Macroprudential reciprocity in the euro area

Pauline Gandré[1*] Stefan Gebauer[2] Margarita Rubio[3]

[1]*University Paris Nanterre & EconomiX*
[2]*European Central Bank*
[3]*University of Nottingham*

July 2026

With interconnected financial institutions and credit markets, national macroprudential policies can lead to cross-border credit spillovers and leakages, potentially reducing their efficiency. Reciprocity in macroprudential policies, defined as applying national measures to foreign banks' exposures in the country that activated the measure, can help reduce such inefficiencies. To evaluate the welfare effects of macroprudential reciprocity in the euro area, we build a two-country New Keynesian dynamic stochastic general equilibrium model with financial frictions, domestic and foreign bank lending, countercyclical macroprudential rules in lender- and borrower-based instruments, and a common monetary policy. We find that the optimality of different macroprudential reciprocity scenarios depends primarily on the type of shocks, the social planner's geographical scope, the degree of financial integration, and the responsiveness of monetary policy to inflation. Our results, therefore, suggest that macroprudential reciprocity should be flexible and tailored to the macro-financial context.

JEL codes: E32, E52, F41, F42.

Keywords: Macroprudential Policy, Reciprocity, Euro area, Monetary Policy, Welfare.

[*]Corresponding author: pgandre@parisnanterre.fr. The views in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank or the Eurosystem. We are grateful to the Europlace Institute of Finance (EIF) for financial support and Clara Horkay for excellent research assistance. We thank Fédéric Holm-Hadulla, Sujit Kapadia, Philipp Hartmann, and participants at the 39th European Economic Association Congress, the 55th Money, Macro and Finance Society Annual Conference, the 19th International Conference on Macroeconomic Analysis and International Finance, the MSY research seminar at the European Central Bank and the Seminar of the Bank of Finland for helpful comments. A preliminary version of this paper was also presented at a poster session in the ASSA meetings 2023.

"To be fully capable to influence the financial cycle, a robust regulatory and macro-prudential framework requires that national supervisors recognise or reciprocate the regulatory and policy measures of the other countries. If reciprocity is applied only selectively, the level playing field is at risk and regulatory arbitrage will generate unintended negative spillovers. I imagine that a wide range of macro-prudential measures would benefit from automatic and mandatory reciprocity". Speech by Vítor Constâncio, Vice-President of the ECB, at the joint conference organised by the European Commission and the European Central Bank "European Financial Integration and Stability", 27 April 2015.

1 Introduction

Macroprudential policies, largely determined at the national level, have become a central pillar of global financial regulation over the past 15 years. Although the optimal design of macroprudential policy in single-country settings has received considerable attention in the literature (e.g., Lambertini et al., 2013, Agénor et al., 2013, Angelini et al., 2014), far fewer studies have considered the impact of cross-border interconnections in credit markets and financial institutions. Hence, most national macroprudential measures apply to the local exposures of domestic banks and resident subsidiaries of foreign banks, but not to direct cross-border lending or local exposures of foreign banks' branches. Therefore, exposures to similar risks in a given country are subject to different regulations. In this context, accounting for potential leakages from domestic to foreign banks and regulatory arbitrage arising from the activation of a macroprudential instrument in a given country is crucial to assessing the efficiency of macroprudential policies (Financial Stability Committee of the European Central Bank, 2020a). This issue particularly matters for the euro area, where the creation of the monetary union fostered financial integration among member countries until the subprime crisis, and with initiatives such as the Banking Union and the Savings and Investments Union fostering financial integration.[1]

To alleviate concerns about cross-border leakages and regulatory arbitrage stemming from domestic macroprudential policies, several macroprudential reciprocity frameworks coexist at the European Union level. Reciprocity is defined as applying a national macroprudential measure to

[1]The Savings and Investments Union project aims to foster a single capital market in the European Union. More information can be found here.

all foreign banks' exposures in the country that activated the measure, i.e., including exposures of foreign (non-resident) branches and direct cross-border exposures.[2] Macroprudential instruments enacted under the Basel III framework – such as the countercyclical capital buffer (CCyB) – are subject to mandatory reciprocity. At a buffer rate of up to 2.5%, the domestic CCyB thus applies to exposures of both domestic and foreign banks in the country that activated the CCyB. In contrast, other macroprudential tools, including borrower-based instruments (e.g., a cap on the loan-to-value (LTV) ratio), do not automatically apply to foreign banks' exposures in the activating country. In fact, European Union law does not impose mandatory reciprocity for these instruments and instead allows for voluntary bilateral reciprocity agreements among member states.

Against this background, the present paper aims to evaluate under which conditions and for which type of instruments macroprudential reciprocity is optimal in the euro area. To this end, we build a two-country euro-area general equilibrium model with financial frictions, and domestic and foreign banks that lend to impatient households in both countries through home and foreign, non-resident branches, subject to regulation in their home country, or via direct cross-border lending. Importantly, we assume that foreign banks face greater information asymmetries than domestic banks when assessing the solvency of domestic borrowers, leading to higher asset-recovery costs in the event of default, as in Iacoviello and Minetti, 2006. This assumption is incorporated into the model through different collateralized borrowing constraints on domestic and foreign debt.

We introduce two countercyclical macroprudential tools to the model: a countercyclical loan-to-value (LTV) ratio cap in the household sector that responds to house price growth – as an archetype of borrower-based measures that are not subject to mandatory reciprocity – and a countercyclical capital-to-asset ratio applied to the banking sector that responds to total domestic credit growth, resembling the Basel III countercyclical capital buffer (CCyB) subject to compulsory reciprocity.

We focus on three types of macro-financial shocks: common cost-push shocks, to focus on the sort of supply shocks that are relevant for understanding the recent period in the euro area; asymmetric bank capital shocks, as archetypes of financial shocks that are specific to each country; and asymmetric housing preference shocks, as representative domestic demand shocks that also affect asset

[2] In the context of macroprudential policy, reciprocity is therefore a distinct concept from coordination, with the latter implying that several countries coordinate the activation of domestic macroprudential instruments that apply to different risk exposures.

markets. The two-country model is calibrated to replicate the features of two stylized groups of countries within the euro area that differ in country size, leverage, and home bias in credit provision. Thus, country A features a small, highly leveraged, and financially open economy – for which reciprocity in macroprudential policy is likely to be a crucial issue –, while country B represents a large, less leveraged, and more credit home-biased economy – which is a relevant reciprocating country as it provides a meaningful share of credit to country A.

Our main findings are threefold. First, we motivate our focus on the optimality of macroprudential reciprocity by showing that activating a countercyclical macroprudential rule in response to macro-financial shocks in country A reallocates credit between domestic and foreign lenders in both countries, for both the LTV ratio cap and the CCyB. Second, in our baseline setting in which country A activates macroprudential policy, we find that the optimality of different counterfactual scenarios of macroprudential reciprocity when maximizing the welfare of the activating country depends strongly on the type of shock. Under common cost-push shocks, the optimal macroprudential tool is a CCyB rule subject to reciprocity. In contrast, under asymmetric bank capital shocks, the optimal macroprudential policy is a mix of a low reaction in the LTV ratio cap and a high reaction in the CCyB without reciprocating any of the instruments. Finally, under asymmetric housing preference shocks, the optimal tool is a reciprocated rule on the LTV ratio cap.

Third, although the type of shock is the main driver of differences across optimal macroprudential reciprocity scenarios, we identify additional factors that can alter the optimal reciprocity setting for some types of shocks. When the social planner maximizes the joint welfare of the whole monetary union rather than that of the activating country alone in the baseline scenario, we find that reciprocity is no longer optimal in response to asymmetric shocks affecting only country A, since reciprocity entails a large welfare loss in country B. In contrast, under a prospective scenario of complete euro area integration, reciprocity becomes more desirable for both the activating country and the entire monetary union, as a larger share of credit exposures circumvents regulation in the absence of reciprocity. Finally, our findings on optimal macroprudential reciprocity remain robust when allowing for a non-zero weight on output growth in the monetary policy rule or for a particularly strong response to inflation, while macroprudential policy is no longer optimal in response to symmetric cost-push shocks when monetary policy becomes passive.

Therefore, our results plead for some degree of flexibility in the application of macroprudential reciprocity in the euro area. The latter should be tailored to the type of shock the countercyclical macroprudential measure responds to, the characteristics of the activating country, and internalize the responsiveness of monetary policy.

The remainder of the paper is organized as follows. Section 2 discusses the related literature, and Section 3 provides an overview of institutional reciprocity agreements in the European Union and the euro area. Section 4 presents the two-country general equilibrium model, and Section 5 describes its calibration and dynamics, focusing on cross-border spillovers from macroprudential policy. Section 6 develops a welfare analysis to assess the optimality of macroprudential reciprocity, while Section 7 conducts a sensitivity analysis across alternative counterfactual scenarios. Section 8 concludes.

2 Related Literature

Macroprudential policies emerged in response to the Global Financial Crisis and have since been the subject of a vast theoretical academic literature in macro-finance. This literature mainly focused on assessing the efficiency of different macroprudential tools and the optimal coordination of macroprudential and monetary policies to promote financial and business cycle stability (e.g., Lambertini et al., 2013, Agénor et al., 2013, Angelini et al., 2014, Gambacorta and Karmakar, 2018). The optimality and degree of coordination in setting such tools were studied for a variety of macro-financial factors, such as different sources of shocks, heterogeneity in financial markets, or the implications of an effective lower bound on nominal interest rates (e.g., Quint and Rabanal, 2014, Rubio and Yao, 2020, Gebauer and Mazelis, 2023).

In this branch of the literature, fewer papers have developed open-economy and multi-country settings to specifically model the cross-border effects of macroprudential policies (Vitek, 2017; Darracq Pariès et al., 2019; Agénor et al., 2021, 2023). Yet, on the empirical side, several studies found evidence of cross-border macroprudential policy spillovers using aggregate data (Houston et al., 2012; Bremus and Fratzscher, 2015; Beirne and Friedrich, 2017; Avdjiev et al., 2017) or bank-level microdata through specific country case studies (Aiyar et al., 2014a) or multi-country investiga-

tions (Buch and Goldberg, 2017; Forbes et al., 2017; Franch et al., 2021). Other empirical papers also emphasized the importance of reciprocity against the backdrop of cross-border leakages in macroprudential policy (Aiyar et al., 2014b; Forbes, 2021). Thus, Aiyar et al., 2014b show that higher minimum capital requirements in the UK over 1998-2007 led to a decrease in lending from domestic banks and resident foreign subsidiaries. In contrast, they triggered an increase in lending from unregulated foreign branches, providing evidence of regulatory leakages.

In light of this empirical evidence, it is crucial to assess the consequences of alternative counterfactual reciprocity arrangements and conduct welfare analyses to evaluate the ex-ante efficiency of several macroprudential policy instruments under different reciprocity regimes. However, the issue of reciprocity has remained largely unaddressed in the theoretical literature on macroprudential policies. Rubio, 2020 and Agénor et al., 2024 represent notable exceptions. Rubio, 2020 shows that macroprudential reciprocity is welfare-improving when considering a countercyclical rule for setting the LTV ratio in response to total factor productivity and housing preference shocks. Agénor et al., 2024 study the optimality of reciprocating countercyclical capital requirements in an advanced core economy-emerging periphery economy setting in response to expansionary monetary policy shocks in the advanced economy. They show that reciprocity can be welfare-improving when regulatory spillovers are weak or when the regulator places a high weight on financial stability.

Importantly, these two papers focus on reciprocity for a single macroprudential instrument: a countercyclical loan-to-value ratio cap in Rubio, 2020 and a countercyclical buffer in Agénor et al., 2024. In addition, none of the models developed in these papers permits investigating the specific context of a monetary union and the EU macroprudential reciprocity framework. The model in Rubio, 2020 is calibrated for the US economy and neither includes nominal rigidities or monetary policy, nor investigates the consequences of reciprocity for the reciprocating country. The model in Agénor et al., 2024 focuses on a specific case in which all banks in the periphery are affiliates of the core economy's global banks. In their setting, reciprocity corresponds to the application of a macroprudential measure activated in the core to its banks' affiliates' exposures in the *reciprocating country*. In contrast, reciprocity in the EU framework means that a macroprudential measure also applies to foreign banks' exposures in the *activating country*.

Our paper is therefore the first to provide a comprehensive assessment of the optimality of macroprudential reciprocity in the euro area by developing a two-country model with financial frictions, foreign lending via foreign banks' branches or direct cross-border lending in both countries, and a common monetary policy. By modeling several macroprudential instruments and their interactions explicitly, we investigate a set of alternative counterfactual reciprocity scenarios, including mandatory reciprocity in CCyB and voluntary reciprocity in borrower-based measures. In addition, we consider several types of shocks (supply, financial, demand, and symmetric vs. asymmetric) and examine how the optimality of macroprudential reciprocity depends on the type of shock. Finally, we investigate to what extent optimal reciprocity is conditional on the characteristics of the activating country and the welfare-maximizing social planner – i.e., that of the activating country, the monetary union, or the reciprocating country –, and how it interacts with a common monetary policy set by a union-wide central bank.

3 Empirical evidence and institutional arrangements

To put our analysis into perspective, we first present empirical evidence of meaningful cross-border credit provision in the euro area, suggesting that macroprudential reciprocity may alleviate leakages and regulatory arbitrage. We then describe the institutional arrangements regarding reciprocity in macroprudential policy that are in place within the EU and the euro area.

3.1 Patterns of cross-border credit provision in the euro area

Reciprocity in macroprudential policy is a crucial issue given that, despite significant home bias in credit, cross-border lending is already non-negligible between some countries, and expected to increase in the context of the Savings and Investments Union in the EU.

Table 1 illustrates the patterns of cross-border credit provision among euro area countries as of the fourth quarter of 2018, based on ECB data (Financial Stability Committee of the European Central Bank, 2020b), highlighting varying degrees of reliance on domestic and foreign banks. In large countries, domestic banks dominate credit provision. For instance, France, Spain, and Germany

receive 90.3%, 86.7%, and 85.2% of their credit domestically, respectively. However, significant cross-border flows are evident in other countries, with French banks providing substantial credit shares to countries such as Luxembourg (42.5%), Belgium (28.2%), and Italy (13.2%). German banks play a notable role in Luxembourg (15% of credit shares), Ireland (7.3%), and Austria (6.5%). Similarly, Dutch banks provide significant credit to Belgium (19.2%) and Luxembourg (6.2%). In addition, over 10% of credit is provided by Finnish banks to Estonia, Latvia, and Lithuania, by Italian banks to Austria, and by Greek banks to Cyprus. In general, smaller countries tend to rely more heavily on foreign banks, with foreign contributions accounting for the majority of credit (87.5% in Slovakia, 81.4% in Luxembourg, 54.6% in Belgium, 50.9% in Slovenia, 42.1% in Portugal, and 41.1% in Ireland). Overall, the data highlight the diverse landscape of cross-border banking relationships in the euro area, where smaller and more financially open economies tend to depend more on foreign credit, while larger economies maintain greater self-sufficiency.

Table 1: Matrix of cross-border credit provision within the euro area

From\To	AT	BE	CY	DE	EE	ES	FI	FR	GR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK
AT	**74.6**	0.2	1.8	0.8	0.0	0.2	0.3	0.2	0.1	0.7	0.2	0.4	0.6	0.4	1.1	0.4	0.1	**14.8**	**37.6**
BE	0.4	**45.4**	0.1	0.8	0.0	0.8	0.4	1.2	0.1	4.2	1.3	0.1	2.0	0.5	0.5	1.8	1.5	0.7	**12.6**
CY	0.0	0.0	**66.3**	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DE	6.5	3.1	4.1	**85.2**	1.1	2.9	3.8	3.0	0.9	7.3	3.5	0.6	**15.0**	2.6	4.3	4.5	2.7	2.4	3.0
EE	0.0	0.0	0.0	0.0	**81.0**	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	1.0	0.0	0.0	0.0	0.0	0.0
ES	0.6	0.7	0.0	1.0	0.1	**86.7**	1.0	1.4	0.2	1.6	1.9	0.1	2.3	0.0	4.9	0.9	**30.9**	0.0	0.2
FI	0.1	0.3	1.2	0.2	**14.2**	0.0	**69.8**	0.1	0.0	0.2	0.0	**17.7**	1.0	**17.1**	0.7	0.2	0.0	0.0	0.0
FR	1.5	**28.2**	2.1	3.2	0.5	3.5	1.9	**90.3**	1.1	6.7	**13.2**	0.1	**42.5**	0.1	4.5	3.9	4.5	**10.5**	2.3
GR	0.0	0.0	**13.8**	0.0	0.0	0.0	0.0	0.0	**96.0**	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.0	0.0
IE	0.2	0.4	0.2	0.3	0.0	0.3	0.2	0.4	0.2	**58.9**	0.1	0.1	0.5	0.0	0.2	0.7	0.2	1.4	0.5
IT	**13.0**	0.9	3.0	3.2	0.4	2.3	0.4	0.8	0.6	1.0	**77.9**	1.3	3.3	2.3	2.2	0.9	0.6	**15.3**	**24.2**
LT	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	**72.5**	0.0	0.4	0.0	0.0	0.0	0.0	0.0
LU	0.2	0.5	0.2	0.1	0.1	0.1	0.2	0.2	0.0	0.3	0.1	0.4	**18.6**	0.1	0.3	0.3	0.2	0.2	0.3
LV	0.0	0.0	0.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	**71.8**	0.0	0.0	0.0	0.0	0.0
MT	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	**71.6**	0.0	0.0	0.1	0.0
NL	1.6	**19.2**	3.5	3.1	0.1	1.9	2.1	1.2	0.3	2.3	1.2	0.1	6.2	0.6	2.9	**84.4**	0.8	0.2	1.3
PT	0.0	0.1	0.0	0.0	0.0	0.6	0.0	0.1	0.1	0.1	0.2	0.0	0.2	0.1	0.2	0.1	**57.9**	0.0	0.0
SI	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	**49.1**	0.1
SK	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	**12.5**
Other	1.0	0.7	2.9	1.8	0.9	0.5	**19.7**	0.5	0.3	**16.4**	0.3	1.8	7.3	2.6	5.9	1.8	0.4	5.2	5.2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: The total credit for each country is the sum of the credit from each EU individual country. Therefore, total credit does not include credit from banks in non-EU countries, unless those banks have a subsidiary under the supervision of the Single Supervisory Mechanism (SSM). 'Other' category includes this case, along with credit from non-euro-area EU countries (Financial Stability Committee of the European Central Bank, 2020b).

Similarly, when focusing more specifically on direct cross-border banking loans and loans granted by foreign non-resident branches (therefore, excluding loans from foreign resident subsidiaries), approximated by the ECB through a residual approach (Financial Stability Committee of the European Central Bank, 2020a) – i.e., the loans that are not subject to domestic macroprudential mea-

sures when the latter are not reciprocated –, some euro area countries display significant exposures. Thus, the share of total loans granted to resident borrowers (all sectors combined) consisting of direct cross-border loans or loans granted by branches of foreign banks is 61% in Luxembourg, 24% in Ireland, 23% in Malta, 15% in Slovenia, and 14% in Belgium and Portugal. Here again, this share is smaller in larger and less leveraged countries, at 11% in Spain and Italy, and 8% and 6% in France and Germany, respectively.

3.2 Institutional arrangements regarding macroprudential reciprocity

Given the significant degree of cross-border credit provision within the euro area, different reciprocity arrangements for national macroprudential measures already exist at the EU level.

The EU legal framework relies primarily on voluntary reciprocity, with a few exceptions in which reciprocity is mandatory. The most notable exception is the CCyB, for which the EU Capital Requirements Directive 2013/36/EU (CRD) requires mandatory reciprocity up to a buffer rate of 2.5%, in line with the Basel III framework.[3] Therefore, when a financial institution operates in several countries, its CCyB is the average of the CCyBs imposed by the countries in which it is exposed, both in the European Union and in third-party countries, weighted by the share of its exposures in each country.

Other macroprudential tools, such as borrower-side measures, do not automatically apply to foreign banks' exposures in the activating country. In this context, the European Systemic Risk Board (ESRB) established a coordinated framework for voluntary reciprocity in 2015 (ESRB/2015/2) for the macroprudential instruments that are not subject to mandatory reciprocity. The country that initially activates a certain macroprudential policy measure can submit a formal request to the ESRB requiring the reciprocation of that measure in other EU member states to ensure that an equivalent macroprudential measure is applied to exposures of foreign banks in the activating country, whether via foreign branches and/or direct cross-border exposures.[4] The ESRB then examines the reciprocity request and provides recommendations for reciprocating the specific national macroprudential measure in the other EU countries. Other member states can then decide

[3] See the 2013/36/EU directive here.
[4] See the ESRB reciprocity framework here.

whether to reciprocate the measure, but are required to formally explain their decision if they do not comply (for instance, due to immaterial exposures in the activating country or because the reciprocating country lacks a legal framework that would allow an equivalent measure to that activated abroad to be imposed on foreign exposures).

The fact that some macroprudential measures are not automatically subject to reciprocity implies that the same types of claims held by domestic and foreign banks in a certain member state are subject to different regulatory treatments. This difference in regulatory treatment may ultimately lead to credit leakages from domestic to foreign banks and regulatory arbitrage, as banks may find it optimal to circumvent the respective macroprudential measures.

3.3 Evidence on reciprocity agreements in the European Union

The ESRB's Overview of National Macroprudential Measures database provides information on the implementation of national macroprudential measures across European countries, as well as on existing bilateral reciprocity agreements for each measure not subject to mandatory reciprocity.[5] Reciprocation of a macroprudential measure is activated once the financial authority in one member state adopts a macroprudential instrument that is either identical to or serving the same purpose as a comparable measure already implemented in another member state. As of December 2025, 173 bilateral reciprocity agreements were identified in the ESRB database for 31 measures, of which 46 agreements remain applicable.[6]

13 European Union countries have macroprudential instruments that other member states have reciprocated: Belgium, Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, Luxembourg, the Netherlands, Norway, Portugal, and Sweden. The country whose macroprudential measures have been the most reciprocated in the European Union is Norway, with 50 reciprocation agreements with other European Union countries, followed by Estonia, with 27, Belgium with 25, Sweden with 14, Finland with 8, France and Germany with 7, Luxembourg and the Netherlands with

[5]The ESRB database contains information about the 27 EU member countries, as well as Iceland, Liechtenstein, Norway, and the United Kingdom.

[6]We assume that measures which have been reciprocated by a given country and then modified (giving rise to a new reciprocation request) are still being reciprocated by that country, unless a notification of non-reciprocity has been issued. Reciprocity agreements on similar instruments but different macroprudential measures (for example, systemic risk buffers with different values) count as separate agreements.

6, Italy and Lithuania with 5, and finally Portugal with 3.

21 European Union countries have reciprocated at least one macroprudential instrument of another member state: Belgium, Croatia, Cyprus, the Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, and the United Kingdom. France is the country that has reciprocated the most measures, with 22 reciprocity agreements, followed by Belgium and Lithuania with 21. Table 2 summarizes the macroprudential measures that have been reciprocated.

4 The model

We now turn to our theoretical exercise, in which we focus on the euro area, even though the ESRB's reciprocity framework applies to all European Union countries. In doing so, we focus on evaluating the optimality of reciprocity in a monetary union where monetary policy is common to all affected countries, while macroprudential policy is set nationally.[7] The model features two euro area countries : country A (the domestic economy) and country B (the foreign economy).[8] Each country includes patient households (savers) and impatient ones (borrowers), domestic banks (consisting of wholesale branches and retail loan branches with domestic and foreign branches), firms, and a national macroprudential authority. Monetary policy is established union-wide by a common monetary policy authority. In the following, we only describe the optimization problems of the different sectors in country A (the domestic economy), given that the optimization problems in country B (the foreign economy) are symmetric.

[7] Note that 83 out of the 173 reciprocity agreements collected from the ESRB dataset were set among euro area countries.

[8] The variables in country B are denoted with an asterisk or with an index B for price and output/consumption variables.

Table 2: Macroprudential measures that have been reciprocated in the EU, by country and year (as of December 2025)

Activating country	Year of initiative	Measure	Status	Nb of reciprocating countries
Belgium	2013	Risk Weights RRE CRE	No longer active	2
Belgium	2015	Risk Weights RRE CRE	No longer active	9
Belgium	2018	Risk Weights RRE CRE	No longer active	7
Belgium	2022	SyRB	No longer active	4
Belgium	2023	SyRB	Currently applicable	3
Denmark	2023	SyRB	Currently applicable	3
Estonia	2016	SyRB	No longer active	14
Estonia	2018	SyRB	No longer active	13
Finland	2017	Risk Weights RRE CRE	No longer active	8
France	2018	Large Exposures	No longer active	7
Germany	2022	SyRB	No longer active	6
Germany	2025	SyRB	Currently applicable	6
Italy	2024	SyRB	Currently applicable	5
Lithuania	2021	SyRB	Currently applicable	5
Luxembourg	2020	LTV	Currently applicable	6
Netherlands	2020	Risk Weights RRE CRE	No longer active	1
Netherlands	2022	Risk Weights RRE CRE	Currently applicable	5
Norway	2014	Risk Weights (others)	Currently applicable	2
Norway	2020	Risk Weights CRE	No longer active	5
Norway	2020	Risk Weights RRE	No longer active	6
Norway	2020	SyRB	No longer active	5
Norway	2022	SyRB	No longer active	10
Norway	2022	Risk Weights CRE	No longer active	5
Norway	2022	Risk Weights RRE	No longer active	6
Norway	2024	SyRB	Currently applicable	11
Portugal	2023	SyRB	Currently applicable	3
Sweden	2014	Pillar II	No longer active	1
Sweden	2018	Risk Weights RRE	No longer active	7
Sweden	2023	Risk Weights combined	No longer active	2
Sweden	2023	Risk Weights CRE	No longer active	4

Note: Risk Weights RRE and CRE refer to Residential Real Estate and Commercial Real Estate. Large exposures refer to a limit applicable to highly indebted large non-financial corporations, and Pillar II refers to a risk-weight floor on mortgage loans.

4.1 Households

4.1.1 Domestic patient households

Domestic patient households value consumption C_t' and housing services provided by real estate assets h_t' and choose working hours l_t'. They make one-period deposits D_t in a domestic bank that pay off a risk-free nominal interest rate $R_{A,t}$ in the next period and invest in foreign bonds

Z_t that pay a nominal rate of R_t. Patient households own the banks' wholesale branches and the firms. The sum of the profits earned by the households writes Π_t. The optimization problem of the representative domestic patient household expressed in units of the good produced in the domestic economy writes as follows:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t (\ln C'_t + jA_{j,t} \ln h'_t - \frac{1}{\eta} l'^{\eta}_t)$$

s.t.

$$C'_{A,t} + \frac{P_{B,t}}{P_{A,t}} C'_{B,t} + d_t + z_t + q_t(h'_t - h'_{t-1}) + \frac{\psi}{2} z_t^2 = (1 + R_{A,t-1}) \frac{d_{t-1}}{\pi_{A,t}} + (1 + R_{t-1}) \frac{z_{t-1}}{\pi_{A,t}} + w'_t l'_t + \frac{\Pi_t}{P_{A,t}},$$

Consumption is a bundle of goods produced in both countries, defined as: $C'_t = C'^{n}_{A,t} C'^{(1-n)}_{B,t}$ with n denoting the relative size of country A. The prices of goods produced in countries A and B are given by $P_{A,t}$ and $P_{B,t}$, respectively. $A_{j,t}$ is a housing preference shock that follows a normally distributed AR(1) process in logs. $\frac{\psi}{2} \frac{Z_t^2}{P_{A,t}}$ is a small quadratic cost of deviating from zero foreign borrowing.[9] $\pi_{A,t} = \frac{P_{A,t}}{P_{A,t-1}}$ refers to the inflation rate of goods produced in country A.
We obtain the following first-order conditions:

$$\frac{C'_{A,t}}{C'_{B,t}} = \frac{nP_{B,t}}{(1-n)P_{A,t}}. \tag{1}$$

$$\frac{nq_t}{C'_{A,t}} = \frac{jA_{j,t}}{h'_t} + \beta E_t[\frac{nq_{t+1}}{C'_{A,t+1}}]. \tag{2}$$

$$nw'_t = C'_{A,t} l'^{(\eta-1)}_t. \tag{3}$$

$$\frac{1}{C'_{A,t}} = \beta E_t[\frac{1}{C'_{A,t+1}} \frac{(1 + R_{A,t})}{\pi_{A,t+1}}]. \tag{4}$$

$$\frac{1 + \psi z_t}{C'_{A,t}} = \beta E_t[\frac{1}{C'_{A,t+1}} \frac{(1 + R_t)}{\pi_{A,t+1}}]. \tag{5}$$

[9] We make this assumption to ensure the stationarity of foreign assets as in Schmitt-Grohé and Uribe, 2003.

We assume that the law of one price holds in a monetary union and therefore $P_{A,t} = P^*_{A,t}$ and $P_{B,t} = P^*_{B,t}$.

4.1.2 Domestic impatient households

We follow Iacoviello, 2005 and assume that impatient households value present consumption by more than patient households, implying that their discount factor γ is lower than the discount factor of patient households β. Domestic impatient households benefit from consumption $C_t = C^n_{A,t} C^{(1-n)}_{B,t}$ and housing services provided by real-estate assets h_t and choose working hours l_t. They can borrow from both domestic banks (b^H_t) at the rate $\tilde{R}^H_t$ or from branches of foreign banks ($b^{F,D}_t$) at the rate $\tilde{R}^F_{t-1}$ to finance instantaneous consumption expenses. The representative impatient household faces the following optimization problem:

$$\max E_0 \sum_{t=0}^{\infty} \gamma^t (\ln C_t + j A_{j,t} \ln h_t - \frac{1}{\eta} l^\eta_t)$$

s.t.

$$C_{A,t} + \frac{P_{B,t}}{P_{A,t}} C_{B,t} + q_t (h_t - h_{t-1}) + (1 + \tilde{R}^H_{t-1}) \frac{b^H_{t-1}}{\pi_{A,t}} + (1 + \tilde{R}^F_{t-1}) \frac{b^{F,D}_{t-1}}{\pi_{A,t}} = b^H_t + b^{F,D}_t + w_t l_t.$$

Impatient households borrow against the future expected real value of their housing assets, which serve as collateral. The choice between borrowing from domestic or foreign banks faced by impatient households mirrors that of Iacoviello and Minetti, 2006. Foreign banks are assumed to face three additional difficulties compared to domestic banks when assessing the creditworthiness of domestic borrowers (greater difficulty in seizing domestic assets in the event of bankruptcy proceedings, greater difficulty in redeploying locally seized assets, and greater information asymmetries). When seizing assets, domestic banks are therefore assumed to incur a proportional cost, while foreign banks incur a convex cost, implying that their liquidation technology exhibits decreasing returns to scale. For borrowers, this implies different borrowing constraints (linked to en-

dogenous liquidation costs), depending on whether they borrow from domestic or foreign banks:[10]

$$E_t[(1+\tilde{R}_t^H)\frac{b_t^H}{\pi_{A,t+1}}] \leq E_t[m\alpha_t q_{t+1} h_t]. \tag{6}$$

$$E_t[(1+\tilde{R}_t^F)\frac{b_t^{F,D}}{\pi_{A,t+1}}] \leq E_t[q_{t+1}(1-\alpha_t)h_t(1-\frac{1-z_h}{qh}(q_{t+1}(1-\alpha_t)h_t))]. \tag{7}$$

α_t represents the share of collateral devoted to domestic borrowing. The impatient household's optimization problem yields the following first-order conditions:

$$\frac{C_{A,t}}{C_{B,t}} = \frac{nP_{B,t}}{(1-n)P_{A,t}}, \tag{8}$$

$$\frac{n}{C_{A,t}} q_t = \frac{jA_{j,t}}{h_t} + \gamma E_t[\frac{n}{C_{A,t+1}} q_{t+1}] + \mu_t E_t[m\alpha_t q_{t+1}] + \mu_t^F (E_t[q_{t+1}(1-\alpha_t) - 2h_t \frac{1-z}{qh} q_{t+1}^2 (1-\alpha_t)^2]), \tag{9}$$

$$nw_t = C_{A,t} l_t^{(\eta-1)}, \tag{10}$$

$$\frac{n}{C_{A,t}} = \gamma E_t[\frac{n}{C_{A,t+1}} \frac{1+\tilde{R}_t^H}{\pi_{A,t+1}}] + \mu_t E_t[\frac{1+\tilde{R}_t^H}{\pi_{A,t+1}}], \tag{11}$$

$$\frac{n}{C_{A,t}} = \gamma E_t[\frac{n}{C_{A,t+1}} \frac{1+\tilde{R}_t^F}{\pi_{A,t+1}}] + \mu_t^F E_t[\frac{1+\tilde{R}_t^F}{\pi_{A,t+1}}], \tag{12}$$

and

$$\mu_t m_h = \mu_t^F E_t[(1 - 2\frac{1-z_h}{qh} q_{t+1}(1-\alpha_t)h_t)], \tag{13}$$

with μ_t and μ_t^F the Lagrange multipliers on the domestic and foreign borrowing constraints, respectively.

[10] We assume that the borrowing constraints are binding at all times and verify that this holds in all our simulations.

4.2 Firms

4.2.1 Domestic final goods producers

The final goods market is perfectly competitive. A continuum of final-goods firms aggregate intermediate goods according to the following production function: $Y_{A,t} = \int_0^1 (Y_{A,t(z)}^{\frac{\epsilon-1}{\epsilon}} dz)^{\frac{\epsilon}{\epsilon-1}}$, implying that the price index of the final good produced in country A is $P_{A,t} = (\int_0^1 P_{A,t(z)}^{1-\epsilon} dz)^{\frac{1}{1-\epsilon}}$, with ϵ the elasticity of demand for the differentiated intermediate goods. The market for intermediate goods is monopolistically competitive. The demand for each intermediate good then writes: $Y_{A,t(z)} = (\frac{P_{A,t(z)}}{P_{A,t}})^{-\epsilon} Y_{A,t}$.

4.2.2 Domestic intermediate goods producers

Intermediate goods are produced by a continuum of monopolistically competitive firms using labor from both patient households (l'_t) and impatient households (l_t) as inputs, and following a Cobb-Douglas production technology for each good z:

$$Y_{A,t}(z) = A l_t(z)^{1-\nu} l_t(z)^{'\nu},$$

where A represents total factor productivity.

Firms minimize their production costs subject to the technology constraint, which yields the first-order conditions for labor demand:

$$w_t = \frac{A(1-\nu) l_t(z)^{-\nu} l_t(z)^{'\nu}}{X_{A,t}}.$$

$$w'_t = \frac{\nu A l_t(z)^{1-\nu} l_t(z)^{'(\nu-1)}}{X_{A,t}},$$

where $X_{A,t}$ is the mark-up (the inverse of the real marginal cost).

In setting their prices, intermediate goods producers face standard Calvo price nominal rigidities (see Appendix A). We introduce a cost-push shock $A_{p,t}$ to the inverse of the mark-up $X_{A,t}$ (or the real marginal cost) which follows an AR(1) process in logs and enters the Calvo framework in a non-linear way as in Harding et al., 2023. The shock enters the first-order condition of the

firm's price-setting problem as a multiplicative shifter of real marginal costs (see equation 20 in the intermediate good firm problem presented in Appendix A).

Defining the relative reset price as $\pi^S_{A,t} = \frac{P^S_{A,t}}{P_{A,t}}$, with $P^S_{A,t}$ being the optimal reset price for firms able to change prices in period t, we obtain:

$$\pi^S_{A,t} = \frac{\epsilon}{\epsilon - 1}\frac{z_{1,t}}{z_{2,t}},$$

with

$$z_{1,t} = X^{-1}_{A,t} A_{p,t} Y_{A,t} + \theta E_t[\Lambda_{t,t+1}\pi^{\epsilon}_{A,t+1} z_{1,t+1}]$$

and

$$z_{2,t} = Y_{A,t} + \theta E_t[\Lambda_{t,t+1}\pi^{\epsilon-1}_{A,t+1} z_{2,t+1}].$$

4.3 Banks

The modeling of the banking sector extends the framework of Gerali et al., 2010 to a two-country setting. In each country, the banking sector consists of a wholesale branch operating in a perfectly competitive environment and monopolistic retail loan branches. The wholesale branch collects deposits from domestic households and grants loans to the retail loan branches. These retail loan branches then provide credit to both domestic and foreign households (through foreign branches or direct cross-border banking).[11]

4.3.1 Domestic wholesale branch

The wholesale bank capital is accumulated each period out of retained earnings, with a no-dividend policy, according to:

$$K^b_t = (1 - \delta^b)\frac{K^b_{t-1}}{\pi_{A,t} A_{k,t}} + \frac{J^b_{t-1}}{\pi_{A,t}},$$

[11] Relative to Gerali et al., 2010, We have chosen to abstract from retail deposit branches for simplicity, since deposits are only provided by domestic households.

where K_t^b is the capital of the bank in real terms in period t, J_{t-1}^b is the total profit of the wholesale and retail branches in the previous period, and δ^b is the capital cost of managing the bank. $A_{k,t}$ is a shock to the bank capital that follows an AR(1) process in the log.

The wholesale bank chooses total loans and deposits to maximize the discounted sum of real cash-flows:

$$\max_{\{b_t,d_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \Bigg[(1+R_t^b) b_t - b_{t+1}\pi_{A,t+1} + d_{t+1}\pi_{A,t+1} - (1+R_{A,t}) d_t \\ + \left(K_{t+1}^b \pi_{A,t+1} - K_t^b \right) - \frac{\kappa_{K^b}}{2} \left(\frac{K_t^b}{b_t} - \nu_t^b \right)^2 K_t^b \Bigg],$$

with R_t^b the net interest rate received on loans b_t granted to retail loan branches, $R_{A,t}$ the net interest rate paid on deposits to domestic households, and $\frac{\kappa_{K^b}}{2} \left(\frac{K_t^b}{b_t} - \nu_t^b \right)^2 K_t^b$ a quadratic cost of deviating from the regulatory constraint on the capital-to-asset ratio. The bank is subject to the balance sheet constraint:

$$b_t = d_t + K_t^b.$$

Substituting the constraint in t and $t+1$ to get rid of deposits, we can rewrite the program of the bank as:

$$\max_{b_t} R_t^b b_t - R_{A,t}(b_t - K_t^b) - \frac{\kappa_{K^b}}{2} \left(\frac{K_t^b}{b_t} - \nu^b \right)^2 K_t^b,$$

and the F.O.C. with respect to b_t writes:

$$R_t^b = R_{A,t} - \kappa_{K^b} \left(\frac{K_t^b}{b_t} - \nu_t^b \right) \left(\frac{K_t^b}{b_t} \right)^2.$$

4.3.2 Domestic retail loan branch

The domestic retail loan branch of bank j obtains wholesale loans $b_t(j)$ from the wholesale unit with a gross real interest rate of R_t^b, differentiates them at no cost, and resells them to domestic and foreign patient households, with $b_t(j) = b_t^H(j) + b_t^{F,S*}(j)$. The retail loan branch operates in monopolistic competition and thus chooses the net interest rates on loans to domestic households, $\tilde{R}_t^H$, and on loans to foreign households, $\tilde{R}_t^{F*}$. Market power in the retail loan sector relies on

a Dixit-Stiglitz framework, in which $\varepsilon^{b,H} > 1$ and $\varepsilon^{b,F} > 1$ represent the constant elasticity of substitution between loan contracts provided by different retail loan branches for domestic and foreign loans, respectively. When setting interest rates, the bank faces quadratic adjustment costs, parameterized by κ_{b_H} and κ_{b_F}, which are proportional to the aggregate interest paid on domestic and foreign loans. The program of the domestic loan branch writes as follows:

$$\max_{\tilde{R}_t^H, \tilde{R}_t^{F*}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \Bigg[\tilde{R}_t^H(j) b_t^H(j) + \tilde{R}_t^{F*} b_t^{F,S*}(j) - R_t^b (b_t^H(j) + b_t^{F,S*}(j)) - \frac{\kappa_{b_H}}{2} \left(\frac{\tilde{R}_t^H(j)}{\tilde{R}_{t-1}^H(j)} - 1 \right)^2 \tilde{R}_t^H b_t^H - \frac{\kappa_{b_F}}{2} \left(\frac{\tilde{R}_t^{F*}(j)}{\tilde{R}_{t-1}^{F*}(j)} - 1 \right)^2 \tilde{R}_t^{F*} b_t^{F,S*}, \Bigg]$$

subject to the aggregate demand of domestic households:

$$b_t^H(j) = (\frac{\tilde{R}_t^H(j)}{\tilde{R}_t^H})^{-\varepsilon^{b,H}} b_t^H$$

and the aggregate demand of foreign households:

$$b_t^{F,S*}(j) = (\frac{\tilde{R}_t^{F*}(j)}{\tilde{R}_t^{F*}})^{-\varepsilon^{b,F}} b_t^{F,S*},$$

with $\tilde{R}_t^H = [\int_1^0 \tilde{R}_t^H(j)^{1-\varepsilon^{b,H}} dj]^{\frac{1}{1-\varepsilon^{b,H}}}$ and $\tilde{R}_t^{F*} = [\int_1^0 \tilde{R}_t^{F*}(j)^{1-\varepsilon^{b,F}} dj]^{\frac{1}{1-\varepsilon^{b,F}}}$. Imposing symmetry, the F.O.Cs. of the banks write:

$$1 - \varepsilon^{b,H} + \varepsilon^{b,H} \frac{R_t^b}{\tilde{R}_t^H} = \kappa_{b_H} \left(\frac{\tilde{R}_t^H}{\tilde{R}_{t-1}^H} - 1 \right) \frac{\tilde{R}_t^H}{\tilde{R}_{t-1}^H}$$
$$-\beta^P \mathbb{E}_t \left[\frac{\lambda_{t+1}^P}{\lambda_t^P} \kappa_{b_H} \left(\frac{\tilde{R}_{t+1}^H}{\tilde{R}_t^H} - 1 \right) \left(\frac{\tilde{R}_{t+1}^H}{\tilde{R}_t^H} \right)^2 \frac{b_{t+1}^H}{b_t^H} \right]$$

and

$$1-\varepsilon^{b,F}+\varepsilon^{b,F}\frac{R_t^b}{\tilde{R}_t^{F*}}=\kappa_{b_F}\left(\frac{\tilde{R}_t^{F*}}{\tilde{R}_{t-1}^{F*}}-1\right)\frac{\tilde{R}_t^{F*}}{\tilde{R}_{t-1}^{F*}}$$
$$-\beta^P\mathbb{E}_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_{b_F}\left(\frac{\tilde{R}_{t+1}^{F*}}{\tilde{R}_t^{F*}}-1\right)\left(\frac{\tilde{R}_{t+1}^{F*}}{\tilde{R}_t^{F*}}\right)^2\frac{b_{t+1}^{F,S*}}{b_t^{F,S*}}\right],$$

with λ_t^P the Lagrange multiplier on the budget constraint of patient households, who own the bank.

4.3.3 Monetary policy

Following Quint and Rabanal, 2014, the central bank of the monetary union follows a Taylor-type reaction function:

$$R_t=[\bar{R}(\frac{\pi_{A,t}^n\pi_{B,t}^{1-n}}{\bar{\pi}_A^n\bar{\pi}_B^{1-n}})^{1+\phi_\pi}(\frac{y_{A,t}^n y_{B,t}^{1-n}}{y_{A,t-1}^n y_{B,t-1}^{1-n}})^{\phi_y}]^{1-\rho_r}R_{t-1}^{\rho_r}. \tag{14}$$

The central bank reacts to deviations in union-wide inflation from its steady-state value and in output growth, with the policy parameters given by ϕ_π and ϕ_y, respectively. The weights on country A and country B variables are governed by the relative sizes of the two economies. In addition, the rule accounts for interest rate smoothing.

4.4 Countercyclical macroprudential rules

Finally, we introduce two countercyclical macroprudential instruments in the domestic country (country A) only: a countercyclical cap on the loan-to-value ratio m_t and a countercyclical capital buffer ν_t^b.[12] The first one responds negatively to the growth rate of house prices in the domestic economy: $\frac{q_t}{q_{t-1}}$, to tighten the loan-to-value ratio, and thus credit conditions, when house prices grow. The second one responds positively to the growth rate of total credit in the domestic economy: $\frac{b_{tot,t}}{b_{tot,t-1}}$, to increase bank capital requirements when credit grows.

The countercyclical rule on the loan-to-value ratio cap applied to domestic borrowing from *domes-*

[12]Throughout the paper, we focus on scenarios in which only one country activates macroprudential policy, to distinguish the specific effects of reciprocity in macroprudential policy relative to coordination in macroprudential policies.

tic banks thus writes:

$$m_t = m_h(\frac{q_t}{q_{t-1}})^{-\phi_{m_h}}, \tag{15}$$

with $\phi_{m_h} > 0$ measuring the responsiveness of the loan-to-value ratio cap to house price growth. In case of reciprocity, the countercyclical rule on the loan-to-value ratio relative to domestic borrowing from *foreign* banks is given by:

$$z_t = z_h(\frac{q_t}{q_{t-1}})^{-\phi_{m_h}}, \tag{16}$$

whereas $z_t = z_h$ in the absence of reciprocity.

As for the countercyclical capital buffer rule, it aligns with the mandatory reciprocity rule for CCyBs in the European Union, as explained in Section 3. The global CCyB rate for the domestic bank is the weighted average of the CCyB rates in each country where the bank has exposures, with weights equal to the share of the bank's exposures in each country. Therefore, under reciprocity, it writes as follows for domestic banks:

$$\nu_t^b = \nu^b \times \omega_{H,t}(\frac{b_{tot,t}}{b_{tot,t-1}})^{\phi_{\nu_h}} \times \omega_{F,t}(\frac{b^*_{tot,t}}{b^*_{tot,t-1}})^{\phi_{\nu_f}}. \tag{17}$$

$\phi_{\nu_h} > 0$ measures the degree of reaction of the domestic target capital-asset ratio ν_t^b to domestic credit growth weighted by the share $\omega_{H,t}$ of domestic exposures in the domestic banks' total assets $\frac{b_t^H}{b_t^H + b_t^{F,S*}}$. $\phi_{\nu_f} > 0$ measures the degree of reaction of the domestic target capital-asset ratio to foreign credit growth weighted by the share $\omega_{F,t}$ of foreign exposures in the domestic banks' total assets $\frac{b_t^{F,S*}}{b_t^H + b_t^{F,S*}}$.[13] Similarly, under reciprocity, the CCyB rule for foreign banks is given by:

$$\nu_t^{b*} = \nu^{b*} \times \omega^*_{F,t}(\frac{b_{tot,t}}{b_{tot,t-1}})^{\phi_{\nu_h}} \omega^*_{H,t} \times (\frac{b^*_{tot,t}}{b^*_{tot,t-1}})^{\phi_{\nu_f}}, \tag{18}$$

with $\omega^*_{F,t} = \frac{b_t^{F,S}}{b_t^{H*} + b_t^{F,S}}$ the share of foreign exposures in foreign banks' total assets and $\omega^*_{H,t} = \frac{b_t^{H*}}{b_t^{H*} + b_t^{F,S}}$ the share of domestic exposures in foreign banks' total assets. In the absence of reci-

[13] Note that in our experiments, we focus on the implementation of the CCyB rule in the domestic economy. Therefore, ϕ_{ν_f} is set to zero in both domestic and foreign rules.

procity in the CCyB and when only country A implements a CCyB, the CCyB rule for foreign banks is given by:

$$\nu_t^{b*} = \nu^{b*} \times \omega_{F,t}^{*}(\frac{b_{tot,t}}{b_{tot,t-1}})^{\phi_{\nu_h}} \omega_{H,t}^{*}.$$

A summary of all the model equations is provided in Appendix B.

5 The 2-country model dynamics: cross-border spillover of macroprudential policy

5.1 Baseline calibration

Our baseline calibration is chosen to investigate the cross-border spillover effects of macroprudential policy within a monetary union, where member countries differ in country size, leverage, and home bias in credit provision.

In Subsection 3.1, we highlighted that the issue of macroprudential reciprocity is particularly crucial for highly-leveraged small euro area economies in which a significant share of domestic credit is provided by banks from less-leveraged and larger euro area economies with high home bias in credit. Therefore, our baseline calibration for countries A and B aims to replicate these distinctive features for the activating country and the reciprocating country. Thus, country A – the domestic economy – features a small, highly leveraged euro area country with a significant share of foreign credit provision, whereas country B – the foreign country – features a larger, less leveraged economy with a strong home bias in credit. Therefore, the relative size of country A n is set to 0.35. The steady-state LTV ratio on domestic borrowing is set to 0.80 in country A, to match that of small financially open euro-area economies, while the steady-state LTV ratio on domestic borrowing in country B is set to 0.75 to approximate that of large and less-leveraged economies, in line with empirical evidence on typical loan-to-value ratios on residential mortgage loans in the euro area (see Calza et al., 2013 and European Mortgage Federation, 2025 for an overview). Steady-state LTV ratios on foreign borrowing are calibrated to feature higher home bias in credit in country B and lower home bias in country A. The steady-state LTV ratios on foreign borrowing of 0.69 in country

A and 0.28 in country B imply respective shares of domestic credit of 65% in country A and 80% in country B, which is consistent with average values on cross-border credit provision presented in Table 1.

The steady-state target capital-to-asset ratio is set at 0.085, in line with Basel III requirements, including a core tier 1 requirement of 6% and a conservation buffer of 2.5%, as in Gambacorta and Karmakar, 2018. The cost for managing the bank's capital position δ_b is set at 0.077, ensuring that the steady-state capital-to-asset ratio equals the target. The other banking sector parameters follow those in Gerali et al., 2010 directly.

Parameters in the household sector are calibrated in line with standard calibrations in the literature on 'Two-Agent New-Keynesian (TANK)' models (Iacoviello, 2005). The labour supply parameter implies a Frisch elasticity of labor of 2. The Calvo probability of fixed price and the elasticity of demand for differentiated intermediate goods are set to standard values in the New Keynesian literature. Regarding the shock parameters, the cost-push shock parameters follow Harding et al., 2023. The standard error of the bank capital shock and the standard error and persistence parameter of the housing preference shock are taken from Gerali et al., 2010. The persistence parameter of the bank capital shock is set at 0.90, a slightly lower value than in Gerali et al., 2010, which allows generating recessive effects of negative financial shocks after a few quarters. The baseline parameters of the Taylor rule are standard values for the euro area. Table 3 provides a summary of the calibrated parameter values.

5.2 Model dynamics

We focus on three illustrative shocks: cost-push shocks common to both countries, and asymmetric bank capital shocks housing preference shocks that affect only one country. This enables us to quantify the spillover effects of non-reciprocated macroprudential policy in the presence of a set of representative supply, financial, and demand shocks. Because the cost-push shock is common to both countries, it can be interpreted as a global inflationary cost-push shock, as was recently observed in the euro area. We then focus on two country-specific shocks to investigate the extent to which national macroprudential policy can leak abroad in the presence of shocks in the financial

Table 3: Baseline calibration

Parameter	Description	Value
β	Patient household discount factor	0.99
γ	Impatient household discount factor	0.95
ν	Labor income share of patient households	0.64
j	Weight on housing in the utility function	0.1
η	Labour supply parameter	3
θ	Calvo probability of fixed price	0.75
ϵ	Elasticity of demand for differentiated intermediate goods	6
n	Relative size of country A	0.35
m_h	Steady-state domestic LTV ratio in country A	0.80
m_f	Steady-state domestic LTV in country B	0.75
z_h	Steady-state foreign LTV in country A	0.69
z_f	Steady-state foreign LTV in country B	0.28
K_k	Cost parameter of deviating from the target capital-to-asset ratio	11.49
δ_b	Cost for managing the bank's capital position	0.077
K_{b_H}	Domestic households loan rate adjustment cost	10.22
K_{b_F}	Foreign households loan rate adjustment cost	10.22
ε_{b_H}	Mark-up on rate on domestic loans	2.79
ε_{b_F}	Mark-up on rate on foreign loans	2.79
v_{b_H}	Steady-state target capital ratio requirement country A	0.085
v_{b_F}	Steady-state target capital ratio requirement country B	0.085
ψ	Cost parameter of deviating from zero foreign borrowing	0.0001
σ_p	Standard error of the cost-push shock	0.0014
σ_k	Standard error of the bank capital shock	0.04
σ_j	Standard error of the housing preference shock	0.05
ρ_p	Persistence parameter of the cost-push shock	0.90
ρ_k	Persistence parameter of the bank capital shock	0.90
ρ_j	Persistence parameter of the housing preference shock	0.92
$1+\phi_\pi$	Coefficient on inflation in Taylor rule	1.5
ϕ_y	Coefficient on output in Taylor rule	0
ρ_r	Interest rate smoothing in Taylor rule	0.80

and demand sectors of the activating country.

Figures A1, A2, and A3 in Appendix C display the impulse response functions of the main macroeconomic and financial variables in both countries in response to the three shocks: a positive cost-push shock common to both countries, a negative bank capital shock in country A, and a positive housing preference shock in country A. We call "negative" bank capital shock a shock that triggers a decrease in bank capital although it corresponds to a positive $\varepsilon_{k,t}$. We see that, as expected, a positive common cost-push shock is both contractionary and inflationary on impact in both countries, leading to a decrease in total credit. A negative bank capital shock in country A generates a decrease in credit and house prices in credit A and an increase in both domestic and foreign loan rates, and becomes recessionary in country A after a few quarters, while generating an increase in output of country B. As for the asymmetric positive housing preference shock, it leads to an increase in house prices, credit, and output in country A and a decrease in inflation.

5.3 Cross-border macroprudential spillovers

Next, we simulate the two-country model to investigate its dynamic quantitative predictions regarding cross-border spillovers from macroprudential policy when country A activates a measure that is not reciprocated in country B, and therefore does not apply to country B's banks' exposures in country A.

5.3.1 Inward spillovers of macroprudential policy

First, we examine the inward spillovers of macroprudential policy across different levels of macroprudential reaction separately for each countercyclical macroprudential rule. According to the Financial Stability Committee of the European Central Bank, 2020b, "Inward transmission of cross-border spillover effects refers to the effects of domestic macroprudential policies on the domestic economy related to the actions of entities headquartered in foreign economies" (p.5).

Figures 1 and 2 show how macroprudential policy spillovers occur in the activating country when the LTV or the CCyB rule, respectively, is not reciprocated for low (ϕ_{m_h} or ϕ_{ν_h} equal to 0.5) and strong (ϕ_{m_h} or ϕ_{ν_h} equal to 5) macroprudential responses, compared with the case without macro-

prudential policy (ϕ_{m_h} or ϕ_{ν_h} equal to 0).

We see that for shocks that trigger a decrease in credit (i.e., positive cost-push shocks and negative bank capital shocks) and therefore a countercyclical macroprudential relaxation of credit conditions, the share of foreign borrowing decreases more with domestic macroprudential policy than without it on impact. Indeed, the relaxation of regulatory constraints on domestic banks allows them to increase their market share domestically. On the contrary, for positive housing preference shocks that raise house prices and credit, thereby triggering a mechanical tightening in countercyclical macroprudential policy, the share of foreign borrowing increases on impact, or decreases less, with macroprudential policy. Indeed, in that case, credit conditions on domestic borrowing are tightened, whereas foreign banks are not subject to these regulatory constraints in the absence of reciprocity. Therefore, we observe credit leakages from domestic to foreign banks. Price adjustments in domestic and foreign borrowing rates occur simultaneously, leading to further adjustments in the share of foreign borrowing a few quarters after each shock.

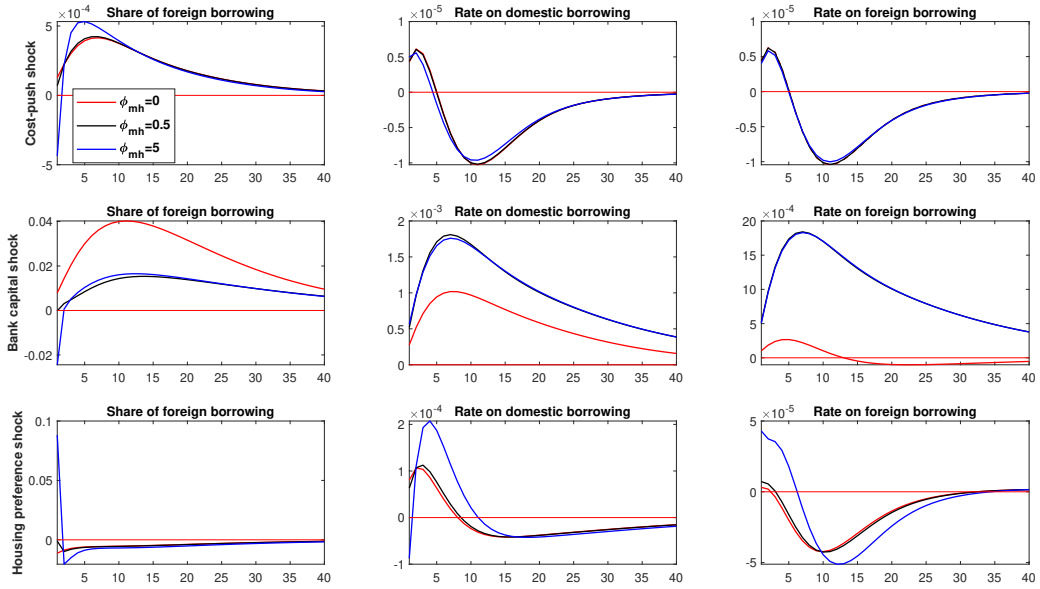
5.3.2 Outward spillovers of macroprudential policy

Second, we consider outward spillovers of macroprudential policy. According to the Financial Stability Committee of the European Central Bank, 2020b, "Outward transmission of cross-border spillover effects refers to the effects of domestic policies on other, foreign, economies" (p.5). Figures 3 and 4 show that macroprudential policy in the activating country (country A) also affects the allocation of credit between domestic and foreign credit in the other economy (country B), as well as the respective price of domestic and foreign credit. Thus, on impact, the share of foreign borrowing in country B increases more in response to macroprudential policy in country A (except for housing preference shocks with a CCyB macroprudential policy) in response to changes in relative regulatory constraints and relative loan rates.

6 Optimal macroprudential reciprocity

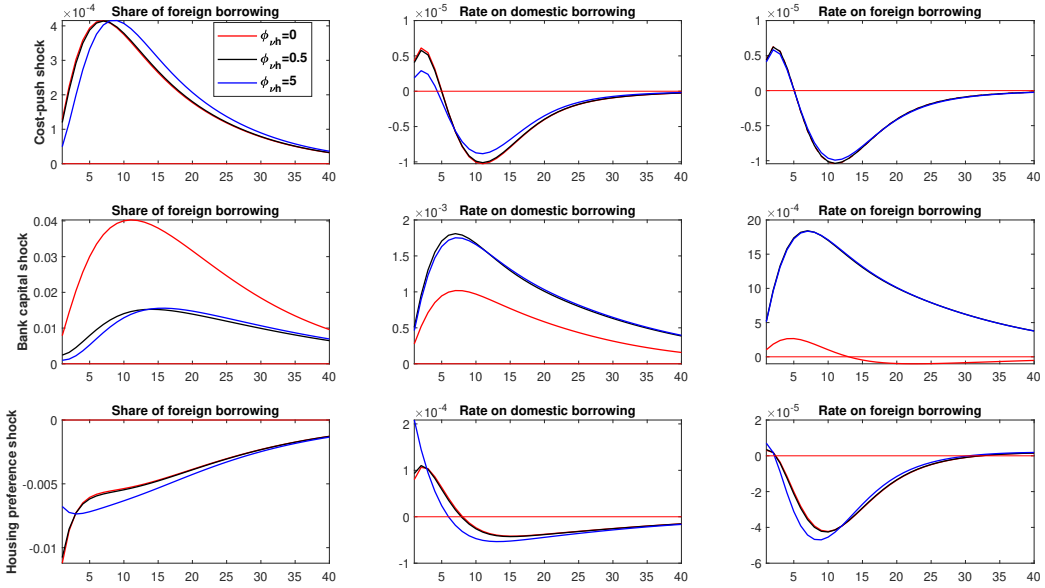
After having provided evidence that non-reciprocated national macroprudential policies generate credit leakages both domestically and abroad in the absence of reciprocity, we investigate the op-

Figure 1: Inward spillovers (in country A) of macroprudential policy. LTV ratio rule.



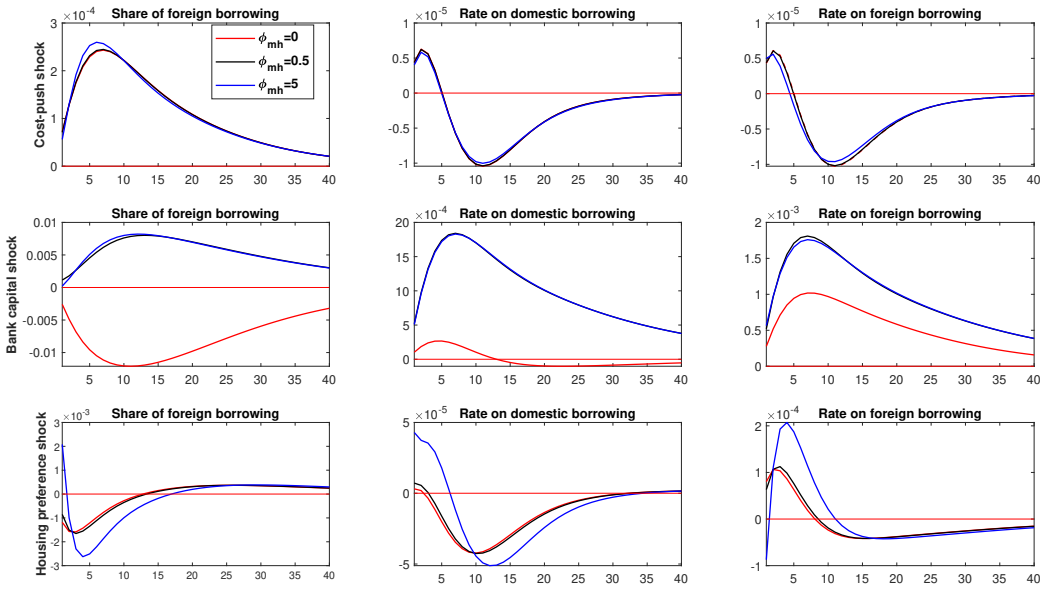
Note: The share of foreign borrowing is the share of credit granted to borrowers in country A by country B's banks' foreign branches $\frac{b_t^{F,S*}}{b_t}$. The rate on domestic borrowing is the rate on loans granted by domestic banks to borrowers in country A $\tilde{R}_t^H$, while the rate on foreign borrowing is the rate on loans granted by country B's banks' foreign branches to borrowers in country A $\tilde{R}_t^{F*}$. The impulse response functions represent deviations from the steady state for different LTV ratio macroprudential rules activated in country A: no LTV ratio macroprudential policy ($\phi_{m_h} = 0$), low LTV ratio macroprudential policy ($\phi_{m_h} = 0.5$), and strong LTV ratio macroprudential policy ($\phi_{m_h} = 5$). The CCyB rule is deactivated ($\phi_{\nu_h} = 0$).

Figure 2: Inward spillovers (in country A) of macroprudential policy. CCyB rule.



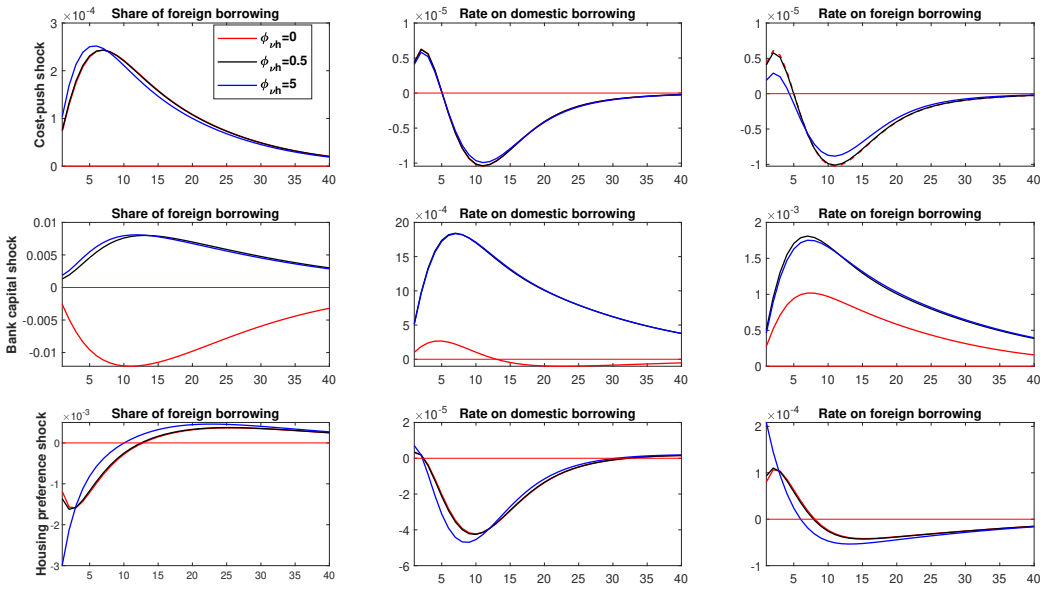
Note: The share of foreign borrowing is the share of credit granted to borrowers in country A by country B's banks' foreign branches $\frac{b_t^{F,S*}}{b_t}$. The rate on domestic borrowing is the rate on loans granted by domestic banks to borrowers in country A $\tilde{R}_t^H$, while the rate on foreign borrowing is the rate on loans granted by country B's banks' foreign branches to borrowers in country A $\tilde{R}_t^{F*}$. The impulse response functions represent deviations from the steady state for different CCyB macroprudential rules activated in country A: no CCyB macroprudential policy ($\phi_{\nu_h} = 0$), low CCyB macroprudential policy ($\phi_{\nu_h} = 0.5$), and strong CCyB macroprudential policy ($\phi_{\nu_h} = 5$). The LTV rule is deactivated ($\phi_{m_h} = 0$).

Figure 3: Outward spillovers (in country B) of macroprudential policy. LTV ratio rule.



Note: The share of foreign borrowing is the share of credit granted to borrowers in country B by country A's banks' foreign branches $\frac{b_t^{F,S}}{b_t^*}$. The rate on domestic borrowing is the rate on loans granted by domestic banks to borrowers in country B $\tilde{R}_t^{H*}$, while the rate on foreign borrowing is the rate on loans granted by country A's banks' foreign branches to borrowers in country B $\tilde{R}_t^F$. The impulse response functions represent deviations from the steady state for different LTV ratio macroprudential rules activated in country A: no LTV ratio macroprudential policy ($\phi_{m_h} = 0$), low LTV ratio macroprudential policy ($\phi_{m_h} = 0.5$), and strong LTV ratio macroprudential policy ($\phi_{m_h} = 5$). The CCyB rule is deactivated ($\phi_{\nu_h} = 0$).

Figure 4: Outward spillovers (in country B) of macroprudential policy. CCyB rule.



Note: The share of foreign borrowing is the share of credit granted to borrowers in country B by country A's banks' foreign branches $\frac{b_t^{F,S}}{b_t^*}$. The rate on domestic borrowing is the rate on loans granted by domestic banks to borrowers in country B $\tilde{R}_t^{H*}$, while the rate on foreign borrowing is the rate on loans granted by country A's banks' foreign branches to borrowers in country B $\tilde{R}_t^F$. The impulse response functions represent deviations from the steady state for different CCyB macroprudential rules activated in country A: no CCyB macroprudential policy ($\phi_{\nu_h} = 0$), low CCyB macroprudential policy ($\phi_{\nu_h} = 0.5$), and strong CCyB macroprudential policy ($\phi_{\nu_h} = 5$). The LTV rule is deactivated ($\phi_{m_h} = 0$).

timality of macroprudential reciprocity. We first determine the optimal macroprudential policy without reciprocity in response to the three types of shocks.

6.1 Optimal non-reciprocated macroprudential policy

The optimal macroprudential policy is determined by the parameters $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ of the counter-cyclical LTV ratio and capital buffer rules that maximize social welfare in the activating country (country A).

6.1.1 Welfare measure

Welfare in each country is defined as the sum of the welfare of patient households (savers) and impatient households (borrowers), weighted by 1 minus their respective discount factors, as in Lambertini et al., 2013, Rubio, 2020 or Gebauer, 2021. Therefore, the social welfare function is such that the social planner equalizes the utility of the different types of agents for a given constant consumption flow. Thus, welfare in the domestic country writes:

$$W_t = (1-\beta)U'_t + (1-\gamma)U_t,$$

where U'_t is the individual welfare of patient households defined as:

$$U'_t = \max E_0 \sum_{t=0}^{\infty} \beta^t (\ln C'_t + j \ln h'_t - \frac{1}{\eta} l'^{\eta}_t)$$

and U_t is the individual welfare of impatient households defined as:

$$U_t = \max E_0 \sum_{t=0}^{\infty} \gamma^t (\ln C_t + j \ln h_t - \frac{1}{\eta} l^{\eta}_t).$$

We evaluate unconditional welfare using the solution to the second-order approximation of the model's structural equations, relying on the recursive representation of the individual welfare functions.[14]

[14] We obtain the optimal macroprudential parameters by minimizing the additive inverse of unconditional welfare with the Matlab global cmaes optimizer. We use different random starting values to verify that the results are insensitive to them.

6.1.2 Optimal macroprudential parameters

Table 4 presents the parameters of the macroprudential rules that maximize social welfare in the activating country (country A) in the absence of reciprocity in macroprudential policy (i.e., when $z_t = z_h$ in equation (16) for the LTV ratio cap and when ${v_{tb}}^* = v_b^*$ in equation (18) for the CCyB). It also displays the associated consumption equivalent gains relative to the benchmark case of no macroprudential intervention.[15]

Table 4: Optimal macroprudential policy for different shocks

	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE savers (%)	CE borrowers (%)
Cost-push shock	0	0	-	-	-
Bank capital shock	0.53	38.36	0.0501	0.0602	-0.0102
Housing preference shock	0.50	0	0.0014	0.0017	-2.9683e-04

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country A (the country that activates the macroprudential measure).

We find that the optimal macroprudential policy depends on the type of shock under consideration. Thus, in the absence of reciprocity, countercyclical macroprudential policy is not optimal in response to symmetric cost-push shocks. On the contrary, a strong reaction to asymmetric bank capital shocks is optimal (in particular through the countercyclical capital buffer, which directly targets the banking sector initially affected by the shock), triggering meaningful consumption equivalent gains in the activating country. Regarding the asymmetric housing preference shock, the optimal macroprudential tool is the countercyclical loan-to-value ratio cap, as it directly responds to house price growth and adjusts the borrowing capacity of impatient households. Therefore, it allows mitigating the effects of the shock in the housing sector and their transmission to the real sector through the financial accelerator mechanism. Consumption equivalent gains associated with optimal countercyclical macroprudential policies are driven in all cases by those of savers, due to the subsequent decrease in inflation and house price volatility (see Tables 7 and 8 below).

[15] Consumption equivalent gains are defined as follows: $\exp(\text{weight} * (\text{Welfare reciprocity-Welfare benchmark})) - 1$.

6.2 Investigating the optimality of different scenarios of macroprudential reciprocity

6.2.1 Comparison of different reciprocity scenarios

Next, we introduce reciprocity in macroprudential policy into the analysis. We compare three different scenarios for each shock: i) a case with no reciprocity, corresponding to the optimal macroprudential policy case studied above, ii) a case with reciprocity in the countercyclical buffer only, corresponding to the compulsory reciprocity in the CCyB in the EU, and iii) a case with full reciprocity, i.e., both in the countercyclical capital buffer and in the loan-to-value ratio cap. The latter corresponds to a case of voluntary reciprocity, in line with the ESRB reciprocity framework. We then compare the optimal parameters of the macroprudential rules under each scenario, and the consumption equivalent gains associated with each reciprocity scenario relative to the no reciprocity benchmark case to identify the optimal setting (Table 5).

Table 5: Optimal macroprudential reciprocity for different shocks

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0.64	1.8244e-07	-1.9622e-06	2.1446e-06
Full reciprocity	0	0.64	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.53	38.36	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.55	28	-0.0132	-0.0270	0.0138
Full reciprocity	0.50	28.15	-0.0130	-0.0269	0.0139
Asymmetric housing preference shock					
No reciprocity	0.50	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.50	0	-	-	-
Full reciprocity	0.50	0	0.0002	-5.3583e-05	0.0003

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country A (the country that activates the macroprudential measure).

We find that the optimal reciprocity scenario depends on the type of shock. Macroprudential reciprocity is optimal in response to common cost-push shocks and asymmetric housing preference shocks. For cost-push shocks, reciprocity in CCyB only is the optimal scenario, given that the optimal macroprudential policy implies a small response of the CCyB rule and a null response of the LTV ratio rule. For housing preference shocks, full reciprocity (i.e., including reciprocity in the LTV ratio rule) is the optimal scenario, as the optimal macroprudential policy implies a small response

of the LTV ratio rule (and no activation of the CCyB rule).

In contrast, in response to asymmetric bank capital shocks, the optimal macroprudential policy is a mix of a small response in the LTV rule and a strong response in the CCyB rule, and all macroprudential reciprocity scenarios are suboptimal relative to the no reciprocity case.

Note that the consumption equivalent gains presented in Table 5 are relatively small because the benchmark (i.e., optimal macroprudential policy) already represents an optimized scenario. They are especially small for cost-push shocks because the shock's standard deviation is small.

For all three shocks, borrowers benefit from reciprocity in macroprudential policy due to a decrease in credit, house prices, or output volatility (see Tables 6, 7, and 8 below), while savers are worse off under reciprocity.

6.2.2 Impact on macro-finance volatility

To better understand the welfare and distributional effects of macroprudential reciprocity for the different types of shocks, we now investigate how reciprocity affects the volatility of the main macro-finance variables in the activating country. Tables 6, 7, and 8 present the standard errors of these variables when parameters of the macroprudential rules are set at their optimal level for each of the shocks and reciprocity scenarios.

For common cost-push shocks (Table 6), we find that the optimal scenario with reciprocity in CCyB triggers a smaller volatility of house prices and inflation in the activating economy relative to the optimal scenario without reciprocity – which implies no macroprudential policy –, but this comes at the expense of higher volatility in output.

For asymmetric bank capital shocks (Table 7), the scenario without reciprocity, which is the optimal one, implies lower volatility in credit and house prices compared to the reciprocity scenarios, but is associated with higher volatility in macroeconomic variables.

Finally, for asymmetric housing preference shocks (Table 8), full reciprocity, which is the optimal scenario, implies a decrease in the volatility of all variables. The fact that savers are nevertheless worse-off under full reciprocity (Table 5) suggests that other variables affect their welfare.

Table 6: Comparison of macro-financial volatilities in the activating country in the different reciprocity scenarios for common cost-push shocks

Scenario	No Macropru	No Reciprocity	Reciprocity in CCyB	Full Reciprocity
Output	9.0395e-04	-	9.0424e-04	-
Inflation	5.6315e-05	-	5.6158e-05	-
Credit	0.0042	-	0.0042	-
House prices	1.8251e-04	-	1.8215e-04	-

Note: For each scenario, parameters of the macroprudential policy rules are set at their optimal level $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ presented in Table 5. Given that the parameters of the no macroprudential and the no reciprocity scenarios on the one hand, and the parameters of the reciprocity in CCyB and full reciprocity scenarios on the other hand, are similar, the redundant volatilities are left blank. The volatilities displayed are those of the variables expressed in log.

Table 7: Comparison of macro-financial volatilities in the activating country in the different reciprocity scenarios for asymmetric bank capital shocks

Scenario	No Macropru	No Reciprocity	Reciprocity in CCyB	Full Reciprocity
Output	0.0014	0.0016	0.0015	0.0015
Inflation	4.6042e-04	3.3777e-04	3.2095e-04	3.2019e-04
Credit	0.1230	0.1236	0.1247	0.1247
House prices	0.0036	0.0029	0.0031	0.0031

Note: For each scenario, parameters of the macroprudential policy rules are set at their optimal level $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ presented in Table 5. The volatilities displayed are those of the variables expressed in log.

Table 8: Comparison of macro-financial volatilities in the activating country in the different reciprocity scenarios for asymmetric housing preference shocks

Scenario	No Macropru	No Reciprocity	Reciprocity in CCyB	Full Reciprocity
Output	4.8539e-04	4.8005e-04	-	4.7970e-04
Inflation	7.7353e-05	7.3887e-05	-	7.3417e-05
Credit	0.0967	0.0943	-	0.0941
House prices	0.0246	0.0246	-	0.0245

Note: For each scenario, parameters of the macroprudential policy rules are set at their optimal level $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ presented in Table 5. Given that the optimal parameters for the no reciprocity and reciprocity CCyB scenarios are similar, the redundant volatilities are left blank. The volatilities displayed are those of the variables expressed in log.

Figures A4, A5 and A6 in Appendix C compare the responses of the main macroeconomic and financial variables in country A (the activating country) for all scenarios: no macroprudential policy, optimal macroprudential policy without reciprocity, optimal macroprudential policy with reci-

procity in the CCyB only, and optimal macroprudential policy with reciprocity in both the CCyB and LTV ratio. The impulse response functions show that macroprudential reciprocity generates substitution effects between credit granted by domestic and foreign banks in the activating country, in both quantities and loan rates. In equilibrium, these substitution effects can imply that macroprudential policy counteracts the initial effect of the shock on macro-financial variables under reciprocity to a lesser extent than it would without it. Thus, for bank capital shocks (Figure A5 in Appendix C), reciprocity in macroprudential policy is associated with a lower countercyclical effect on credit relative to the no reciprocity case. This is because domestic credit decreases more under reciprocity than without it following negative bank capital shocks, due to higher reallocation effects towards foreign credit, as foreign banks are also affected by the relaxation in credit conditions under reciprocity. The decrease in domestic credit is not fully compensated by the increase in foreign credit because of simultaneous adjustments in loan rates, eventually triggering a higher decrease in total credit under reciprocity, thus implying a lower countercyclical effect of macroprudential policy on credit. These substitution effects between domestic and foreign credit can explain the non-optimality of reciprocity for this type of shock originating in the banking sector of the activating country.

6.2.3 Optimality of reciprocity at a monetary union level

We next evaluate the optimality of macroprudential reciprocity at the level of the monetary union, accounting for its impact on households' welfare in the reciprocating country (country B) also. We define welfare in the monetary union W_t^{EA} as the sum of the welfare of the domestic country and the welfare of the foreign country, weighted by their respective relative size, as follows:

$$W_t^{EA} = nW_t + (1-n)W_t^*.$$

Table 9 compares the different reciprocity scenarios for the three types of shock when the social planner maximizes the welfare at the level of the monetary union.

The optimal macroprudential tools for the different reciprocity scenarios are similar to the optimal macroprudential tools when only the welfare of the activating country is optimized (i.e., an active

Table 9: Optimal macroprudential reciprocity at the monetary union level for different shocks

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains EA (%)	CE gains A (%)	CE gains B (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0.29	2.9009e-08	1.2701e-07	-2.3761e-08
Full reciprocity	0	0.29	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.54	39.81	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.56	22.11	-0.0080	-0.0144	-0.0045
Full reciprocity	0.76	23.47	-0.0089	-0.0146	-0.0059
Asymmetric housing preference shock					
No reciprocity	0.50	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.50	0	-	-	-
Full reciprocity	0.49	0	-6.0530e-06	2.1673e-04	-1.2602e-04

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule while $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when country A is the activating country and when we maximize welfare at the euro area level.

CCyB only for common cost-push shocks, a mix of an active CCyB and active LTV ratio for bank capital shocks, and an active LTV ratio only for housing preference shocks), but the optimal parameter values slightly differ.

In terms of reciprocity, we find that, at the monetary union level, it is optimal to impose macroprudential reciprocity for common cost-push shocks, but not for asymmetric bank capital shocks or housing preference shocks. For cost-push shocks and housing preference shocks, macroprudential reciprocity is associated with positive consumption equivalent gains for country A (the activating country) but not for country B (the reciprocating country). For housing preference shocks in particular, the welfare losses associated with macroprudential reciprocity in country B make reciprocity suboptimal at the monetary union level, given country B's larger size. All in all, it appears that macroprudential reciprocity is optimal at the monetary union level for the common shocks, but not for the asymmetric shocks that we consider.

7 Alternative scenarios

7.1 Optimal reciprocity when country B is the activating country

We now examine the optimal macroprudential reciprocity scenario, assuming that country B activates the countercyclical macroprudential tools (and thus the reciprocating country is now country A). Indeed, country B presents specific characteristics relative to country A that may affect the optimality of macroprudential reciprocity: it is larger, less leveraged, and presents a stronger home bias in credit. Table 10 compares the different reciprocity scenarios when country B is the activating country, and the welfare of country B is optimized.

Table 10: Optimal macroprudential reciprocity for different shocks for country B

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0	-	-	-
Full reciprocity	0	0	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.27	70.30	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.30	49.66	-0.03089	-0.0627	0.0318
Full reciprocity	0.30	49.66	-0.03088	-0.0626	0.0318
Asymmetric housing preference shock					
No reciprocity	0.33	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.33	0	-	-	-
Full reciprocity	0.34	0	1.8592e-05	1.4330e-05	4.2616e-06

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country B (that activates the macroprudential policy).

For asymmetric bank capital and housing preference shocks, the optimal macroprudential reciprocity scenario is similar to that for country A: no reciprocity makes households better off in response to bank capital shocks, whereas full reciprocity is optimal in response to housing preference shocks. However, the optimal parameters of the macroprudential rules differ relative to those of country A: a lower response of the loan-to-value ratio cap is sufficient for both shocks, due to the lower leverage of country B, whereas a higher response of the CCyB is optimal for bank capital shocks, due to the higher reliance of country B on domestic banks. Moreover, because of this higher home bias domestic credit, consumption equivalent gains associated with full reciprocity (relative

to the no reciprocity benchmark) for asymmetric housing preference shocks are lower than those for country A for similar shocks. For common cost-push shocks, unlike our results for country A, we find that countercyclical macroprudential policy is never optimal, regardless of the reciprocity scenario.[16]

We now compare the different reciprocity scenarios for the three types of shocks when the social planner maximizes welfare at the monetary union level, and country B is the activating country (Table A1 in Appendix D). These results are different from those in Table 9, in which we maximized welfare at the monetary union level when country A is the activating country. We find that the optimal parameters of the macroprudential rules are very close to those obtained when maximizing country B's welfare, due to the predominant weight of country B in the social planner's function in relation to the larger size of country B. Differently from when country A is the activating country, at the monetary union level, it is optimal to have no countercyclical macroprudential policy in response to common cost-push shocks and full reciprocity in response to asymmetric housing preference shocks (as it is optimal for country B, and the weight on country B is larger than that for country A in the social planner's function).

7.2 Optimal reciprocity under full credit integration in the Eurozone

We now investigate the optimal reciprocity framework in the context of full credit integration in the Eurozone, i.e., when half of the domestic credit is granted by foreign banks in both country A and country B. This experiment can be understood as a prospective approach. Indeed, because the aim of the Savings and Investments Union project, in conjunction with the ongoing Banking Union, is to foster financial integration in the euro area, home bias in bank credit is expected to decrease in the next decades, which would make reciprocity in macroprudential policies even more acute. Table 11 compares the optimality of the different reciprocity scenarios in this full credit integration scenario when country A is the activating country (our benchmark case).

In qualitative terms, the results are similar to those obtained with home bias in credit. However, compared with this case, the optimal macroprudential response is stronger, and the consumption

[16] Further examination reveals that reciprocity generates higher volatility in country B's output and credit relative to the case without reciprocity, which can explain this result.

Table 11: Optimal macroprudential reciprocity without home bias in credit

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	5.95	4.2982e-06	-1.1621e-05	1.5919e-05
Full reciprocity	0	5.95	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.30	100.62	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.56	13.77	-0.0725	-0.1116	0.0391
Full reciprocity	0.87	12.76	-0.0719	-0.1113	0.0394
Asymmetric housing preference shock					
No reciprocity	0.51	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.51	-	-	-	-
Full reciprocity	0.54	0	0.0003	-4.8471e-05	0.0004

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country A (that activates the macroprudential policy).

equivalent gains associated with macroprudential reciprocity are higher because, under full integration, a larger share of domestic exposures escapes macroprudential regulation in the absence of reciprocity. At the monetary union level, although results are not altered for cost-push and bank capital shocks relative to the home bias case, full reciprocity is optimal for housing preference shocks in the no home bias case, whereas it was not in the baseline scenario (Table A2 in Appendix D). Full credit integration in the Eurozone therefore makes reciprocity even more desirable at the monetary union level.

7.3 Interactions with monetary policy

We additionally investigate the interactions between the monetary policy stance and the optimality of the different macroprudential reciprocity scenarios. We find that our benchmark results are robust when considering alternatively a monetary policy that also reacts to output growth ($\phi_y = 0.5$) and a more active monetary policy in terms of responding to inflation ($\phi_\pi = 2$) (Tables A3 and A4 in Appendix D). However, in the case of a passive monetary policy ($\phi_\pi \simeq 0$), macroprudential policy in response to the common cost-push shock is never optimal for country A, which implies that reciprocity is not required (Table 12). Table A6 in Appendix D shows that the suboptimality of a macroprudential response to cost-push shocks when monetary policy is passive relates to higher

output volatility.

In addition, the optimal macroprudential parameters in response to the other types of shocks are smaller than in the benchmark monetary policy case (except for the optimal LTV ratio parameter for the bank capital shock). Moreover, savers' losses and borrowers' gains associated with macroprudential reciprocity are both smaller than in the benchmark case.

Table 12: Optimal macroprudential reciprocity for different shocks. Passive monetary policy. $\phi_\pi = 0.00001$.

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0	-	-	-
Full reciprocity	0	0	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.67	36.52	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.68	24.69	-0.0106	-0.0226	0.0120
Full reciprocity	0.62	24.62	-0.0103	-0.0227	0.0125
Asymmetric housing preference shock					
No reciprocity	0.43	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.43	0	-	-	-
Full reciprocity	0.45	0	0.0002	-3.1820e-05	0.0002

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country A (that activates the macroprudential policy).

These findings show that the optimality of macroprudential reciprocity in the activating country depends to some extent on the degree of monetary policy's responsiveness to inflation at the monetary union level.

7.4 Sensitivity to the share of borrowers

Finally, given that the welfare implications of macroprudential reciprocity differ for borrowers and savers, we investigate the sensitivity of our results to the share of borrowers. Indeed, in our benchmark case, savers are always worse off under reciprocity, whereas borrowers always benefit from reciprocity (Table 5). In Table 13, we therefore consider a scenario with a large share of borrowers. Thus, we compare the optimality of the different reciprocity frameworks when the shares of savers and borrowers in the activating country are reversed, i.e., the share of savers ν is equal to 0.36 instead of 0.64.

Table 13: Optimal macroprudential reciprocity for different shocks. Higher share of borrowers (share of savers $\nu = 0.36$ instead of 0.64).

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	3.39	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	3.39	0	-	-	-
Full reciprocity	3.01	0	-1.3072e-05	-6.642e-06	-6.43e-06
Asymmetric bank capital shock					
No reciprocity	0.54	35.47	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.55	23.97	-0.0230	-0.0223	-0.00069149
Full reciprocity	0.49	23.89	-0.0224	-0.0223	-0.0002
Asymmetric housing preference shock					
No reciprocity	0.65	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.65	0	-	-	-
Full reciprocity	0.67	0	0.0003	-0.0002	0.0005

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when maximizing the welfare of country A (that activates the macroprudential policy).

In the scenario with a large share of borrowers in the activating economy (country A), a countercyclical response in the loan-to-value ratio becomes optimal for all shocks even in the absence of reciprocity, and the optimal strength of macroprudential policy is higher. The loan-to-value ratio – that directly targets the borrowing sector – becomes the optimal macroprudential tool in response to cost-push shocks whereas the CCyB was optimal in the benchmark case. This implies that macroprudential reciprocity becomes suboptimal. Nevertheless, the optimal reciprocity scenario remains similar for bank capital shocks (no reciprocity) and housing preference shocks (full reciprocity). For bank capital shocks, consumption equivalent losses associated with reciprocity are stronger than those with a lower share of borrowers, as even borrowers are worse off under reciprocity as a result of lower credit supply. By contrast, for housing preference shocks, consumption equivalent gains associated with full reciprocity are larger because borrowers gain more and savers incur lower losses. Therefore, the share of borrowers in the economy can affect the optimal macroprudential reciprocity scenario.

8 Conclusion

In this paper, we provide an analytical framework for studying the welfare effects of alternative counterfactual scenarios of macroprudential reciprocity in a 2-country macro-financial model of the euro area that accounts for heterogeneity across countries in size, leverage, and home bias in credit, as well as a common monetary policy. We find that the optimal macroprudential tools and reciprocity scenario depend on the nature of the shock, whether a supply, demand, or financial shock. Macroprudential reciprocity is optimal in response to common cost-push shocks and asymmetric housing preference shocks, but not country-specific bank capital shocks. The optimality of macroprudential reciprocity also partly depends on the social planner's objective, the share of borrowers in the economy, and the responsiveness of monetary policy to inflation. Considering a prospective scenario of full integration within the euro area, motivated by the project of the Savings and Investments Union, we also find that the disappearance of home bias in credit in the euro area is associated with higher welfare gains from reciprocity, as foreign banks bear a larger share of domestic credit exposures. Our findings therefore call for flexibility in macroprudential reciprocity decisions, depending on the current macro-financial environment, in line with the EU reciprocity framework for macroprudential instruments other than the CCyB.

References

Agénor, P., Alper, K., and Pereira da Silva, L. (2013). Capital regulation, monetary policy and financial stability. *International Journal of Central Banking*, 9:198–243.

Agénor, P.-R., Jackson, T., Kharroubi, E., Gambacorta, L., Lombardo, G., and Pereira da Silva, L. (2021). Assessing the gains from international macroprudential policy cooperation. *Journal of Money, Credit and Banking*, 53(7):1819–1866.

Agénor, P.-R., Jackson, T. P., and Pereira da Silva, L. A. (2023). Global Banking, Financial Spillovers and Macroprudential Policy Coordination. *Economica*, 90(359):1003–1040.

Agénor, P.-R., Jackson, T. P., and Pereira da Silva, L. A. (2024). Cross-Border Regulatory Spillovers and Macroprudential Policy Coordination. *Journal of Monetary Economics*, 146:103582.

Aiyar, S., Calomiris, C. W., Hooley, J., Korniyenko, Y., and Wieladek, T. (2014a). The international transmission of bank capital requirements: Evidence from the UK. *Journal of Financial Economics*, 113(3):368–382.

Aiyar, S., Calomiris, C. W., and Wieladek, T. (2014b). Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment. *Journal of Money, Credit and Banking*, 46:181–214.

Angelini, P., Neri, S., and Panetta, F. (2014). The Interaction between Capital Requirements and Monetary Policy. *Journal of Money, Credit and Banking*, 46(6):1073–1112.

Avdjiev, S., Koch, C., McGuire, P., and von Peter, G. (2017). International prudential policy spillovers: A global perspective. *International Journal of Central Banking*, 13(2):5–33.

Beirne, J. and Friedrich, C. (2017). Macroprudential policies, capital flows, and the structure of the banking sector. *Journal of International Money and Finance*, 75:47–68.

Bremus, F. and Fratzscher, M. (2015). Drivers of structural change in cross-border banking since the global financial crisis. *Journal of International Money and Finance*, 52:32–59.

Buch, C. and Goldberg, L. (2017). Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network. *International Journal of Central Banking*, 13:505–558.

Calvo, G. A. (1983). Staggered Prices in a Utility-maximizing Framework. *Journal of Monetary Economics*, 12(3):383–398.

Calza, A., Monacelli, T., and Stracca, L. (2013). Housing finance and monetary policy. *Journal of the European Economic Association*, 11:101–122.

Darracq Pariès, M., Kok, C., and Rancoita, E. (2019). Macroprudential policy in a monetary union with cross-border banking. Working Paper Series 2260, European Central Bank.

European Mortgage Federation (2025). A Review of Europe's Mortgage and Housing Markets. Technical report.

Financial Stability Committee of the European Central Bank (2020a). Cross-border spillover effects of macroprudential policies: a conceptual framework. Occasional Paper Series 242, European Central Bank.

Financial Stability Committee of the European Central Bank (2020b). Framework to assess cross-border spillover effects of macroprudential policies. Technical report.

Forbes, K., Reinhardt, D., and Wieladek, T. (2017). The spillovers, interactions, and (un)intended consequences of monetary and regulatory policies. *Journal of Monetary Economics*, 85:1–22.

Forbes, K. J. (2021). The International Aspects of Macroprudential Policy. *Annual Review of Economics*, 13(1):203–228.

Franch, F., Nocciola, L., and Zochowski, D. (2021). Cross-border effects of prudential regulation: Evidence from the euro area. *Journal of Financial Stability*, 53:100820.

Gambacorta, L. and Karmakar, S. (2018). Leverage and Risk-Weighted Capital Requirements. *International Journal of Central Banking*, 14(5):153–191.

Gebauer, S. (2021). Welfare-Based Optimal Macroprudential Policy with Shadow Banks. Working paper 817, Banque de France.

Gebauer, S. and Mazelis, F. (2023). Macroprudential Regulation and Leakage to the Shadow Banking Sector. *European Economic Review*, 154:104404.

Gerali, A., Neri, S., Sessa, L., and Signoretti, F. M. (2010). Credit and Banking in a DSGE Model of the Euro Area. *Journal of Money, Credit and Banking*, 42:107–141.

Harding, M., Lindé, J., and Trabandt, M. (2023). Understanding Post-COVID Inflation Dynamics. *Journal of Monetary Economics*, 140:101–118.

Houston, J. F., Lin, C., and Ma, Y. (2012). Regulatory Arbitrage and International Bank Flows. *Journal of Finance*, 67(5): 1845-1895.

Iacoviello, M. (2005). House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle. *American Economic Review*, 95(3).

Iacoviello, M. and Minetti, R. (2006). International Business Cycles with Domestic and Foreign Lenders. *Journal of Monetary Economics*, 53(8):2267–2282.

Lambertini, L., Mendicino, C., and Teresa Punzi, M. (2013). Leaning against boom-bust cycles in credit and housing prices. *Journal of Economic Dynamics and Control*, 37(8):1500–1522.

Quint, D. and Rabanal, P. (2014). Monetary and Macroprudential Policy in an Estimated DSGE Model of the Euro Area. *International Journal of Central Banking*, 10(2):169–236.

Rubio, M. (2020). Cross-country Spillovers from Macroprudential Regulation: Reciprocity and Leakage. *Journal of International Money and Finance*, 103:102134.

Rubio, M. and Yao, F. (2020). Macroprudential Policies in a Low Interest Rate Environment. *Journal of Money, Credit and Banking*, 52(6):1565–1591.

Schmitt-Grohé, S. and Uribe, M. (2003). Closing small open economy models. *Journal of International Economics*, 61(1):163–185.

Vitek, M. F. (2017). Policy, risk and spillover analysis in the world economy: A panel dynamic stochastic general equilibrium approach. IMF Working Papers 2017/089, International Monetary Fund.

Appendix

A The intermediate good firm price-setting problem

Following Calvo, 1983, in each period, the firm can reset its price $P_{A,t(z)}$ with probability $1-\theta$. Therefore, the problem of the firm in period t is to choose the price $P_{A,t(z)}$ that maximizes its expected inter-temporal profit (in terms of current units of good A), considering the probability θ^k that the price $P_{A,t(z)}$ is still in place in $t+k$:

$$\max_{P_{A,t(z)}} E_t[\sum_{k=0}^{\infty} \theta^k \Lambda_{t,t+k}(\frac{P_{A,t(z)}}{P_{A,t+k}} Y_{A,t+k}(z) - X_{A,t+k}^{-1} Y_{A,t+k}(z))], \tag{19}$$

with $\Lambda_{t,t+k} = \beta \frac{C'_{A,t}}{C'_{A,t+k}}$ being the stochastic discount factor and $X_{A,t}$ being the mark-up.
Plugging in the demand function yields:

$$\max_{P_{A,t(z)}} E_t[\sum_{k=0}^{\infty} \theta^k \Lambda_{t,t+k}(\frac{P_{A,t(z)}}{P_{A,t+k}})^{1-\epsilon} Y_{A,t+k} - X_{A,t+k}^{-1}(\frac{P_{A,t(z)}}{P_{A,t+k}})^{-\epsilon} Y_{A,t+k})].$$

Following Harding et al., 2023, we introduce the cost-push shock $A_{p,t}$ directly into the first-order condition of the problem. The F.O.C. is given by:

$$P_{A,t}^S = \frac{\epsilon}{\epsilon-1} \frac{E_t[\sum_{k=0}^{\infty} \theta^k \Lambda_{t,t+k} X_{A,t+k}^{-1} A_{p,t} P_{A,t+k}^{\epsilon} Y_{A,t+k}]}{E_t[\sum_{k=0}^{\infty} \theta^k \Lambda_{t,t+k} P_{A,t+k}^{\epsilon-1} Y_{A,t+k}]} = \frac{\epsilon}{\epsilon-1} \frac{Z_{1,t}}{Z_{2,t}}, \tag{20}$$

with

$$Z_{1,t} = X_{A,t}^{-1} A_{p,t} P_{A,t}^{\epsilon} Y_{A,t} + \theta E_t[\Lambda_{t,t+1} Z_{1,t+1}]$$

$$Z_{2,t} = P_{A,t}^{\epsilon-1} Y_{A,t} + \theta E_t[\Lambda_{t,t+1} Z_{2,t+1}].$$

If we define $z_{1,t} = \frac{Z_{1,t}}{P_{A,t}^{\epsilon}}$ and $z_{2,t} = \frac{Z_{2,t}}{P_{A,t}^{\epsilon-1}}$, we get:

$$\pi_{A,t}^S = \frac{\epsilon}{\epsilon-1} \frac{z_{1,t}}{z_{2,t}},$$

with

$$z_{1,t} = X_{A,t}^{-1} A_{p,t} Y_{A,t} + \theta E_t[\Lambda_{t,t+1} \pi_{A,t+1}^{\epsilon} z_{1,t+1}]$$

$$z_{2,t} = Y_{A,t} + \theta E_t[\Lambda_{t,t+1}\pi_{A,t+1}^{\epsilon-1} z_{2,t+1}].$$

B Summary of the model's equilibrium conditions

B.1 Domestic patient households:

$$\frac{C'_{A,t}}{C'_{B,t}} = \frac{n}{(1-n)} P_{B_A,t}.$$

$$\frac{nq_t}{C'_{A,t}} = \frac{jA_{j,t}}{h'_t} + \beta E_t[\frac{nq_{t+1}}{C'_{A,t+1}}].$$

$$nw'_t = C'_{A,t} l_t^{'(\eta-1)}.$$

$$\frac{1}{C'_{A,t}} = \beta E_t[\frac{1}{C'_{A,t+1}} \frac{1+R_{A,t}}{\pi_{A,t+1}}].$$

$$\frac{1+\psi z_t}{C'_{A,t}} = \beta E_t[\frac{1}{C'_{A,t+1}} \frac{1+R_t}{\pi_{A,t+1}}].$$

B.2 Foreign patient households:

$$\frac{C'^*_{A,t}}{C'^*_{B,t}} = \frac{n}{(1-n)} P_{B_A,t}.$$

$$\frac{(1-n)q^*_t}{C'^*_{B,t}} = \frac{j}{h'^*_t} + \beta E_t[\frac{(1-n)q^*_{t+1}}{C'^*_{B,t+1}}].$$

$$(1-n)w'^*_t = C'^*_{B,t} l_t^{'*(\eta-1)}.$$

$$\frac{1}{C'^*_{B,t}} = \beta E_t[\frac{1}{C'^*_{B,t+1}} \frac{1+R_{B,t}}{\pi_{B,t+1}}].$$

$$\frac{1+\psi z^*_t}{C'^*_{B,t}} = \beta E_t[\frac{1}{C'^*_{B,t+1}} \frac{1+R_t}{\pi_{B,t+1}}].$$

B.3 Domestic impatient households:

$$\frac{C_{A,t}}{C_{B,t}} = \frac{n}{(1-n)} P_{B_A,t}.$$

$$\frac{n}{C_{A,t}} q_t = \frac{jA_{j,t}}{h_t} + \gamma E_t[\frac{n}{C_{A,t+1}} q_{t+1}] + \mu_t E_t[m\alpha_t q_{t+1}] + \mu_t^F (E_t[q_{t+1}(1-\alpha_t) - 2h_t \frac{1-z}{qh} q^2_{t+1}(1-\alpha_t)^2]).$$

$$nw_t = C_{A,t} l_t^{(\eta-1)}.$$

$$E_t[(1+\tilde{R}_t^H)\frac{b_t^H}{\pi_{A,t+1}}] = E_t[m\alpha_t q_{t+1} h_t].$$

$$E_t[(1+\tilde{R}_t^F)\frac{b_t^{F,D}}{\pi_{A,t+1}}] = E_t[q_{t+1}(1-\alpha_t)h_t(1-\frac{1-z}{qh}(q_{t+1}(1-\alpha_t)h_t))].$$

$$\frac{n}{C_{A,t}} = \gamma E_t[\frac{n}{C_{A,t+1}}\frac{1+\tilde{R}_t^H}{\pi_{A,t+1}}] + \mu_t E_t[\frac{1+\tilde{R}_t^H}{\pi_{A,t+1}}].$$

$$\frac{n}{C_{A,t}} = \gamma E_t[\frac{n}{C_{A,t+1}}\frac{1+\tilde{R}_t^F}{\pi_{A,t+1}}] + \mu_t^F E_t[\frac{1+\tilde{R}_t^F}{\pi_{A,t+1}}].$$

$$\mu_t m = \mu_t^F E_t[(1-2\frac{1-z}{qh}q_{t+1}(1-\alpha_t)h_t)].$$

$$C_{A,t} + P_{B_A,t}C_{B,t} + q_t(h_t - h_{t-1}) + (1+\tilde{R}_{t-1}^H)\frac{b_{t-1}^H}{\pi_{A,t}} + (1+\tilde{R}_{t-1}^F)\frac{b_{t-1}^{F,D}}{\pi_{A,t}} = w_t l_t + b_t^H + b_t^{F,D}.$$

B.4 Foreign impatient households:

$$\frac{C_{A,t}^*}{C_{B,t}^*} = \frac{n}{(1-n)}P_{B_A,t}.$$

$$\frac{1-n}{C_{B,t}^*}q_t^* = \frac{j}{h_t^*} + \gamma E_t[\frac{1-n}{C_{B,t+1}^*}q_{t+1}^*] +$$
$$\mu_t^* E_t[m\alpha_t^* q_{t+1}^*] + \mu_t^{F,*}(E_t[q_{t+1}^*(1-\alpha_t^*) - 2h_t^*\frac{1-z}{q^*h^*}q_{t+1}^{*,2}(1-\alpha_t^*)^2]).$$

$$(1-n)w_t^* = C_{B,t}^* l_t^{*(\eta-1)}.$$

$$E_t[(1+\tilde{R}_t^{H*})\frac{b_t^{H*}}{\pi_{B,t+1}}] = E_t[m\alpha_t^* q_{t+1}^* h_t^*].$$

$$E_t[(1+\tilde{R}_t^{F*})\frac{b_t^{F,D*}}{\pi_{B,t+1}}] = E_t[q_{t+1}^*(1-\alpha_t^*)h_t^*(1-\frac{1-z}{qh}(q_{t+1}^*(1-\alpha_t^*)h_t^*))].$$

$$\frac{1-n}{C_{B,t}^*} = \gamma E_t[\frac{1-n}{C_{B,t+1}^*}\frac{1+\tilde{R}_t^{H*}}{\pi_{B,t+1}}] + \mu_t^* E_t[\frac{1+\tilde{R}_t^{H*}}{\pi_{B,t+1}}].$$

$$\frac{1-n}{C_{B,t}^*} = \gamma E_t[\frac{1-n}{C_{B,t+1}^*}\frac{1+\tilde{R}_t^{F*}}{\pi_{B,t+1}}] + \mu_t^{F*} E_t[\frac{1+\tilde{R}_t^{F*}}{\pi_{B,t+1}}].$$

$$\mu_t^* m = \mu_t^{F*} E_t[(1-2\frac{1-z}{qh}q_{t+1}^*(1-\alpha_t)^* h_t^*)].$$

$$\frac{1}{P_{B_A,t}}C^*_{A,t} + C^*_{B,t} + q^*_t(h^*_t - h^*_{t-1}) + (1+\tilde{R}^{H*}_{t-1})\frac{b^{H*}_{t-1}}{\pi_{B,t}} + (1+\tilde{R}^{F*}_{t-1})\frac{b^{F,D^*}_{t-1}}{\pi_{B,t}} = w^*_t l^*_t + b^{H*}_t + b^{F,D*}_t.$$

B.5 Domestic banks:

$$b_t = b^H_t + b^{F,S*}_t.$$

$$b_t = d_t + K^b_t.$$

$$K^b_t = (1-\delta^b)\frac{K^b_{t-1}}{\pi_{A,t}A_{k,t}} + \frac{J^b_{t-1}}{\pi_{A,t}}.$$

$$J^b_t = \tilde{R}_t{}^H b^H_t + \tilde{R}_t{}^{F*} b^{F,S*}_t - R_{A,t}d_t - \frac{\kappa_{K^b}}{2}\left(\frac{K^b_t}{b_t} - \nu^b_t\right)^2 K^b_t$$
$$-\frac{\kappa_{b_H}}{2}\left(\frac{\tilde{R}^H_t}{\tilde{R}^H_{t-1}} - 1\right)^2 \tilde{R}^H_t b^H_t - \frac{\kappa_{b_F}}{2}\left(\frac{\tilde{R}^{F*}_t}{\tilde{R}^{F*}_{t-1}} - 1\right)^2 \tilde{R}^{F*}_t b^{F,S*}_t.$$

$$R^b_t = R_{A,t} - \kappa_{K^b}\left(\frac{K^b_t}{b_t} - \nu^b_t\right)\left(\frac{K^b_t}{b_t}\right)^2.$$

$$1 - \varepsilon^{b,H} + \varepsilon^{b,H}\frac{R^b_t}{\tilde{R}^H_t} = \kappa_{b_H}\left(\frac{\tilde{R}^H_t}{\tilde{R}^H_{t-1}} - 1\right)\frac{\tilde{R}^H_t}{\tilde{R}^H_{t-1}}$$
$$-\beta\mathbb{E}_t\left[\frac{C'_{A,t}}{C'_{A,t+1}}\kappa_{b_H}\left(\frac{\tilde{R}^H_{t+1}}{\tilde{R}^H_t} - 1\right)\left(\frac{\tilde{R}^H_{t+1}}{\tilde{R}^H_t}\right)^2 \frac{b^H_{t+1}}{b^H_t}\right].$$

$$1 - \varepsilon^{b,F} + \varepsilon^{b,F}\frac{R^b_t}{\tilde{R}^{F*}_t} = \kappa_{b_F}\left(\frac{\tilde{R}^{F*}_t}{\tilde{R}^{F*}_{t-1}} - 1\right)\frac{\tilde{R}^{F*}_t}{\tilde{R}^{F*}_{t-1}}$$
$$-\beta\frac{C'_{A,t}}{C'_{A,t+1}}\mathbb{E}_t\left[\kappa_{b_F}\left(\frac{\tilde{R}^{F*}_{t+1}}{\tilde{R}^{F*}_t} - 1\right)\left(\frac{\tilde{R}^{F*}_{t+1}}{\tilde{R}^{F*}_t}\right)^2 \frac{b^{F,S*}_{t+1}}{b^{F,S*}_t}\right].$$

B.6 Foreign banks:

$$b^*_t = b^{H*}_t + b^{F,S}_t.$$

$$b^*_t = d^*_t + K^{b*}_t.$$

$$K_t^{b*} = (1-\delta^b)\frac{K_{t-1}^{b*}}{\pi_{B,t}} + \frac{J_{t-1}^{b*}}{\pi_{B,t}}.$$

$$J_t^{b*} = \tilde{R}_t^{\ H*} b_t^{H*} + \tilde{R}_t^{\ F} b_t^{F,S} - R_{B,t} d_t^* - \frac{\kappa_{K^b}}{2}\left(\frac{K_t^{b*}}{b_t^*} - \nu_t^{b*}\right)^2 K_t^b$$
$$-\frac{\kappa_{b_H}}{2}\left(\frac{\tilde{R}_t^H}{\tilde{R}_{t-1}^H} - 1\right)^2 \tilde{R}_t^H b_t^H - \frac{\kappa_{b_F}}{2}\left(\frac{\tilde{R}_t^{F*}}{\tilde{R}_{t-1}^{F*}} - 1\right)^2 \tilde{R}_t^{F*} b_t^{F,S*}.$$

$$R_t^{b*} = R_{B,t} - \kappa_{K^b}\left(\frac{K_t^{b*}}{b_t^*} - \nu_t^{b*}\right)\left(\frac{K_t^{b*}}{b_t^*}\right)^2.$$

$$1 - \varepsilon^{b,H} + \varepsilon^{b,H}\frac{R_t^{b*}}{\tilde{R}_t^{H*}} = \kappa_{b_H}\left(\frac{\tilde{R}_t^{H*}}{\tilde{R}_{t-1}^{H*}} - 1\right)\frac{\tilde{R}_t^{H*}}{\tilde{R}_{t-1}^{H*}}$$
$$-\beta\mathbb{E}_t\left[\frac{C_{B,t}'^*}{C_{B,t+1}'^*}\kappa_{b_H}\left(\frac{\tilde{R}_{t+1}^{H*}}{\tilde{R}_t^{H*}} - 1\right)\left(\frac{\tilde{R}_{t+1}^{H*}}{\tilde{R}_t^{H*}}\right)^2 \frac{b_{t+1}^{H*}}{b_t^{H*}}\right].$$

$$1 - \varepsilon^{b,F} + \varepsilon^{b,F}\frac{R_t^{b*}}{\tilde{R}_t^F} = \kappa_{b_F}\left(\frac{\tilde{R}_t^F}{\tilde{R}_{t-1}^F} - 1\right)\frac{\tilde{R}_t^F}{\tilde{R}_{t-1}^F}$$
$$-\beta\mathbb{E}_t\left[\frac{C_{B,t}'^*}{C_{B,t+1}'^*}\kappa_{b_F}\left(\frac{\tilde{R}_{t+1}^F}{\tilde{R}_t^F} - 1\right)\left(\frac{\tilde{R}_{t+1}^F}{\tilde{R}_t^F}\right)^2 \frac{b_{t+1}^{F,S}}{b_t^{F,S}}\right].$$

B.7 Domestic intermediate-good firms

$$w_t l_t = \frac{1-\nu}{X_{A,t}} v_{A,t}^P Y_{A,t}.$$

$$w_t' l_t' = \frac{\nu}{X_{A,t}} v_{A,t}^P Y_{A,t}.$$

B.8 Foreign intermediate-good firms

$$w_t^* l_t^* = \frac{1-\nu}{X_{B,t}} v_{B,t}^P Y_{B,t}.$$

$$w_t^{'*} l_t^{'*} = \frac{\nu}{X_{B,t}} v_{B,t}^P Y_{B,t}.$$

B.9 Aggregate prices and output:

$$z_{1,t} = X_{A,t}^{-1} A_{p,t} Y_{A,t} + \theta\beta E_t[\frac{C_{A,t}^{'}}{C_{A,t+1}^{'}} \pi_{A,t+1}^{\epsilon} z_{1,t+1}].$$

$$z_{2,t} = Y_{A,t} + \theta\beta E_t[\frac{C_{A,t}^{'}}{C_{A,t+1}^{'}} \pi_{A,t+1}^{\epsilon-1} z_{2,t+1}].$$

$$z_{1,t}^* = X_{B,t}^{-1} A_{p,t} Y_{B,t} + \theta\beta E_t[\frac{C_{B,t}^{'*}}{C_{B,t+1}^{'*}} \pi_{B,t+1}^{\epsilon} z_{1,t+1}^*].$$

$$z_{2,t}^* = Y_{B,t} + \theta\beta E_t[\frac{C_{B,t}^{'*}}{C_{B,t+1}^{'*}} \pi_{B,t+1}^{\epsilon-1} z_{2,t+1}^*].$$

$$\pi_{A,t}^S = \frac{\epsilon}{\epsilon - 1} \frac{z_{1,t}}{z_{2,t}}.$$

$$\pi_{B,t}^S = \frac{\epsilon}{\epsilon - 1} \frac{z_{1,t}^*}{z_{2,t}^*}.$$

$$Y_{A,t} v_{A,t}^P = A_t l_t^{1-\nu} l_t^{'\nu}.$$

$$v_{A,t}^P = (1-\theta)(\pi_{A,t}^S)^{-\epsilon} + \theta \pi_{A,t}^{\epsilon} v_{A,t-1}^P.$$

$$Y_{B,t} v_{B,t}^P = A_t^* l_t^{*(1-\nu)} l_t^{*'\nu}.$$

$$v_{B,t}^P = (1-\theta)(\pi_{B,t}^S)^{-\epsilon} + \theta \pi_{B,t}^{\epsilon} v_{B,t-1}^P.$$

$$1 = \theta \pi_{A,t}^{\epsilon-1} + (1-\theta)(\pi_{A,t}^S)^{1-\epsilon}.$$

$$1 = \theta \pi_{B,t}^{\epsilon-1} + (1-\theta)(\pi_{B,t}^{S})^{1-\epsilon}.$$

$$\frac{P_{B_A,t}}{P_{B_A,t-1}} = \frac{\pi_{B,t}}{\pi_{A,t}}.$$

B.10 Market clearing and resource constraints:

Housing market:

$$h_t + h_t' = 1.$$

$$h_t^* + h_t'^* = 1.$$

Domestic good market:

$$nY_{A,t} = nC_{A,t}' + nC_{A,t} + (1-n)C_{A,t}'^* + (1-n)C_{A,t}^* + n\frac{\kappa_{K^b}}{2}\left(\frac{K_{t-1}^b}{b_{t-1}} - \nu^b\right)^2 \frac{K_{t-1}^b}{\pi_{A,t}} +$$
$$n\frac{\kappa_{b_H}}{2}\left(\frac{\tilde{R}_t^H}{\tilde{R}_{t-1}^H} - 1\right)^2 \tilde{R}_t^H \frac{b_t^H}{\pi_{A,t}} + n\frac{\kappa_{b_F}}{2}\left(\frac{\tilde{R}_t^{F*}}{\tilde{R}_{t-1}^{F*}} - 1\right)^2 \tilde{R}_t^{F*} \frac{b_t^{F,S*}}{\pi_{A,t}} + n\frac{\psi}{2} z_t^2 + n\delta^b \frac{K_{t-1}^b}{\pi_{A,t}}.$$

Foreign good market:

$$(1-n)Y_{B,t} = nC_{B,t}' + nC_{B,t} + (1-n)C_{B,t}'^* + (1-n)C_{B,t}^* + (1-n)\frac{\kappa_{K^b}}{2}\left(\frac{K_{t-1}^{*b}}{b_{t-1}^*} - \nu^{*b}\right)^2 \frac{K_{t-1}^{*b}}{\pi_{B,t}} +$$
$$(1-n)\frac{\kappa_{b_H}}{2}\left(\frac{\tilde{R}_t^{H*}}{\tilde{R}_{t-1}^{H*}} - 1\right)^2 \tilde{R}_t^{H*} \frac{b_t^{H*}}{\pi_{B,t}} + (1-n)\frac{\kappa_{b_F}}{2}\left(\frac{\tilde{R}_t^{F}}{\tilde{R}_{t-1}^{F}} - 1\right)^2 \tilde{R}_t^{F} \frac{b_t^{F,S}}{\pi_{B,t}} + (1-n)\frac{\psi}{2} z_t^{*2} + (1-n)\delta^b \frac{K_{t-1}^{*b}}{\pi_{B,t}}.$$

Market clearing for domestic foreign loans:

$$nb_t^{F,D} = (1-n)\frac{P_{B,t}}{P_{A,t}} b_t^{F,S}.$$

Market clearing for foreign foreign loans:

$$(1-n)\frac{P_{B,t}}{P_{A,t}} b_t^{F,D^*} = nb_t^{F,S^*}.$$

Foreign bonds are in zero-net supply:

$$nz_t + (1-n)\frac{P_{B,t}}{P_{A,t}} z_t^* = 0.$$

Domestic net foreign asset position:

$$z_t = \frac{1-n}{n} C'^*_{A,t} + \frac{1-n}{n} C^*_{A,t} - \frac{P_{B,t}}{P_{A,t}} C'_{B,t} - \frac{P_{B,t}}{P_{A,t}} C'_{B,t} + b_t^{F,D} + R_{t-1} \frac{z_{t-1}}{\pi_{A_t}} + \tilde{R}^{F,*}_{t-1} \frac{b^{F,S*}_{t-1}}{\pi_{A,t}} - \tilde{R_{t-1}}^{F} * \frac{b^{F,D}_{t-1}}{\pi_{A,t}} - b_t^{F,S*}.$$

B.11 Monetary policy and macroprudential rules

$$R_t = [\bar{R}(\frac{\pi^n_{A,t}\pi^{1-n}_{B,t}}{\bar{\pi}^n_A \bar{\pi}^{1-n}_B})^{\phi_\pi} (\frac{y^n_{A,t} y^{1-n}_{B,t}}{y^n_{A,t-1} y^{1-n}_{B,t-1}})^{\phi_y}]^{1-\rho_r} R^{\rho_r}_{t-1}.$$

$$b_{tot,t} = b_t^H + b_t^{F,D}.$$

$$m_t = m_h (\frac{b_{tot,t}}{b_{tot,t-1}})^{-\phi_{m_h}}.$$

$$m_t^* = m_f.$$

$$\nu_t^b = \nu^b \times \frac{b_t^H}{b_t^H + b_t^{F,S*}} (\frac{b_{tot,t}}{b_{tot,t-1}})^{\phi_\nu}.$$

In case of non-reciprocity:

$$z_t = z.$$

$$\nu_t^{b*} = \nu^{b*}.$$

In case of reciprocity in the domestic CCyB:

$$\nu_t^{b*} = \nu^{b*} \times \frac{b_t^{F,S}}{b_t^{H*} + b_t^{F,S}} (\frac{b_{tot,t}}{b_{tot,t-1}})^{\phi_\nu}.$$

In case of reciprocity in the domestic LTV ratio rule:

$$z_t = z_h (\frac{b_{tot,t}}{b_{tot,t-1}})^{-\phi_{m_h}}.$$

B.12 Shock processes:

Common cost-push shock:

$$\ln(A_{p,t}) = \rho_p \ln(A_{p,t-1}) + \varepsilon_{p,t}.$$

Asymmetric bank capital shock:

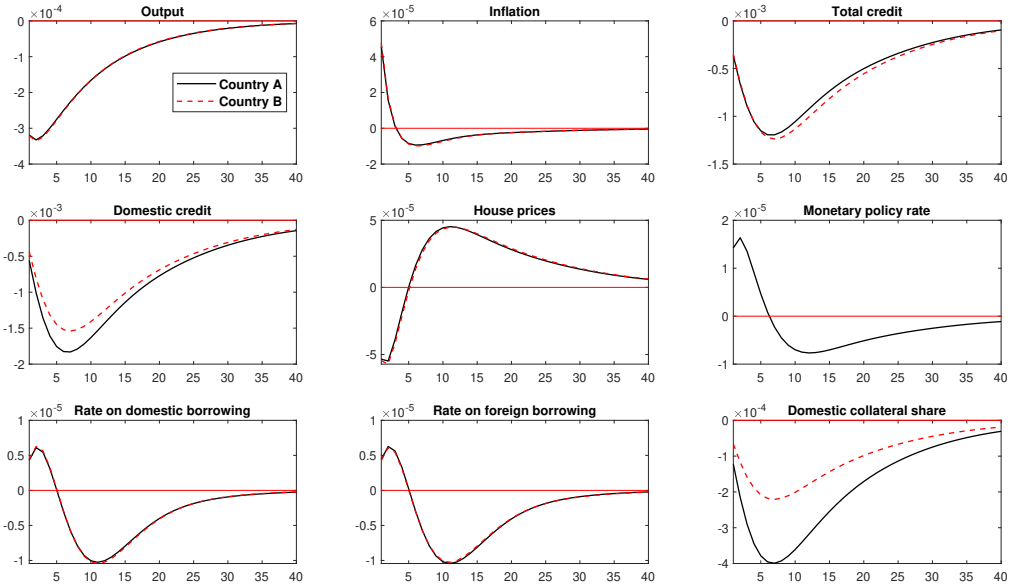
$$\ln(A_{k,t}) = \rho_k \ln(A_{k,t-1}) + \varepsilon_{k,t}.$$

Asymmetric housing preference shock:

$$\ln(A_{j,t}) = \rho_j \ln(A_{j,t-1}) + \varepsilon_{j,t}.$$

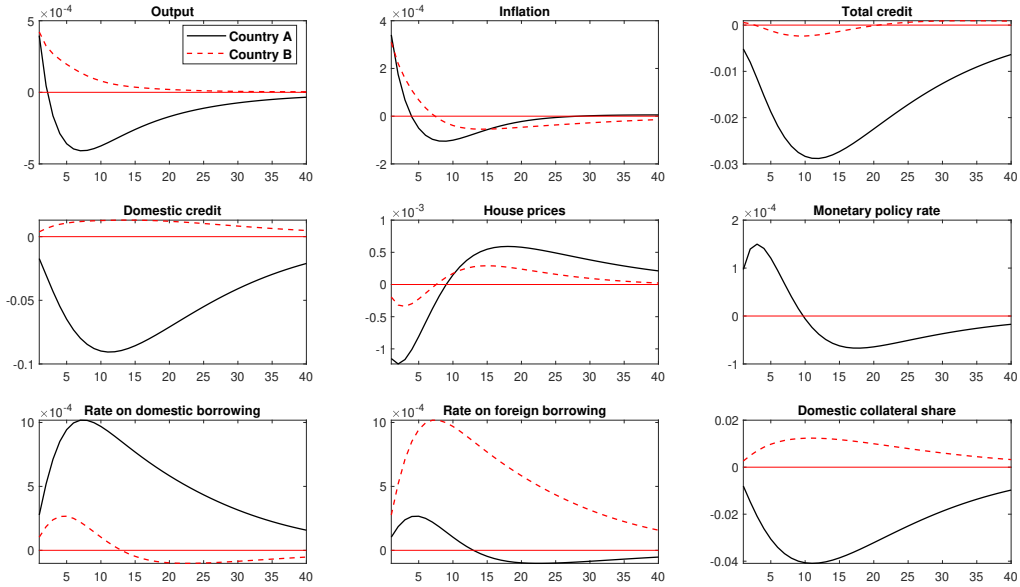
C Impulse response functions

Figure A1: Main impulse response functions to a positive common cost-push shock



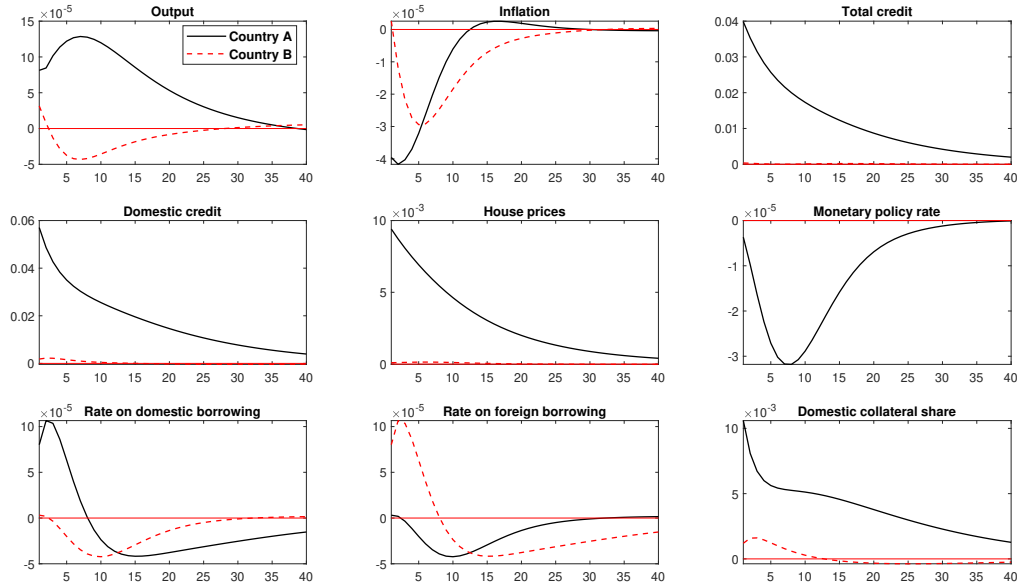
Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels.

Figure A2: Main impulse response functions to a negative bank capital shock in country A



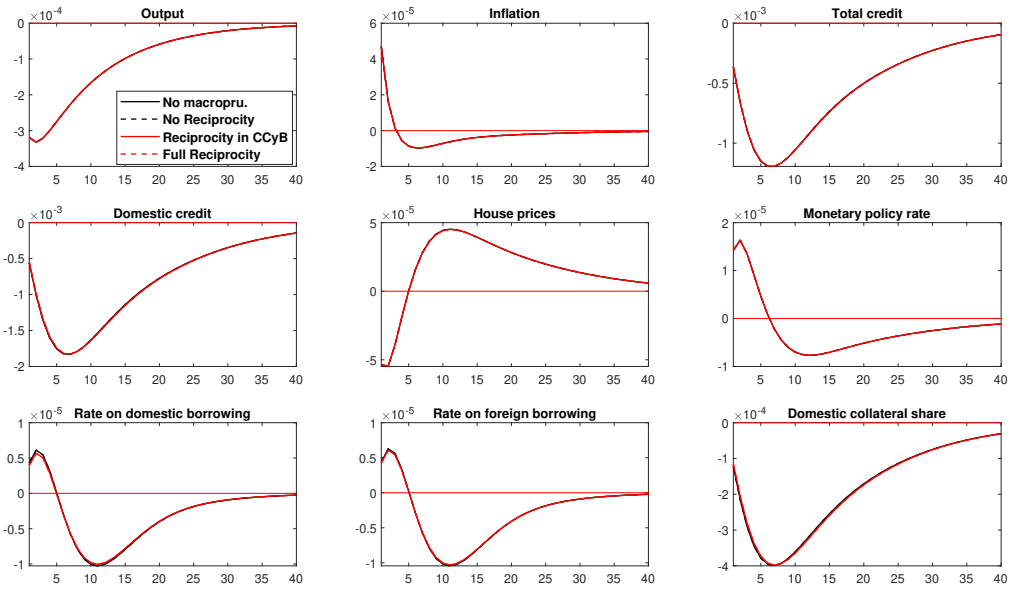
Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels.

Figure A3: Main impulse response functions to a positive housing preference shock in country A



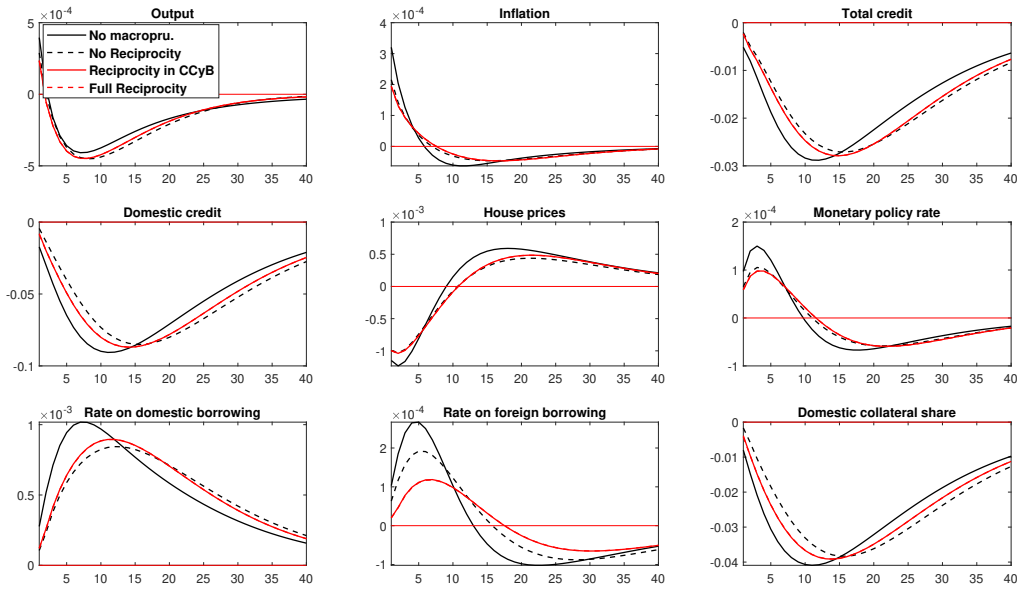
Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels.

Figure A4: Main impulse response functions to a positive cost-push shock in country A for different reciprocity scenarios



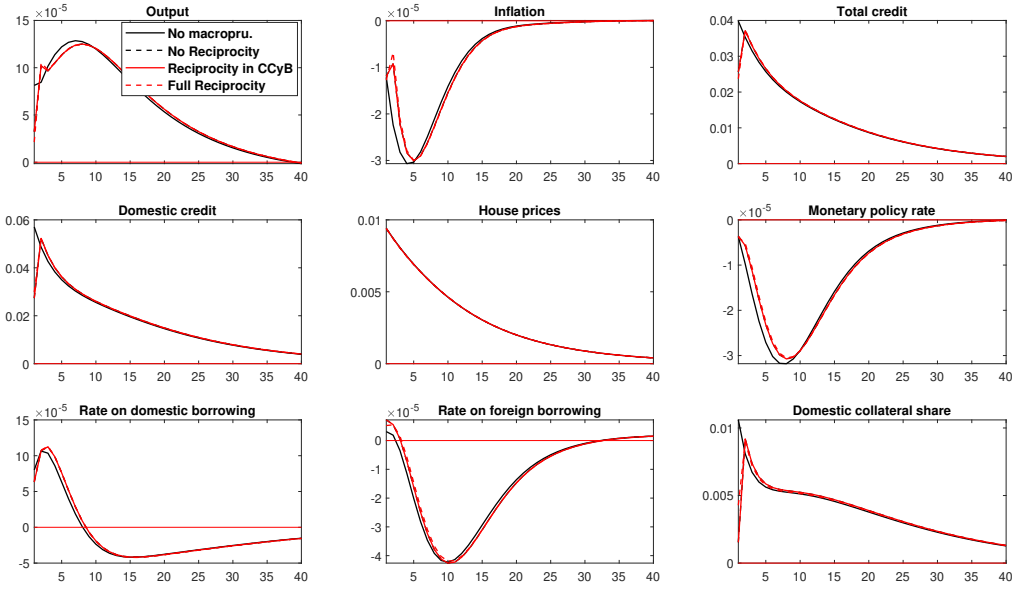
Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels. For each reciprocity scenario (no reciprocity, reciprocity in CCyB, and full reciprocity), the parameters of the two macroprudential policy rules are taken at their optimal values $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ obtained under each reciprocity scenario (Table 5). For cost-push shocks, the no reciprocity scenario is similar to the no macroprudential policy scenario (given that the optimal parameters of the macroprudential rules ϕ^*_h and $\phi^*_{\nu_h}$ are equal to 0 in the no reciprocity scenario), and the full reciprocity scenario is similar to the reciprocity in CCyB scenario (given that the optimal parameter of the LTV rule ϕ^*_h is equal to 0 in the full reciprocity scenario.)

Figure A5: Main impulse response functions to a negative bank capital shock in country A for different reciprocity scenarios



Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels. For each reciprocity scenario (no reciprocity, reciprocity in CCyB, and full reciprocity), the parameters of the two macroprudential policy rules are taken at their optimal values $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ obtained under each reciprocity scenario (Table 5).

Figure A6: Main impulse response functions to a positive housing preference shock in country A for different reciprocity scenarios



Note: Impulse response functions for output, inflation, credit, and house prices are log-deviations from the steady state, while impulse response functions for interest rates and the domestic collateral share α are deviations from the steady state in absolute levels. For each reciprocity scenario (no reciprocity, reciprocity in CCyB, and full reciprocity), the parameters of the two macroprudential policy rules are taken at their optimal values $\phi^*_{m_h}$ and $\phi^*_{\nu_h}$ obtained under each reciprocity scenario (Table 5). For housing preference shocks, the reciprocity in CCyB scenario is similar to the no reciprocity scenario, given that the optimal parameter of the CCyB rule $\phi^*_{\nu_h}$ is equal to 0 in the reciprocity in CCyB scenario.

D Additional tables

Table A1: Optimal macroprudential reciprocity at the monetary union level for different shocks for country B

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains EA (%)	CE gains A (%)	CE gains B (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0	-	-	-
Full reciprocity	0	0	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.28	67.88	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.30	40.30	-0.0227	-0.0048	-0.0323
Full reciprocity	0.30	40.30	-0.0227	-0.0048	-0.0323
Asymmetric housing preference shock					
No reciprocity	0.39	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.39	0	-	-	-
Full reciprocity	0.39	0	4.7348e-07	-3.9687e-05	2.2099e-05

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when country B is the activating country and when maximizing welfare at the euro area level.

Table A2: Optimal macroprudential reciprocity at the monetary union level without home bias in credit

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains A (%)	CE gains B (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	3.10	1.7189e-06	3.3306e-06	8.5111e-07
Full reciprocity	0	3.10	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.34	71.19	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.36	12.18	-0.0272	-0.0689	-0.0048
Full reciprocity	0.33	12.14	-0.0272	-0.0686	-0.0049
Asymmetric housing preference shock					
No reciprocity	0.49	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.49	0	-	-	-
Full reciprocity	0.46	0	5.0922e-05	2.8195e-04	-7.3478e-05

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule when country A is the activating country and when maximizing welfare at the euro area level.

Table A3: Optimal macroprudential reciprocity for different shocks. $\phi_y = 0.5$.

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0.87	2.5708e-07	-2.1104e-06	2.3675e-06
Full reciprocity	0	0.87	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.51	39.19	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.53	28.87	-0.0133	-0.0274	0.0141
Full reciprocity	0.48	28.85	-0.0131	-0.0274	0.01431
Asymmetric housing preference shock					
No reciprocity	0.48	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.48	0	-	-	-
Full reciprocity	0.50	0	0.0002	-2.4176e-05	0.0002

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule.

Table A4: Optimal macroprudential reciprocity for different shocks. $\phi_\pi = 2$.

Reciprocity scenario	$\phi^*_{m_h}$	$\phi^*_{\nu_h}$	CE gains (%)	CE gains savers (%)	CE gains borrowers (%)
Common cost-push shock					
No reciprocity	0	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0	0.41	9.8095e-08	-1.5511e-06	1.6492e-06
Full reciprocity	0	0.41	-	-	-
Asymmetric bank capital shock					
No reciprocity	0.65	33.06	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.66	25.31	-0.0100	-0.01854	0.0084935
Full reciprocity	0.60	25.28	-0.0098	-0.0186	0.0088
Asymmetric housing preference shock					
No reciprocity	0.49	0	Benchmark	Benchmark	Benchmark
Reciprocity in CCyB	0.49	0	-	-	-
Full reciprocity	0.51	0	0.0002	-2.8436e-05	0.0003

Note: $\phi^*_{m_h}$ represents the optimized parameter of the LTV ratio rule and $\phi^*_{\nu_h}$ represents the optimized parameter of the CCyB rule.

Table A5: Comparison of macro-financial volatilities in the activating country in the different reciprocity scenarios for passive monetary policy and cost-push shocks. $\phi_\pi = 0.00001$.

Scenario	No Macropru	No Reciprocity	Reciprocity in CCyB	Full Reciprocity
Output	9.3001e-04	-	9.3025e-04	-
Inflation	6.3778e-05	-	6.3683e-05	-
Credit	0.0042	-	0.0042	-
House prices	1.8355e-04	-	1.8320e-04	-

Note: In this experiment, we take the macroprudential policy parameters equal to those optimized in the benchmark monetary policy case. This implies first that under no reciprocity, these parameters are null. Therefore, this case is not different from the no macroprudential policy scenario. This implies secondly that under reciprocity in CCyB and under full reciprocity $\phi^*_{\nu_h} = 0.64$. These two cases are therefore equivalent.

Table A6: Comparison of macro-financial volatilities in the activating country in the different reciprocity scenarios for passive monetary policy and cost-push shocks. $\phi_\pi = 0.00001$.

Scenario	No Macropru	No Reciprocity	Reciprocity in CCyB	Full Reciprocity
Output	9.3001e-04	-	9.3025e-04	-
Inflation	6.3778e-05	-	6.3683e-05	-
Credit	0.0042	-	0.0042	-
House prices	1.8355e-04	-	1.8320e-04	-

Note: In this experiment, we take the macroprudential policy parameters equal to those optimized in the benchmark monetary policy case. This implies first that under no reciprocity, these parameters are null. Therefore, this case is not different from the no macroprudential policy scenario. This implies secondly that under reciprocity in CCyB and under full reciprocity $\phi^*_{\nu_h} = 0.64$. These two cases are therefore equivalent.