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Macroprudential Capital Regulation and Fiscal Balances in the Euro Area

Abstract

We examine the fiscal footprint of macroprudential policy in euro area countries arising through the bond market channel (Reis, 2021). Using local projections, we estimate impulse responses of the fiscal balance to an unexpected tightening in macroprudential capital regulation. Our findings suggest a dichotomy between country groups. In peripheral countries, the cyclically adjusted primary balance ratio deteriorates after a restrictive capital-based macroprudential policy shock. Since banks are important investors in domestic government debt, the shift in the public budget toward higher borrowing after the innovation might pose a threat to financial stability to the extent that sovereign risk increases. By contrast, in core countries, the cyclically adjusted primary balance ratio barely reacts to a sudden tightening in capital regulation.

JEL-Codes: C330, G280, H630, K330.

Keywords: fiscal footprint, macroprudential capital regulation, sovereign-bank nexus, local projections.

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1 Introduction

Macroprudential policy contributes to strengthening banks' resilience to shocks such as the recent COVID-19 crisis, particularly through capital-based instruments (ESRB, 2021a). However, as pointed out in a theoretical study by Reis (2021), this type of policy might have the unintended side effect of leaving a fiscal footprint. For instance, banks' incentives to invest in sovereign bonds might increase in response to a tightening of capital requirements. Thus, macroprudential policy affects the price at which sovereign bonds sell and hence the cost of borrowing (Reis, 2021). The attractiveness of sovereign bonds is related to their favourable treatment in regulatory capital requirements; in many countries, such as the euro area, they are assigned a zero-risk weight.

However, by incentivising banks to increase their exposure to domestic government debt, macroprudential policy, for example a tightening of capital regulation, might contribute to strengthening the so-called *sovereign-bank nexus* (BCBS, 2017; Altavilla et al., 2017; IMF, 2014, 2018; Hristov et al., 2021), which is perceived as a core problem of the European debt crisis of 2010-2012, as it triggered *doom loops* (Acharya et al., 2014a; Brunnermeier et al., 2016; Farhi and Tirole, 2018; Dell'Ariccia et al., 2018). Particularly, banks' solidity in peripheral countries was strained by the downgrading of governments' creditworthiness, which induced a severe drop in the market value of sovereign bonds. Peripheral governments responded by providing safety guarantees to battered banks or even implementing substantial rescue packages. However, these increased sovereign risk (Acharya et al., 2014a). As a result, governments' creditworthiness declined further. Reis (2021) shows that if government finances are already fragile or in distress, a macroprudential tightening can be especially detrimental by increasing the likelihood of a fiscal crisis or the doom loop. By contrast, if the sovereign is solvent, the stability of the banking sector might benefit from a higher exposure to public debt (Chari et al., 2020).

In this study, we examine the fiscal footprint of macroprudential policy in euro area countries arising through the *bond market channel*. Following Jordà (2005), we estimate local projections to derive impulse responses of important fiscal variables to shocks that proxy the unexpected component of macroprudential capital regulation. We distinguish between two groups of countries, namely the core and periphery. The analysis covers the period 2005-2018. As our sample is short, we use panel techniques.

Our findings suggest a dichotomy between the country groups. In peripheral countries, the cyclically adjusted primary balance ratio, that is, the primary balance as a percentage of GDP, deteriorates after a restrictive capital-based macroprudential policy shock. The worsening can be attributed to a simultaneous increase in the government's cyclically adjusted expenditure ratio and a decrease in the corre-

sponding cyclically adjusted revenue ratio. Moreover, consistent with the theoretical mechanism discussed by Reis (2021), banks in peripheral countries increase their domestic sovereign bond holdings after a sudden tightening in macroprudential capital regulation. Thus, the volume of assets in bank portfolios that receive a regulatory zero-risk weight rises.

In core countries, the fiscal footprint is substantially weaker. The cyclically adjusted primary balance ratio responds sluggishly to a restrictive capital-based macroprudential policy shock, exhibiting only a short-lived deterioration. The cyclically adjusted expenditure ratio increases gradually, however, the rise is comparatively weak and accompanied by an increase in the corresponding revenue ratio. Moreover, banks in core countries decrease their domestic government bond holdings gradually after an unexpected tightening in macroprudential capital regulation.

Finally, in both country groups, the reactions of the cyclically adjusted primary balance ratio (CAPB) to a restrictive shock to macroprudential capital regulation are state dependent. Particularly, the decline in the CAPB is more pronounced when banks' holdings of domestic government bonds relative to total assets is comparatively large. Furthermore, in peripheral countries, there is evidence that capital markets have a disciplining effect; that is, a relatively high government debt ratio seems to create incentives to avoid a worsening of the CAPB after stricter capital requirements.

Our study contributes to a number of studies that analyse the link between banks' asset portfolio choices in the euro area and macroprudential capital regulation (Acharya et al., 2014b; Acharya and Steffen, 2015; Gropp et al., 2019; Altavilla et al., 2017; Hristov et al., 2021). The results of these studies suggest that banks in peripheral countries increase their domestic sovereign bond holdings in response to a tightening in capital requirements if their ability to improve their regulatory capital position is limited. Banks' portfolio adjustments toward higher government debt contribute to strengthening the sovereign-bank nexus, thereby potentially posing risks to financial stability (Acharya et al., 2014b; Acharya and Steffen, 2015). Our analysis complements these findings by showing that macroprudential policy is indeed associated with a fiscal footprint. Particularly, governments in peripheral countries shift to a more lenient fiscal stance after a restrictive shock in capital regulation. Thus, the structure of the public budget seems to change towards higher borrowing after stricter capital requirements.

The remainder of this study is organised as follows. Section 2 discusses the related literature. Section 3 sets out the baseline model, introduces the data, and discusses the derivation of macroprudential policy shocks. Section 4 presents our results. First, we discuss the impulse responses of the baseline model to restrictive shocks to macroprudential capital regulation. Second, we examine the response of banks' demand for sovereign debt to the innovations. Third, we assess the robust-

ness of our results. Finally, we estimate state-dependent impulse responses. Section 5 presents the conclusion.

2 Related literature

Our study draws on several strands of literature. The most closely related study is by Reis (2021), who formalises the fiscal footprint of macroprudential policy within a general-equilibrium framework. Three possible channels are identified: the *bond market channel*, through which macroprudential policy influences the price of government bonds; the *business cycle channel*, through which policy affects credit conditions, which in turn influence economic activity; and the *financial crisis channel*, through which policy reduces the severity of financial crises, and, thus, their fiscal cost when they occur (Reis, 2021). In this study, we focus on the *bond market channel*.[1]

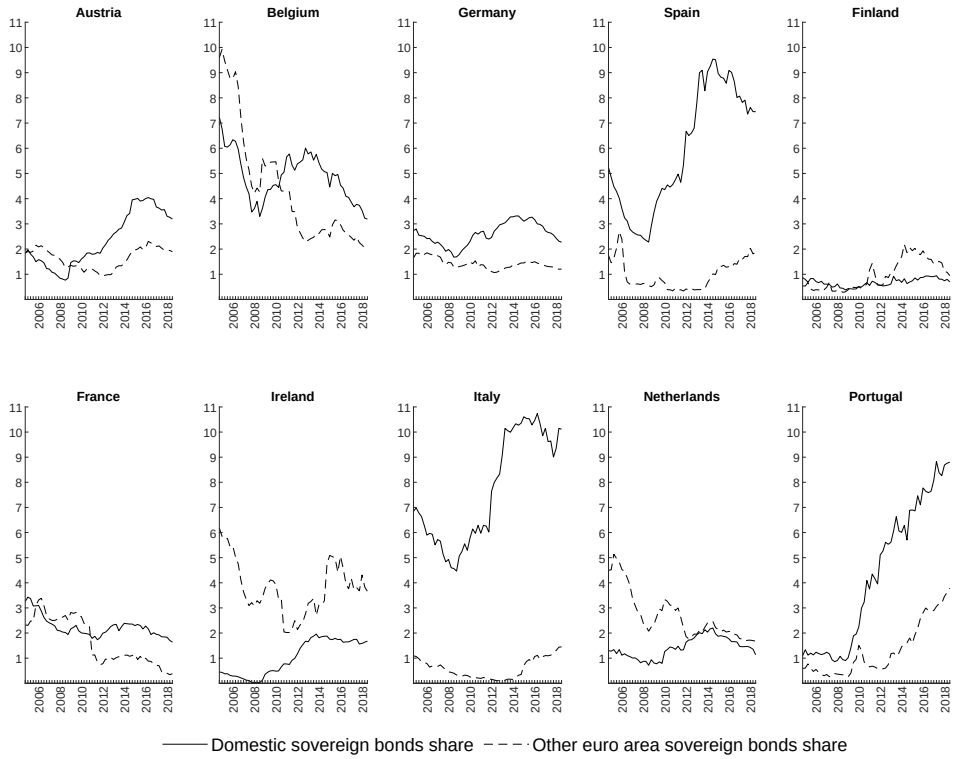
Various studies examine the incentive for banks in the euro area to shift their portfolios toward higher sovereign debt in response to a tightening in macroprudential capital regulation. Acharya et al. (2014b) assess the European stress test of 2011. They find that banks' incentive to diversify their portfolios is limited owing to regulatory risk weights. As a result, banks excessively favour assets with low-risk weights, such as domestic government bonds. Acharya and Steffen (2015) show that banks in peripheral countries increased their domestic sovereign exposure during the European debt crisis, as domestic government bonds offered high yields but were subject to zero regulatory risk weights. Particularly, banks with low Tier 1 capital ratios increased their demand for sovereign debt, thus, taking advantage of the financial regulation. Gropp et al. (2019) also evaluate the European stress test of 2011. They report that banks reduce the volume of risk-weighted assets in their portfolios in response to higher capital requirements to increase the capital ratio rather than raising the level of equity. Moreover, Hristov et al. (2021) show that banks in peripheral countries expand their exposure to domestic sovereign debt following a restrictive capital-based macroprudential policy shock. Banks shift their portfolios toward lower-risk assets such as government bonds, if their ability to improve the regulatory capital position is limited.[2]

[1] The business cycle channel of macroprudential policy has been extensively investigated in the literature - see e.g. Galati and Moessner (2018) and Budnik and Ruenstler (2022). Regarding the financial crisis channel, constructing a solid empirical exercise is difficult given the small number of financial crises in the euro area over the past years and the corresponding difficulties in measuring their likelihood. Nevertheless, several studies provide indirect evidence by showing that a more restrictive macroprudential regulation can potentially reduce downside risks for GDP growth; that is, improve growth at risk (Duprey and Ueberfeldt, 2020; Franta and Gambacorta, 2020; Galán, 2020; Brandao-Marques et al., 2022).

[2] Other studies report that banks increase their exposure to domestic sovereign debt because of *moral suasion* (Horváth et al., 2015; Becker and Ivashina, 2017; Ongena et al., 2019). Accordingly,

Euro area banks generally hold a significant amount of European sovereign debt (Acharya and Steffen, 2015; Ongena et al., 2019). However, as evident in Figure 1, banks' holdings of domestic government bonds in peripheral countries increased notably after 2010, when the sovereign debt crisis unfolded. The rise was particularly observable in months with relatively high domestic sovereign bond issuance (Ongena et al., 2019). Additionally, the holdings of sovereign debt issued by other euro area countries was increased. Banks in core countries also raised their exposure to sovereign debt, although to a lesser extent. The increase in government bond holdings coincided with the period of tighter macroprudential capital regulation (see Figure 2 further below). Moreover, in several euro area countries, government debt as a share of GDP increased at that time (Hülsewig and Rottmann, 2022).

Figure 1: Euro area banks' sovereign bond holdings ratio



Notes: Banks' sovereign bond holdings relative to total assets. Shares are measured in %. Data are taken from the ECB Statistical Data Warehouse.

Finally, a number of studies discusses the government's incentive to finance public expenditure by means of borrowing instead of raising taxes (Feldstein, 1985; Alesina and Perotti, 1995; Hamilton and Flavin, 1986; Roubini and Sachs, 1989; D'Erasmo et al., 2016, among others). This literature offers a potential explanation why an increase in the demand for government debt tends to translate into more government borrowing.

banks expand their holdings of domestic government bonds at the request of the government, and not because of stricter capital requirements.

3 Empirical model, data and macroprudential policy shocks

We estimate local projections to examine the reaction of fiscal variables to capital-based macroprudential policy shocks in two groups of euro-area countries, the core and periphery. An advantage of the method is that it also allows us to analyse non-linearities.

3.1 Baseline model

Following Jordà (2005), the baseline model is given by:

$$X_{i,t+h} = \theta_h \text{MPS}_{i,t} + \phi_h(L) Z_{i,t-1} + \zeta_h \text{MPS}_{i,t} \times I_{i,t-1} + \alpha_{i,h} + u_{i,t+h} \tag{1}$$

where $X_{i,t+h}$ is the variable of interest of country i, $\text{MPS}_{i,t}$ is a shock to macroprudential policy, which measures the unsystematic component of macroprudential capital regulation, and θ_h is the coefficient corresponding to the shock. Moreover, $Z_{i,t-1}$ is a vector of control variables, $\phi_h(L)$ is a polynomial in the lag operator, ζ_h is the coefficient corresponding to the interaction between the shock and $I_{i,t-1}$, which is a vector of interaction variables, $\alpha_{i,h}$ captures country-fixed effects, and $u_{i,t+h}$ is an error term. In our baseline model, the variables of interest are the cyclically adjusted versions of the government's primary balance ratio (CAPB), expenditure ratio and revenue ratio. The vector of control variables Z comprises lags of the government debt ratio, real output, a real measure of the stance of monetary policy, the banks' domestic government bond holdings ratio, and a measure of fiscal stress. The vector of interaction variables I includes the first lag of the banks' domestic government bond holdings ratio and government debt ratio. For every control variable in $Z_{i,t-1}$, we impose a lag order of four. The choice of the lag order takes account of the notion that fiscal adjustments are subject to time lags with respect to decision making and implementation (Born et al., 2018; Hülsewig and Rottmann, 2022).

We derive impulse responses to a capital-based macroprudential policy shock at time t by estimating a series of single regressions for each horizon $h = 0, 1, 2, ..., H$. For the calculation of standard errors, we use the method of Driscoll and Kraay (1998) which accounts for the serial correlation in the error terms induced by the successive leading of the dependent variable (Ramey and Zubairy, 2018). As in Tenreyro and Thwaites (2016), we set the maximum autocorrelation lag to $H + 1$.

3.2 Data

Since our sample is short, we adopt panel techniques. The group of core countries includes Austria, Belgium, Finland, France, Germany, and the Netherlands, while the peripheral countries comprise Ireland, Italy, Portugal, and Spain.[3] The panel approach allows us to pool the information within each country group, while controlling for heterogeneity across the units by taking account of country-fixed effects. The main advantage of the approach is that it increases the efficiency of the statistical inference.

In estimating separate panels of countries, we allow for possible structural heterogeneities between the two groups that appear a priori likely given the differences in terms of the economic development during our sample, which includes both the global financial crisis and European debt crisis. All countries in the euro area slipped into recession because of the global financial crisis. However, in peripheral countries, the economic downturn was more pronounced due to a substantial loss of international price competitiveness, weakening of the banking sector and sharp increase in public and/or private debt. Furthermore, peripheral sovereigns faced increasing difficulties in issuing bonds on international capital markets, leading to extraordinary financial distress. By contrast, core countries faced comparatively moderate recessions and benefited from their *safe-haven* status.

Our data are obtained from the ECB and comprise quarterly time series.[4] We consider the period 2005Q1-2018Q4.[5] The fiscal data comprise the CAPB, i.e. the cyclically adjusted government primary deficit or surplus as a percentage of GDP, the cyclically adjusted primary expenditure ratio, which corresponds to the difference between total expenditure and interest expenditure relative to GDP, as well as the cyclically adjusted revenue ratio, that is, cyclically adjusted government total revenue as a percentage of GDP. Moreover, we use the government debt ratio, that is, government debt as a percentage of GDP. Real output is in logs.[6] The ECB's monetary policy stance is measured by the EURIBOR three-month rate. Following Cloyne et al. (2020), we construct a real indicator for monetary policy measures by

[3]We exclude Greece from our analysis, because it obtained external finance virtually only through financial aid programmes from May 2010 onwards.

[4]See Appendix A.1 for details on the data.

[5]We focus on this period because the implementation of macroprudential policy measures was substantially more limited before 2005 and the macroprudential database does not extend beyond the end of 2018.

[6]Note that Irish GDP exhibits a shift of roughly 23% in 2015Q1 compared with the previous quarter. There was a shift in GDP because the country's low corporate tax rates attracted cooperation from some large multinationals to relocate their economic activity to the country. We consider the structural break in Irish GDP by smoothing the series; that is, we keep the dynamics of the series, but adjust for the shift.

calculating the difference between the EURIBOR three-month rate and first difference in the log of the Harmonised Index of Consumer Price (HICP). The banks' domestic government bond holdings ratio is calculated as the share of the holdings of domestic government bonds relative to total assets. The Sovereign Composite Indicator of Systemic Stress (SovCISS) is used as an indicator of fiscal stress. Finally, in extended specifications, we use additional bank balance sheet data in levels, as discussed below, the sovereign bond yield, and the Country-Level Index of Financial Stress (CLIFS) as an indicator of financial stress.

3.3 Cyclical adjustment of fiscal variables

As we are interested in identifying the governments' discretionary decisions on public debt, we cyclically adjust the fiscal variables by removing the part related to the aggregate business cycle. We use the methodology of the European Commission (EC), according to which the cyclically adjusted component of the ratio of a nominal fiscal variable to nominal output is defined as (Mourre et al., 2019; Mourre and Poissonnier, 2019):

$$\left(\frac{X_{i,t}}{Y^n_{i,t}}\right)^{ca} = \frac{X_{i,t}}{Y^n_{i,t}} - \epsilon^X_i y^{gap}_{i,t},$$

where $y^{gap}_{i,t}$ is the real output gap of country i, $X_{i,t}$ is the respective fiscal variable, $Y^n_{i,t}$ is nominal output and ϵ^X_i is the semi-elasticity associated with X_i. The output gap is defined as:

$$y^{gap}_{i,t} = \frac{Y_{i,t} - Y^P_{i,t}}{Y^P_{i,t}},$$

where $Y_{i,t}$ denotes real output and $Y^P_{i,t}$ its potential level. We resort to the EC for the approximation of potential output and the semi-elasticities ϵ^X_i (Mourre et al., 2019).[7]

3.4 Capital-based macroprudential policy shocks

Macroprudential policy is aimed at safeguarding financial stability by counteracting the accumulation of systemic risks and vulnerabilities in the financial system and making it sufficiently resilient to various disturbances while, at the same time, being vigilant of the potential costs of any policy intervention in terms of economic activity.

[7] In addition, we consider alternative definitions of the cyclically adjusted component of the fiscal variables. We replace the real output gap by the cyclical component of real output derived with the Hodrick-Prescott filter with a smoothing parameter of 1,600. Moreover, regarding the cyclical adjustment of the fiscal variables, we alternatively approximate the cyclical-adjusted variables by the residuals of a linear regression of $X_{i,t}/Y_{i,t}$ on different lags of the real output gap. In all cases, our results remain qualitatively unchanged.

Accordingly, macroprudential authorities are supposed to tighten the instruments at their disposal when there are signs of elevated vulnerability and/or an inadequate degree of resilience.[8] Macroprudential authorities react to the information provided by numerous indicators of the soundness of the financial system like measures of indebtedness, credit spreads, asset price developments, financial stress, and the level of capital and liquidity buffers. Given this potential endogeneity of macroprudential policy, a simple regression of a target macroeconomic variable, for instance, the primary balance ratio, on actual macroprudential policy interventions would merely reflect correlations rather than a causal relationship. To uncover the latter, we need a measure of the unsystematic component of such interventions. In the following, we discuss the computation of this measure.

For each country group, we estimate a panel vector autoregressive (VAR) model of the form:

$$y_{i,t} = \sum_{j=1}^{p} B_j y_{i,t-j} + c_i + \varepsilon_{i,t}, \tag{2}$$

where $y_{i,t}$ is a vector of endogenous variables for country i, B_j is a matrix of autoregressive coefficients for lag j, p is the number of lags, c_i is a vector of country-specific intercepts, which account for possible heterogeneity across the units, and $\varepsilon_{i,t}$ is a vector of reduced-form residuals. The vector of endogenous variables includes an indicator for capital-based macroprudential policy measures (hereafter denoted by *MPI*), the Basel credit-to-GDP gap[9], the lending spread, the Country-Level Index of Financial Stress (CLIFS) as an indicator for stress in financial markets, the bank capital ratio, and nominal house prices.[10]

The panel VAR model (2) is estimated with Bayesian methods using a Normal-Wishart prior for the parameters. Inference is based on 10,000 draws from the corresponding posterior distribution. The relationship between the structural shocks $\eta_{i,t}$ and the reduced-form residuals is governed by $\varepsilon_{i,t} = A_0 \eta_{i,t}$, which holds for each cross-sectional unit and $\Sigma = A_0 A_0'$. The structural shock related to capital-based macroprudential policy is identified by imposing a recursive ordering. This is implemented by assuming that the matrix A_0 corresponds to the lower triangular element in the Choleski factorisation of the variance-covariance matrix Σ of ε_t. The *MPI* is

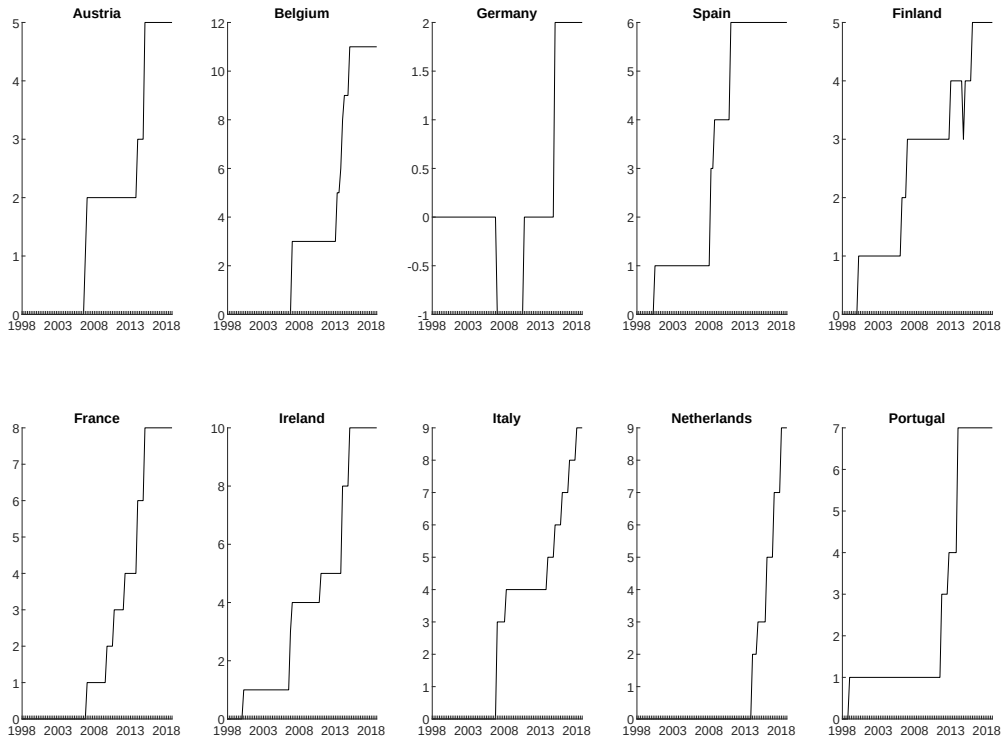
[8] See Benes and Kumhof (2015), Angelini et al. (2014) and Boar et al. (2017) as well as ESRB (2019, 2021b, 2022), and ECB (2022), among others.

[9] The Basel gap is the credit-to-GDP gap detrended by a one-sided Hodrick-Prescott filter with a smoothing parameter of $\lambda = 400,000$.

[10] See Appendix A.2 for a description of the data. The lending spread is calculated as the difference between the loan rate and the three-month EURIBOR rate, where the loan rate is derived as the weighted average of the loan rate on loans extended to non-financial corporations and mortgage lending rate.

ordered first and the corresponding orthogonal disturbance is interpreted as capturing the unsystematic component of capital-based macroprudential policy measures. The ordering implies that the *MPI* reacts only to its own shock on impact while responding to all other shocks with a lag of at least one quarter. This identification scheme is guided by the observation that macroprudential policy, unlike monetary policy, tends to be slow-moving.[11] For each period in our sample, we derive the structural shock as the mean over the 10,000 draws for that period. The innovations are standardised to have a mean of zero and standard deviation of one.

Figure 2: Capital-based macroprudential policy indicator



Notes: Capital-based macroprudential policy indicator of Hristov et al. (2021), which measures cumulative changes in capital-based macroprudential policy.

The MPI is taken from Hristov et al. (2021), who use the Macroprudential Policy Evaluation Database (MaPPED) provided by Budnik and Kleibl (2018) to construct the indicator. It comprises adjustments of (i) 'capital buffer requirements', (ii) 'loan-loss provisioning', (iii) 'minimum capital requirements' and (iv) 'risk weights'. Each individual policy change is assigned a value of +1 if it is a tightening, a value of

[11] Reasons for this include phase-ins of macroprudential policies as well as decision and implementation lags due to difficulties to proxy the financial cycle or systemic risk (see Arslan and Upper, 2017) or a multiplicity of macroprudential authorities in countries (see Edge and Liang, 2022). Hristov et al. (2021) estimate very similar VARs and show that the results are qualitatively robust to alternative orderings of MPI.

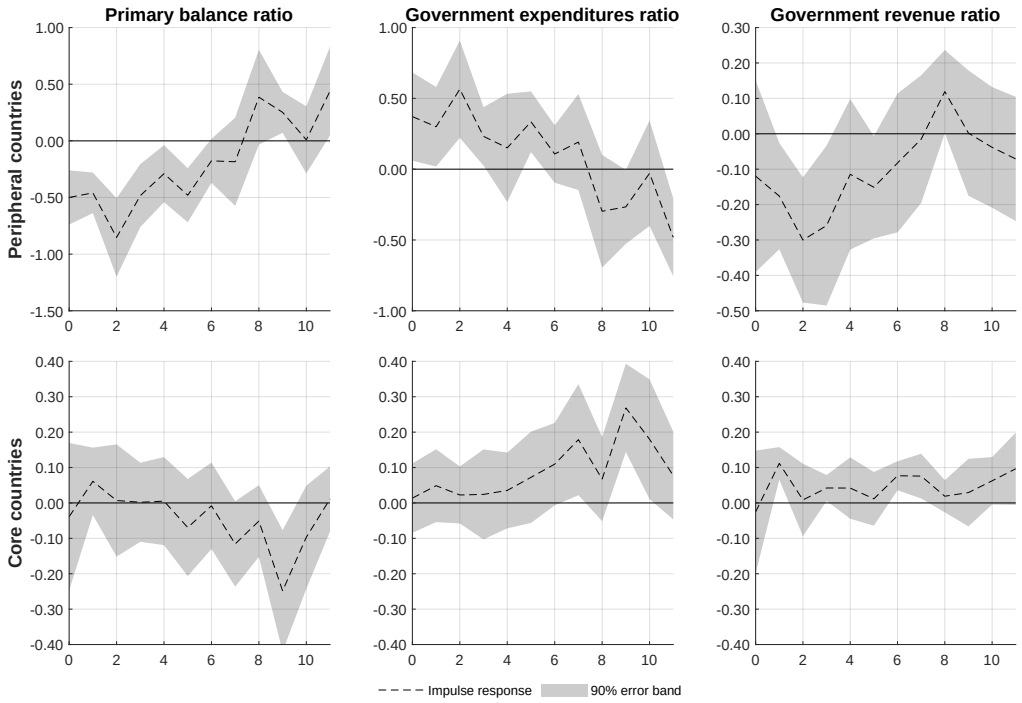
-1 if it is a loosening, and of zero if the intervention is characterised as 'unspecified or with ambiguous impact' (Hristov et al., 2021). In case a country reports more than one policy change in a particular quarter, the associated discrete values are added up, resulting in the *net policy change* in that quarter. The capital-based macroprudential policy indicator is constructed as the cumulative sum over the quarterly values. Figure 2 displays the respective indicator for each country.

4 Empirical results

4.1 Baseline model impulse responses

We estimate baseline model (1) for both groups of countries to obtain impulse responses to a sudden tightening of macroprudential capital regulation. In this section, we focus on the linear effects of the shock via the term $\theta_h \text{MPS}_{i,t}$ in (1) and derive the impulse responses under the assumption that each interaction variable $I_{i,t-1}$ equals its pooled mean. An analysis of potential non-linearities – i.e. when the variables in $I_{i,t-1}$ lie above or below the pooled mean – is postponed to Section 4.4.

Figure 3: Impulse responses to a restrictive macroprudential policy shock



Notes: Impulse responses to a restrictive capital-based macroprudential policy shock. Positive values of the primary balance ratio denote an improvement, negative values a deterioration. The variation in the ratios is measured in percentage points.

Figure 3 displays the results. The dashed lines are the estimated impulse re-

sponses and the shaded areas their 90% error bands. In peripheral countries, the cyclically adjusted primary balance ratio (CAPB) worsens after a restrictive capital-based macroprudential policy shock. The maximum drop to a one standard deviation macroprudential policy disturbance is approximately 0.85 percentage points, which is reached two quarters after the shock. The decline is related to both an increase in the cyclically adjusted primary expenditure ratio and decrease in the cyclically adjusted revenue ratio. Thus, the structure of the public budget is realigned toward a higher government spending in response to a sudden macroprudential policy tightening that is financed by an increase in borrowing.

By contrast, in core countries, the CAPB reacts only sluggishly to a restrictive capital-based macroprudential policy shock. The cyclically adjusted expenditure ratio increases gradually; however, the increase is comparatively modest and accompanied by an increase in the cyclically adjustd revenue ratio. Consequently, the CAPB shows a short-lived deterioration of 0.25 percentage points around nine quarters after the shock.

4.2 Exploring the channel: banks' sovereign bonds demand

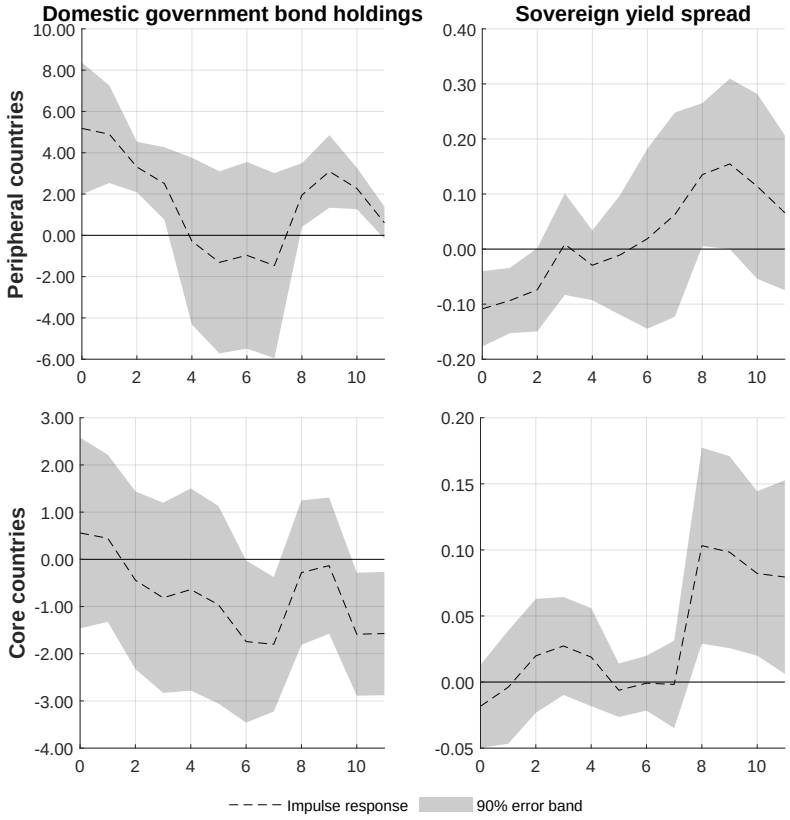
To gain insights into the mechanism underlying the fiscal reactions, we estimate the responses of banks' domestic sovereign bond holdings as well as that of the corresponding sovereign yield spread to a capital-based macroprudential policy shock. Regarding banks' domestic sovereign bond holdings, we employ a model similar to (1), where the control variables comprise the log of the volume of bank loans extended to private non-banks, the log of bank capital, the spread between the loan rate and the government bond yield, the EURIBOR three-month rate as a measure for the conditions in the money market, and the SovCISS, which measures the degree of fiscal stress.[12] We use four lags as in our baseline model. Regarding the reaction of the sovereign yield spread to a restrictive capital-based macroprudential policy innovation, we re-estimate baseline model (1), that is, using the same control variables. The spread is calculated as the difference between the yield on sovereign bonds and EURIBOR three-month rate.[13]

[12]Since the variables of interest are in levels, we use bank balance sheet variables in levels as controls. The loan volume is calculated as the sum of the volume of loans extended non-financial cooperations and loans for housing purchases. The loan rate is again derived as the weighted average of the loan rate on loans extended to non-financial corporations and the mortgage lending rate.

[13]We focus on the sovereign yield spread instead of the absolute yield to take account of monetary policy measures. For instance, Mendicino et al. (2020) show in a calibrated model for the euro area that the policy rate declines after a restrictive shock to macroprudential capital regulation. For the US, Budnik and Ruenstler (2022) find that the federal fund rate also decreases in response to a tightening of capital requirements. Moreover, Eickmeier et al. (2018) conclude for the US that,

The impulse responses of the two additional variables to a restrictive macroprudential capital regulation shock are depicted in Figure 4 together with the respective 90% error bands.

Figure 4: Responses of additional variables to a macroprudential policy shock



Notes: Impulse responses to a restrictive capital-based macroprudential policy shock. The variation in banks' domestic sovereign bond holdings is in percent. The variation in the sovereign bond spread is measured in percentage points.

In peripheral countries, banks increase their exposure to sovereign debt in response to a restrictive macroprudential capital regulation shock. Domestic government bond holdings rise by approximately 5% on impact after the innovation. Thus, peripheral banks respond to a sudden tightening in macroprudential capital regulation by expanding the volume of assets in their portfolios, which receive a favourable treatment in the regulatory capital requirement due to their blanket zero regulatory risk weight. The sovereign yield spread falls by 0.1 percentage points on impact in response to the innovation.

By contrast, in core countries, banks decrease their domestic government bond holdings gradually in response to a restrictive shock to macroprudential capital regulation. The decline is approximately 1.7% after seven quarters.[14] The sovereign

historically, the Federal Reserve accommodated policy rates after capital requirement tightenings.

[14]Estimating baseline model (1) with the banks' domestic government bond holdings *ratio* as

yield spread initially remains unchanged in response to the restrictive innovation, but as banks' holdings of domestic government bonds steadily decline, it starts to rise.

Overall, in both groups of countries, the macroprudential shock tends to push banks' holdings of domestic government bonds and the corresponding sovereign yield spreads in opposite directions. This suggests that the results are mainly driven by changes in banks' demand for public debt. In accordance with Reis (2021), this finding is consistent with the *bond market channel* of macroprudential policy, that is, by changing the demand for sovereign bonds, capital-based regulatory measures alter government borrowing cost. In peripheral countries, banks increase their domestic sovereign bond holdings in response to the shock, which contributes to easing governments' fiscal constraints as the yield spread on sovereign bonds declines. As a result, peripheral governments may increase their borrowing, as shown in Figure 3. Since banks are significant investors in sovereign debt (Arslanalp and Tsuda, 2014; Acharya and Steffen, 2015; BCBS, 2017; Ongena et al., 2019), the shift toward higher domestic government bond holdings in the periphery may exacerbate the adverse effects of the sovereign-bank nexus to the extent that sovereign risk rises. By contrast, in core countries, banks reduce their exposure to sovereign debt in response to the shock. Thus, the scope of core governments to rise borrowing is more limited. A strengthening of the nexus cannot be observed.

4.3 Robustness

Alternative monetary policy measures. First, we re-estimate baseline model (1) using alternative measures of monetary policy. We use the shadow short-rate of Krippner (2013) in real terms instead of the real EURIBOR three-month rate.[15] Additionally, we expand the baseline model by including lags of the log of national central banks' total assets to control for unconventional monetary policy measures implemented in the form of government bond purchases.[16] Figure 5 displays the impulse responses derived from the alternative model specifications together with the baseline-model 90% error bands.

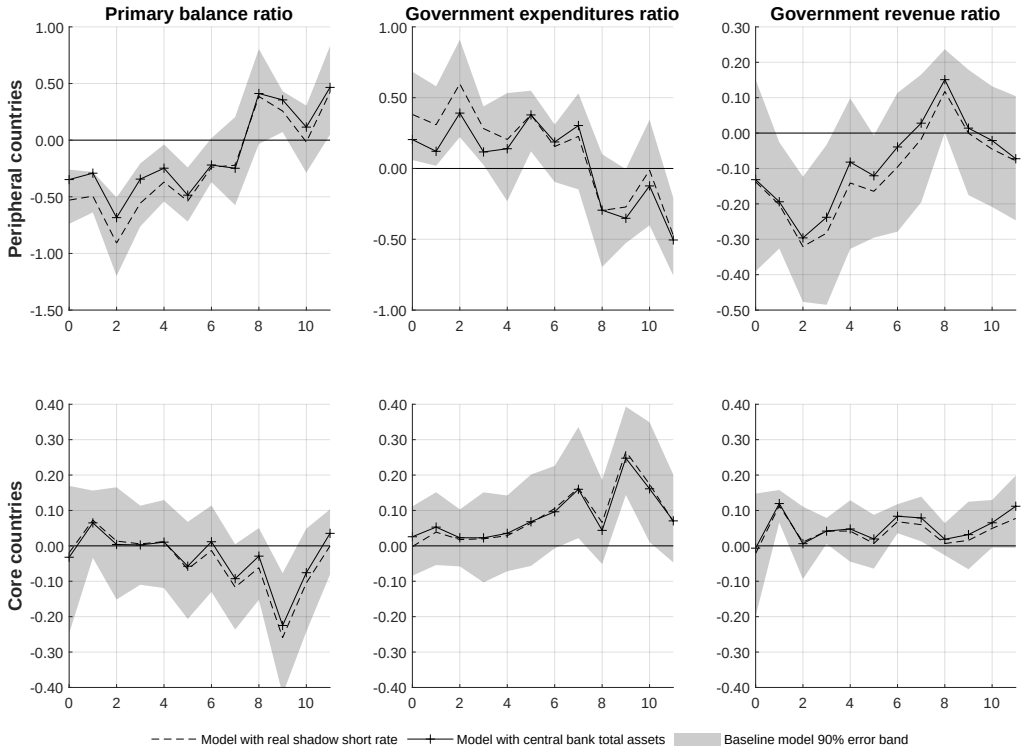
In peripheral countries, the deterioration of the CAPB after a restrictive shock to macroprudential capital regulation is somewhat less pronounced in the model

the variable of interest instead shows in analogy to Figure 4 that the *relative* volume of sovereign debt in banks' portfolios increases temporarily in the periphery and falls temporarily in core after a tightening in capital-based macroprudential policy. The impulse responses are available upon request.

[15]The real shadow short-rate is calculated as the difference between the shadow short-rate and the first difference in the log of the HICP.

[16]Consistent with baseline model (1), we use four lags of this additional control variable.

Figure 5: Alternative unconventional monetary policy measures



Notes: Impulse responses to a restrictive capital-based macroprudential policy shock. Positive values of the cyclically adjusted primary balance ratio denote an improvement, negative values a deterioration. The variation in the ratios is measured in percentage points.

controlling for the log of central bank total assets. However, the differences in the impulse responses compared to those derived from the baseline model are only minor. All estimated impulse responses are well within the baseline model 90% error bands.

Alternative macroprudential policy shocks. Second, we estimate alternative panel VAR models to generate capital-based macroprudential policy shocks. The specification of model (2) is supposed to reflect the macroprudential authorities' reaction function. However, there are additional financial indicators that might be relevant.

For this reason, we extend the model by including a number of such indicators, one at a time. These comprise the ratio of bank loans to nominal GDP instead of the Basel gap, real output, the stock price index covering the banking sector, bank credit default swaps, the banks' volume of loans extended to the private sector relative to total assets, the bank capital ratio, and the banks' domestic government bond holdings ratio, that is, domestic government bond holdings relative to total assets. In addition, we also consider the announcement of macroprudential capital policy measures. So far, the exogenous macroprudential policy shock is derived

Table 1: Deviation of alternative macroprudential capital regulation shocks

Variables	BL	A1	A2	A3	A4	A5	A6	A7
MPI cumulated	X	X	X	X	X	X	X	X
Basel gap	X		X	X	X	X	X	X
Lending spread	X	X	X	X	X	X	X	X
CLIFS	X	X	X	X	X	X	X	X
Nominal house prices in logs	X	X	X	X	X	X	X	X
Bank capital ratio	X	X	X	X	X	X	X	X
Bank-loans-to-GDP ratio		X						
MPIANN cumulated			X					
Real GDP in logs				X				
Bank stock price in logs					X			
Bank credit default swap						X		
Bank loans to total assets ratio							X	
Bank dom. gov. bond holdings ratio								X

Notes: Alternative panel VAR model specifications to derive macroprudential capital regulation shocks. "BL" denotes the baseline model. "A1-A7" denote the alternative specifications. Moreover, "MPI" is the macroprudential policy indicator based on implementation dates. "MPIANN" is an equivalent indicator derived on the basis of announcement dates. "Bank loans" are loans to private non-financial corporations and loans for house purchases.

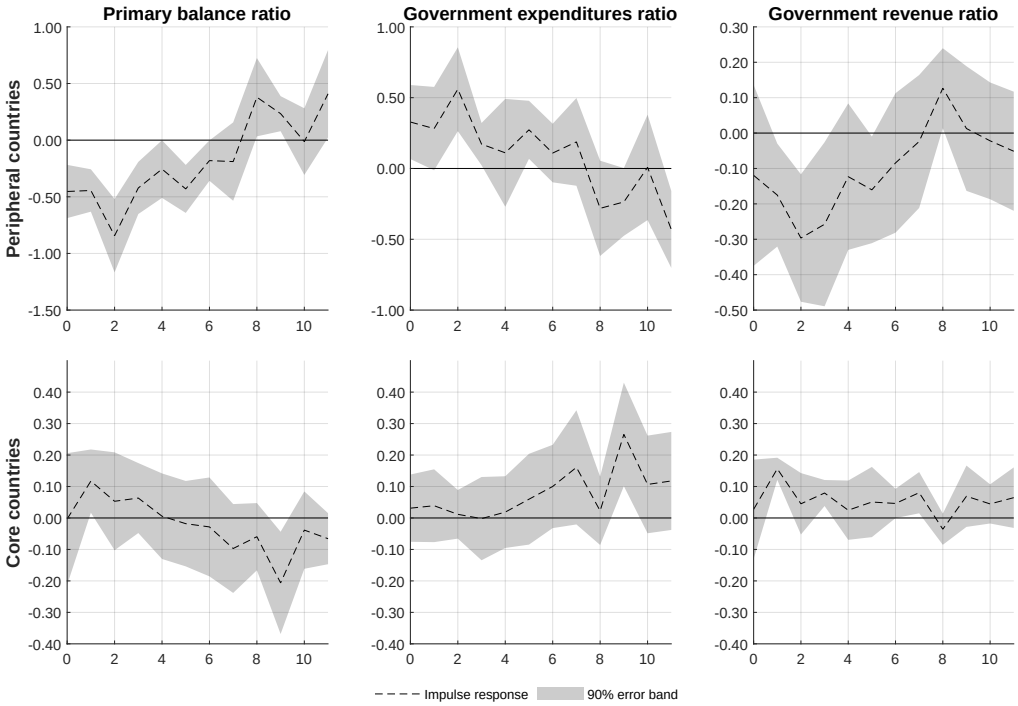
from an indicator based on implementation dates as recorded in MaPPED, which, however, might suffer from the shortcoming that the implemented macroprudential interventions are announced in advance (Hristov et al., 2021). Thus, at the time of actual policy implementation, the economy as a whole might have already started to adjust to the mere announcement of a capital-based regulatory change. All in all, we end up with seven alternative models. They are summarized in Table 1 in which an "X" indicates that the variable of the corresponding row enters the VAR of the corresponding column.

Again, every panel VAR model is estimated with Bayesian methods using a Normal-Wishart prior for the parameters. Inference is based on 10,000 draws from the corresponding posterior distribution. We extract the capital-based macroprudential policy shocks from the estimated models by calculating the mean of the shock series of the respective 10,000 draws.[17] In a next step, we derive the first principal component of the resulting seven structural macroprudential policy shocks. Since the correlation across the individual shocks is very high, the first principal component explains 95.9% of their variance. That component then serves as the indicator of the unsystematic component of macroprudential policy.[18]

[17]For the group of core countries, the shock series derived from alternative model A5 starts in 2006Q3, as credit default swaps for the Netherlands are only available from that date.

[18]We also estimated impulse responses of the fiscal variables to each of the seven individual shocks separately. The results are similar to the baseline.

Figure 6: Impulse responses to a principal component shock



Notes: Impulse responses to a principal component shock measuring a restrictive capital-based macroprudential policy innovation. Positive values of the cyclically adjusted primary balance ratio denote an improvement, negative values a deterioration. The variation in the ratios is measured in percentage points.

Figure 6 shows the reactions of the fiscal variables to the principal component shock. The impulse responses are very similar to those reported before.[19]

Alternative model specifications. Finally, we re-estimate baseline model (1) using alternative model specifications: lag orders of two and six, a linear trend as well as a linear and quadratic trend. The results are reported in Appendix E, and are again similar to our baseline.

4.4 State-dependent impulse responses

The impulse responses discussed so far display the average reactions of the CAPB to capital-based macroprudential policy innovations. Thus, they are computed under the assumption that all variables equal their pooled mean, and that, accordingly, the interaction terms in equation (1) drop out.

In the following, we examine whether the dynamics of the fiscal response to

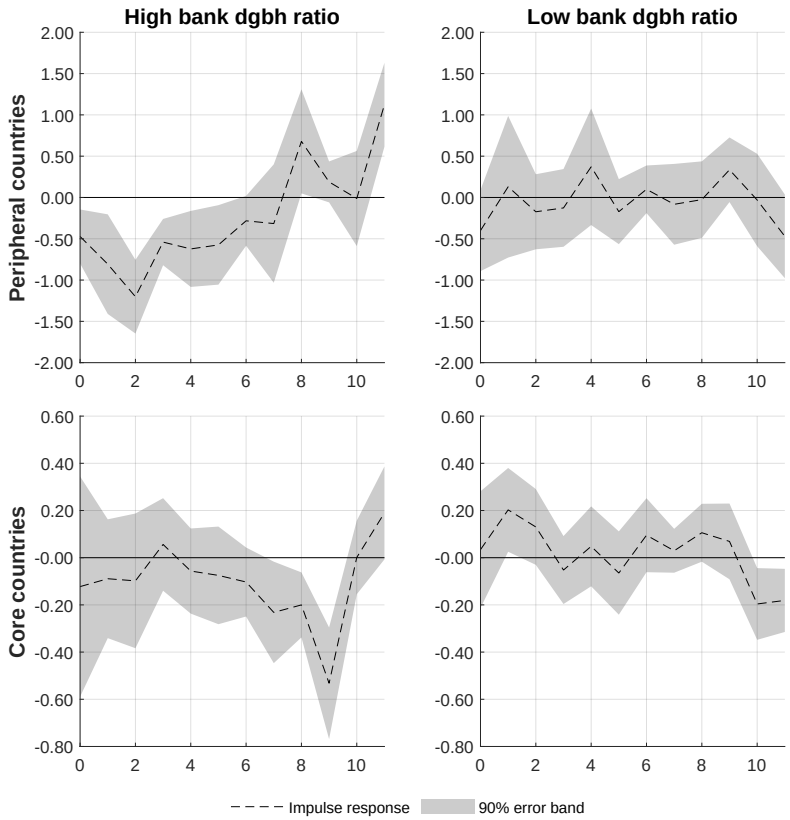
[19]Moreover, we also show that our result does not depend on our use of the MaPPED dataset to generate the MPI. Appendix D shows robustness to using the IMF iMaPP dataset of macroprudential regulation instead.

macroprudential policy shocks depend on the state of the economy as reflected by the levels of the interaction variables. Particularly, we consider the level of the banks' domestic government bond holdings ratio as well as the government debt ratio in period $t-1$, the period preceding the shock. Thus, on the basis of (1), we compute the following conditional impulse response for every horizon $h = 0, 1, 2, ..., H$:

$$\frac{\partial X_{t+h}}{\partial \text{MPS}_t}|_{I_{v,t-1}=I_v^*, I_{-v,t-1}=\bar{I}_{-v}} = \theta_h + \zeta_h I_v^*, \tag{3}$$

where we condition on the respective interaction variable $I_{v,t-1}$ taking the value I_v^*. The second interaction variable is assumed to equal its pooled mean, that is, $I_{-v,t-1} = \bar{I}_{-v}$. For each v, we consider a high and a low value of I_v^*, which are given by one standard deviation above and below the pooled mean, respectively.

Figure 7: Reaction of cyclically adjusted primary balance ratio conditional on banks' domestic government bond holdings ratio ratio

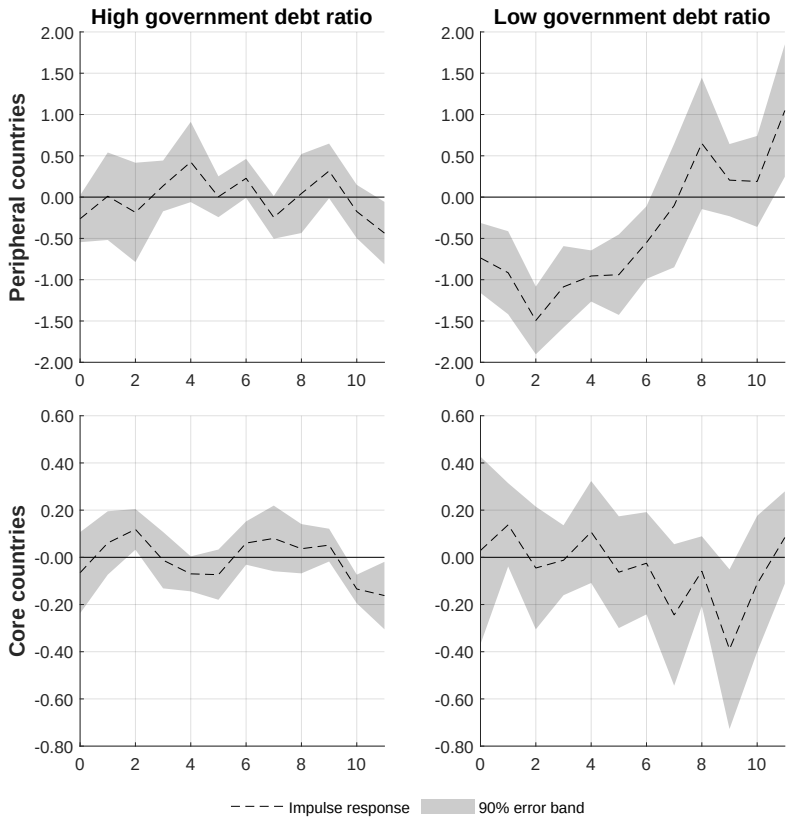


Notes: State-dependent impulse responses of the cyclically adjusted primary balance ratio to a restrictive capital-based macroprudential policy shock. The responses are conditional on a high level of the banks' domestic government bond holdings ('dgbh') ratio and a low level, respectively, which are identified by one standard deviation above and below the pooled mean. Positive values of the primary balance ratio denote an improvement, negative values a deterioration. The variation in the primary balance ratio is measured in percentage points.

Figure 7 shows the impulse responses of the CAPB to a sudden capital-based

macroprudential policy tightening conditional on the level of the banks' domestic government bond holdings ratio. When this share and thus the nexus are already elevated, the worsening of the CAPB in response to a restrictive shock to macroprudential capital regulation is comparatively strong. The result holds for both groups of countries, but the dynamics of the CAPBs again differ between the two groups. In peripheral countries, the drop in the CAPB occurs immediately after the shock, while in core countries, the decline is delayed. By contrast, when banks' holdings of domestic government bonds are relatively low, the cyclically adjusted primary balance ratio barely reacts to the shock.

Figure 8: Reaction of cyclically adjusted primary balance ratio conditional on the government debt ratio



Notes: State-dependent impulse responses of the cyclically adjusted primary balance ratio to a restrictive capital-based macroprudential policy shock. The responses are conditional on a high level of the government debt ratio and a low level, respectively, which are identified by one standard deviation above and below the pooled mean. Positive values of the primary balance ratio denote an improvement, negative values a deterioration. The variation in the primary balance ratio is measured in percentage points.

Furthermore, Figure 8 displays the responses of the CAPB to a capital-based macroprudential policy shock conditioned on the level of the government debt ratio. Empirical evidence suggests that the fiscal space is restricted when the government debt ratio is relatively high (Bohn, 1998; Ghosh et al., 2013). Particularly, the scope

for a further increase in debt is limited by the disciplining effect of the capital markets. Our findings support this view for both country groups. The cyclically adjusted primary balance ratio barely worsens after the shock when the government debt ratio is already high. Accordingly, fiscal policy seems to follow a rather conservative path. By contrast, in peripheral countries the CAPB deteriorates after the shock when the government debt ratio is relatively low. This suggests that the scope for higher public borrowing following such a tightening is being used.

According to our results, macroprudential policy should be aware of the unintended side effects of a tightening in macroprudential capital regulation. Banks may increase their exposure to sovereign debt in response to the tightening due to the regulatory zero risk weight. Thus, the intensity of the sovereign-bank nexus may rise. Moreover, the fiscal balance may worsen, possibly resulting in an increase in the risk to financial stability. However, the capital market exerts a disciplining effect, as a relatively high government debt ratio appears to limit public borrowing after a tightening of macroprudential capital regulation. The fiscal rules prescribed by the European Commission might also contribute to such a disciplining effect.[20]

5 Conclusion

We examine the fiscal footprint of macroprudential policy in euro area countries arising through the *bond market channel*, according to which policy affects the price at which government bonds sell (Reis, 2021). Particularly, we estimate local projections to generate impulse responses of the cyclically adjusted primary balance to shocks that reflect an unexpected tightening in macroprudential capital regulation.

Our results suggest that in peripheral countries, the cyclically adjusted primary balance ratio deteriorates after a restrictive capital-based macroprudential shock. Thus, the structure of the public budget appears to shift toward higher borrowing. Moreover, banks in peripheral countries increase their domestic sovereign bond holdings after a sudden tightening in macroprudential capital regulation, which contributes to the lowering of the yield spread, that is, the difference between the yield on sovereign bonds and EURIBOR three-month rate. Hence, macroprudential policy leaves a fiscal footprint, which may amplify the negative effect of the sovereign-bank nexus to the extent that sovereign risk rises. By contrast, in core countries, the cyclically adjusted primary balance ratio barely deteriorates after a sudden tightening in macroprudential capital regulation.

[20] See e.g. https://economy-finance.ec.europa.eu/economic-and-fiscal-governance/fiscal-frameworks-eu-member-states/fiscal-rules-eu-member-states_en .

Furthermore, our findings suggest that in both groups of countries, the responses of the cyclically adjusted primary balance ratio to a capital-based macroprudential policy shock are state-dependent. The worsening of that ratio is more pronounced when banks' holdings of domestic government bonds is comparatively large. However, in peripheral countries, there is a disciplining effect emanating from capital markets, that is, a relatively high government debt ratio seems to create incentives to avoid a deterioration of the primary balance following a restrictive capital-based macroprudential policy innovation.

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A Data

A.1 Baseline model

ECB Statistical Data Warehouse:

- Gross domestic product at market prices, chain linked volume
  MNA.Q.Y.XX.W2.S1.S1.B.B1GQ._Z._Z._Z.EUR.LR.N
- Government primary balance as % of GDP, deficit (-)/ surplus (+)
  GFS.Q.N.XX.W0.S13.S1._Z.B.B9P._Z._Z._Z.XDC_R_B1GQ._Z.S.V.N._T
- Government total expenditure as % of GDP
  GFS.Q.N.XX.W0.S13.S1.P.D.OTE._Z._Z._T.XDC_R_B1GQ._Z.S.V.N._T
- Government interest expenditure as % of GDP
  GFS.Q.N.XX.W0.S13.S1.C.D.D41._Z._Z._T.XDC_R_B1GQ._Z.S.V.N._T
- Government total revenue as % of GDP
  GFS.Q.N.XX.W0.S13.S1.P.C.OTR._Z._Z._Z.XDC_R_B1GQ._Z.S.V.N._T
- Government debt as % of GDP
  GFS.Q.N.XX.W0.S13.S1.C.L.LE.GD.T._Z.XDC_R_B1GQ_CY._T.F.V.N._T
- MFIs' holdings of domestic government bonds, outstanding amount (stock) in millions of euro, monthly frequency
  BSI.M.XX.N.A.A30.A.1.U6.2100.EUR.E
  This is converted to quarterly data using end-of-period monthly values.
- Total assets of a country's MFIs, outstanding amount (stock) in millions of euro, monthly frequency
  BSI.M.XX.N.A.T00.A.1.Z5.0000.Z01.E
  This is converted to quarterly data using end-of-period monthly values.
- EURIBOR 3-month rate
  FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA
  This is converted to quarterly data using monthly averages.
- Harmonized index of consumer prices
  ICP.M.XX.N.000000.4.INX
  This is converted to quarterly data using monthly averages.
- Sovereign composite indicator of systemic stress
  CISS.M.XX.Z0Z.4F.EC.SOV_CI.IDX
  This is converted to quarterly data using monthly averages.

In the series' codes XX is a placeholder for the country acronym: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), the Netherlands (NL), Ireland (IR), Italy (IT), Portugal (PT), and Spain (ES). All fiscal data are seasonally adjusted by means of the IRIS Macroeconomic Modelling Toolbox.

A.2 Panel VAR model

Bank of International Settlements:

- Basel credit-to-GDP gap:
  `Q:XX:P:A:C`
- Nominal house prices, index:
  `Q:XX:N:628`

ECB Statistical Data Warehouse:

- The lending rate is computed as the weighted average over the lending rates on NFC loans and loans for house purchase. The weights correspond to the respective share of NFC loans and loans for house purchase.
  1. Lending rate on loans to households for house purchase, new business, monthly frequency,
     `MIR.M.XX.B.A2C.A.R.A.2250.EUR.N`
  2. Lending rate on loans to NFCs, new business, monthly frequency,
     `MIR.M.XX.B.A2A.A.R.A.2240.EUR.N`

  These were converted to quarterly averages from monthly observations.
- Financial stress indicator
  `CLIFS.M.XX._Z.4F.EC.CLIFS_CI.IDX`
  This is converted to quarterly data using monthly averages
- Banks' capital and reserves (banks' equity), outstanding amount, monthly frequency, end-of-period stocks,
  `BSI.M.XX.N.A.L60.X.1.Z5.0000.Z01.E`
  This is converted to quarterly end-of-period values from monthly observations.

Capital-based macroprudential policy indicators:

- From Hristov et al. (2021).

A.3 Additional variables

ECB Statistical Data Warehouse:

- MFI loan volume corresponds to the sum of NFC loans and household loans for house purchase:

  1. MFI volume of loans to households for house purchase, monthly frequency, end-of-period stock,
     BSI.M.XX.N.A.A20.A.1.U6.2250.Z01.E
  2. MFI volume of loans non-financial corporations (NFCs), monthly frequency, end-of-period stock,
     BSI.M.XX.N.A.A20.A.1.U6.2240.Z01.E

  These were converted to quarterly end-of-period values from monthly data.

- Sovereign bond rate, monthly frequency,
  IRS.M.XX.L.L40.CI.0000.EUR.N.Z
  This is converted to quarterly data using monthly averages

- National central banks total assets, outstanding amounts at the end of the period (stocks), millions of euro, monthly frequency,
  BSI.M.XX.N.N.T00.A.1.Z5.0000.Z01.E
  This is converted to quarterly end-of-period values from monthly observations.

Refinitiv-Datastream:

- Stock market index, sectoral subindex for "Banks",
  BANKSXX
  This is converted to quarterly data using monthly averages.

- Credit default swaps, 5-year government bonds,
  XXG5EAC
  This is converted to quarterly data using monthly averages.

Shadow short rate:

- Leo Krippner's shadow short rate is taken from: https://www.ljkmfa.com/.

B Panel VAR model set-up

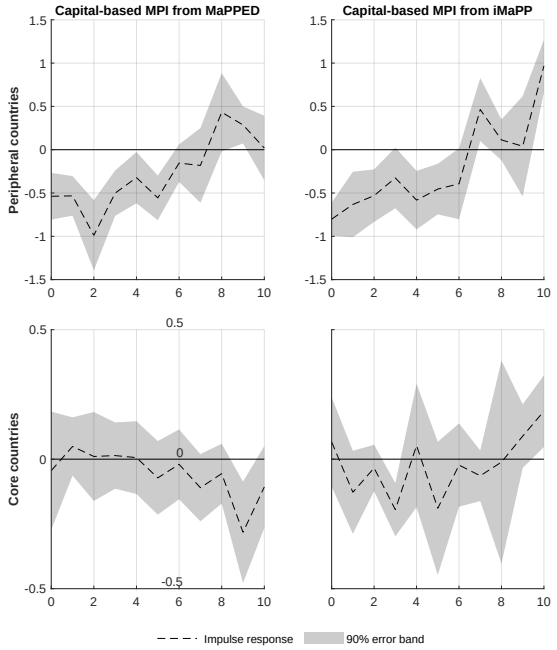
For every element of the vector of endogenous variables $y_{i,t}$, we use a pooled set of $M \cdot T$ observations, where M denotes the number of countries and T the number of observations. For each cross-sectional unit, the error terms are assumed to be normally distributed with a homogeneous variance-covariance matrix Σ, that is $\varepsilon_{i,t} \sim \mathcal{N}(0, \Sigma)$. After stacking the $\varepsilon_{i,t}$ into a vector $\varepsilon_t = [\varepsilon'_{1,t} \dots \varepsilon'_{M,t}]'$, we have $\varepsilon_t \sim \mathcal{N}(0, I_M \otimes \Sigma)$, where I_M is an identity matrix of dimension M.

C Details on the MaPPED database

The MaPPED database by Budnik and Kleibl (2018) has been constructed by ECB experts and national authorities based on a survey. It features 1,925 policy actions in 27 EU countries and the UK for the sample 1995-2018. The database provides a detailed characterisation of each policy action, for example, whether it was a tightening, loosening, or ambiguous. Moreover, it includes the activation date of a measure, announcement date, and previous or subsequent adjustments. Relative to other macroprudential databases such as the IMF iMaPP, it contains more detailed information on each measure and a better coverage of euro area countries over our sample.

D Alternative macroprudential indicator

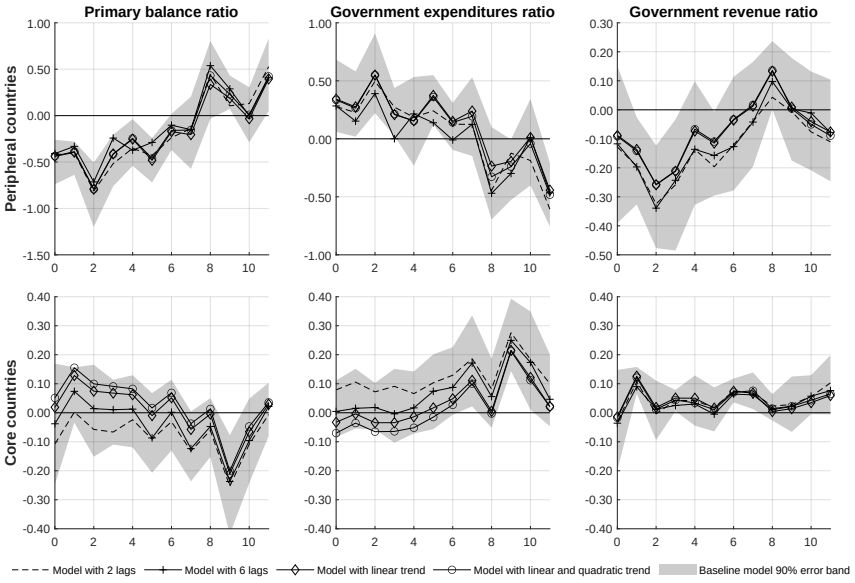
Figure 9: Reactions of the primary balance for shocks from different capital-based macroprudential indicators



Notes: Impulse responses the cyclically adjusted primary balance ratio to two different restrictive capital-based macroprudential policy shocks: Our baseline MPI shock based on the MaPPED database (left column) and an alternative indicator based on capital-based regulatory events from the IMF iMaPP indicator, derived just like our MPI shock (we take 1,000 instead of 10,000 draws here). Positive values of the primary balance ratio denote an improvement, negative values a deterioration. The variation in the ratios is measured in percentage points.

E Alternative model specifications

Figure 10: Alternative model specifications



Notes: Impulse responses to a restrictive capital-based macroprudential policy shock. Positive values of the cyclically adjusted primary balance ratio denote an improvement, negative values a deterioration. The variation in the ratios is measured in percentage points.