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Fiscal and macroprudential policy coordination for stabilization purposes

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Abstract

The COVID-19 pandemic has highlighted the need of maintaining financial and economic stabilization to mitigate the negative effects of the health crisis. In the context of a currency area, national governments count on national fiscal and macroprudential instruments to stabilize their own economy. Through a DSGE model for a monetary union I assess the welfare implications of different macroprudential-fiscal policy combinations, that are set with stabilization purposes. The findings confirm that for a supply and a demand shock, as the ones responsible for the economic crisis of 2020, the stabilizing policy mix might deteriorate welfare. By contrast, after a financial shock, similar to that of the Great Recession, the stabilizing policy combination strategies always achieve welfare gains.

KEYWORDS

financial system, macroprudential-fiscal coordination, monetary union, stabilization

JEL CLASSIFICATION

E12, E61, F42, F45, G15

1 | INTRODUCTION

The growing interest in macroprudential policy characterizes much of the literature that followed 2007 as, after the devastating consequences of the Great Recession, financial system stability became one of the top priorities of governments (see the 2013 Recommendations of the European Systemic Risk Board (ESRB/2013/1)). Years later, when the world economy was hit by the

COVID-19 pandemic, that already established strong macroprudential framework contributed to the economic recovery through continued lending. Thus, the 2020 crisis has confirmed the importance of financial system stabilizing policies to maintain a healthy global economy.

According to the latter, the novelty of this work is the assessment of the welfare implications of stabilizing policies that aim at minimizing ad hoc loss functions rather than maximizing welfare. The appeal of this analysis is that it allows to answer whether it is possible to improve welfare by adopting a stabilization strategy under different economic shocks.

In the context of a monetary union, the Euro Area's experience has shown that a single monetary policy cannot stabilize each economy in the union. Therefore, authors usually focus their research on the combination of monetary policy, set at the union level, and either fiscal or macroprudential policies. While the former targets price stability, fiscal policy is used to stabilize the business cycle and macroprudential measures pursue financial stability. But, usually, the monetary authority's objectives might be in conflict with the goals pursued by the national authorities. Thus, as a follow up of Malmierca (2023), this paper evaluates the desirability of coordinating those national policies in a monetary union.

The contribution of this article is threefold. First, it provides an analysis of the stabilization properties of different fiscal and macroprudential coordination scenarios in a monetary union, taking monetary policy as given. The rationale for this macroprudential-fiscal joint analysis is based on De Blas and Malmierca (2020). They find that, after a financial shock, a negative correlation arises between private and public debt, that destabilizes the economy. They look for a policy mix that offsets this negative correlation and stabilizes both variables at the same time. Public debt stability is achieved through national fiscal policies that aim at controlling the government budget. Private debt stability is the goal of a macroprudential instrument that controls the nominal credit growth. I evaluate this interaction by minimizing a variety of loss functions through the coordination of specific fiscal and macroprudential rules.

Second, the analysis is performed for a supply and a demand shock, similar to the ones that drive the economic crisis of 2020, and for a financial shock, similar to the one of the Great Recession. This comparison allows to distinguish the strategies that policymakers should undertake in order to stabilize the economy after recessions of different nature.

Finally, this study also sheds new light on the stabilizing properties of national and supranational macroprudential policies and their welfare implications. The former reacts to domestic financial indicators. The latter, by contrast, sets a common macroprudential rule for both countries.

With all that aims, I use a two-country DSGE model for a monetary union hit by asymmetric shocks. The home country represents the side of the union where the shock is originated. The foreign country is the side that indirectly suffers the consequences of the home country shock. To model, in a very simplified way, the periphery and the core of the Euro Area the home country is a net international borrower (periphery) and the foreign country is a net international lender (core). This setting is consistent with Bordo (2014) who explains that TARGET liabilities have increased in countries like Greece, Ireland, Portugal, and Spain (GIPS), since 2007, while TARGET claims have increased in countries like Germany. Then, I set an active monetary policy in the spirit of Leeper (1991). This implies that, again following Leeper (1991), fiscal policy is passive in order to ensure public budget stability and, thus, a determinate equilibrium in the model. The macroprudential tool of the model monitors the amount of loans to the private sector. More concretely, the measure is equivalent to countercyclical capital buffers, based on the ECB Vice-president's speech of March 2021, that illustrated the importance of releasing capital buffers during the health crisis.

My results show that the stability of the main economic and financial variables is achieved though different macroprudential and fiscal coordination strategies that depend on the kind of shock that generates the recession. Moreover, the nature of the shock also determines the welfare implications of each stabilization policy mix considered.

The layout of the paper is as follows. Section 2 briefly reviews the relevant literature. In Section 3, I describe the two-country model used for this analysis. Section 4 contains the calibration of the model parameters. In Section 5, I perform the stabilization analysis and provide the results. Section 6 provides the conclusions.

2 | RELATED LITERATURE

This theoretical research uses a new Keynesian model to analyze the coordination of stabilizing policies in a monetary union. An extensive literature studies the interplay of economic policies through the use of microfounded DSGE models. Numerous papers analyze the fiscal-monetary policy mix such as Gomes and Seoane (2018) or Bianchi (2010) and, more concretely, for a monetary union such as Beetsma and Jensen (2005), Kirsanova et al. (2007), Galí and Monacelli (2008) or, more recently, Bartocci et al. (2020), among others. Another strand of the literature analyzes the interaction between monetary and macroprudential measures, like Kannan et al. (2012), Lambertini et al. (2013), Rubio and Carrasco-Gallego (2016) or Brzoza-Brzezina et al. (2015) and, in the context of a monetary union see, for instance, Dehmej and Gambacorta (2017), Angelini et al. (2012), Quint and Rabanal (2014) or Poutineau and Vermandel (2017). A reduced group of articles deals with the joint analysis of macroprudential and fiscal policies through new Keynesian techniques for closed economies (De Blas & Malmierca, 2020) or within currency areas (see Malmierca, 2022, 2023).

The existing research on macroprudential-fiscal interaction is very scarce. De Mooij and Keen (2016) use a panel of banks to show how fiscal policies can contribute to systemic risk. Estrada and Saurina (2016) provide an empirical review of the Spanish boom and bust and explain that financial stability might be achieved by fiscal measures that encourage capital financing. Reis (2020), through a simple partial equilibrium model of the government bond market, finds that macroprudential policies affect fiscal stabilization. This article also finds key to coordinate fiscal and macroprudential measures in the seek for fiscal and financial stability. But the novelty of this paper is that it analyzes the fiscal-macroprudential interplay through the loss function minimization strategy in a DSGE model.

The paper fits within the branch of the policy mix literature that analyzes the welfare implications of stabilizing policies in a monetary union. For instance, Kirsanova et al. (2007) evaluate the welfare gains of different fiscal policy rules aimed at national stabilization in a monetary union. They find different effects on welfare when fiscal policy stabilizes output or when it also stabilizes inflation. Poutineau and Vermandel (2017) evaluate the welfare gains brought by different scenarios of macroprudential policies to the periphery and core countries of the EMU. As opposed to the former papers, I perform the joint analysis of macroprudential and fiscal policy to assess the welfare gains of both fiscal and also financial stabilization. More concretely, the research minimizes ad hoc loss functions to optimize the value of the policy parameters (see Ferrero, 2009 or Angelini et al., 2012 as examples of the same stabilization method) and then evaluates the welfare implications of each computed simple policy rule. I measure welfare as the conditional expectation of lifetime utility and then I compute the welfare costs of different macroprudential-fiscal coordination scenarios. This methodology for welfare evaluation is in line with Schmitt-Grohé and Uribe (2004), Quint and Rabanal (2014) or Rubio and Carrasco-Gallego (2016).

Moreover, this analysis shows that the desirability both of implementing one or another policy and of the authorities coordination, depends on the shock considered. Among the papers that also find different stabilization implications under shocks of different nature the following stand out. Angelini et al. (2012) observe that macroprudential policy attains little macroeconomic stability under supply shocks but that it becomes key for stabilization under financial crisis. They explain that conflicts will arise when there is no policy cooperation, no matter the kind of shock that hits the economy. Kannan et al. (2012) find that, under financial shocks, monetary policy can react less aggressively when coordinated with macroprudential policy but the former is key after technology shocks that provide no role for macroprudential measures. Poutineau and Vermandel (2017) argue that financial shocks require a stronger response of macroprudential policy.

There is a very recent literature that studies the policy mix in response to the COVID-19 shock. Forbes (2021), Bergant and Forbes (2021), Edwards (2021), Le Quang and Scialom (2021) or Igan et al. (2022) are some examples of the macroprudential policy analysis after a COVID-19 shock. Other articles use new Keynesian techniques to assess the policy coordination after a pandemic. Bartocci et al. (2020) analyze the monetary-fiscal interaction in a DSGE model for a monetary union affected by a pandemic. Can et al. (2021) evaluate fiscal and monetary measures implemented in Turkey after the COVID-19. Boscá et al. (2021) performs a policy-mix analysis in times of a pandemic crisis based on the Spanish economy. This paper compares the policy coordination strategies that authorities should implement when the economy is hit by a pandemic (replicated by negative supply and demand shocks as in Bartocci et al., 2020) to those needed after a financial crisis. Malmierca (2023) analyzes the welfare effects of the fiscal-macroprudential policy mix replicating the economic impacts of the COVID-19 and also compare those optimal policies to the ones that are optimal during financial crisis. This paper is a follow-up of the latter as it analyzes coordination in terms of stabilization (rather than welfare maximization) and it also provides an overview of the welfare implication of that policy cooperation.

The article develops an open economy version of the closed new-Keyneasian model of the Fernández-Villaverde (2010a), with financial frictions as in Bernanke et al. (1999). To model monetary policy I use a Taylor rule that stabilizes inflation, in line with the literature that advocate the need to maintain price stability through monetary measures (Ferrero, 2009 or Galí & Monacelli, 2008).[1] Fiscal policy in the model consists of a government spending rule and proportional taxes based on Fernández-Villaverde (2010a).

I follow Leeper (1991) in the characterization of active and passive fiscal and monetary policies. Leeper (1991) explains that equilibrium determinacy might be achieved only by particular interactions of fiscal and monetary policy, more specifically, one of them should be active and the other one passive. This paper applies Leeper's definitions to a monetary union as in Leith and Wren-Lewis (2006) that explains that an active (common) monetary policy, that is, inflation targeting, implies that each economy of the union should implement a national passive fiscal policy. The current analysis aims at simulating the European Monetary Union (hereinafter EMU) case, so it is focused only on the combination of active monetary and passive fiscal

[1]Be aware that modeling non-conventional monetary measures such as the ones used by the European Central Bank during the post crisis when the interest rate remained at the zero lower bound lies beyond the scope of this paper.

policies, that is, a monetary dominance regime.[2] According to Leith and Wren-Lewis (2006), a fiscal dominance regime in a monetary union will endow only one single national fiscal policy to influence inflation dynamics, while the rest of national fiscal policies should ensure debt stability together with monetary policy. Thus, the fiscal dominance regime is not representative of the currency union that this paper represents so it was not considered in the current economic analysis.

The macroprudential tool is in line with Basel III statement that "national authorities should monitor credit growth". Therefore, it is based on the one of Quint and Rabanal (2014) which monitors the amount of private loans and reacts to credit growth. Poutineau and Vermandel (2017) are other example of this approach, although they model the tool as a tax on refinancing from the central bank rather than a limit to the lending ability of the financial sector. Also unlike theirs, the macroprudential instrument in this article interacts with fiscal policy.

Although the ESRB/2013/1 refers to the macroprudential authority as a national authority, this research also evaluates the impact of establishing a supranational macroprudential authority. This follows other studies, such as Rubio (2014), Dehmej and Gambacorta (2019) or Poutineau and Vermandel (2017), that also analyze national and supranational macroprudential policy implementations in a monetary union. Unlike theirs, this study shows how the appropriateness to implement macroprudential instruments at the country or union level depends on the kind of shock that hits the economy.

3 | THE MODEL

I consider a two-country monetary union with financial frictions, as in Bernanke et al. (1999), an international financial market, based on Quint and Rabanal (2014), and a market for consumption goods that are internationally traded. Capital and labor are non-mobile across the two countries. The home country is of size n and the foreign country of size $1 - n$. Each economy is composed of households, intermediate good producers, final good producers, entrepreneurs, capital goods producers and domestic financial intermediaries. International financial intermediaries connect the domestic financial intermediaries of both countries. Fiscal authorities are national. Macroprudential authorities can be either national or supranational. In what follows, variables and parameters for the foreign country are denoted with superscript $*$.

3.1 | Households

There is a continuum of households with infinite life that consume, work and save. The representative household maximizes its utility function, choosing total consumption, c_t, of foreign or domestic goods, time devoted to work, l_t, and financial assets that can be either deposits, a_t, or government bonds, d_t, both in positive amounts.

The individual's utility function is given by

[2]This is also consistent with the *Stability and Growth Pact* of the EMU.

$$E_t \sum_{t=0}^{\infty} \beta^t e^{\phi_t} \left[\log(c_t - hc_{t-1}) - \psi \frac{l_t^{1+\vartheta}}{1+\vartheta} \right], \tag{1}$$

where $\beta \in (0, 1)$ is the discount factor; $h \geq 0$ reflects the degree of habit persistence; $\psi > 0$ denotes the magnitude of the labor disutility relative to consumption utility; and $\vartheta > 0$ is the inverse of the Frisch elasticity of labor supply. Variable ϕ_t represents an intertemporal preference shock with law of motion

$$\phi_t = \rho_\phi \phi_{t-1} + \sigma_\phi \varepsilon_{\phi,t} \text{ where } 0 < \rho_\phi < 1 \text{ and } \varepsilon_{\phi,t} \backsim N(0,1). \tag{2}$$

Parameter ρ_ϕ is the persistence coefficient and σ_ϕ the volatility of the preference shock.

The representative household makes decisions subject to the budget constraint:

$$(1+\tau_c)c_t + \frac{a_t}{p_t} + \frac{d_t}{p_t} = (1-\tau_l)w_t l_t + [1 + (1-\tau_R)(R_{t-1}-1)] \frac{a_{t-1}}{p_t} + R_{t-1}^d \frac{d_{t-1}}{p_t} + T_t + F_t + tre_t. \tag{3}$$

The left hand side of Equation (3) represents the household's expenditures. The right hand side describes the sources of income to the household: labor income, $w_t l_t$, being w_t the real wage; interests on last period investment on deposits, $R_{t-1}a_{t-1}$ and on public assets, $R_{t-1}^d d_{t-1}$; and net transfers received from the government, T_t. There are proportional taxes on real consumption, τ_c, on labor income, τ_l and on net returns on deposits, τ_R. Dividends are paid by firms to households, F_t; and tre_t is a net transfer received from entrepreneurs, defined as follows:

$$tre_t = (1-\gamma^e)n_t - w^e, \tag{4}$$

where $\gamma^e = \frac{1}{1+e^{-\overline{\gamma}^e}}$ is the rate of entrepreneurs that survives from one period to the next one. Then the net wealth of the dead entrepreneurs, $(1-\gamma^e)n_t$, is paid back to households and these transfer w^e to incoming entrepreneurs. This constitutes the initial real net wealth of the new entrepreneurs.

Foreign households also maximize lifetime utility subject to their budget constraint.

Then, households choose their allocations between home and foreign goods maximizing the consumption index subject to total expenditures. The domestic consumption index follows:

$$c_t = \left[(1-\varphi)^{\frac{1}{\zeta}} (c_{H,t})^{\frac{\zeta-1}{\zeta}} + \varphi^{\frac{1}{\zeta}} (c_{F,t})^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}}, \tag{5}$$

where $c_{H,t}$ is the consumption of domestic goods and $c_{F,t}$ is the amount of imports. The parameter $\varphi \in [0,1]$ is a measure of the degree of openness and therefore $1-\varphi$ represents the home bias in consumption. The degree of substitutability between domestic and foreign goods is given by $\zeta > 0$. Total consumption expenditures are given by

$$p_t c_t = p_{H,t} c_{H,t} + p_{F,t} c_{F,t}, \tag{6}$$

the price of domestic goods, $p_{H,t}$, and the price of foreign goods, $p_{F,t}$ compose the home consumer price index, p_t. For simplicity, I assume that the law of one price holds so the prices of goods produced at the foreign country are the same across countries and so are the prices of goods produced at the home country. That is, $p_{H,t} = p^*_{H,t}$ and $p_{F,t} = p^*_{F,t}$. As this model represents a monetary union all prices are in the same monetary units.

The demand equations for $c_{H,t}$ and $c_{F,t}$ can be derived from this maximization problem:

$$c_{H,t} = \left(\frac{p_{H,t}}{p_t}\right)^{-\zeta}(1-\varphi)c_t, \tag{7}$$

and

$$c_{F,t} = \left(\frac{p_{F,t}}{p_t}\right)^{-\zeta}\varphi c_t. \tag{8}$$

The same maximization problem applies for the foreign country with a degree of openness of φ^*.

To express the degree of competitiveness of one country with respect to the other, the variable terms of trade, t_t, relates the price of the domestically produced goods to the price of the goods produced in the foreign country,

$$t_t = \frac{p_{F,t}}{p_{H,t}}. \tag{9}$$

3.2 | Intermediate goods producers

They produce differentiated goods that are then sold in a monopolistically competitive market to final good producers, who use them in their production process. Each intermediate good producer, i, chooses labor, l_{it}, and capital, k_{it-1}, as factors of production and creates her output, y_{it}, through the following production function:

$$y_{it} = e^{z_t}k^{\alpha}_{it-1}l^{1-\alpha}_{it}, \tag{10}$$

where $0 \leq \alpha \leq 1$ is the capital share of the intermediate production function.

Technology follows an exogenous AR(1) process $z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t}$ where $0 < \rho_z < 1$ and $\varepsilon_{z,t} \backsim N(0, 1)$, being ρ_z the persistence coefficient and σ_z the volatility of the technology shock.

Labor is hired from households in exchange for real wages, w_t. Capital is rented from entrepreneurs at the real interest rate, r_t. Intermediate goods producers minimize their costs function subject to their production function. Cost minimization implies

$$k_{it-1} = \frac{\alpha}{1-\alpha}\frac{w_t}{r_t}l_{it}\frac{p_t}{p_{H,t}}. \tag{11}$$

These firms also reset their prices through a Calvo pricing mechanism. Each period, a fraction $1-\theta$ of producers can change their price, while a fraction θ has to keep the previous period's price which is then indexed to past inflation.

Firms resetting their price in period t maximize their discounted profits,

$$E_t \sum_{\tau=0}^{\infty} (\beta\theta)^{\tau} \frac{\lambda_{t+\tau}}{\lambda_t} \left[\left(\prod_{s=1}^{\tau} \frac{\Pi_{H,t+s-1}^{\chi}}{\Pi_{H,t+s}} \frac{p_{H,it}}{p_{H,t}} - mc_{t+\tau} \right) y_{it+\tau} \right], \tag{12}$$

subject to a sequence of demand functions[3]

$$y_{it+\tau} = \left(\prod_{s=1}^{\tau} \frac{\Pi_{H,t+s-1}^{\chi}}{\Pi_{H,t+s}} \frac{p_{H,it}}{p_{H,t}} \right)^{-\varepsilon} y_{t+\tau}. \tag{13}$$

In the expressions above, $\frac{\lambda_{t+\tau}}{\lambda_t}$ is the stochastic discount factor, taken as given by the intermediate good producer; mc_t denotes the marginal cost; $p_{H,it}$ is the price set in period t by the intermediate goods producer i; $p_{H,t}$ is the aggregate domestic price level; $\Pi_{H,t}$ denotes domestic inflation; $y_{it+\tau}$ represents output at $t+\tau$ for a firm that last reset its price in period t; $y_{t+\tau}$ is the aggregate level of output in time $t+\tau$ and $\varepsilon \geq 1$ is the elasticity of substitution across goods. Let the domestic reset price relative to the domestic price level be $\overline{\Pi}_{H,t} = \frac{\overline{p}_{H,t}}{p_{H,t}}$.

The aggregate price index can be expressed as follows:

$$1 = \theta \left(\frac{\Pi_{H,t-1}^{\chi}}{\Pi_{H,t}} \right)^{1-\varepsilon} + (1-\theta) \overline{\Pi}_{H,t}^{(1-\varepsilon)}. \tag{14}$$

3.3 | Final goods producers

Final goods producers buy intermediate goods and combine them to obtain the homogeneous final good according to a CES (constant elasticity of substitution) production function, which is one of the cases considered by Dixit and Stiglitz (1977) and thus called the Dixit-Stiglitz technology function:

$$y_t = \left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{15}$$

where y_t is the aggregate demand of the economy, and $\varepsilon > 1$ is the elasticity of substitution across goods. The final good is sold to households or to the government in a perfectly competitive market. Thus, these firms maximize profits taking both the price of the intermediate good $p_{H,it}$ and the price of the final good $p_{H,t}$ as given. The domestic price level is given by

[3]The individual demand for each differentiated good is in line with the Dixit and Stiglitz (1977) specification.

$$p_{H,t} = \left(\int_0^1 p_{H,it}^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}. \tag{16}$$

3.4 | Capital goods producers

These agents operate in a perfectly competitive market and create new capital, x_{t+1}, using investment, i_t, and installed capital, x_t, via the following production function:

$$x_{t+1} = x_t + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t, \tag{17}$$

where $S\left[\frac{i_t}{i_{t-1}}\right]$ denotes adjustment costs, such that $S'[\cdot] > 0; S''[\cdot] > 0; S[1] = 0;$ and $S'[1] = 0$. Installed capital is previously purchased from entrepreneurs. Let q_t denote the relative price of capital, then discounted profits are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[q_t \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t - i_t \right]. \tag{18}$$

The law of motion of capital is given by

$$k_t = (1-\delta)k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t, \tag{19}$$

where $\delta \in [0, 1]$ is the capital depreciation rate.

3.5 | Entrepreneurs

Entrepreneurs transform installed capital, x_t, into inputs used by intermediate goods producers, k_{t-1}. Each period, entrepreneurs buy new capital, k_t, from capital goods producers at a price q_t, to undertake their investment. They use both internal and external funds to purchase the newly installed capital, $q_t k_t$. Internal funds are composed by the end-of-period net worth (equity of entrepreneurs), n_t; while external funds consist of loans (liabilities of entrepreneurs) borrowed from financial intermediaries, b_t. Therefore, they borrow[4]

$$\frac{b_t}{p_t} = q_t k_t \frac{p_{H,t}}{p_t} - n_t. \tag{20}$$

Their technology is affected by an idiosyncratic shock, ω_{t+1}, lognormally distributed with cumulative distribution $F(\omega, \sigma_{\omega,t})$ with parameters $\mu_{\omega,t}$ and $\sigma_{\omega,t}$. I assume that $E_t \omega_{t+1} = 1$ for all t.

[4]Notice that this expression means that the contract is set in nominal terms, what implies that the debt deflation channel may affect the entrepreneurs' networth.

The dispersion, $\sigma_{\omega,t}$, is the credit risk of the model that may arise from household overborrowing or from risk-taking in financial markets and follows:

$$\frac{\sigma_{\omega,t}}{\sigma_{\omega}} = \left(\frac{\sigma_{\omega,t-1}}{\sigma_{\omega}}\right)^{\rho_{\sigma_{\omega}}} \exp\left(\eta_{\sigma_{\omega}\varepsilon_{\sigma_{\omega},t}}\right) \text{ where } \varepsilon_{\sigma_{\omega},t} \backsim N(0,1). \tag{21}$$

Parameter $\rho_{\sigma_{\omega}} \in [0,1]$ is the persistence coefficient and $\eta_{\sigma_{\omega}}$ is the volatility of the shock, revealed at the end of the period, just before the investment decisions for $t+1$ are taken.

Let r_{t+1} be the price that the entrepreneur charges to the intermediate good producer per unit of capital rented, and let $q_{t+1}(1-\delta)$ be the cost that the capital good producer assumes for the repurchase of the old non-depreciated capital, paid to the entrepreneur at the end of the period. The ex-post average return of the entrepreneur per unit of investment between t and $t+1$, R^k_{t+1}, can be defined as

$$R^k_{t+1} = \Pi_{H,t+1}\frac{r_{t+1} + q_{t+1}(1-\delta)}{q_t}. \tag{22}$$

The realization of ω_{t+1} is private information to entrepreneurs, and the contract with financial intermediaries is signed before it is known. As in Bernanke et al. (1999), I consider a costly state verification (CSV) problem, that is solved via a standard debt contract: entrepreneurs observe their outcome for free, but financial intermediaries need to pay a cost, proportional to the gross payoff of the entrepreneur's capital.

The standard debt contract specifies a state-contingent non-default repayment, R^l_{t+1} (dependent on R^k_{t+1}), that the entrepreneur promises to pay to the financial intermediary in case of success of the investment project. Otherwise the entrepreneur will default.

At the moment of the debt contract agreement there is aggregate uncertainty because R^k_{t+1} is not known yet. Once the entrepreneur has decided on the amount of capital to purchase, $q_t k_t \frac{p_{H,t}}{p_t}$, and therefore the amount of external funds it needs, the entrepreneur and the financial intermediary agree to sign the one period contract given the ex-ante values of $q_t k_t \frac{p_{H,t}}{p_t}$ and $\frac{b_t}{p_t}$. The threshold value of the idiosyncratic shock, ϖ_{t+1}, below which the entrepreneur defaults, is given by

$$R^l_{t+1} b_t = \varpi_{t+1} R^k_{t+1} p_{H,t} q_t k_t. \tag{23}$$

Hence, the CSV problem ensures that whenever the entrepreneur has generated enough revenue to pay its obligations it has an incentive to do so (Freixas & Rochet, 2008).

The debt contract also establishes the return R^l_{t+1} the financial intermediary gets from the entrepreneur, arising from the zero profit condition

$$\left[1 - F\left(\varpi_{t+1}, \sigma_{\omega,t}\right)\right] R^l_{t+1} b_t + (1-\mu)\int_0^{\varpi_{t+1}} \omega dF\left(\omega, \sigma_{\omega,t}\right) R^k_{t+1} p_{H,t} q_t k_t = R_t(a_t + B_t). \tag{24}$$

Following Fernández-Villaverde (2010), the entrepreneur chooses both the leverage ratio and the schedule for ϖ_{t+1} by maximizing its expected net worth

$$\max_{\frac{b_t}{p_t}} \frac{\frac{b_t}{p_t}}{n_t}\varpi_{t+1}\frac{R^k_{t+1}}{R_t}\left[1-\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]\left(1+\frac{\frac{b_t}{p_t}}{n_t}\right), \tag{25}$$

subject to the zero profit condition of the financial intermediary,

$$\left[\frac{R^k_{t+1}}{R_t}\left[\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)-\mu G\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]\left(1+\frac{\frac{a_t+B_t}{p_t}}{n_t}\right)-\frac{\frac{a_t+B_t}{p_t}}{n_t}\right], \tag{26}$$

and given that in equilibrium $a_t + B_t = \eta_t b_t$, where η_t denotes the macroprudential instrument (see Section 3.10). Then, $F\left(\varpi_{t+1},\sigma_{\omega,t}\right)$ denotes the probability of default and

$$G\left(\varpi_{t+1},\sigma_{\omega,t}\right)=\int_0^{\varpi_{t+1}}\omega dF\left(\omega,\sigma_{\omega,t}\right). \tag{27}$$

Function $\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)$ stands for the share of entrepreneurial earnings accrued to the financial intermediary

$$\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)=\varpi_{t+1}\left[1-F\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]+G\left(\varpi_{t+1},\sigma_{\omega,t}\right). \tag{28}$$

As mentioned in Section 3.1, at the end of every period a fraction γ^e of entrepreneurs survives while the rest die. Capital demand and capital return by entrepreneurs depend on the evolution of their net worth. Entrepreneurs' net worth (equity) depends on their earnings net of interest payments to financial intermediaries. Therefore it is necessary to assume that entrepreneurs have some initial networth, w^e, in order to begin operating. The new entrepreneurs replacing exiting ones enter the economy with initial net worth w^e.

The average net wealth follows

$$n_t=\gamma^e\frac{1}{\Pi_t}\left\{\left[1-\mu G\left(\varpi_t,\sigma_{\omega,t-1}\right)\right]R^k_t q_{t-1}k_{t-1}\frac{p_{H,t-1}}{p_{t-1}}-R_{t-1}\frac{b_{t-1}}{p_{t-1}}\eta_t\right\}+w^e. \tag{29}$$

3.6 | Domestic financial intermediaries

Domestic financial intermediaries operate in a perfectly competitive market, receiving deposits from households, a_t, and lending loans to entrepreneurs, b_t. In case the demand for loans exceeds the amount of domestic deposits, domestic financial intermediaries obtain funds from the international financial market, $B_t > 0$, lent to entrepreneurs in the form of loans. When there is a surplus of domestic deposits relative to the amount of loans that entrepreneurs borrow, domestic financial intermediaries deposit the excess of funds in the international financial markets, $B_t < 0$. As markets are incomplete, the international bond is uncontingent, that is, there is not an outcome for each state of nature.

Their objective function is given by

$$\left\{\left[1-F\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]R^{l}_{t+1}b_t+(1-\mu)\int_0^{\varpi_{t+1}}\omega dF\left(\omega,\sigma_{\omega,t}\right)R^{k}_{t+1}p_{H,t}q_t k_t-R_t\left(a_t+B_t\right)\right\}, \tag{30}$$

which shows expected returns in case of a successful project, plus revenues in case of default, minus the costs for the financial intermediary. See Appendix A for a detailed explanation of the contract between the financial intermediary and the entrepreneur.[5]

3.7 | International financial intermediaries

Following Quint and Rabanal (2014), the model incorporates international financial intermediaries between domestic financial intermediaries of the home country and of the foreign country. These agents borrow from the country with excess loanable funds to lend them to the country that has a shortage of loanable funds. They pay to the lending country a rate equal to the interest on deposits of that country and receive from the borrowing country a rate equal to the interest on deposits of that other country. Incomplete markets in this model imply that the interest rate differs across countries. Thus, the differential between the deposit rates of both countries is the profit of international financial intermediaries. This differential or country debt premium, is given by

$$R_t-R^*_t=e^{\Omega\left(\frac{B_t}{p_t y}-\frac{B}{py}\right)}-1. \tag{31}$$

For simplicity, as in Quint and Rabanal (2014), I take the home country as the reference so that the debt premium depends on the ratio of real international debt, $\frac{B_t}{p_t}$, to steady state real GDP, y, of the home country. In what follows I will denote real international debt by $\overline{B}_t$ and real private debt by $\overline{b}_t$. If the home country borrows from the international market, $B_t>0$ and $R_t>R^*_t$. The parameter $\Omega>0$ denotes the elasticity of the debt premium.

The profits of international financial intermediaries are distributed proportionally across households of both countries.

3.8 | Fiscal authority

The national fiscal authority (or government) finances its expenditures via taxes and public debt, according to the following budget constraint:

$$\frac{d_t}{p_t}=g_t+R^d_{t-1}\frac{d_{t-1}}{p_t}-tax_t, \tag{32}$$

[5]Be aware that given that the domestic financial intermediary operates in a perfectly competitive market, this objective function will be equal to zero according to Equation (24)

where d_t denotes current issue of public debt; g_t is government spending; and tax_t are tax revenues defined by

$$tax_t = \tau_c c_t + \tau_l w_t l_t + \tau_R (R_{t-1} - 1)\frac{a_{t-1}}{p_t}. \tag{33}$$

As in Fernández-Villaverde (2010a), I assume that government spending evolves by:

$$\frac{g_t}{g} = \left(\frac{g_{t-1}}{g}\right)^{\gamma_g} \exp\left(d_g \frac{d_{t-1}}{\Pi_t y_t} - \frac{d}{\Pi y}\right) \exp(\sigma_g \varepsilon_{g,t}), \text{ where } \varepsilon_{g,t} \backsim N(0,1). \tag{34}$$

Parameter $d_g \leq 0$ is the sensitivity of government expenditure to changes in the ratio of debt over output, its sign reflects the objective of public debt stabilization; $\gamma_g \in [0, 1]$ is the persistence coefficient; and σ_g is the volatility of the government spending shock.

3.9 | Monetary authority

The monetary authority is common for both countries and uses monetary policy to stabilize the monetary union gross inflation rate, Π_t^{MU}, and real output, y_t^{MU}. With that aim, the central bank sets the interest rate for the union. This analysis takes into account the active/passive definitions introduced by Leeper (1991). Thus, an active policy is the one unconstrained by sovereign debt and a passive policy is the one constrained by current budgetary conditions and active authority actions. In this model different national passive fiscal policies are combined with an active monetary policy that stabilizes the union inflation.

The monetary union inflation is given by

$$\Pi_t^{MU} = \frac{p_t^{MU}}{p_{t-1}^{MU}}, \tag{35}$$

where

$$p_t^{MU} = (p_t)^n (p_t^*)^{1-n}, \tag{36}$$

and the monetary union real output is

$$y_t^{MU} = (y_t)^n (y_t^*)^{1-n}. \tag{37}$$

The central bank follows a standard Taylor Rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left(\left(\frac{\Pi_t^{MU}}{\Pi^{MU}}\right)^{\gamma_\Pi} \left(\frac{y_t^{MU}}{y^{MU}}\right)^{\gamma_y}\right)^{(1-\gamma_R)} \exp(\sigma_m \varepsilon_{m,t}), \tag{38}$$

where $\gamma_R \in [0, 1]$ is the persistence parameter; $\gamma_\Pi \geq 0$ and $\gamma_y \geq 0$ indicate how strong is the response of the interest policy rate to deviations of Π_t^{MU} and y_t^{MU} from their steady states, respectively; and σ_m is the volatility of the monetary policy shock, $\varepsilon_{m,t} \backsim N(0, 1)$.

The nominal interest rate is modified through open market operations financed by transfers, T_t and T_t^* for the home and foreign country, respectively.

3.10 | Macroprudential authority

The macroprudential authority stabilizes the financial system. Through counter-cyclical macroprudential policy, private debt volatility is reduced to guarantee a more stable cycle.

Therefore, following Quint and Rabanal (2014), the macroprudential tool controls the ability to lend of the domestic financial intermediaries in the following way:

$$\frac{1}{\eta_t}(B_t + a_t) = b_t, \tag{39}$$

where η_t is a new variable that affects the credit market conditions.

Higher values of η_t reflect a tightening macroprudential policy, while lower values reflect an easing macroprudential policy. When the regulation is tightening, domestic financial intermediaries can only lend a fraction of the funds they get from households and from international financial intermediaries. In this case, thE measure would be equivalent to a reserve requirement ratio or countercyclical capital buffers that make banks accumulate capital during good times. However, in line with Quint and Rabanal (2014), the macroprudential instrument can go below one. So when macroprudential policy is easing, capital buffers are released to maintain the provision of credit to the real economy.

In line with Basel III, that states that monitoring excessive credit growth is one of the most important objectives of macroprudential policy, I follow Quint and Rabanal (2014) and Malmierca (2023) and make η_t dependent on the deviation of nominal credit growth, Ψ_t, from its steady state, Ψ, as follows:

$$\eta_t = \left(\frac{\Psi_t}{\Psi}\right)^{\gamma_\eta}, \tag{40}$$

where $\gamma_\eta > 0$ reflects how responsive η_t is to nominal credit growth. Notice that macroprudential policies do not affect the steady state since $\eta = 1$ whenever $\Psi_t = \Psi$.

Nominal credit growth is computed as:

$$\Psi_t = \frac{\bar{b}_t}{\bar{b}_{t-1}}\Pi_t. \tag{41}$$

Thus, the macroprudential instrument becomes tightening when there is an increase in the nominal private credit growth and easing if the latter decreases.

I analyze the case of supranational macroprudential policy implying that the macroprudential tool, η_t^{MU}, is the same in both countries of the union. Malmierca (2023) shows that a supranational macroprudential policy, reacting to aggregate variables (as in Rubio, 2014 or Dehmej & Gambacorta, 2019), entails destabilization for the foreign country. The reason is that the latter has to bear the costs of stabilizing the home country, responsible for the shock. Therefore, as the purpose of this analysis is to investigate the most stabilizing policy mixes, the supranational macroprudential policy reacts to each country's financial indicator with different degrees of responsiveness, that is, γ_η and γ_η^* might differ.

$$\eta_t^{MU} = n\left(\frac{\Psi_t}{\Psi}\right)^{\gamma_\eta} + (1-n)\left(\frac{\Psi_t^*}{\Psi^*}\right)^{\gamma_\eta^*}. \tag{42}$$

The introduction of macroprudential policy affects the credit conditions in the model. In particular, the lending-deposit spread becomes

$$\frac{R_{t+1}^l}{R_t} = \frac{\eta_t}{\left[1 - F\left(\varpi_{t+1}, \sigma_{\omega,t}\right)\right] + \frac{(1-\mu)}{\varpi_{t+1}} \int_0^{\varpi_{t+1}} \omega dF\left(\omega, \sigma_{\omega,t}\right)}. \tag{43}$$

When the macroprudential policy is tightening, the lending-deposit spread increases. The opposite holds when the macroprudential policy is easing.

3.11 | Equilibrium and market clearing

The equilibrium in this model can be defined as the sequence of quantities $\{c_t, c_{H,t}, c_{F,t}, l_t, a_t, k_t, i_t, b_t, B_t, c_t^*, c_{H,t}^*, c_{F,t}^*, l_t^*, a_t^*, k_t^*, i_t^*, b_t^*, B_t^*\}_{t=0}^{\infty}$; fiscal policy $\{g_t, tax_t, d_t, g_t^*, tax_t^*, d_t^*\}_{t=0}^{\infty}$; prices $\left\{p_t, p_{H,t}, p_{F,t}, r_t, w_t, q_t, p_t^*, r_t^*, w_t^*, q_t^*\right\}_{t=0}^{\infty}$, and interest rates $\{R_t^d, R_t, R_t^k, R_t^l, R_t^{d*}, R_t^*, R_t^{k*}, R_t^{l*}\}_{t=0}^{\infty}$, given exogenous variables $\{z_t, \widehat{\sigma}_{\omega,t}, \phi_t, z_t^*, \widehat{\sigma}_{\omega,t}^*, \phi_t^*,\}_{t=0}^{\infty}$, such that:

- optimality conditions are satisfied for all agents of both countries in the model; and
- all markets clear, that is, in the case of the home country

$$y_t = c_{H,t} + \frac{1-n}{n} c_{H,t}^* + i_t + g_t + \mu G\left(\varpi_t, \sigma_{\omega,t-1}\right)\left(r_t + q_t(1-\delta)\right)k_{t-1}, \tag{44}$$

is aggregate demand,

$$y_t = \frac{1}{\upsilon_t} e^{z_t} k_{t-1}^{\alpha} l_t^{1-\alpha}, \tag{45}$$

is aggregate supply, being υ_t the inefficiency created by price dispersion that follows:

$$\upsilon_t = \theta\left(\frac{\Pi_{H,t-1}^{\chi}}{\Pi_{H,t}}\right)^{-\varepsilon} \upsilon_{t-1} + (1-\theta)\left(\overline{\Pi}_{H,t}\right)^{-\varepsilon}. \tag{46}$$

The labor market clearing is implied by

$$l_t^s = l_t^d, \tag{47}$$

and the international and domestic financial markets'equilibrium, respectively, are represented by:

$$nB_t = (1-n)(-B_t^*) \tag{48}$$

$$\begin{cases} a_t + B_t = b_t & \text{if macroprudential policy is not included,} \\ \frac{1}{\eta_t}(a_t + B_t) = b_t & \text{if macroprudential policy is included.} \end{cases} \tag{49}$$

- plus the laws of motion

$$k_t = (1-\delta)k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t, \text{ and} \tag{50}$$

$$\frac{d_t}{p_t} = g_t + R_{t-1}^d \frac{d_{t-1}}{p_t} - tax_t \tag{51}$$

and the home country's net foreign asset position which is

$$n\overline{B}_t = nR_{t-1}\frac{\overline{B}_{t-1}}{\Pi_t} + n\frac{p_{F,t}}{p_t}c_{F,t} - (1-n)\frac{p_{H,t}}{p_t}c_{H,t}^*. \tag{52}$$

For the foreign country the market clearing is replicated using foreign variables. First order conditions of the model agents can be found in Appendix B.

4 | CALIBRATION OF THE PARAMETERS AND STEADY STATE

Table 1 shows the model parametrization. Most of the parameters are calibrated based on Gomes and Seoane (2018), Fernández-Villaverde (2012), Fernández Villaverde (2010b) or Bernanke et al. (1999). All parameters and steady states are the same for both countries except for home country imports and foreign country imports, $\frac{c_F}{y}$ and $\frac{c_H^*}{y^*}$ respectively, and the steady states that result from these values. Parameters d_g and d_g^*, from the fiscal policy rules and γ_η and γ_η^*, from the macroprudential rules, depend on the optimized value that minimizes a specific loss function.

5 | POLICY STABILIZATION ANALYSIS

This section studies the stabilization properties of different macroprudential and fiscal policy scenarios. Malmierca (2023) analyzes the optimal fiscal-macroprudential policy combinations in terms of welfare maximization. Thus, as a follow-up, I optimize the value of the policy

TABLE 1 Calibration of the non-optimized parameters and steady states.

Parameter	Description	Value	Source
β	Discount factor	0.999	Fernández Villaverde (2010b)
h	Consumption habits	0.5	Fernández Villaverde (2010b)
n	Size of the home country	0.5	Faia (2001)
$\frac{c_F}{y}$	Imports-to-GDP	0.1	Own calibration to obtain $\frac{\overline{B}}{y} = 1.88$
$\frac{c_H^*}{y^*}$	Exports-to-GDP	0.11	Own calibration to obtain $\frac{\overline{B}}{y} = 1.88$
ζ	Substitutability between domestic and foreign goods	1.5	Faia (2001)
Ω	Debt elasticity of country premium	0.0043	Quint and Rabanal (2014)
t	Steady state for the terms of trade	1	Faia (2001)
ϑ	Frisch elasticity of labor	0.5	Fernández Villaverde (2010b)
α	Capital share	0.33	Fernández-Villaverde (2012)
δ	Capital depreciation rate	0.023	Fernández-Villaverde (2012)
θ	Home country calvo parameter	0.72	Fernández Villaverde (2010b)
θ^*	Foreign country calvo parameter	0.62	Quint and Rabanal (2014)
ε	Elasticity of substitution across goods	8.577	Fernández-Villaverde (2012)
χ	Degree of indexation	0.6	Fernández Villaverde (2010b)
$pdef$	Annual probability of default	0.03	Bernanke et al. (1999)
μ	Bankruptcy costs	0.15	Fernández-Villaverde (2012)
$s = s^*$	Average spread	1.0025	Fernández-Villaverde (2012)
$\overline{\gamma}^e = \overline{\gamma}^{e*}$	Entrepreneurs exit coefficient	3.67	Fernández Villaverde (2010b)
$\tau_l = \tau_l^*$	Steady state of labor tax rate	0.24	Fernández Villaverde (2010b)
$\tau_r = \tau_r^*$	Steady state of capital tax rate	0.42	Own calibration to obtain $\frac{\overline{B}}{y}$ of 1.88
$\Pi = \Pi^* = \Pi_H = \Pi_F$	Target gross inflation	1.005	Fernández Villaverde (2010b)
$l = l^*$	Time devoted to work	1/3	Fernández Villaverde (2010b)
$q = q^*$	Tobin's q. Price of capital	1	Fernández Villaverde (2010b)
R^d	Steady state of interest rate on home public debt	$\frac{\Pi}{\beta}$	Fernández Villaverde (2010b)
R	Steady state of interest rate on home deposits	$\frac{R^d-1}{1-\tau_R}+1$	Fernández Villaverde (2010b)
R^{d*}	Steady state of interest rate on foreign public debt	$\frac{\Pi^*}{\beta}$	Fernández Villaverde (2010b)
R^*	Steady state of interest rate on foreign deposits	$\frac{R^{d*}-1}{1-\tau_R^*}+1$	Fernández Villaverde (2010b)

(Continues)

TABLE 1 (Continued)

Parameter	Description	Value	Source
$\frac{\bar{b}}{k} = \frac{\bar{b}^*}{k^*}$	Loan-to-capital ratio	1/3	Fernández Villaverde (2010b)
$\frac{g}{y} = \frac{g^*}{y^*}$	Public spending-to-GDP ratio	0.2	Gomes and Seoane (2018)
$\frac{d}{y} = \frac{d^*}{y^*}$	Public debt-to-GDP ratio	0.6	Gomes and Seoane (2018)
$S''[1]$	Capital adjustment costs	14.477	Fernández-Villaverde (2012)
ρ_ϕ	Preference shock persistence	0.95	Fernández-Villaverde (2012)
σ_ϕ	Preference shock volatility	0.032	Gomes and Seoane (2018)
γ_g	Public spending shock persistence	0.95	Fernández-Villaverde (2012)
σ_g	Public spending shock volatility	0.007	Gomes and Seoane (2018)
ρ_z	Technology shock persistence	0.95	Fernández-Villaverde (2012)
σ_z	Technology shock volatility	0.025	Gomes and Seoane (2018)
ρ_σ	Credit risk shock persistence	0.95	Fernández-Villaverde (2012)
η_σ	Credit risk shock volatility	0.074	Christiano et al. (2010)
γ_R	Monetary policy shock persistence	0.95	Fernández-Villaverde (2012)
σ_m	Monetary policy shock volatility	0.003	Gomes and Seoane (2018)
$\gamma_\Pi(1-\gamma_R)$	Response of intervention rate to changes in inflation	1.5	Fernández-Villaverde (2012)
$\eta = \eta^*$	Steady state of macroprudential tool	1	Quint and Rabanal (2014)

parameters to minimize different loss functions depending on the scenario considered. Then the welfare implications of those optimized policy rules are evaluated. Although the specification of the loss functions is ad hoc, it provides a starting point for policy makers to decide on whether macroprudential and fiscal policy should be coordinated or not. The analysis captures a general result: coordination between authorities is only advisable under certain type of shocks. Moreover, it relates the stabilization properties of the policy mix with its welfare implications.

This paper compares national macroprudential authorities with a supranational macroprudential authority. Moreover, the analysis is performed for three different macroprudential and fiscal coordination scenarios. First, I consider the case where macroprudential and fiscal authorities share the objective of minimizing the same union-wide loss function. In the second scenario, macroprudential and fiscal authorities minimize the same national loss functions. Third and last I analyze a non-coordination case where the macroprudential authority minimizes the union's loss function, while fiscal authorities focus on national objectives.

The analysis is replicated for a supply and a demand shock, similar to those of the COVID-19 crisis, and for a financial shock, in line with the trigger of the Great Recession. All the shocks are originated in the home country. The foreign country indirectly suffers the consequences.

The model takes as a starting point a baseline regime that operates before the loss functions are minimized. Following Leeper's definitions this regime consists of a common active monetary policy and two national passive fiscal policies, that is, the fiscal rule stabilizes public debt. More concretely, the fiscal stabilization parameters, d_g and d_g^* are set to −0.01 in the baseline case. Also, the baseline regime is characterized by a zero macroprudential response $\left(\gamma_\eta = \gamma_\eta^* = 0\right)$.

To ensure reasonable values of the policy parameters, I follow Malmierca (2023) and set a lower and an upper limit for the minimization exercise. Thus, d_g and d_g^* range between −0.01 and −0.0004. A value of the fiscal parameters higher than −0.0004 would imply that fiscal policy is active, resulting in indeterminacy (see Leith & Wren-Lewis, 2006 for the active-passive analysis in a monetary union). The macroprudential parameters, γ_η and γ_η^*, are restricted to a range between 0 and 5.00 to be consistent with the existing literature.

The passive fiscal policies react to changes in public debt. A less passive fiscal policy stabilizes more the business cycle than a more passive fiscal policy, more focused on public debt stabilization. Hence, it is reasonable to consider the volatility of both GDP, σ_y, and public debt-to-GDP, $\sigma_{\frac{d}{y}}$, the fiscal authorities' loss functions. Also, as De Blas and Malmierca (2020) find a trade-off between stabilizing output and financial variables, in this analysis both the GDP volatility, σ_y, and credit growth volatility, σ_Ψ, are included in the macroprudential loss functions. The loss functions represent a loss in the sense that less volatility is preferred to more. Parameters ϕ_y, ϕ_{y^*} and $\phi_{y^{MU}} \in [0,1]$ indicate the relative weights of σ_y, σ_{y^*} and $\sigma_{y^{MU}}$, respectively, in the objective loss functions. In line with Angelini et al. (2012), $\phi_y = \phi_{y^*} = \phi_{y^{MU}} = 0.5$ in the non-coordination scenario, where policies are set separately. In the coordination scenarios, when policies interact to minimize a joint loss function, I set $\phi_y = \phi_{y^*} = \phi_{y^{MU}} = 1$ because, as in Angelini et al. (2012), the common loss function is the result of the aggregation of each authority's individual loss function. Following these authors, in the loss function, I give a weight equal to one to σ_Ψ and to $\sigma_{\frac{d}{y}}$, because they are the "key argument of the loss function that the authority seeks to minimize".

Tables 2–4 contain the values of the optimized policy parameters after the loss function minimization in the event of supply, demand and financial home country shocks, respectively.

TABLE 2 Loss function minimization. Optimal values of the policy parameters and welfare costs in consumption equivalents.

	γ_η	γ_η^*	d_g	d_g^*	$\mathcal{W}$	$\mathcal{W}^*$	$\mathcal{W}^{MU}$
Non-coordination	5	1.98	−0.01	−0.01	0.037%	−0.032%	0.002%
Coordination at union level	3.60	0.21	−0.01	−0.0004	0.025%	−0.040%	−0.008%
Coordination at country level	5	0.34	−0.01	−0.01	0.130%	0.020%	0.074%

Note: Home country technology shock.

TABLE 3 Loss function minimization. Optimal values of the policy parameters and welfare costs in consumption equivalents.

	γ_η	γ_η^*	d_g	d_g^*	$\mathcal{W}$	$\mathcal{W}^*$	$\mathcal{W}^{MU}$
Non-coordination	0.42	0	−0.01	−0.01	−0.004%	−0.006%	−0.005%
Coordination at union level	0	0	−0.01	−0.006	−0.0002%	−0.001%	−0.001%
Coordination at country level	5	1.30	−0.01	−0.01	0.089%	−0.006%	0.041%

Note: Home country preference shock.

TABLE 4 Loss function minimization. Optimal values of the policy parameters and welfare costs in consumption equivalents. Home country credit risk shock.

	γ_η	γ^*_η	$\mathbf{d_g}$	$\boldsymbol{d^*_g}$	$\mathcal{W}$	$\mathcal{W}^*$	$\mathcal{W}^{MU}$
Non-coordination	1.89	5	−0.01	−0.01	−0.009%	0.001%	−0.004%
Coordination at union level	1.81	5	−0.01	−0.008	−0.009%	0.0004%	−0.004%
Coordination at country level	4.45	0.84	−0.01	−0.004	−0.021%	−0.005%	−0.013%

Note: Home country credit risk shock.

The last three columns of Tables 2–4 include the welfare costs that each computed optimal policy rule entails. To evaluate welfare for each loss function minimization scenario the model is solved through a second order approximation of the equilibrium equations (Schmitt-Grohé & Uribe, 2004). Then, welfare is computed as the conditional expectation of lifetime utility as of time zero assuming that at time zero all variables equal their non-stochastic steady state values.

I define welfare for the home country as:

$$\mathcal{W} = E_t \sum_{t=0}^{\infty} \beta^t e^{\phi_t} \left[\log(c_t - hc_{t-1}) - \psi \frac{l_t^{1+\vartheta}}{1+\vartheta} \right], \tag{53}$$

and for the foreign country as

$$\mathcal{W}^* = E_t \sum_{t=0}^{\infty} \beta^t e^{\phi^*_t} \left[\log\left(c^*_t - hc^*_{t-1}\right) - \psi \frac{l_t^{*1+\vartheta}}{1+\vartheta} \right]. \tag{54}$$

The aggregate welfare of the union is the weighted sum of the national welfares:

$$\mathcal{W}^{MU} = n\mathcal{W} + (1-n)\mathcal{W}^*, \tag{55}$$

where n is the size of the home country. To compare welfare in the scenarios considered, the welfare costs are measured as the fraction of consumption that a household is willing to give up to be indifferent between the optimal policy scenario and the baseline regime (see Schmitt-Grohé & Uribe, 2004, Quint & Rabanal, 2014 or Rubio & Carrasco-Gallego, 2016, among others). Thus, with respect to the baseline scenario, a positive value of the welfare measure implies a decrease in welfare and a negative value entails a welfare gain.

The first row of Tables 2–4, *Non-coordination*, represents the scenarios where national fiscal authorities minimize the national variables' volatility while a common macroprudential authority is concerned with the union aggregate variables' variability.

Hence, in the non coordination scenario, the home country determines the value of d_g that minimizes

$$\mathcal{L}_{FP} = \sigma^2_{\frac{d}{y}} + \phi_y \sigma^2_y; \tag{56}$$

similarly, the foreign country's fiscal authority determines the value of d_g^*, that minimizes

$$\mathcal{L}_{FP}^* = \sigma_{\frac{d^*}{y^*}}^2 + \phi_{y^*}\sigma_{y^*}^2, \tag{57}$$

and the supranational macroprudential authority sets the values of γ_η and γ_η^* that minimize the union-wide loss function:

$$\mathcal{L}_{MaP}^{MU} = \sigma_{\Psi^{MU}}^2 + \phi_{y^{MU}}\sigma_{y^{MU}}^2. \tag{58}$$

The second row of the results in Tables 2–4, *Coordination at union level*, displays the scenarios where the supranational macroprudential and the national fiscal authorities minimize the volatility of financial and fiscal union aggregate variables implied by

$$\mathcal{L}^{MU} = \sigma_{\Psi^{MU}}^2 + \sigma_{\frac{d^{MU}}{y^{MU}}}^2 + \phi_{y^{MU}}\sigma_{y^{MU}}^2. \tag{59}$$

Finally, the last row of Tables 2–4, *Coordination at the country level*, reports the results of the scenarios where national macroprudential and fiscal policies minimize the volatility of national variables. To perform a more realistic approach, although fiscal and macroprudential authorities coordinate, each country minimizes its own loss function being

$$\mathcal{L} = \sigma_\Psi^2 + \sigma_{\frac{d}{y}}^2 + \phi_y\sigma_y^2 \tag{60}$$

the home country loss function, and

$$\mathcal{L}^* = \sigma_{\Psi^*}^2 + \sigma_{\frac{d^*}{y^*}}^2 + \phi_{y^*}\sigma_{y^*}^2 \tag{61}$$

the foreign country loss function.

Below, I analyze the loss function minimization results for each shock.

5.1 | Loss function minimization under a negative supply shock

After a negative home country technology shock that reduces aggregate supply, home GDP goes down generating a fall in the collection of taxes. This increases public leverage and, with the aim of stabilizing the latter, the fiscal authority reduces its expenditures. Similar to the COVID-19 consequences, prices go up and, with an inflation-targeting monetary authority, interest rates might also increase deteriorating the financial system conditions. Thus, the role of a macroprudential authority is key in this situation. Let us analyze its stabilization properties and welfare implications when it coordinates with the fiscal authority.

Under this shock, the macroprudential policy that better stabilizes the national and union-wide economies, responds aggressively to changes in home country financial variables (γ_η is equal to 5.00 or 3.6 in Table 2). This macroprudential strategy encourages private debt growth in the home country what increases private investment and ensures GDP stabilization. At the same time, the most stabilizing macroprudential policy implies a moderate reaction to foreign financial indicators. This is because foreign GDP does not fluctuate a lot after a home technology shock so a counter-cyclical macroprudential policy would destabilize foreign GDP.

When fiscal and macroprudential authorities are coordinated, the foreign macroprudential response is even lower as an aggressive macroprudential policy might destabilize foreign public debt. Hence, the values of the foreign macroprudential parameter, γ_η^*, are close to 0 when fiscal and macroprudential authorities share a same objective (0.21 and 0.34 in Table 2).

Each of the loss function minimization objectives requires a passive fiscal rule in the home country to ensure a stable path of public finances when macroprudential instruments operate aggressively to stabilize GDP. In the foreign country, if the national fiscal authority coordinates with a supranational macroprudential institution, an active fiscal policy will be implemented. This is because home passive fiscal measures achieve public debt stabilization.

After a home technology shock, the different policy strategies that seek for stabilization always entail a labor rise in the home country, thus deteriorating its welfare. National macroprudential measures stabilize the home and foreign countries the most, as the policy objective directly targets the stabilization of each economy's variables. However, this scenario also entails the highest welfare costs for both economies. First, because the home financial system stabilization entails a significant labor rise in the home country. Second, because the foreign financial system stabilization implies a fall of foreign consumption. The best scenario, in terms of welfare, for the foreign country and the union as a whole, is also the one that implies less home country welfare costs: coordinating authorities at the union level (second row of Table 2).

Hence, the assessment of the loss function minimization strategies, in the event of a home technology shock, shows that aggressive home macroprudential policy is needed to stabilize the home economy but it always entails home country welfare costs.

5.2 | Loss function minimization under a negative demand shock

When a positive demand shock is originated in the home country, thus constraining private consumption, the consequences are similar to the second phase of the health crisis of 2020. This time the fall of GDP in the home country is generated by a drop in aggregate demand. Therefore, prices decrease and so do the interest rates, raising private debt in the home country and, consequently, private investment. As in the case of a negative supply shock, the public sector experiences a decrease in tax revenues and a rise of public leverage.

Table 3 shows the loss function minimization after a home country preference shock.

The results suggest that with a supranational macroprudential authority (coordinated or not) macroeconomic stability is attained through fiscal policy only ($\gamma_\eta = 0.00$ and $\gamma_\eta^* = 0.00$) or a very moderate response of home country macroprudential policy ($\gamma_\eta = 0.42$). This strategy ensures that supranational macroprudential policy does not destabilize the union's GDP.

If macroprudential policies are set by national authorities, the results for the home country are similar to those observed under a supply shock. Aggressive national macroprudential policies are required to minimize the home country loss function ($\gamma_\eta = 5$). Such response is necessary to stabilize home private debt and investment. However, it entails a home country welfare loss.

The fall of prices in the home country raises the terms of trade, making foreign goods less competitive. The consequent increase in home country net exports generates a drop of foreign

GDP. At the same time, foreign private investment and consumption increase compensating the rise in foreign aggregate demand and stabilizing it. Hence, a too aggressive foreign macroprudential policy might stabilize the fall in foreign private debt and investment but at the cost of destabilizing GDP and public leverage. This provides a rational for the moderate foreign national macroprudential response $\left(\gamma_{\eta}^{*}=1.3\right)$.

The high volatility of public debt under this shock, together with the active monetary policy, are the main causes for the very passive fiscal policy required to minimize the loss function.

After a home country preference shock, the best scenario, in terms of welfare, for both countries and the union as a whole, is the non coordination scenario. Specifically, in the event of this demand shock, a zero or very discreet reaction of macroprudential policy might improve welfare slightly. However, as in the previous supply shock case, an aggressive macroprudential reaction deteriorates welfare.

5.3 | Loss function minimization under a credit risk shock

After a financial home country shock, financial conditions are deteriorated and private investment and GDP decrease in the home country. This shock is similar to the one that caused the Great Recession in 2007. In the absence of macroprudential policy, on the one hand, foreign credit is barely destabilized; on the other hand, the home country's private debt falls significantly.

If the macroprudential authority is supranational, after a credit risk shock in home country, the optimized value of γ_{η} and γ_{η}^{*} are 1.89 and 5, respectively (see Table 4). Thus, the response to home country financial variables does not need to be very aggressive compared to the response to foreign financial variables. At first glance, this does not seem to be the most congruent strategy because it raises a lot (even destabilizes) foreign private debt and, at the same time, does not react sufficiently to the home country's financial conditions. However, under a supranational scenario, the macroprudential authority pursues the union aggregate variables stabilization, achieved by imposing opposite and destabilizing paths on foreign and home country private debts. Actually, minimizing the variability of union-wide aggregate variables implies very low welfare gains in the home country and welfare costs in the foreign economy. Thus, the union-wide welfare does not improve significantly.

If macroprudential policy is implemented by a national authority, the strategy to achieve the policy objective is completely different. The home country should implement an aggressive macroprudential policy to stabilize its own financial system, through which the effects of this shock are transmitted to the broader economy. The foreign country only needs a moderate macroprudential response as its financial system remains quite stable. A national macroprudential policy in the home country directly targets its financial sector, where the shock is originated. A foreign macroprudential policy also meets the foreign country financial needs. Thereupon, national loss function minimization by both national macroprudential and fiscal policies brings welfare gains to all members of the monetary union, and consequently, to the union as a whole. Thus, under financial shocks, the national macroprudential scenario is better, in terms of welfare, than any other macroprudential strategy.

Under this kind of shock fiscal policy does play a role in the stabilization of foreign country variables. A moderate foreign macroprudential policy by itself barely affects the economy of any of the countries. The reason is that economic instability within the currency area comes from the home country private financial sector, which is not directly addressed by foreign macroprudential policy. This explains why the foreign macroprudential authority implements such a moderate policy devolving to foreign fiscal policy the economic stability objective, so $d_g^* = -0.004$.

It is interesting to observe that the loss function minimization objective implies that fiscal policy needs to be passive so that public debt is stabilized and its variability minimized.

6 | CONCLUSION

The analysis of this paper assesses the welfare implications of macroprudential-fiscal coordination scenarios that are implemented with stabilization purposes rather than welfare maximization objectives. With that aim, this paper considers a series of ad hoc loss functions that authorities might try to minimize through the implementation of macroprudential and fiscal measures.

A first conclusion of the analysis is that the use of macroprudential policy and its coordination with fiscal instruments entails different stabilization outcomes depending on the type of shock that drives the economic fluctuations. Under a supply shock, a trade-off arises: macroprudential policy brings economic and financial stabilization but deteriorates welfare. In the event of a demand shock, the most stabilizing policy mix implies a non-existent or very weak macroprudential response, moreover the more aggressive that response is the higher the welfare loss. A credit risk shock requires strong macroprudential actions to stabilize the financial system and the business cycle (in line with the findings of previous literature such as Quint & Rabanal, 2014 or Poutineau & Vermandel, 2017). Under this shock, the macroprudential strategies that achieve minimization of the different loss functions are also welfare improving. Therefore, stabilizing macroprudential policies improve welfare under financial shocks but not under supply and demand shocks.

This work also reveals that a passive fiscal policy is necessary to complement macroprudential policy that aims at both financial and macroeconomic stabilization. However, it is interesting to underline that fiscal policy might become active in the foreign country to stabilize the business cycle when foreign macroprudential policy is too weak to reach that goal. A weak foreign macroprudential reaction is generally observed because the foreign financial system is barely destabilized by the home country shocks. This result applies for all shock considered.

Regarding coordination, this paper is a follow up of Malmierca (2023) and strengthens the results obtained by the latter. More concretely, the findings show that, after a credit risk shock, the national coordination between fiscal and macroprudential authorities brings the highest welfare gains across all the stabilization strategies considered. For the case of a supply shock, the better strategy in terms of welfare is achieved through a coordinated response of macroprudential and fiscal measures at the union level. Finally, if the economy fluctuates due to a demand shock, the non-coordination scenario is the one that entails the greatest welfare improvement.

This analysis opens the door to a wide range of topics that can be the subject of further research. It could be interesting to assess the welfare implications of these stabilization policies when monetary policy behaves passively (see for instance Malmierca, 2022) or it is constrained by the zero lower bound. In future work, the analysis of alternative fiscal and macroprudential instruments can also be studied to robust the results obtained. Moreover it could be enriching to assess how the results change with alternative parameter calibrations.

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DATA AVAILABILITY STATEMENT

Research data was not used.

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APPENDIX A

A.1 | Contract between nancial intermediary and entrepreneur

The model includes a productivity shock ω_{t+1} that is lognormally distributed with a cumulative distribution function represented by $F(\omega, \sigma_{\omega,t})$, being $\mu_{\omega,t}$ the average and $\sigma_{\omega,t}$ the standard deviation of the distribution where $E_t\omega_{t+1} = 1$. From the properties of the lognormal distribution:

$$E_t\omega_{t+1} = e^{\mu_{\omega,t}+\frac{1}{2}\sigma^2_{\omega,t}} \Rightarrow e^{\mu_{\omega,t}+\frac{1}{2}\sigma^2_{\omega,t}} = 1 \Rightarrow \mu_{\omega,t} + \frac{1}{2}\sigma^2_{\omega,t} = 0 \Rightarrow \mu_{\omega,t} = -\frac{1}{2}\sigma^2_{\omega,t}. \tag{A1}$$

In the computations to obtain the loglinearized version of the model I use the following equations that are also derived from the properties of the lognormal distribution:

$$\Gamma(\varpi_{t+1}, \sigma_{\omega,t}) = \varpi_{t+1}(1 - F(\varpi_{t+1}, \sigma_{\omega,t})) + G(\varpi_{t+1}, \sigma_{\omega,t}), \tag{A2}$$

$$\Gamma_\omega(\varpi_{t+1}, \sigma_{\omega,t}) = 1 - F(\varpi_{t+1}, \sigma_{\omega,t}), \tag{A3}$$

$$G(\varpi_{t+1}, \sigma_{\omega,t}) = 1 - \phi\left(\frac{\frac{1}{2}\sigma^2_{\omega,t} - \log\varpi_{t+1}}{\sigma_{\omega,t}}\right), \tag{A4}$$

and

$$G_\omega(\varpi_{t+1}, \sigma_{\omega,t}) = \varpi_{t+1}F_\omega(\varpi_{t+1}, \sigma_{\omega,t}). \tag{A5}$$

APPENDIX B

B.1 | First order conditions

B.1.1 | Households

The first order conditions obtained from the representative household's problem are the following:

$$e^{\phi_t}\frac{1}{c_t - hc_{t-1}} - \beta E_t\frac{h}{c_{t+1} - hc_t} = \lambda_t(1 + \tau_c), \tag{B1}$$

$$\lambda_t = \beta E_t \lambda_{t+1} \frac{[1 + (1 - \tau_R)(R_t - 1)]}{\Pi_{t+1}}, \tag{B2}$$

$$\lambda_t = \beta E_t \lambda_{t+1} \frac{R_t^d}{\Pi_{t+1}}, \tag{B3}$$

$$e^{\phi_t} \psi l_t^{\vartheta} = (1 - \tau_l) w_t \lambda_t, \tag{B4}$$

where λ_t is the Lagrange multiplier that represents the marginal value of wealth of households.

B.1.2 | Intermediate goods producers

The first order conditions of intermediate good producers are obtained from a cost minimization problem and a profit maximization problem. Cost minimization implies

$$k_{it-1} = \frac{\alpha}{1 - \alpha} \frac{w_t}{r_t} l_{it} \frac{p_t}{p_{H,t}}. \tag{B5}$$

The first order conditions from the intermediate firms' profits maximization problem are[6]:

$$\frac{k_{t-1}}{l_t} = \frac{\alpha}{1 - \alpha} \frac{w_t}{r_t} \frac{p_t}{p_{H,t}}, \tag{B6}$$

$$mc_t = \left(\frac{1}{1 - \alpha} \right)^{1-\alpha} \left(\frac{1}{\alpha} \right)^{\alpha} \frac{w_t^{1-\alpha} r_t^{\alpha}}{e^{z_t}} \left(\frac{p_t}{p_{H,t}} \right)^{1-\alpha}, \tag{B7}$$

$$\varepsilon f_t^1 = (\varepsilon - 1) f_t^2, \tag{B8}$$

where

$$f_t^1 = \lambda_t mc_t y_t + \beta \theta E_t \left(\frac{\Pi_{H,t}^{\chi}}{\Pi_{H,t+1}} \right)^{-\varepsilon} f_{t+1}^1, \tag{B9}$$

and

$$f_t^2 = \lambda_t \overline{\Pi}_{H,t} y_t + \beta \theta E_t \left(\frac{\Pi_{H,t}^{\chi}}{\Pi_{H,t+1}} \right)^{1-\varepsilon} f_{t+1}^2 \left(\frac{\overline{\Pi}_{H,t}}{\overline{\Pi}_{H,t+1}} \right). \tag{B10}$$

where, following Fernández Villaverde (2010), f_t^1 and f_t^2 are two auxiliary variables.

[6] Since all intermediate good producers face the same prices and because of market clearing, subscript i can be removed from the previous expression, meaning that all the monopolistically competitive producers choose the same ratio for the production factors they use $\frac{k_{it-1}}{l_{it}}$, so that capital and labor will be expressed in aggregate levels.

B.1.3 | Capital goods producers

The first order condition is the following:

$$q_t\left(1-S\left[\frac{i_t}{i_{t-1}}\right]-S'\left[\frac{i_t}{i_{t-1}}\right]\frac{i_t}{i_{t-1}}\right)+\beta E_t\frac{\lambda_{t+1}}{\lambda_t}q_{t+1}S'\left[\frac{i_{t+1}}{i_t}\right]\left[\frac{i_{t+1}}{i_t}\right]^2=1. \tag{B11}$$

B.1.4 | Entrepreneurs

The first order conditions are given by

$$\begin{aligned}&E_t\frac{R^k_{t+1}}{R_t}\left[1-\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]\\&+\xi_t\left\{\frac{R^k_{t+1}}{R_t}\left[\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)-\mu G\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]-\eta_t\right\}=0,\end{aligned} \tag{B12}$$

and

$$-\Gamma_\omega\left(\varpi_{t+1},\sigma_{\omega,t}\right)+\xi_t\left[\Gamma_\omega\left(\varpi_{t+1},\sigma_{\omega,t}\right)-\mu G\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]=0, \tag{B13}$$

where ξ_t is the Lagrangian multiplier.

After some algebra, I get

$$q_tk_t\frac{p_{H,t}}{p_t}=\left[\frac{\xi_t\eta_t}{E_t\frac{R^k_{t+1}}{R_t}\left[1-\Gamma\left(\varpi_{t+1},\sigma_{\omega,t}\right)\right]}\right]n_t, \tag{B14}$$

where $q_tk_t\frac{p_{H,t}}{p_t}$ are purchases of capital, as explained before, and where $\frac{R^k_{t+1}}{R_t}$ is the external finance premium, inversely related to the net wealth of the entrepreneur.