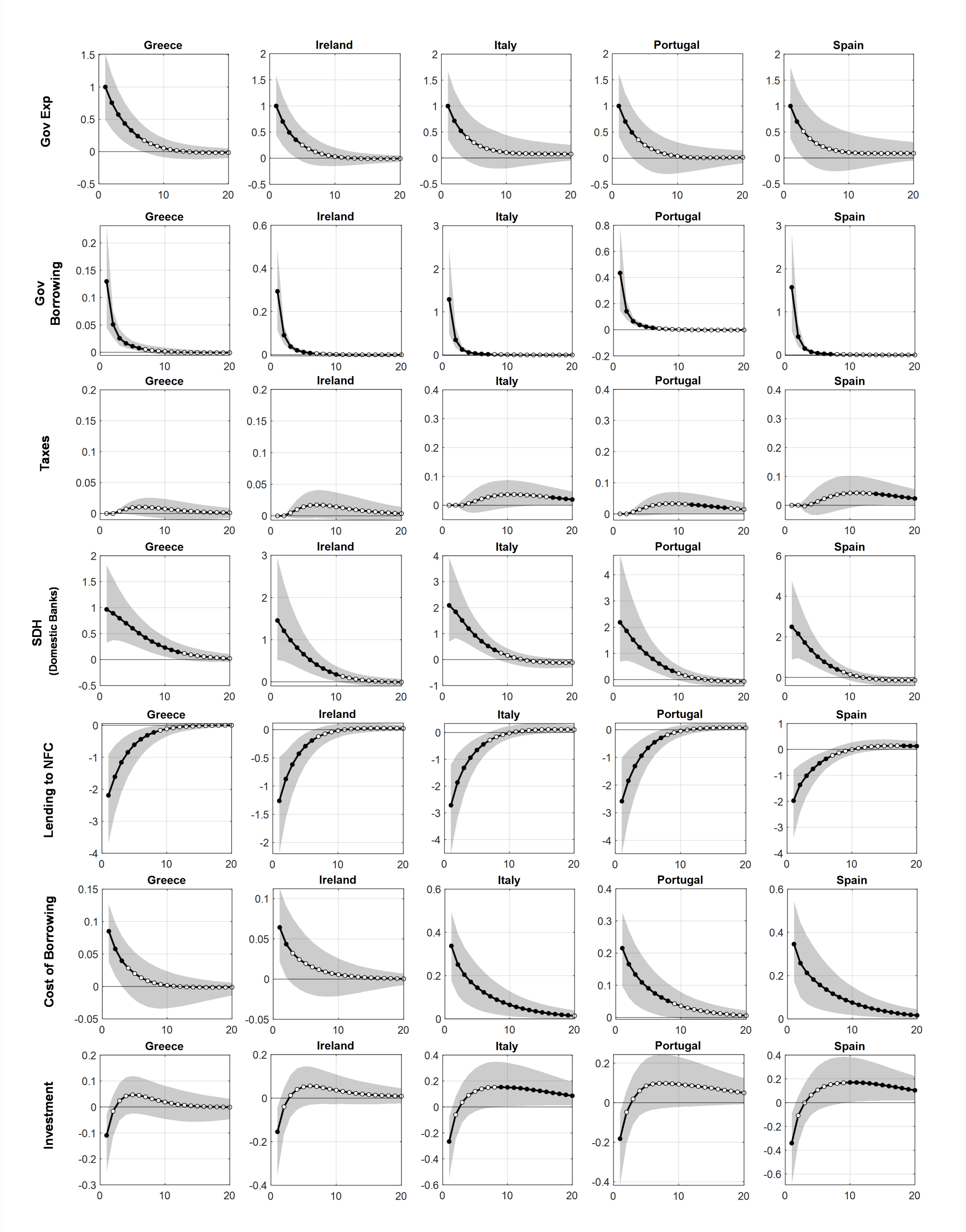
$$\beta_i \sim \mathcal{N}(b, \Sigma_b) \tag{5}$$

Equation 5 indicates that the PVAR coefficients differ across countries. By considering β_i as an exchangeable prior to deriving the posterior distribution, Bayesian techniques can be employed to identify the random coefficient in eq. 5 utilising either the Zellner and Hong (1989) or the hierarchical prior approach proposed by Jarociński (2010). The methodology employed in this work adopts the latter.[12]

Figure 2 presents the impulse response functions to a government spending shock across GIIPS economies normalised to unity on impact. This standardisation scales the shocks to a 1 percent deviation from trend, allowing for consistent evaluation of fiscal transmission and facilitating cross-country comparisons to the same-size shock. Each row corresponds to a macroeconomic or financial variable, and each column represents a specific country. The solid line represents the median response, while the shaded grey areas denote 68% credible intervals. Statistically significant responses are marked by black circles, whereas non-significant responses are denoted by white circles. The top row shows the positive government spending shock. The results reveal heterogeneity in the persistence of the responses across countries. In particular, the response is more persistent in Greece and Ireland, while it dissipates more quickly in the remaining economies. Following a one percent deviation from trend in government spending, the response remains statistically visible for roughly six quarters in Greece and about four quarters in Ireland. By contrast, the effects fade after approximately three quarters in Italy and Portugal. Overall, the effects generally dissipate within about one year. The second row shows the response of government borrowing following the fiscal shock. The increase is particularly pronounced in Spain, reaching approximately 1.5 percent deviation from trend, followed by Italy with a peak response of about 1.3 percent. In all countries, the effects gradually dissipate and

[12] The choice of identification lies in the fact that the hierarchical prior approach allows to estimate not only β_i, but also of the rest of the parameters assumed to be known under the Zellner and Hong (1989) approach. This implies that under a hierarchical approach, $\Sigma_i = [\Sigma_1, \Sigma_2, \ldots, \Sigma_N]$ and the common mean and covariance coefficients (b and Σ_b) are also estimated as they are treated as random variables. This allows for a richer specification of the model because although β_i (for i = 1,...,N) is still estimated in the model, the means and covariance coefficients are obtained as the posterior median for the specified hyperparameters.

Figure 2: Response to a government spending shock for EU periphery countries



Median responses (solid line) normalised to a 1-unit increase in government spending on impact under a random effect estimator based on 5,000 iteration runs (after a burn-in of 1,000 iterations). Black circles indicate a statistically significant response for the corresponding period, while white circles represent a non-significant response. The y-axis depicts the median responses in percentage deviations from trend, with the 68% credible intervals represented by the shaded gray area. The cost of borrowing, defined as a rate, is expressed in percentage points. The horizontal axis indicates the time in quarters.

return to baseline within roughly six quarters. The third row reports the response of taxation. Taxes exhibit only marginal adjustments following the spending shock, and these responses are not statistically significant across countries. Taken together, these results suggest that the increase in government spending is primarily accommodated through higher borrowing rather than through immediate adjustments in tax policy.

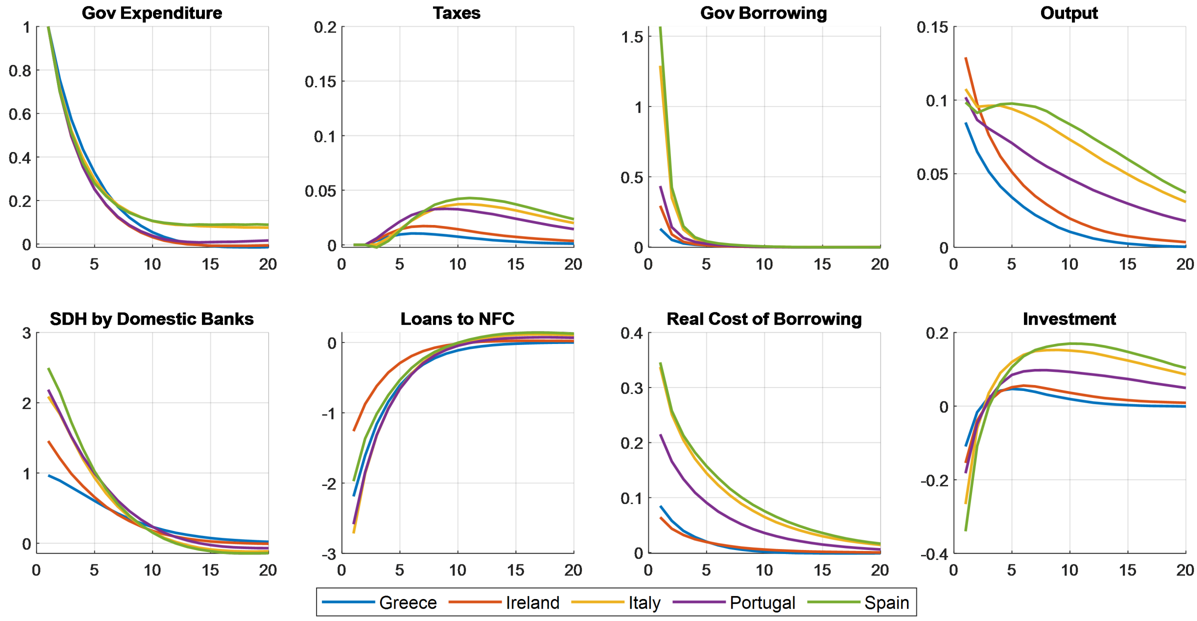
The fourth row reports the response of sovereign debt holdings by domestic financial institutions following the fiscal expansion. A key observation is the significant increase in sovereign debt holdings across countries. In particular, countries with larger increases in government borrowing also exhibit greater exposure of their banking systems to sovereign debt, as observed in Spain, Italy, and Portugal. For these three countries, sovereign debt holdings increase by approximately 2 to 2.5 percent deviations from trend. However, while government borrowing rises more strongly in Italy and Spain than in Portugal, the increase in sovereign debt holdings is of a similar magnitude across these three countries. This pattern suggests heterogeneity in the extent to which domestic banking systems absorb newly issued government debt across GIIPS economies.

The fifth row reports the response of credit to the non-financial corporate sector. Credit declines across all economies following the fiscal expansion, consistent with previous findings in the literature documenting credit contractions under sovereign exposure in European economies (see, e.g., Becker and Ivashina (2018), Bottero et al. (2020)). The decline in NFC lending is particularly pronounced in Italy and Portugal, where credit falls by more than 2.5 percent deviations from trend. Spain and Greece exhibit somewhat smaller declines, with reductions between 2 and 2.5 percent, while Ireland shows a more moderate contraction of around 1.3 percent deviations from trend. It is worth noting that countries with higher sovereign exposure in their banking systems, such as Italy, Portugal, and Spain, are also those experiencing the largest contractions in lending, consistent with the greater absorption of sovereign debt by financial institutions in these economies. Greece, however, presents a notable exception: despite relatively lower sovereign exposure, it exhibits the third-largest contraction in credit.

The sixth row reports the response of borrowing costs following the spending shock. Borrowing costs increase across all economies, although the effects appear relatively short-lived in Greece and Ireland. Notably, borrowing costs rise more strongly in countries with larger increases in government borrowing and greater sovereign exposure in their banking systems, such as Spain, Italy, and Portugal. The final row illustrates the response of private investment, which declines following the fiscal expansion, with particularly pronounced contractions in these three countries. This decline is consistent with a crowding-out effect associated with increased sovereign debt absorption by financial institutions, which reduces the availability of credit for private sector investment. In line with the contraction in credit to non-financial corporations documented in the previous row, tighter financial conditions following the fiscal expansion appear to translate into lower private capital formation.

Figure 3 presents all impulse responses in a single graph to facilitate comparison across countries for each variable. We further compare the results from the Pooled Panel BVAR model and the country-specific (random effects) Panel BVAR model (see Figure A.3). The estimates from the pooled model closely align with the country-specific results, indicating that the impulse responses are broadly consistent across specifications.

Figure 3: Response to a government spending shock (normalised)



Solid lines represent the median responses to a government spending shock normalised so that the impact response of government expenditure equals one, estimated using a random effects estimator, based on 5,000 iteration runs following a burn-in of 1,000 iterations. The y-axis reports responses in percentage deviations from trend, except for the cost of borrowing which is expressed in percentage points. The x-axis measures time in quarters.

Taken together, these results support the idea that countries with higher debt issuance following a government spending expansion, exhibit larger effects and sharper crowding out of investment. In this regard, Italian and Spanish banks, followed by Portuguese banks, appear to be the most exposed to sovereign debt, experiencing the largest declines in investment. This pattern is consistent with recent evidence on sovereign exposures in European banking systems (see i.e. ECB (2020); Deutsche Bank Research (2024)). While investment contracts in all countries following a government spending shock, the magnitude of the decline varies across economies relative to the observed contraction in credit. This asymmetric response suggests that investment dynamics are not driven solely by credit supply constraints, but also by cross-country differences in the transmission of financial conditions. In this sense, the structure of domestic credit markets plays an important role in shaping the transmission of fiscal shocks.

Although the underlying sources of this asymmetry lie beyond the scope of this paper, several factors may contribute to these differences. One potential mechanism is the level of bank capital, which determines the ability of financial institutions to accommodate balance sheet expansions when increasing their holdings of sovereign bonds (i.e. Affinito et al. (2022)). Cross-country variation in lending responses may also reflect structural differences in credit markets across the periphery countries, including the range of financial products offered to firms, the nature of firm–bank relationships, and the maturity and cost of credit (i.e. Kosekova et al. (2026)). Heterogeneity in the use and valuation of pledged collateral by firms (i.e Degryse et al. (2025)), as well as differences in banking sector structure, including market concentration and the presence of foreign banks (i.e Kouretas and Pawłowska (2020)), may further contribute to these differences. In addition, differences in borrower composition, particularly the relative share of small versus large firms, may play a role, as smaller firms typically face tighter financing constraints and are more sensitive to fluctuations in credit conditions (i.e Roux and Savignac (2024)). Taken together, these micro-level findings, while not explicitly modelled here, may help explain the heterogeneity in the responses shown above, in addition to the sovereign exposure channel examined in this paper.

We now turn to a quantitative comparison of impact responses to characterise the extent of cross-country heterogeneity. Table 2 reports impact responses across GIIPS economies together with cross-country dispersion statistics. A key result is that financial variables exhibit substantially greater cross-country dispersion than real activity variables.

Table 2: Normalised Impact Responses and Cross-Country Dispersion Across GIIPS Economies

	Output	Loans to NFC	Real cob	Investment	SDH	Gov. Borrowing
Greece	0.085	-2.190	0.085	-0.110	0.966	0.130
Ireland	0.129	-1.262	0.064	-0.154	1.455	0.294
Italy	0.108	-2.717	0.337	-0.266	2.088	1.290
Portugal	0.102	-2.585	0.215	-0.182	2.186	0.434
Spain	0.098	-1.974	0.346	-0.340	2.496	1.569
Std. dev.	0.016	0.577	0.134	0.092	0.617	0.643

Note: Dispersion is measured as the standard deviation across country-level median responses.

The responses of real activity variables are relatively similar across countries. Output shows very limited dispersion (0.016), while investment also varies moderately across economies (0.092). By contrast, variables capturing financial conditions display substantially greater heterogeneity. In particular, lending to non-financial corporations (std. dev. 0.577) and the real cost of borrowing (0.134) exhibit noticeably larger cross-country dispersion. This suggests that the transmission of the fiscal shock through credit markets differs across banking systems. In addition, sovereign debt holdings by banks (SDH) display considerable variation across countries (std. dev. 0.617), while government borrowing also varies substantially across economies (0.643). The two responses appear positively associated: countries where government borrowing increases more strongly following the fiscal expansion, such as Italy and Spain, also exhibit larger increases in SDH. This pattern is consistent with banks absorbing part of the additional sovereign issuance.

This pattern suggests that the transmission of the debt-financed fiscal shock operates importantly through financial intermediaries. Differences in banking sector balance sheets and in banks' exposure to sovereign debt imply that the same fiscal expansion affects credit conditions differently across countries. In economies where banks absorb a larger share of newly issued government debt, balance sheet adjustments are stronger, which can influence lending to firms and borrowing costs. As a result, financial responses display greater cross-country heterogeneity than real activity.

3 A DSGE Model with Banking Sovereign Exposure

To provide a structural interpretation of the empirical findings, we study the effects of a debt-financed fiscal expansion in a medium-scale flexible-price DSGE model with financial intermediation. The model is designed to isolate the balance sheet channel, through which sovereign debt issuance affects the supply of credit to the private sector. In particular, it allows us to discipline the interaction between fiscal policy, banks' balance sheets, firm borrowing and investment dynamics within a coherent general equilibrium framework. Specifically, the model builds on the framework developed by Kamber and Thoenissen (2013), incorporating a banking sector with financial frictions in the form of borrowing constraints on firms (Kiyotaki and Moore (1997) and Iacoviello (2005)), as well as bank capital constraints following Gerali et al. (2010). We further extend this setup by requiring domestic banks to hold locally issued government bonds, allowing us to capture the sovereign exposure channel and more accurately reflecting the dynamics observed in peripheral economies. The model is formulated in real terms and abstracts from nominal rigidities. This simplification allows us to focus directly on balance sheet interactions and portfolio allocation decisions, which depend on expected real returns and are central to the mechanism studied here.[13]

The stylised two-country model features six types of agents in each country: (i) patient households, who supply labour and save in the form of internationally traded bank deposits; (ii) impatient entrepreneurs, who acquire loans and invest in physical capital while being subject to a binding borrowing constraint;[14] (iii) an intermediate goods-producing sector, which rents capital and labour from patient households; (iv) a final goods-producing sector, which combines home- and foreign-produced intermediate goods to generate final consumption and investment goods; (v) a fiscal authority, which issues debt and collects taxes to finance public spending; and (vi) an integrated banking sector, which funds loans to both entrepreneurs and the government by raising funds from the interbank market.[15] To save space, we present only the model

[13]The sovereign exposure mechanism operates through banks' portfolio allocation between government bonds and private loans and through constraints on bank balance sheets. These decisions depend on the relative returns and quantities of assets. Even if government bonds were nominal, banks' portfolio choices would be driven by expected real returns. Both the nominal return on sovereign bonds and the nominal return on loans incorporate expected inflation, implying that the relative return between assets, which drives portfolio allocation, remains determined by real returns. Introducing inflation would therefore add nominal dynamics without altering the financial intermediation channel that is the focus of the analysis.

[14]Because the model considers two types of agents, for the credit market to function, one of them must save for the other to borrow. Thus, we ensure that entrepreneurs do not delay spending and rapidly accumulate wealth to the point where they would no longer need to borrow, as this would eliminate the role of financial intermediaries in the transmission of shocks to the real economy.

[15]Markets are segmented, meaning that agents do not interact directly with each other but instead operate

equations for the home economy. An analogous set of equations applies to the foreign economy.

3.1 Households

Households maximise expected utility defined over consumption c' and hours worked, n:

$$U_0 = E_t \sum_{t=0}^{\infty} \beta^t \left(\Gamma_c \log(c'_t - \epsilon_c \bar{c'}_{t-1}) - \phi_0 \frac{n_t^{1+\eta}}{1+\eta} \right) \tag{6}$$

where c'_t denotes final goods consumption which is a CES aggregate of home and foreign-produced intermediate goods. Households display external consumption habits, where $\bar{c'}$ denotes aggregate per capita household consumption. $\Gamma_c = 1 - \epsilon_c$ is a constant that ensures that steady state consumption is not affected by the presence of external habits. Households smooth consumption by purchasing internationally traded deposits denominated in units of the foreign consumption good, d_t. The one-period return on these deposits, in terms of domestic goods is $(1+r_t)\frac{s_{t+1}}{s_t} d_t$ where s_t denotes the consumption-based real exchange rate between the home and the foreign economy at time t and r_t denotes the interest rate on deposits held between periods t and $t+1$. The representative household receives a wage from supplying labour to the firm as well as any dividends accruing from ownership of the intermediate goods producer, Π_t^G, and a share, $(1-\omega)$ of those accruing from the banking sector Π_t^B. The household also faces lump-sum taxes, T_t, levied by the fiscal authority.[16]

$$d_t = (1 + r_{t-1}) \frac{s_t}{s_{t-1}} d_{t-1} - c'_t + w_t n_t + \Pi_t^G + (1-\omega)\Pi_t^B - T_t. \tag{7}$$

The household's optimisation problem yields the following optimality conditions for consumption, hours worked and deposit holdings:

$$\frac{\Gamma_c}{c'_t - \epsilon_c \bar{c'}_{t-1}} = \lambda_t \tag{8}$$

$$-\phi_0 n_t^{\eta} + \lambda_t w_t = 0 \tag{9}$$

Optimal bond holdings:

$$\lambda_t = \beta E_t \lambda_{t+1} (1 + r_t) \frac{s_{t+1}}{s_t} \tag{10}$$

where λ_t defines the marginal utility of consumption.

through financial intermediaries to access funding (see Sims and Wu (2021); Gertler and Karadi (2018); Carlstrom et al. (2017)). The assumption of segmented markets, as modelled here, ensures that all transactions occur through financial institutions, preventing the government from obtaining funds directly from households and requiring households to save in the form of deposits through banking institutions.

[16] In Figure A.5 we consider an alternative specification in which entrepreneurs also bear part of the tax burden. The results remain qualitatively similar to the baseline specification.

3.2 Entrepreneurs

Entrepreneurs produce the capital stock used in the production of intermediate goods. They maximise utility defined only over entrepreneurial consumption, c_t'':

$$U_0^E = E_t \sum_{t=0}^{\infty} \beta^{E,t} \left(\Gamma_c \log(c_t'' - \epsilon_c \bar{c''}_{t-1}) \right) \tag{11}$$

What differentiates entrepreneurs from households is their degree of impatience; specifically, they discount the future more heavily than households, which implies that $\beta^E < \beta$ (see Iacoviello (2005)). This assumed asymmetry implies that the entrepreneur faces a borrowing constraint. The additional assumption that shocks hitting the economy are small enough ensures that the borrowing constraint is binding and subsequently that entrepreneurs have a demand for loans from the banking sector. Entrepreneurs maximise their intertemporal utility subject to the following set of constraints:

$$c_t'' = \rho_t k_{t-1} - i_t + q_t - (1 + r_{t-1}^q) q_{t-1} - \frac{\psi}{2} \left(\frac{i_t}{k_{t-1}} - \delta \right)^2 k_{t-1} \tag{12}$$

$$k_t = (1 - \delta) k_{t-1} + i_t \tag{13}$$

$$(1 + r_t^q) q_t = \chi E_t [\varphi_{t+1} k_t (1 - \delta)]. \tag{14}$$

Equation (12) is the budget constraint faced by the entrepreneur, indicating that consumption depends on income from the capital stock rented to the intermediate goods producers $\rho_t k_{t-1}$, new credit from banking institutions q_t minus the interest paid on already granted loans in previous periods $(1 + r_{t-1}^q) q_{t-1}$ and investments incurred in the present period i_t. The term $\frac{\psi}{2} \left(\frac{i_t}{k_{t-1}} - \delta \right)^2 k_{t-1}$ captures the usual capital adjustment costs. Equation (13) is the standard law of motion of physical capital where δ is the depreciation rate. Equation (14) represents the collateral constraint for entrepreneurs. This constraint indicates that to access credit (LHS of the equation), entrepreneurs need to provide collateral (RHS of the equation), which is a fraction χ of the market value of the future installed capital after depreciation $\varphi_{t+1} k_t (1 - \delta)$.

First order conditions for c_t'', q_t, k_{t+1} and i_t are:

$$\frac{\Gamma_c}{c_t'' - \epsilon_c \bar{c''}_{t-1}} = \lambda_t^E \tag{15}$$

$$\lambda_t^E = \beta^E E_t \lambda_{t+1}^E (1 + r_t^q) + \lambda_t^E \Delta_t (1 + r_t^q) \tag{16}$$

$$\varphi_t = E_t \left\{ \beta^E \frac{\lambda_{t+1}^E}{\lambda_t^E} \left[\rho_{t+1} + \varphi_{t+1}(1 - \delta) - \frac{\psi}{2} \left(\frac{i_{t+1}}{k_t} - \delta \right)^2 + \left(\frac{i_{t+1}}{k_t} - \delta \right) \frac{i_{t+1}}{k_t} \right] + \Delta_t \chi \varphi_{t+1} (1 - \delta) \right\} \tag{17}$$

$$\varphi_t = 1 + \psi\left(\frac{i_t}{k_{t-1}} - \delta\right) \tag{18}$$

where λ_t^E is the marginal utility of consumption of the entrepreneur; Δ_t is the multiplier on the borrowing constraint; and φ_t the multiplier on the capital accumulation constraint, interpreted as Tobin's q.

3.3 Intermediate goods producers

Intermediate goods producers combine capital rented from entrepreneurs with hired labour from households using a Cobb-Douglas production function:

$$y_t = a_t k_{t-1}^{\alpha} n_t^{1-\alpha} \tag{19}$$

where a_t denotes the level of total factor productivity. Intermediate goods producers maximise profits:

$$\Pi_t^G = p_t^h y_t - w_t n_t - \rho_t k_{t-1} \tag{20}$$

taking the relative price of home produced goods p_t^h, the real wage w_t, as well as the rental rate for capital ρ_t, as given. The optimisation problem yields the usual first-order conditions for n_t and k_{t-1}

$$w_t = p_t^h(1-\alpha)a_t k_t^{\alpha} n_t^{-\alpha} \tag{21}$$

$$\rho_t = p_t^h \alpha a_t k_t^{\alpha-1} n_t^{1-\alpha} \tag{22}$$

3.4 Final goods producers

Households and entrepreneurs use final goods for consumption and investment. Final goods are a CES aggregate of home and foreign-produced intermediate goods. Defining absorption as $A_t = c' + c'' + i_t + g_t + K_t^B$, competitive final goods producers maximise:

$$A_t = \left[v^{\frac{1}{\theta}} \left(A_t^h\right)^{\frac{\theta-1}{\theta}} + (1-v)^{\frac{1}{\theta}} \left(A_t^f\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}. \tag{23}$$

subject to

$$P_t A_t = P_t^h A_t^h + P_t^f A_t^f. \tag{24}$$

From which we get domestic demand for home and foreign-produced intermediate goods[17]:

$$A_t^h = v\left(p_t^h\right)^{-\theta} A_t \tag{25}$$

$$A_t^f = (1-v)\left(p_t^f\right)^{-\theta} A_t. \tag{26}$$

[17] Where $p_t^h = \frac{P_t^h}{P_t}$ and $p_t^f = \frac{P_t^f}{P_t}$.

3.4.1 Real exchange rate

We define the consumption-based real exchange rate as the price of the foreign consumption basket in terms of the home consumption basket: $s_t = \frac{P_t^*}{P_t}$. The final goods producers' problem yields a price index that corresponds to the CES aggregate in equation (23) and for its foreign economy counterpart.

$$P_t^{1-\theta} = v(P_t^h)^{1-\theta} + (1-v)(P_t^f)^{1-\theta}$$

$$P_t^{*1-\theta} = v^*(P_t^{h^*})^{1-\theta} + (1-v^*)(P_t^{f^*})^{1-\theta}$$

It is convenient to express the share of home produced goods in total absorption in home and foreign, v and v^*, in terms of the relative country size of the home economy, N, and its openness to trade, γ. Following De Paoli (2009) we can write:

$$v = 1 - (1-N)\gamma \tag{27}$$

$$v^* = N\gamma \tag{28}$$

We can now express the relative prices used in the model as functions of relative country size, trade openness and the terms of trade, P^f/P^h:

$$(p_t^h)^{1-\theta} = (1-(1-N)\gamma) + (1-N)\gamma\left(\frac{P_t^f}{P_t^h}\right)^{1-\theta} \tag{29}$$

$$(p_t^f)^{1-\theta} = (1-(1-N)\gamma)\left(\frac{P_t^f}{P_t^h}\right)^{\theta-1} + (1-N)\gamma \tag{30}$$

$$(p_t^{h^*})^{1-\theta} = N\gamma + (1-N\gamma)\left(\frac{P_t^f}{P_t^h}\right)^{1-\theta} \tag{31}$$

$$(p_t^{f^*})^{1-\theta} = N\gamma\left(\frac{P_t^f}{P_t^h}\right)^{\theta-1} + (1-N\gamma) \tag{32}$$

Assuming that the law of one price holds, this yields a simple expression for the real exchange rate:

$$s_t = \frac{p_t^h}{p_t^{h^*}} \tag{33}$$

In our model, the real exchange rate deviates from purchasing power parity as long as openness to trade, γ is not complete such that $\gamma < 1$. Incomplete openness to trade can be justified by the presence of consumption home-bias.

3.5 Fiscal authority

The public sector in our model consumes the domestic final good. Government spending is financed via lump-sum taxation, T_t and the issuance of government bonds, b_t^g. Net borrowing is captured by $\Delta b_t^g = b_t^g - b_{t-1}^g$, which reflects the change in real government debt. Rearranged, net borrowing can be expressed as $\Delta b_t^g = g_t + r_{t-1}b_{t-1}^g - T_t$, indicating that the government must issue new debt to finance both its primary deficit and real interest obligations. Government issued bonds are only held domestically and pay-off in units of home consumption. The fiscal authority faces the following intertemporal budget constraint:

$$T_t + b_t^g = g_t + (1 + r_{t-1})b_{t-1}^g. \tag{34}$$

The tax revenue raised by the government each period follows a standard fiscal policy rule that states that taxes rise in proportion ϕ_T with last period's outstanding government debt, relative to its steady state level. The fiscal authority issues (buys back) bonds when government expenditure, g_t exceeds (falls below) steady-state government spending, $\bar{g}$.

$$T_t = \phi_T \left(b_{t-1}^g - \bar{b^g}\right) + \bar{g} \tag{35}$$

3.6 Banking sector

The model incorporates sovereign debt as a component of banks' asset portfolio, reflecting their exposure to government bonds. The function of the domestic banking sector is to provide credit to borrowing-constrained entrepreneurs and to the fiscal authority. In our framework, banks combine internationally traded interbank deposits, D_t, with bank capital, K_t^B, to make loans to entrepreneurs, q_t and to the government, b_t^g. The bank holds domestically issued government bonds, b_t^g that pay out in units of domestic consumption. The balance sheet constraint for financial institutions states that total lending Q_t must be made out of interbank deposits and the bank's own capital stock:

$$Q_t = D_t + K_t^B \tag{36}$$

where $Q_t = q_t + b_t^g$. Bank capital evolves according to a standard law of motion as follows:

$$K_t^B = (1 - \delta^B)K_{t-1}^B + \omega\Pi_t^B \tag{37}$$

where δ^B captures the cost of managing the bank's capital stock and $\omega\Pi^B$ denotes the profits or losses of the bank not remitted to the household. The representative bank maximises the following profit function denominated in units of home-country consumption:

$$\begin{aligned} \Pi_t^B &= q_{t-1}(1 + r_{t-1}^q) - q_t + b_{t-1}^g(1 + r_{t-1}) - b_t^g \\ &+ D_t - D_{t-1}(1 + r_{t-1})\frac{s_t}{s_{t-1}} + K_t^B - K_{t-1}^B - \frac{\kappa}{2}\left(\frac{K_{t-1}^B}{Q_{t-1}} - z\right)^2 K_{t-1}^B \end{aligned} \tag{38}$$

subject to the balance sheet constraint. The final term in the bank's objective function introduces a convex capital adjustment cost, $\frac{\kappa}{2}\left(\frac{K_{t-1}^B}{Q_{t-1}} - z\right)^2 K_{t-1}^B$ when the ratio of bank capital to loans intermediated deviates from a prescribed bank capital to loan ratio, z. This cost serves as a reduced-form representation of a leverage ratio constraint.[18] This formulation captures the institutional and regulatory pressures faced by banks to maintain a minimum level of capital relative to their total exposures, irrespective of asset composition.[19] The target ratio z thus serves as a regulatory or internal benchmark that anchors bank behaviour, ensuring that capital buffers grow proportionately with total assets, and κ is a positive adjustment cost parameter, where the larger it is, the more costly it is to deviate from z. This approach allows the bank's optimisation to explicitly consider the leverage ratio requirement, balancing the profitability of holding assets with the regulatory need to maintain sufficient capital.[20]

While this approach differs from incentive-based banking frameworks such as Gertler and Karadi (2011), both frameworks share a similar macroeconomic implication: bank lending capacity depends on net worth, so balance sheet shocks translate into changes in credit supply. The key difference lies in the microfoundation of the constraint. In incentive-based models the leverage limit arises from agency frictions between bankers and depositors, whereas in our specification it reflects regulatory leverage considerations and capital adjustment costs. As a result, both approaches effectively imply that a decline in bank capital tightens the balance sheet constraint and reduces financial intermediation. Accordingly, the resulting balance sheet channel linking bank net worth to credit supply is closely related across the two frameworks.

The bank's problem involves choosing the optimal amount of interbank borrowing, D_t and lending to firms, q_t. Note that the bank does not choose how much government debt to hold, this being determined by the fiscal authority. The optimisation problem yields the following condition for the evolution of the interest rate spread:

$$(1 + r_t^q) - (1 + r_t)\frac{E_t s_{t+1}}{s_t} = -\kappa \left(\frac{K_t^B}{Q_t} - z\right)\left(\frac{K_t^B}{Q_t}\right). \tag{39}$$

The difference between the rate faced by entrepreneurs, $(1 + r_t^q)$ and the rate in the interbank market, $(1 + r_t)\frac{E_t s_{t+1}}{s_t}$ is determined by the deviation between the capital-to-asset ratio and z.

[18] The leverage ratio, according to Basel III, is a regulatory measure calculated as the proportion of a bank's Tier 1 capital to its total exposure, expressed as a percentage. Its primary objective is to constrain the accumulation of excessive leverage in the banking sector by ensuring that banks maintain a minimum capital base relative to their total exposures, even when holding predominantly low-risk assets.

[19] Unlike frameworks where capital adequacy is tied to the perceived riskiness of individual asset classes (i.e., the risk-weighted capital ratio), the leverage ratio is defined as the ratio of capital to total unweighted exposures. This specification enforces discipline over the absolute size of the balance sheet, regardless of asset risk. Both indicators are key regulatory metrics under the Basel III framework for assessing a bank's financial soundness.

[20] Although stylised, the quadratic cost function models the dual pressures of regulatory compliance and economic efficiency. For instance, undercapitalised banks holding capital below regulatory thresholds face penalties imposed by European prudential authorities, such as periodic penalty payments (PPPs), mandated earnings retention to increase capital and reduce dividend payments, or enforcement measures implemented in coordination with national authorities, depending on the bank's location within a member country. Enforcement available here: https://www.bankingsupervision.europa.eu/banking/tasks/enforcement/html/in. Conversely, banks that exceed the required capital face opportunity costs for retaining excess resources on their balance sheets rather than deploying them to generate returns. While such costs are not direct penalties from regulators, they reduce the expected cash flows of the banking sector. For example, Albertazzi et al. (2020) argue the bank capital channel works by making it costly for banks to break the minimum capital requirements imposed by regulation. As equity/capital funding is more costly compared with other forms of funding, financial institutions tend to diminish the amount of capital in excess of what regulators require.

3.7 Consolidated budget constraints

Substituting equations (20) and (34) into the household's budget constraint (7), then adding to that the entrepreneur's budget constraint, (12) and substituting in the bank's budget constraint, (38) yields an expression for the economy's current account[21]:

$$c_t + i_t + g_t + \frac{\psi}{2}\left(\frac{i_t}{k_{t-1}} - \delta\right)^2 k_{t-1} = -(d_t - D_t) + (1 + r_{t-1})\frac{s_t}{s_{t-1}}(d_{t-1} - D_{t-1}) + p_t^H y_t$$

where d_t are interbank deposits held by households and D_t is interbank borrowing by the banking sector. The difference between international lending and borrowing $b_t = (d_t - D_t)$ equals net foreign assets:

$$b_t = (1 + r_{t-1})\frac{s_t}{s_{t-1}} b_{t-1} + p_t^h y_t - c_t - i_t - g_t - \frac{\psi}{2}\left(\frac{i_t}{k_{t-1}} - \delta\right)^2 k_{t-1} \tag{40}$$

3.8 Market clearing

We close the model by ensuring that the demand for home (and foreign) produced intermediate goods equals supply:

$$y_t^h = (1-(1-N)\gamma){p_t^h}^{-\theta}(c_t+i_t+ac_t+g_t+\delta^B K_{t-1}^B)+(1-N)\gamma {p_t^{*h}}^{-\theta}(c_t^*+i_t^*+ac_t^*+g_t^*+\delta^B K_{t-1}^{B*}) \tag{41}$$

where $ac_t = \frac{\psi}{2}\left(\frac{i_t}{k_{t-1}} - \delta\right)^2 k_{t-1}$.

To ensure that the domestic net foreign asset position is stationary, we assume that rate r_t at which households and banks borrow on the interbank market is equal to the foreign interest rate, r_t^* plus a small risk premium that rises with the economy's net foreign indebtedness. See Schmitt-Grohé and Uribe (2003).

3.9 Calibration

Table 3 shows the calibrated model parameters. For the baseline calibration of the model, a discount factor of 0.99 is established for the household utility function which equates an annual interest rate of 4 percent, whereas for entrepreneurs, the discount factor is set to 0.98, indicating an annual discount rate of 8 percent.[22] For the Cobb–Douglas production function, the share of capital input in intermediate goods production α is set to 0.3 as a standard value from the RBC literature. Additionally, a standard capital depreciation rate $\delta = 0.025$ is used, which is equivalent to a 10 percent yearly rate. η is the inverse of the Frisch elasticity, and ϕ_0 is a parameter in the utility function set so that steady-state hours worked equals 1/3 of available

[21] We treat the adjustment cost faced by banks, $\frac{\kappa}{2}\left(\frac{K_{t-1}^B}{Q_{t-1}} - z\right)^2 K_{t-1}^B$ as a tax on banks that gets rebated to consumers and thus does not present a resource cost to the economy

[22] Among recent literature that consider differences in discount factors and use similar values are: Gallegati et al. (2019) set the impatient discount factor to 0.98; Jensen et al. (2018) set it to 0.97; Batini et al. (2019) set entrepreneurs' discount factor to 0.98.

time. The habit parameter ϵ_c is set to 0.60 as standard in literature and in line with estimates reported in Smets and Wouters (2003) for Europe.

Table 3: Calibrated Parameters

Description	**Param**	**Value**
Discount Factor for Patient Household	β	0.990
Discount Factor for Impatient Entrepreneur	β^E	0.980
Inverse Frisch elasticity	η	0.330
Habit persistence	ϵ_c	0.600
Capital Share in Production	α	0.300
Physical Capital Depreciation Rate	δ	0.025
Leverage ratio for Financial Intermediaries	z	0.100
Elasticity of spread to capital requirements	κ	100.0
Loans to valuation	χ	0.300
Gov. Expenditure share	$\bar{g}$	0.200
Steady state Debt share	$\frac{b^g}{y}$	4.000
Fiscal speed of adjustment	ϕ_T	0.200
Relative size of GIIPS	N	0.430
Openness to trade	γ	0.700
Investment adj. cost	ψ	1.000
Elasticity of subst. home/foreign goods	θ	1.000
Share of bank profits	ω	0.990

For the financial sector, the parameter z is calibrated to 10 percent, guided by empirical evidence from the ECB's Supervisory Banking Statistics.[23] Rather than tying costs directly to regulatory thresholds, such as the Basel III minimum leverage ratio of 3%, we anchor the steady state in observed capitalisation levels in GIIPS, reflecting banks' tendency to operate with buffers above minimum requirements, and adopt a higher steady-state value to account for differences in the definition of exposures.[24] Once these definition differences are taken into account, calibrating to a higher leverage ratio is not only consistent with regulatory standards, but also necessary to accurately capture both the regulatory intent and the actual capitalisation behaviour observed in the banking sector. We set κ to 100 so as to ensure that deviations of bank capital from its target level have a quantitatively meaningful effect on lending spreads. The loans to valuation χ is set to 0.3 taken from other studies that set a value ranging from [0.3-0.38].[25] For the steady state ratios, $\bar{g}$ is set to 20% consistent with the share of general government consumption to GDP in European countries. Debt-to-GDP $\frac{b^g}{y}$ is set to 4, which corresponds to an annual value of 100 percent of GDP, reflecting the average level observed for these countries over 2003–2019. The

[23] Focusing on the pre-2019 period, which corresponds to the sample used in the analysis, leverage ratios in Greece and Ireland reached around 10% and 9%, respectively, while Spain and Italy reported lower averages of around 6%, and Portugal around 7%.

[24] Specifically, the model abstracts from off-balance-sheet items, netting adjustments, and other regulatory refinements included under Basel III.

[25] Other authors that set values similar to this are: Christensen et al. (2007), who set it to 0.32, for firms that can borrow against business capital calibrated for Canada, Chadha and Corrado (2012) set the capital as collateral as 0.2 in their model; Gallegati et al. (2019) set the value of loan-to-value for entrepreneurs to 0.5; Batini et al. (2019) set entrepreneurs loan-to-value ratio to 0.38.

parameter ϕ_T, which governs the fiscal rule, is set to 0.2. This value is chosen to match the timing observed in the impulse response functions from the empirical estimates presented in Section 2. In particular, it ensures that government bond issuance gradually returns to its steady-state level within the horizon shown in the impulse responses.[26] Finally, the relative size of the home economy, the set of GIIPS countries, is set to 0.43, which is their approximate relative size compared to the core European block. We calibrate the openness parameter γ to 0.7 to match the average trade share (exports plus imports over GDP) for Greece, Italy, Portugal, and Spain over the period 2000–2019, using data from the World Bank's World Development Indicators. We set the investment adjustment cost parameter ψ and the elasticity of substitution θ equal to 1 in the baseline calibration. To assess robustness, we conduct a Monte Carlo exercise reported in the Appendix (Figure A.6), where parameters are drawn from the ranges $\psi \in [0.8, 1.2]$, $\gamma \in [0.5, 0.8]$, and $\theta \in [0.9, 2]$.

3.10 Responses to a Debt-Financed Fiscal Expansion under Alternative Financial Structures

Having outlined the model, we now use it as a laboratory to trace how sovereign debt issuance propagates through the banking system and affects real activity. The key question is whether the presence of banks as intermediaries of government debt amplifies or dampens the transmission of fiscal shocks through the credit market.

To isolate this mechanism, we compare two financial structures of the economy following an identical fiscal expansion. In both specifications, the fiscal authority operates under the same government budget constraint and fiscal rule, and government debt is ultimately backed by taxes. The only difference lies in how public debt is held within the economy.

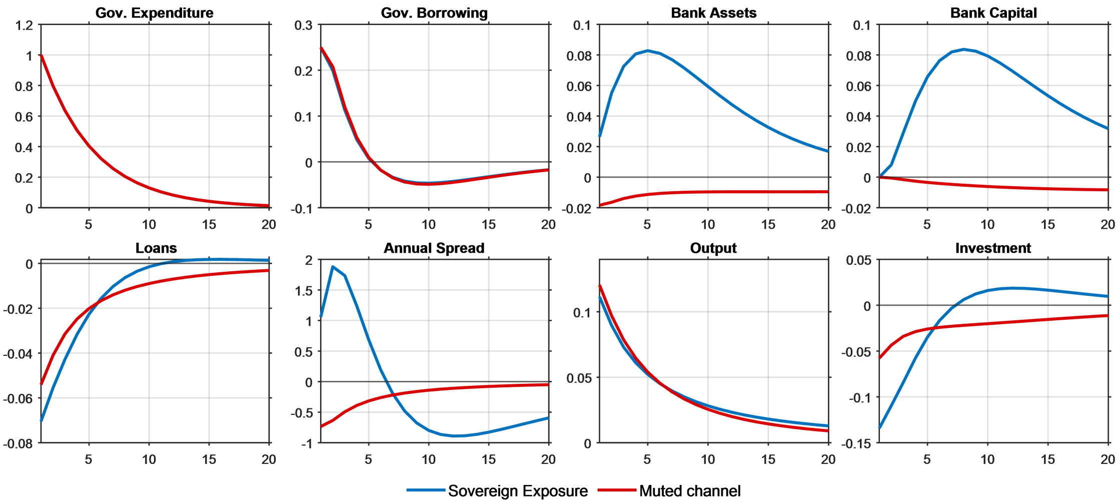
In the benchmark economy, government bonds are intermediated by banks: households hold deposits d_t, while banks allocate part of their balance sheet to government securities. Thus, households are indirectly exposed to public debt through the banking system. In the alternative specification, banks do not hold government bonds. Instead, households include them directly in their asset portfolio. All other model equations and parameters remain identical across the two specifications. This comparison therefore isolates the role of bank intermediation in shaping the transmission of fiscal expansions.

Figure 4 reports impulse responses under the two financial structures. The blue lines correspond to the benchmark economy in which banks hold sovereign bonds, whereas the red lines correspond to the muted-channel specification in which households hold government bonds directly.[27]

[26] Lower values of ϕ_T imply a slower adjustment back to the steady state.

[27] To assess the robustness of the results to parameter uncertainty, we perform a Monte Carlo sensitivity analysis around the calibrated parameter values; the resulting distribution of impulse responses is reported in Appendix Figure A.6.

Figure 4: Banking Sector Impulse Responses: Sovereign Exposure vs. Muted Channel



Responses of selected variables to a government spending shock normalised to unity on impact, shown as percentage deviations from the steady state. Blue lines represent the responses under domestic banking sector exposure to sovereign debt holdings, while red lines correspond to the case in which this channel is muted. Figure A.6 shows a Monte Carlo sensitivity analysis around the calibrated parameter values for each scenario.

We begin by describing the transmission mechanism operating in the benchmark economy (blue), before contrasting it with the muted-channel specification (red). We focus on the behaviour of financial variables to illustrate the role of sovereign exposure in shaping credit market dynamics.[28] To understand the resulting credit market dynamics, it is important to highlight both the supply and demand sides of the credit market. On the supply side, bonds issued by the fiscal authority are acquired by the financial sector, expanding the asset side of banks' balance sheets. This debt-financed fiscal expansion affects banks' leverage ratios and weakens their financial positions. As sovereign debt holdings increase, banks must raise additional capital to comply with regulatory capital requirements. However, since bank capital does not adjust immediately to the expansion in assets, the leverage ratio temporarily deviates from regulatory requirements. To restore compliance, banks must generate higher profits to rebuild capital, which requires adjusting the supply of loans to the private sector while accommodating higher credit to the government. Financial intermediaries therefore initially contract lending to firms in order to preserve intermediation margins. This contraction in credit supply raises lending rates for firms, increasing the cost of borrowing and widening the credit spread between the loan rate and the risk-free (savings) rate.

On the demand side, the increase in borrowing costs affects firms' financing decisions. Higher lending rates discourage firms from taking new loans, leading to a decline in credit demand and lower investment. In addition, entrepreneurs in the model are subject to binding collateral constraints. When the value of installed capital (the Q ratio) declines, the collateral available to secure loans also decreases, reducing borrowing capacity.[29]

[28] The full set of impulse responses is reported in Figure A.4.

[29] The reason why the productive sector is affected through its collateral comes from the relationship between in-

In both scenarios, whether or not banks hold sovereign bonds, a fiscal expansion increases public borrowing and reduces national savings. This adds upward pressure on real interest rates (and thus the deposit rate), reducing the intermediation margin that banks earn from lending. This is reflected in a decline in the credit spread. In response, banks adjust their balance sheets by tightening credit to restore the optimal relationship between marginal income and marginal cost, as implied by their optimisation problem. As such, in the muted scenario (red), where banks do not hold government debt, this tightening leads to a reduction in lending to businesses and thus in total bank assets.

By contrast, under sovereign exposure (blue), banks absorb the additional public debt, causing their balance sheets to expand. To satisfy leverage requirements, banks must raise additional capital, which can only be accumulated gradually through retained earnings. This causes a further contraction in credit supply and raises the cost of borrowing above the deposit rate, raising credit spreads as opposed to the case where the channel remains muted. Thus, while both scenarios result in lower lending to entrepreneurs, the presence of sovereign debt exposure amplifies the contraction in credit supply. This amplification mechanism leads to stronger declines in investment and capital formation when banks intermediate public debt.

Taken together, financial frictions on both the supply and demand sides of the credit market help capture the connection between sovereign bond holdings on bank balance sheets and the effects on corporate lending. This highlights a key implication of the model: sovereign debt exposure amplifies the transmission of fiscal shocks through banks' balance sheets. The comparison between the blue and red responses shows that this amplification results in a larger contraction in private lending and investment relative to the muted-channel specification.

We further quantify the role of the bank lending channel in the transmission of fiscal policy by computing dynamic output and investment multipliers under the SDH exposure model and under a counterfactual specification in which this channel is muted.[30] Table 4 reports cumulative multipliers at selected horizons. The impact output multiplier is 0.45 in the SDH exposure model and 0.48 when the bank exposure channel is muted, indicating that banks' holdings of sovereign debt slightly dampen the short-run transmission of fiscal policy. Over time, however, the cumulative output multipliers converge across the two specifications, reaching approximately 0.55 after twelve quarters. This suggests that the bank balance sheet channel primarily affects the short-run propagation of fiscal shocks. In contrast, the effects on investment are more pronounced. Investment multipliers are negative in both specifications, indicating that fiscal expansions crowd out private investment. In the benchmark SDH exposure model, the impact investment multiplier is -0.13, reflecting a relatively strong contraction in investment following the fiscal expansion. When the bank exposure channel is muted, the impact multiplier

vestment and the Q ratio. An increase (decrease) implies a looser (tighter) borrowing constraint for entrepreneurs, thus increasing (decreasing) their investment.

[30] Cumulative fiscal multipliers are computed as the cumulative response of output or investment to a fiscal policy shock over a given horizon, divided by the cumulative increase in government spending over the same horizon. Formally, the multiplier at horizon h is defined as $M(h) = \frac{\sum_{t=0}^{h} \Delta Y_t}{\sum_{t=0}^{h} \Delta G_t}$, where ΔY_t denotes the change in the macroeconomic variable of interest and ΔG_t denotes the change in government expenditure.

increases to -0.05, indicating that the decline in investment is substantially smaller when banks do not absorb additional sovereign debt. This difference reflects the reallocation of bank balance sheets toward government bonds in the SDH exposure model, which reduces the availability of credit for private investment. Over time, however, these differences gradually diminish: the cumulative investment multipliers converge across the two specifications after twelve quarters. These differences are summarised in Figure A.7, which plots the gap in cumulative multipliers across horizons between the muted-channel and SDH specifications.[31] The figure shows that sovereign exposure amplifies the contraction in private investment while only modestly reducing the expansion in output.

Table 4: Cumulative Output and Investment Multipliers

Horizon	Output (SDH)	Output (Muted Channel)	Investment (SDH)	Investment (Muted Channel)
0 (impact)	0.446	0.482	-0.132	-0.052
6	0.481	0.509	-0.110	-0.059
12	0.546	0.554	-0.074	-0.074

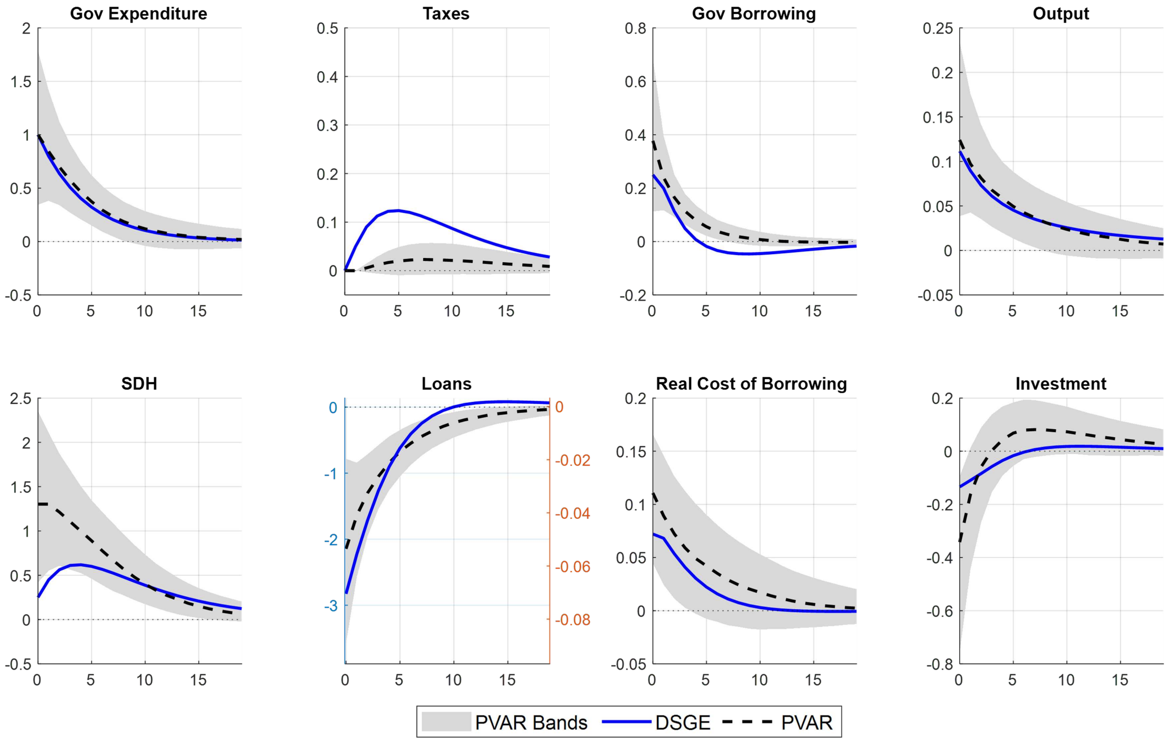
4 Comparison with Empirical Evidence

To relate the model to the empirical evidence, we compare its impulse responses with those obtained from the PVAR in Section 2. Rather than seeking an exact correspondence, this comparison assesses whether the model captures the main macro-financial patterns observed in the data, particularly the role of sovereign debt holdings by financial institutions in shaping overall economic dynamics. By contrasting model-implied and empirically estimated responses to debt-financed fiscal shocks, we use the model as a structured framework to interpret the transmission mechanism in the data, while also highlighting differences in magnitude and persistence across approaches. For ease of comparison, all impulse responses are normalised to a one-unit increase in government spending on impact.

Figure 5 reports the corresponding impulse responses from the DSGE model and the pooled PVAR estimation, allowing for a direct comparison across the two approaches. The solid blue line represents the responses from the DSGE model, while the dashed black line denotes the median responses from the PVAR model, with the shaded grey areas indicating the 68% error bands for the empirical estimates. The responses of government expenditure, output, cost of borrowing, and investment exhibit a broadly similar pattern in both models, with the DSGE model's impulse responses largely contained within the PVAR bands.

[31] The difference in multipliers is computed as the cumulative multiplier under the muted-channel specification minus that under the specification with active sovereign debt exposure. Formally, at each horizon h, the difference is given by $\Delta M_h = M_h^{\text{Muted}} - M_h^{\text{SDH}}$.

Figure 5: DSGE and PVAR (pooled) comparison to a government spending shock



The dashed black line represents the median responses to a government spending shock normalised to a one-unit increase under a PVAR pooled estimator, while the solid blue line denotes the corresponding responses implied by the calibrated DSGE model. The y-axis measures the median responses in percentage points, and the x-axis represents time in quarters.

A notable difference arises in the response of SDH by domestic banks. While both models indicate an increase in bank holdings of government debt, the PVAR model suggests a more pronounced rise. Similarly, loans to NFCs decline in both models, although the DSGE model captures a much more muted adjustment (left hand scale). This may reflect the parsimonious representation of financial frictions in the model relative to the richer dynamics captured in the data.

Overall, although DSGE models and VARs are not expected to produce identical results, the comparison suggests that the model captures the key qualitative patterns in the data, with responses broadly aligning with those observed in the PVAR. Some differences in persistence and magnitude remain, particularly in financial sector variables, where the stronger impact of sovereign debt holdings in the PVAR model may reflect financial frictions and institutional factors that are more directly captured in the empirical data. These differences are expected, given that DSGE models impose a structural framework with theoretical constraints, while PVARs rely on data-driven estimates that may reflect additional financial frictions and institutional features present in the real world, which we may abstract from.

5 Conclusion

This paper provides new empirical and theoretical evidence on the impact of debt-financed fiscal expansions on financial intermediation and private sector credit dynamics in peripheral European economies. Using a Bayesian Panel VAR framework, we document that increased government debt issuance, when primarily absorbed by domestic financial institutions, leads to a reallocation of bank balance sheets away from corporate lending, resulting in a contraction of credit supply and investment. These effects are particularly pronounced in economies with higher sovereign exposure, highlighting the role of the banking sector in the transmission of fiscal policy.

We complement these findings with a DSGE model, which provides a structural interpretation of the underlying mechanisms. The model shows that the accumulation of sovereign assets by banks imposes constraints on credit supply, leading to higher borrowing costs and lower capital formation. Our counterfactual analysis indicates that, in the absence of financial intermediation of sovereign debt, these crowding-out effects are mitigated, reinforcing the view that the balance sheet channel plays a central role in shaping macro-financial outcomes following debt-financed fiscal expansions.

While our DSGE framework abstracts from monetary policy and central bank interventions, the balance sheet channel described in this paper would operate similarly in their presence. In particular, policies such as large-scale asset purchases (LSAPs), whereby central banks purchase government bonds from commercial banks, reduce banks' sovereign exposure on their balance sheets. This alleviates balance sheet constraints and can support lending to the private sector. Importantly, such interventions do not alter the underlying mechanism highlighted in this paper, but rather mitigate its effects by offsetting the increase in sovereign exposure.

Our findings contribute to the broader literature on the sovereign-bank nexus and the macroeconomic consequences of fiscal policy. Unlike previous studies that focus primarily on sovereign risk channels or crowding-out effects through interest rate mechanisms, our analysis emphasises the balance sheet channel as a determinant of credit market responses to fiscal expansions. More broadly, the results highlight the importance of macro-financial linkages in bank-based economies. These findings also have important policy implications, particularly for the European Monetary Union, where sovereign debt accumulation and financial stability remain closely interconnected. Given the region's reliance on a bank-based financial system, fluctuations in bank balance sheets can affect macroeconomic policy transmission.

Policymakers should therefore consider the implications of banks' sovereign debt exposure when designing fiscal stimulus measures, especially as the financial sector assumes a greater role in sovereign debt absorption given the unwinding of central bank asset purchase programs. We however acknowledge that if increased public spending, including on military expenditures, stimulates regional economic activity by boosting demand, employment, or innovation, its effects on private investment may differ from the crowding-out associated with debt-financed fiscal expansions. Furthermore, if debt is financed by foreign capital under a low-risk environment, such as through EU-level debt issuance, it could help sustain economic activity without displacing private investment. External financing reduces pressure on domestic financial institutions, mitigating balance sheet constraints that could otherwise limit credit supply to non-financial firms.

Nevertheless, our findings remain relevant in highlighting the conditions under which sovereign debt accumulation may affect private credit markets. In economies where banks are the primary holders of domestic government debt and reliance on foreign markets is limited, debt-financed public spending absorbed domestically may lead to tightening credit supply to the private sector. The macro-financial implications of increased public spending will depend on the way this expansion is financed, the prevailing economic conditions, and the capacity of financial institutions to absorb additional sovereign debt while sustaining corporate lending. Additionally, the design of macroprudential policies, together with fiscal discipline, plays an important role in shaping the extent to which sovereign debt accumulation affects credit supply and investment. Future research could extend this analysis by incorporating richer financial frictions, including heterogeneity across banks and firms, as well as the role of non-bank financial intermediaries.

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Appendix A:

A.1 Data Sources and Definition of Variables

The data series are transformed to real terms with base year 2015 and de-trended using the HP-one sided filter. *For each country i, the variables are:*

- GC_{it} : General government final consumption expenditure - Millions of Euros, current prices, quarterly levels, seasonally adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.

- T_{it} : Total general government revenue – Millions of Euros, current prices, quarterly levels, seasonally adjusted (X-12 filter). Source: Quarterly Non-Financial Accounts for General Government, European Central Bank (ECB).

- B_{it} : General government net lending/net borrowing (inverted) – Millions of Euros, current prices, quarterly levels, seasonally adjusted (using X-12 filter). The variable is constructed as the inverse of the net lending/net borrowing indicator, such that increases indicate greater government borrowing. Source: Government Finance Statistics, European Central Bank (ECB).

- GDP_{it} : Gross domestic product (expenditure approach) - Millions of Euros, current prices, quarterly levels, seasonally adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.

- INV_{it} : Gross fixed capital formation - Millions of Euros, current prices, quarterly levels, seasonally adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.

- NL_{it}: New Loans - Millions of Euros, current prices, quarterly flows, seasonally adjusted (using X-12 filter) - Monetary Financial institutions, Total Loans other than revolving loans to Non-Financial Corporations. Source: ECB Monetary Interest Rate (MIR) statistics series- Statistical Data Warehouse.[32]

- SDH_{it} : Sovereign debt holdings by domestic credit institutions – Millions of Euros quarterly levels, seasonally adjusted (using X-12 filter). Source: Historical country-level data

[32] This variable captures the total volume of new loan agreements between non-financial corporations and banks, excluding extensions of existing contracts without renegotiation. It includes only new financial contracts or renegotiated agreements. The data are available at monthly frequency and aggregated to quarterly frequency by summing monthly flows. Total new lending is constructed by aggregating loans up to and over EUR 1 million.

retrieved from Merler and Pisani-Ferry (2012).[33]

Deflators:

- $GDP_{it}^{deflator}$: Gross Domestic Product - Deflator base 2015, Seasonally Adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.
- $GC_{it}^{deflator}$: General government final consumption expenditure - Deflator- 2015=100, Seasonally Adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.
- $GFCF_{it}^{deflator}$: Gross fixed capital formation - Deflator - 2015=100, Seasonally Adjusted. Source: Quarterly National Accounts, Organisation for Economic Co-operation and Development (OECD) Stats.

Definition of data variables: The time series are constructed as follows and subsequently filtered to extract the cyclical component:

$$g_{it} = ln\left(\frac{GC_{it}}{GC_{it}^{deflator}}\right) * 100 \tag{A.1}$$

$$t_{it} = ln\left(\frac{T_{it}}{GC_{it}^{deflator}}\right) * 100 \tag{A.2}$$

$$b_{it} = ln\left(\frac{B_{it}}{GC_{it}^{deflator}}\right) * 100 \tag{A.3}$$

$$y_{it} = ln\left(\frac{GDP_{it}}{GDP_{it}^{deflator}}\right) * 100 \tag{A.4}$$

$$I_{it} = ln\left(\frac{INV_{t}}{GFCF_{it}^{deflator}}\right) * 100 \tag{A.5}$$

$$l_{it}^{nfc} = LN\left(\frac{NL_{t}}{GDP_{it}^{deflator}}\right) * 100 \tag{A.6}$$

$$sdh_{it} = ln\left(\frac{SDH_{t}}{GDP_{it}^{deflator}}\right) * 100 \tag{A.7}$$

[33]This dataset on sovereign bond holdings collects data from the specific country's national authorities for 10 European countries (Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain), the UK and the USA. The data is disaggregated by holding sector (resident and non-resident banks) for each specific country on a quarterly basis. This dataset is useful as it compiles publicly available data provided by national authorities that generally differ across countries, allowing for a more comparable cross-country analysis.

This paper uses the cost-of-borrowing indicator for non-financial corporations (NFC) which is derived as a weighted average of short-term and long-term loan rates to non-financial corporations and that takes into account the financial structure of businesses. The cost-of-borrowing indicator is estimated by the ECB and is publicly available on their website under interest rate statistics of monetary financial institutions. This variable allows for cross-country comparability and accurately measures the borrowing costs for firms in European countries. We define the real interest rate by adjusting for inflation $(i^q - \pi)$ captured by the Harmonised Index of Consumer Prices (HICP) for each country. This approach facilitates the analysis of changes in conventional monetary policy by capturing its direct impact on borrowing costs while also accounting for its influence on inflation. This is particularly relevant given that the study period encompasses the post-crisis era, during which the European Central Bank (ECB) responded by reducing monetary policy interest rates, reaching the effective lower bound in 2015. Additionally, the credit easing programs and other non-conventional monetary policy measures implemented since 2015 further influenced loan rates offered by financial institutions. Although we do not explicitly model monetary policy, the impact of the monetary policy rate is largely embedded in borrowing costs for financial institutions, where both variables move in tandem throughout the period of analysis, hinting at an effective pass-through of monetary actions. Moreover, since all economies in the study are subject to the same monetary shocks, the analysis can focus on disentangling the effects of fiscal shocks on the credit channel.

A.2 Posterior distribution and Parameter Specification under Random Effects

The complete posterior distribution for the model $\pi(\beta, b, \Sigma_b, \Sigma \mid y)$ is proportional to:

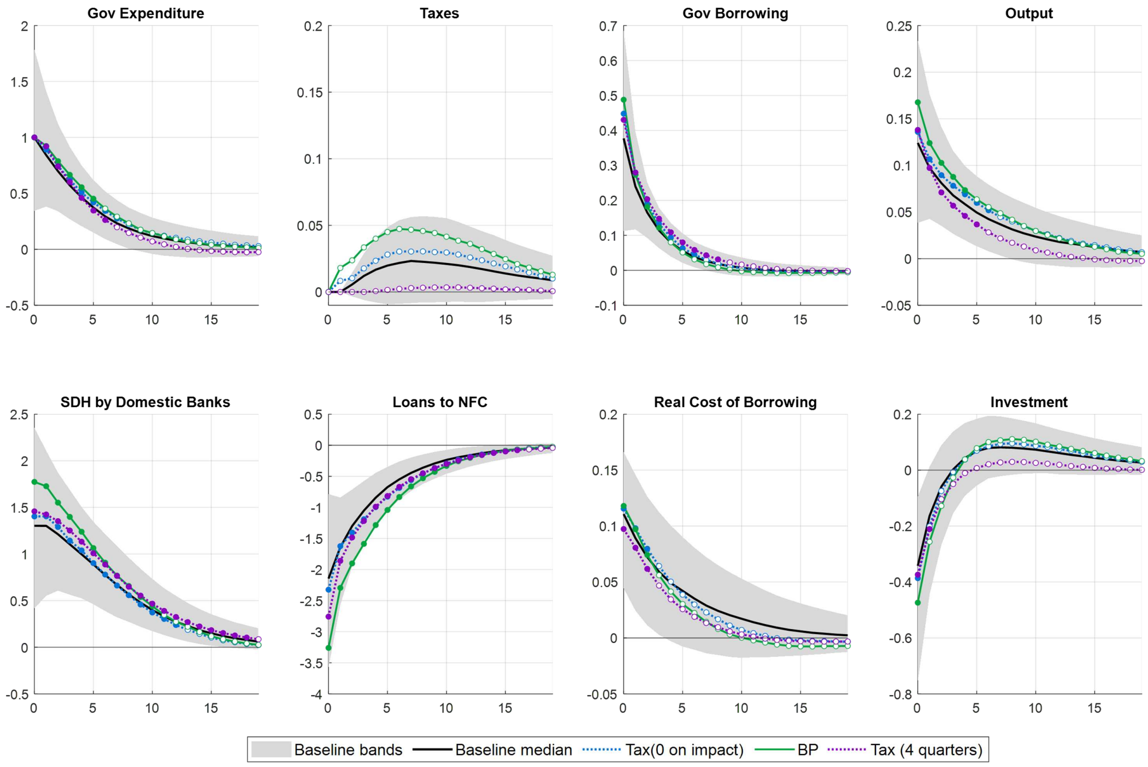
$$\pi(\beta, b, \Sigma_b, \Sigma \mid y) \propto \pi(y \mid \beta, \Sigma)\pi(\beta \mid b, \Sigma_b)\pi(b)\pi(\Sigma_b)\pi(\Sigma) \tag{A.8}$$

where the first term is the likelihood function of the data, and the second is the conditional prior distribution for β on the two hyperparameters, b and Σ_b, for which hyperpriors are defined as $\pi(b)$ and $\pi(\Sigma_b)$, respectively. The final term is the prior of Σ for the Σ_i matrix.

The parameters and hyperparameters follow standard values from macroeconomic literature and the Gibbs sampler for the hierarchical prior allows us to derive the posterior distribution for the model. In particular, the selected forms for b and Σ are diffuse priors, allowing for the posterior distributions to rely less on the prior information and capture the underlying data structure. For Σ_b which is the full covariance matrix defined as $\Sigma_b = (\lambda_1 \otimes I_q)\ \Omega_b$, the specified $\lambda_1 \sim \mathcal{IG}(s_0/2, v_0/2)$ follows an Inverse Gamma distribution with shape $s_0/2$ and scale $v_0/2$. The priors for s_0 and v_0 are set to be weakly informative as standard in the literature by using values of 0.001 for both, as suggested by Jarociński (2010) and Gelman (2006). This allows us to obtain a posterior of structural differences in the responses to debt shocks which endogenously weighs country-specific and average cross-sectional information. The covariance matrix is captured by Ω_b, whose off-diagonal elements are zeros as no covariance is assumed between terms in β_i. The variance of parameters in β_i that relate endogenous variables to their own lags is given by: $\sigma^2_{aii} = \left(\frac{1}{l^{\lambda_3}}\right)^2$, where l is the lag considered by the coefficient and λ_3 is the scaling parameter that controls the speed at which coefficients for lags greater than 1 converge to zero. For the cross-lag coefficients the variance is given by $\sigma^2_{aij} = \left(\frac{\sigma^2_i}{\sigma^2_j}\right)\left(\frac{\lambda_2}{l^{\lambda_3}}\right)^2$, where λ_2 represents a cross-variable variance parameter. The way to obtain the scaling parameters controlling for the relative coefficient sizes on variables i and j ($\sigma^2_i \mid \sigma^2_j$), is by fitting the autoregressive models by OLS for all n endogenous variables in the model and obtaining the st. deviations. Since the variance is assumed common across countries, the autoregressive models are calculated by pooling the data of all the units for each endogenous variable. The cross-variable weighting parameter (λ_2) is set to 0.5 to give more weighting to the i^{th} variable lags than lags of other variables, and the lag decaying parameter (λ_3) is set to 2 as standard in the literature. The posterior distribution of the parameters relies on Gibbs sampler numerical methods.

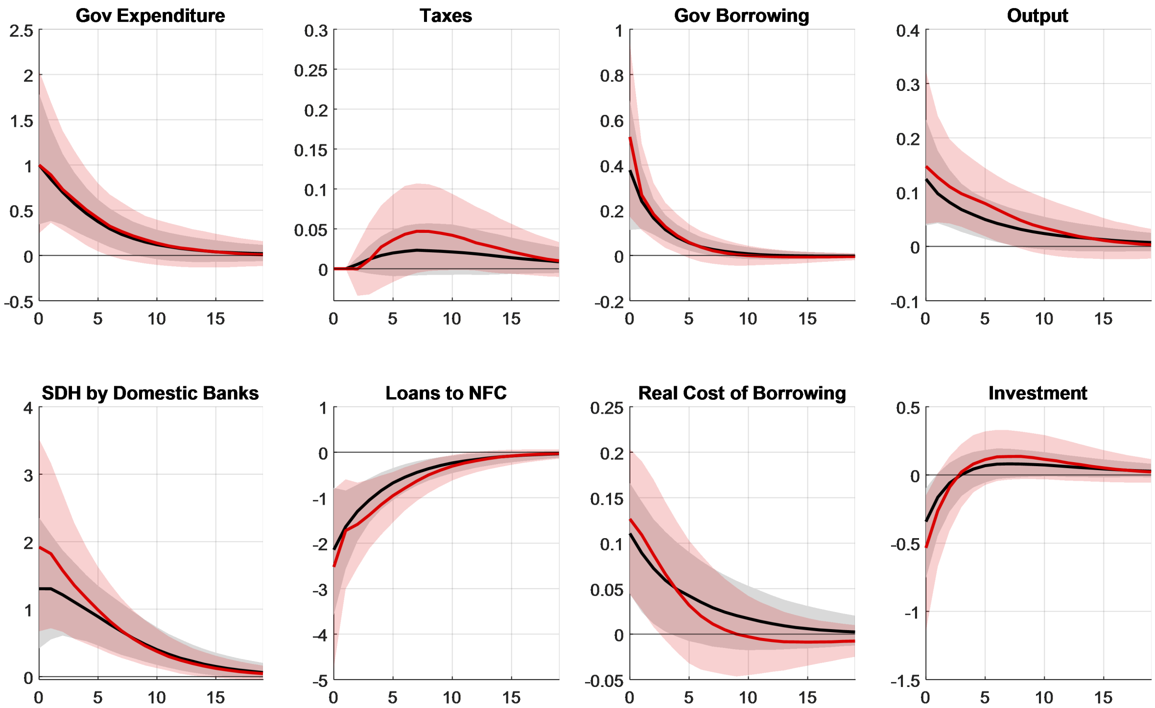
A.3 Additional Figures

Figure A.1: Alternative Tax Timing Restrictions and Blanchard–Perotti Identification



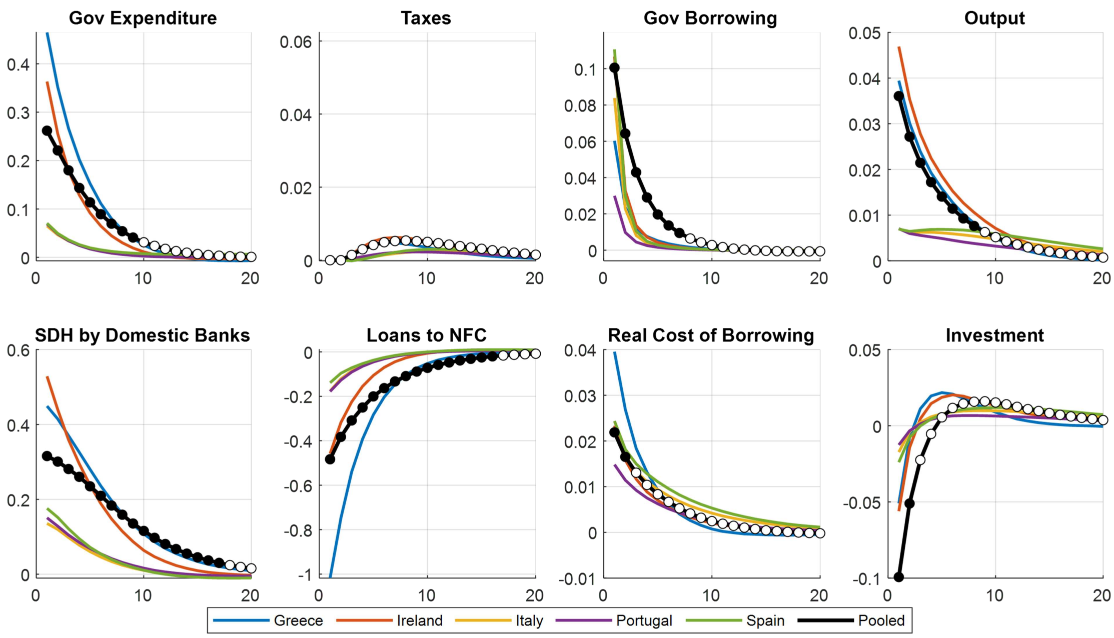
Note: Responses to a government spending shock normalised to unity on impact. The solid black lines show the median responses reported in the main text, with 68% credible intervals. The figure compares the baseline specification with alternative tax timing restrictions and an additional identification scheme. The dashed lines correspond to alternative tax timing assumptions: the purple line imposes a four-quarter restriction on the non-response of taxes following Mountford and Uhlig (2009), while the blue line restricts taxes only on impact. In the baseline specification, taxes are restricted not to respond for two quarters. The green solid line reports results obtained under a Blanchard–Perotti style identification, where the contemporaneous revenue elasticity is calibrated using estimates reported by the European Commission on Mourre et al. (2019), averaged across the GIIPS countries. To preserve readability, confidence bands for the alternative specifications are omitted. Instead, colored circles denote horizons at which the corresponding alternative response is statistically significant, whereas white circles denote horizons at which it is not statistically significant.

Figure A.2: Responses to a Government Spending Shock: Baseline and Sovereign Risk Controls



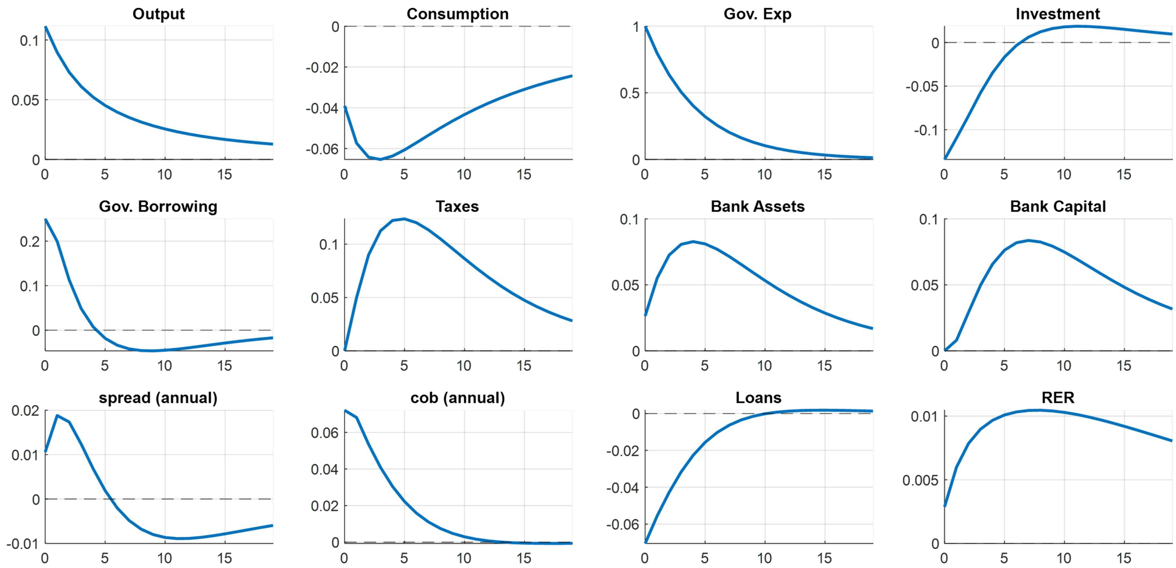
Note: Responses to a government spending shock normalised to unity on impact. The solid black lines show the median responses reported in the main text, with 68% credible intervals. The red lines report results from a specification that additionally controls for country-level sovereign CDS spreads to account for sovereign risk, together with their corresponding 68% credible intervals. The impulse responses remain similar across specifications.

Figure A.3: Pooled and Individual responses to a government spending shock



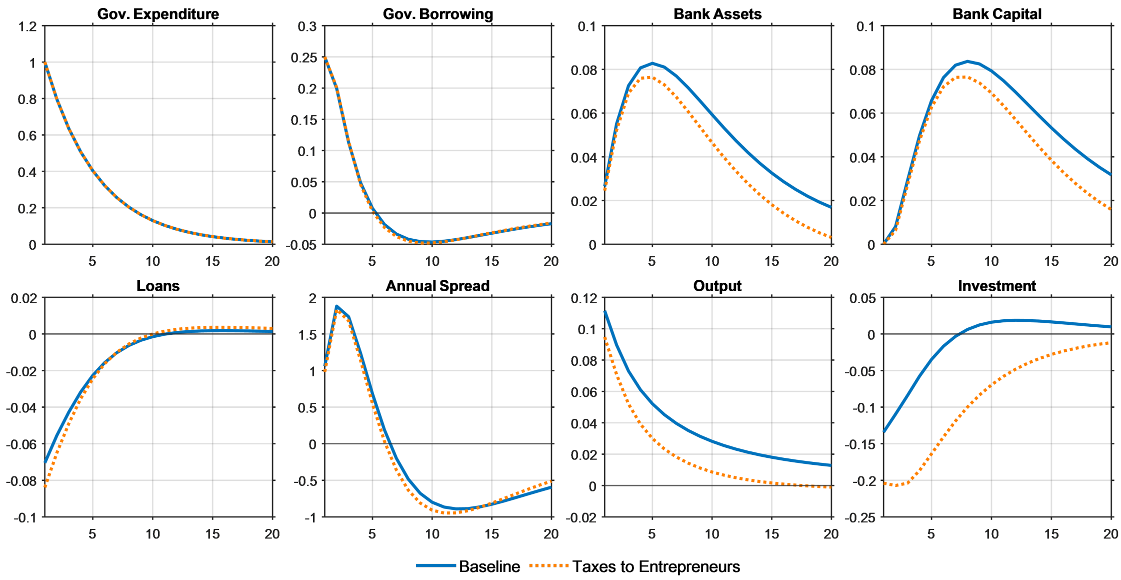
Note: Median responses (solid line) normalised to a 1-unit increase in government expenditure on impact under a random effect estimator based on 5,000 iteration runs (after a burn-in of 1,000 iterations). Black circles indicate a statistically significant response under the pooled estimation for the corresponding period, while white circles represent a non-significant response. The y-axis depicts the median responses in percentage points and horizontal axis indicates the time in quarters.

Figure A.4: Gov. spending shock under financial intermediation of sovereign debt



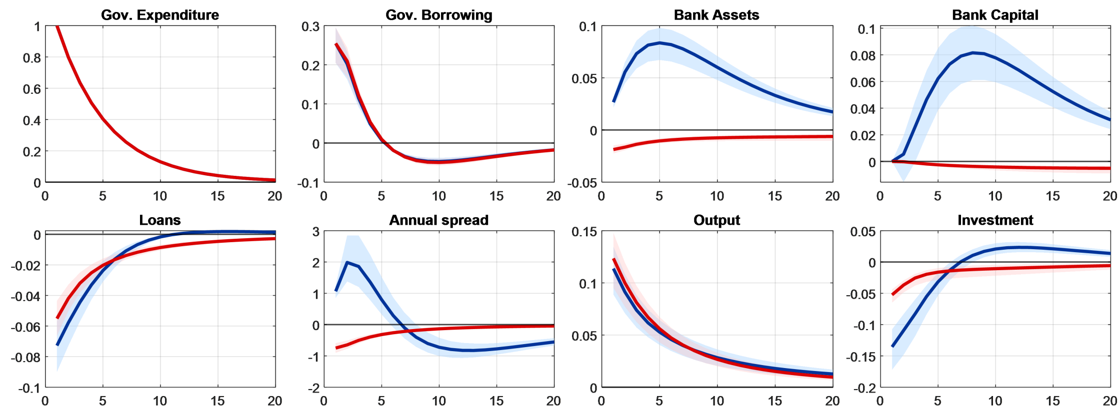
Note: The figure reports the effects of a one-unit government spending shock in an environment where financial institutions absorb government bonds. Fiscal expansion crowds out consumption and investment, although only partially. The net foreign asset position deteriorates as the fiscal expansion generates a trade deficit. Higher government spending reduces national savings and tightens the supply of loanable funds, raising the real interest rate faced by households and firms. The increase in deposit rates encourages household saving and further dampens consumption. At the same time, higher government spending implies a modest increase in taxes, generating a negative income effect for households. The decline in consumption raises labour supply, which expands output while exerting downward pressure on wages. The horizontal axis is measured in quarters and y -axis is in percentage deviations from trend, except for the spread and cob, which are expressed in percentage points.

Figure A.5: Baseline specification and Taxing entrepreneurs



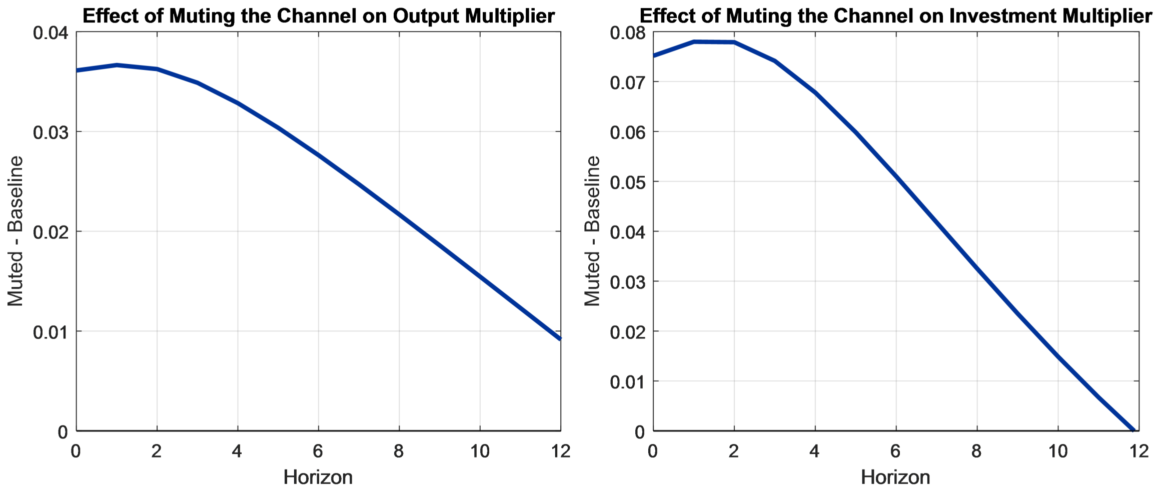
Note: The figure compares impulse response functions to a government spending shock under the baseline specification, where lump-sum taxes are borne entirely by households, and an alternative specification in which entrepreneurs bear 20 percent of the tax burden. The calibration of the entrepreneur tax share is guided by evidence on the composition of tax revenues (Statista Research Department). All responses are normalised to a unit government spending shock on impact. Real variables are expressed as percent deviations from trend, while interest rates are reported in percentage points. Solid lines denote the baseline specification, and dashed lines correspond to the alternative tax incidence. The horizontal axis is measured in quarters and y -axis is in percentage deviations from trend.

Figure A.6: Monte Carlo sensitivity analysis around the calibrated parameter vector



Note: We draw parameter values from a multivariate normal distribution centered at the baseline calibration, subject to admissible bounds. The parameters varied in the Monte Carlo exercise are $\psi \in [0.8, 1.2]$, $\bar{g} \in [0.2, 0.3]$, $\gamma \in [0.5, 0.8]$, and $\theta \in [0.9, 2]$. For each draw, the model is solved and impulse responses are computed. We report the median response together with the 5th and 95th percentiles across successful simulations. Blue lines correspond to the baseline model with bank-intermediated government debt, while red lines represent the counterfactual case without bank intermediation.

Figure A.7: Contribution of Sovereign Debt Exposure to Fiscal Transmission



Note: The y-axis measures the difference in cumulative fiscal multipliers in percentage points (pp), and the x-axis represents the horizon in quarters. The difference is computed as the multiplier $M(h)$ under the muted channel (no sovereign debt holding by domestic banks) minus the multiplier under the specification with sovereign debt exposure active, where $M(h) = \sum_{t=0}^{h} y_t / \sum_{t=0}^{h} g_t$. Difference in cumulative multipliers between the muted-channel specification and the baseline. Positive values indicate that shutting down bank intermediation of government debt increases the fiscal multiplier.