Systemic risk and the interaction between monetary and macroprudential policies

Lucas Souza Beppler *[1], Regis Augusto Ely[1], Anderson Mutter Teixeira †[2], and Benjamin Miranda Tabak[3]

[1]Department of Economics, Federal University of Pelotas, Pelotas, RS, Brazil.
[2]Faculty of Management, Accounting and Economics, Federal University of Goias, FACE/UFG, Goiânia, Brazil.
[3]School of Public Policy and Government at Getulio Vargas Foundation, Brasília, DF, Brazil

July 26, 2023

Abstract

We investigate the effectiveness of macroprudential tools and their interaction with monetary policy using a comprehensive cross-country database of 37 countries. For that purpose, we calculate Taylor rules and macroprudential policy indexes for each country, combining them in fixed effects and dynamic panel data regressions. Our results indicate that macroprudential policies have an asymmetric effect on banks' risk-taking with more pronounced effects when a diverse set of instruments is used. However, tightening measures are less effective in enhancing financial stability when a country is already in a restrictive monetary policy stance. This result is associated with the fact that, in such stances, these measures tend to reduce banks' profitability, thereby compromising financial stability. The results bring new evidence of the possible conflict between monetary and macroprudential policies when dealing with systemic risk.

Keywords: Macroprudential policy, Monetary policy, Financial stability
JEL Classification: E52, E58, G18, G28

---

*Corresponding author: lucasbeppler@gmail.com
†Financial support from the CNPq foundation.

1 Introduction

A recent challenge for policymakers and researchers is how to coordinate the interaction between monetary and macroprudential policies to mitigate systemic risk. The Great Financial Crisis (GFC) highlighted the importance of macroprudential instruments in containing a set of systemic events that could compromise financial stability. However, the design and coordination of monetary and macroprudential policies present two major challenges.

The first is an assessment of the effectiveness of the macroprudential policies. The empirical literature on the effectiveness of macroprudential instruments in general confirms that instruments such as loan-to-value ratios (LTV), countercyclical capital buffers (CCB), reserve requirements (RR) and others have favorable effects on banking risk, financial system resilience, smoothing of business cycles, house prices, and transmission of monetary policy (Claessens and Laeven, 2004; Claessens et al., 2013a; Montes and Peixoto, 2014; de Moraes et al., 2016; Cerutti et al., 2017; Jiménez et al., 2017; Altunbas et al., 2018; Bruno et al., 2017; Akinci and Olmstead-Rumsey, 2018; Ely et al., 2021)

The second challenge concerns the interaction between monetary and macroprudential policies and potential conflicts between policies. Kim and Mehrotra (2018) and Revelo and Levieuge (2022) suggest that achieving the targets of price and financial stability requires the coordination of both policies. Empirical literature regarding the interaction between the two policies is in its early stages, and the results are still unclear. Some of the studies that analyzed this interaction include Aiyar et al. (2016), Bruno et al. (2017), Kim and Mehrotra (2018), Revelo et al. (2020), Gambacorta and Murcia (2020) and Altavilla et al. (2020), which investigate the effectiveness of macroprudential policies to curb credit growth and whether their are affected by monetary policy conditions, Takáts and Temesvary (2021), which show that this interaction affects cross-border bank lending and Bekiros et al. (2020), which investigated how both policies affect the prices of real estate and default.

This study contributes to the recent empirical literature on the interaction between macroprudential and monetary policies. We investigate whether there is a possible conflict between these two policies in terms of their effects on financial stability. To achieve this objective, we examine four key questions: (i) What is the effect of macroprudential tools on systemic risk? (ii) Is there an asymmetry between tightening and loosening macroprudential measures? (iii) How this effect changes when both macroprudential and monetary policies are restrictive? (iv) What is the transmission channel for the relationship between macroprudential and monetary policies?

To the best of our knowledge, this study is the first empirical examination of the interaction between monetary and macroprudential policies and their consequences for systemic risk using a comprehensive cross-country database. The articles closest to our contribution are Revelo and Levieuge (2022), Zhang et al. (2020), Revelo et al. (2020) and Takáts and Temesvary (2021). Revelo and Levieuge (2022) investigates the relationship between these policies and financial stability, but does so within a DGSE model with financial frictions. Zhang et al. (2020) studies the interaction between the policies on systemic risk, but they solely analyze the case of China, employing a different methodology and measure of systemic risk compared to our study. Revelo et al. (2020) and Takáts and Temesvary (2021) utilize methodologies similar to ours; however, they respectively analyze the interaction effects of these policies on credit growth and cross-bank lending.

Our results support the findings that macroprudential tools can effectively enhance financial system stability (Altunbas et al., 2018; Ely et al., 2021), but we find a more pronounced effect when a diverse set of instruments is used. Altunbas et al. (2018) also shows that macroprudential tools are more effective during tightening cycles than loosening ones, however, we find that this asymmetry is more pronounced when a higher number of macroprudential instruments is used. While Revelo and Levieuge (2022), Revelo et al. (2020) and Takáts and Temesvary (2021) find evidence of complementarity and conflict between the interaction of macroprudential and monetary policies from the point of view of credit and lending, we focus on the relationship of those policies when dealing with systemic risk and we find potential conflicts that helps to shed light on the results of Revelo and Levieuge (2022). Finally, while Ely et al. (2021) suggested that macroprudential tools primarily reduce systemic risk through the leverage channel, our findings reveal that, during periods of restrictive monetary policy, macroprudential tools reduce banks' return on assets

(ROA), thereby influencing financial stability through the profit channel.

To carry out this study we use a comprehensive accounting database of 37 countries including data from the International Monetary Fund (IMF), World Bank, Federal Reserve Economic Data (FRED), Integrated Macroprudential Policy Database (iMaPP) and Thomson Reuters Database. To assess monetary policy stance, we use the well-known Taylor rule, such as Hofmann and Bogdanova (2012) and Revelo et al. (2020). To assess the macroprudential policy stance, we build four indices which follows the existing literature as well (Cerutti et al., 2017; Revelo et al., 2020). To assess systemic risk, we use an aggregate measure of the banks' Z-score, which is a proxy for financial stability and default probability commonly used in the literature (Cihák and Hesse, 2007; Demirgüç-Kunt and Detragiache, 2011; Demirgüç-Kunt and Maksimovic, 2002). Finally, we estimate fixed effects panel regressions and system-GMM models to investigate the interaction between macroprudential and monetary policies, as formulated by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents data and methods used to determine the stances of macroprudential and monetary policies and the relationship between both policies and financial stability. Section 4 presents and discusses the results. The final section concludes this paper.

2 Literature Review

Our study relates to several strands of literature. In the first strand, we highlight studies of the effectiveness of macroprudential policies (MPs) in general. When it comes to bank risk, certain macroprudential instruments have proven successful in reducing it. Altunbas et al. (2018), using a panel of data for 61 developed and emerging countries, suggest that macroprudential instruments have a significant impact on bank risk. Meuleman and Vander Vennet (2020) also found that macroprudential measures have a downward effect on banks' systemic risk. Ely et al. (2021) investigate the transmission mechanisms of the effect of a set of 12 macroprudential instruments on bank risk-taking. They find that the leverage channel has a considerable effect in reducing systemic risk. In general, macroprudential measures tend to limit bank leverage, thereby reducing the exposure to risk.[1]

When it comes to credit, De Jonghe et al. (2020) and Vandenbussche et al. (2015) find that capital requirements are important for lowering credit supply for firms and households. Kuttner and Shim (2016) find relative effectiveness of macroprudential policies in curbing housing credit and house price. Cerutti et al. (2017), using an IMF survey covering the use of 12 macroprudential measures in 119 countries instruments such as LTV and others that limit the level of indebtedness were associated with the decline in credit growth, especially in real estate lending. Alam et al. (2019) find evidence that LTV limits are effective on household credit. Additionally, Aiyar et al. (2014) suggested a strong effect of capital requirements on loans for UK banks, and Jiménez et al. (2017) confirmed the impact of macroprudential policies on pro-cyclical banking lending to companies.

In addition to this empirical literature, Claessens et al. (2013a) showed that the maximum limits of LTV, debt service-to-income ratios (DSTI), and loans in foreign currency were effective in reducing the growth of bank leverage and asset prices. Cerutti et al. (2017) use an IMF survey to document the use of macroprudential policies in 119 countries. This study confirms that the use of macroprudential policies has increased and is used more frequently in emerging economies. In general, advanced countries use more intensive borrower-based policies, and macroprudential policies can reduce the financial cycles associated with lower credit growth, notably household credit. However, some studies have specifically focused on the possible trade-offs of using MPs. Gurrea-Martínez and Remolina (2019), for example, argued that the implementation of capital requirements could be socially undesirable, at least in certain countries. Mirzaei and Moore (2021), Scalco et al. (2021) and Gonzalez (2022) have recently analyzed the effect of macroprudential policies on bank competition.

The second strand of the literature looks at the interaction between macroprudential and monetary policies [2] because both policies aim at different targets that could

[1] Adrian and Shin (2010) and Borio and Zhu (2012) debate about the impact of monetary policy on private-sector risk-taking.

[2] This is the initial discussion that we recommend regarding the interaction between macroprudential and monetary policy: Ireland (2005), Claessens et al. (2013b) and Beyer (2017). Ngam-

conflict with one another. Generally, the macroprudential policy aims to promote financial stability, whereas the primary objective of monetary policy is to maintain price stability. This empirical literature is recent and includes only a few studies on the relationship between the two policies. Aiyar et al. (2016) use data on UK banks' minimum capital requirements to study the interaction between monetary policy and capital requirement regulation. These authors find that tightening either capital requirements or monetary policy reduces the supply of lending. However, large banks exhibit a significant response to changes in capital requirements rather than changes in monetary policy. There is no other evidence of interaction effects between monetary policy and capital requirements policy.

Bruno et al. (2017) use a sample of 12 Asia-Pacific economies to investigate whether macroprudential policies were synchronized with changes in monetary policy. They find that macroprudential policies have a greater effect on mitigating credit growth when reinforced by monetary policy. Empirical evidence from Gambacorta and Murcia (2020), using meta-analysis techniques and credit registry data for a sample of five Latin American countries, finds that macroprudential policies have been effective in dampening credit cycles, and the effect is greater when reinforced by the use of monetary policy in the same direction. For euro area countries, Zhang and Tressel (2017) find that LTV is more effective in containing credit growth and housing prices when monetary policy is tightened. However, these results are relatively mixed and depend on the lag order of the estimated coefficients interacting with LTV and the interest rate gap computed using a Taylor rule.

Revelo et al. (2020), consistent with our approach, consider different macroprudential instruments from a sample of 37 countries and use a Taylor Gap estimate as a measure of different monetary policy stances to conclude that a restrictive monetary policy influences the impact of macroprudential tightening action on domestic credit growth. In addition, the study suggests that monetary policy helps reduce the transmission delay of macroprudential policy actions. Finally, they confirm complementarities between the two policies and the benefits of coordination. The em-

bou Djatche (2022) provides a literature review on the interaction of monetary and macroprudential policies through their impacts on bank risk-taking. Additionally, it examines the challenges related to their coordination.

pirical literature still examines the interaction between changes in monetary policy and macroprudential policy in cross-border banking lending (Takáts and Temesvary, 2021).

Zhang et al. (2020) analyze the effectiveness, channels, and timeliness of monetary and macroprudential policies' impacts on systemic risk in China. This study finds evidence that macroprudential policy has a greater impact on systemic risk. Additionally, a monetary shock immediately increases systemic risk following a positive interest rate shock. The main contribution of this study is the utilization of macroprudential policy as its primary tool and monetary policy as a supplement to restrain the outbreak of systemic risk. Recently, Bekiros et al. (2020) developed a tractable dynamic stochastic general equilibrium (DSGE) model to study the impact of variations on house price expectations on macroeconomic dynamics and their implications for monetary and macroprudential policies [3].

Furthermore, within the second literature strand, our paper contributes to studies that highlight the potential for conflicts between the two policies, which can negatively impact the real side of the economy (Richter et al., 2019; Fraisse et al., 2020; Juelsrud and Wold, 2020; Gropp et al., 2019). The literature also discusses how to optimally articulate cooperation between both policies, such as Lazopoulos and Gabriel (2019) and Bodenstein et al. (2019), which bring evidence of gains from the cooperation of monetary policy and macroprudential instruments.

Collard et al. (2017) model the optimal interaction of monetary and prudential policies in a scenario in which bank capital requirements are a tool for addressing the risk-taking incentives created by limited liability and deposit insurance. Evidence shows that optimal interaction would require cutting (raising) interest rates to moderate the contractions (expansions) caused by tightening (loosening) capital requirements. Aikman et al. (2023), developed a simple, calibrated new Keynesian model to explore how monetary and macroprudential policies affect the economy. The calibrated results suggest that deploying countercyclical capital buffers improves the outcomes when monetary policy is the only instrument. Nonetheless, the instruments

[3] The non-exhaustive list of related literature papers of DSGE models that analyze the effects of macroprudential and monetary contains: Kannan et al. (2012), Angeloni and Faia (2013), Angelini et al. (2014), Mendicino and Punzi (2014), Bailliu et al. (2015), Rubio and Carrasco-Gallego (2016), Tayler and Zilberman (2016) and Gelain and Ilbas (2017).

are typically substitutes, and the policy message is that the benefits of coordinating these policies are small, and similar economic performance can be achieved by distinct policymakers pursuing distinct objectives. Kim and Mehrotra (2018), examined the effects of monetary and macroprudential policies in the Asia-Pacific region. They find evidence that a complementarity relationship between both policies to achieve the targets of price and financial stability may be challenging in an environment of low inflation and strong credit growth. Finally, our study is consistent with the recent theoretical study by Revelo and Levieuge (2022). The paper provides a comprehensive analysis of the potential conflicts between macroprudential and monetary policies using a DGSE model with financial frictions.

Lastly, the third strand of the literature analyzes monetary policy and systemic risk. After the GFC, some articles claim that monetary policy influenced credit, asset price booms, and excessive risk-taking by financial intermediaries (Freixas et al., 2015). Borio and Zhu (2012) was the first article to mention the term monetary policy risk-taking channel through the risk appetite of financial intermediation. Our paper is consistent with the initial models that analyze the link between monetary policy, credit and asset price bubbles (Allen and Gale, 2000; Allen and Gale, 2009; Allen and Gale, 2011). Diamond and Rajan (2012) and Laeven et al. (2010) investigate the link between monetary policy and excessive risk-taking in lending, but analyze the problem of moral hazard and asymmetric information as well. Farhi and Tirole (2012) demonstrate that when the central bank wants to lend ex-post, it can result in more banking risk-taking ex-ante. Acharya and Naqvi (2012) find that access to abundant liquidity can influence asset bubble formation. In addition, Adrian and Shin (2010) and Stein (2012) discuss the role of leverage and collateral in excessive risk-taking among financial intermediaries.

3 Data and Methods

To assess the effect of macroprudential tools on systemic risk and whether the monetary policy stance strengthens this effectiveness, we first define the macroprudential policy stance and the monetary policy stance. Section 3.1 provides an overview of the implementation of macroprudential instruments over the past decade and Section 3.2 defines the macroprudential policy stance. Section 3.3 deals with the definition of the monetary policy stance. Finally, Section 3.4 deals with the relationship between both stances and financial risk.

3.1 Macroprudential Instruments

To define the macroprudential policy position, we use the the IMF's integrated Macroprudential Policy (iMaPP) Database, originally constructed by Alam et al. (2019). We consider all 17 macroprudential instruments present in the database for a sample of 37 emerging and developed countries between 2011 and 2021. Table 1 provides a brief description of each instrument used.

The iMaPP database attributes monthly values, by country, for each of the 17 macroprudential instruments. Three values can be assigned: +1, -1 or 0. If the instrument has more tightening actions than loosening actions during the month, the value assigned is +1 for that month. If the instrument has more loosening actions, the value is -1. If the instrument is not used in the month or the number of tightening actions is the same as the number of loosening actions, the value is 0. It is important to note that usually only one macroprudential action is taken per month, which makes the values attributed by the database (+1, 0 or -1) a good approximation of the number of tightening and loosening actions taken by a country in general.

Table 1. Description of the 17 macroprudential instruments available at the iMaPP database

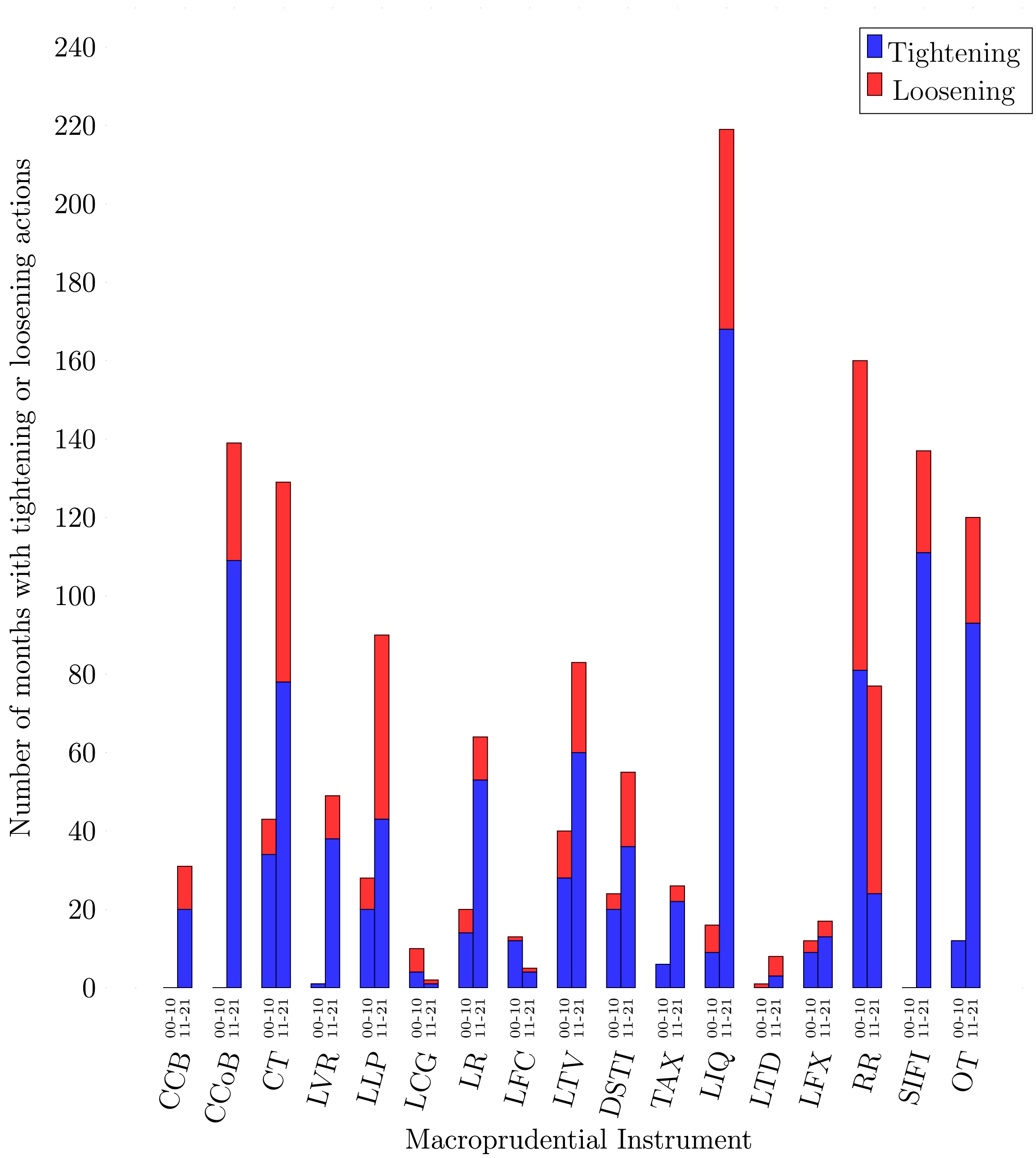
Instrument	Description
Countercyclical Capital Buffer (CCB)	Capital buffer is capital that a bank must hold beyond the minimum that is required. A Countercyclical capital buffer, then, is a type of buffer imposed on banks that would increase (decrease) requirements on capital during economic expansions (recessions)
Capital Conservation Buffer (CCoB)	It was introduced to ensure that banks have additional usable capital when losses occur
Capital Requirements (CT)	Requirements for banks which include systemic risk buffers and minimum capital requirements
Limits on Leverage of Banks (LVR)	It is calculated by dividing a measure of capital by the bank's non-risk-weighted exposures
Loan Loss Provision (LLP)	Specific provisioning is required for defaults on loan contracts. It allows the creation of reserves during periods of economic growth that are meant to be used in periods of recession to cover the defaults that eventually occur (Ely et al., 2021)
Limits on Credit Growth (LCG)	Limits set on growth or volume of aggregate credit and on domestic or corporate sector credit
Loan Restrictions (LR)	Lending limits and prohibitions conditional on loan characteristics such as interest rate type, maturity, size and LTV
Limits on Foreign Currency Lending (LFC)	Foreign currency borrowing is limited, reducing vulnerability to foreign currency risks
Limits to Loan-to-Value Ratios (LTV)	Cap on the percentage of an asset's value that can be financed by a bank loan in order to guarantee a minimum collateral for a loan (Ely et al., 2021)
Limits to Debt-Service-to-Income Ratio and Loan-to-Income Ratio (DSTI)	Minimum levels are imposed on the expected capacity of borrowers to pay their debts
Tax (TAX)	Taxes and fees applied to specific transactions, assets or liabilities
Measures to mitigate systemic liquidity (LIQ)	Measures that include, for example, minimum requirements for LCR (liquid coverage ratio)
Limits to Loan-to-Deposit Ratio (LTD)	Limits on LTD. It compares bank's total loans to bank's total deposits over the same period.
Limits on Foreign Exchange Positions (LFX)	Limitations on deposits and other monetary amounts held by domestic financial institutions in foreign currency
Reserve requirements (RR)	Parcel of the account holders' money that banks are required to keep at their Central Bank
Measures to Mitigate Risks from Global and Domestic Systemically Important Financial Institutions (SIFI)	Surcharges imposed on capital requirements for financial institutions that are considered systematically important
Others (OT)	Measures not captured in previous categories, such as exposure limits between financial institutions

Source: Elaborated by the author based on information from IMF's integrated Macroprudential Policy (iMaPP) Database, originally constructed by Alam et al. (2019)

Figure 1 shows the number of months with more tightening or loosening actions from 2000 to 2010 and from 2011 to 2021. We see that, approximately, the most used instruments were measures taken to mitigate systemic liquidity (LIQ), reserve requirements (RR), capital requirements (CT) and measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFI). We also observe a dominance of months in which tightening actions prevailed compared to months in which loosening months prevailed in both periods of time. The main exception relates to RR, as these tools are predominantly utilized by developing countries. In our sample, Brazil, Serbia and Turkey emerged as the largest users of the instrument, accounting for nearly 60% of its usage. Finally, it is evident that macroprudential tools have witnessed a substantial surge in usage. The period from 2011 to 2021 has experienced a significant increase in their implementation compared to the preceding period of 2000-2010. The only instruments that experienced greater usage during the 2000-2010 period are limits on credit growth (LCG), limits on foreign currency lending (LFC), and RR.

Table 2 shows us that macroprudential instruments reached peak usage from 2015 onwards. Among the instruments, CCoB, LIQ, and SIFI exhibited the most substantial increase in usage since 2015. Figure 2 show us that macroprudential policy is not confined to a niche domain but is utilized by countries worldwide. CCoB, LIQ, SIFI and Loan loss provisions (LLP) were used by almost all countries of our sample from 2011 to 2021.

Figure 1. Number of months with more tightening or loosening actions by macroprudential instrument from 2000 to 2010 and from 2011 to 2021 across 37 countries



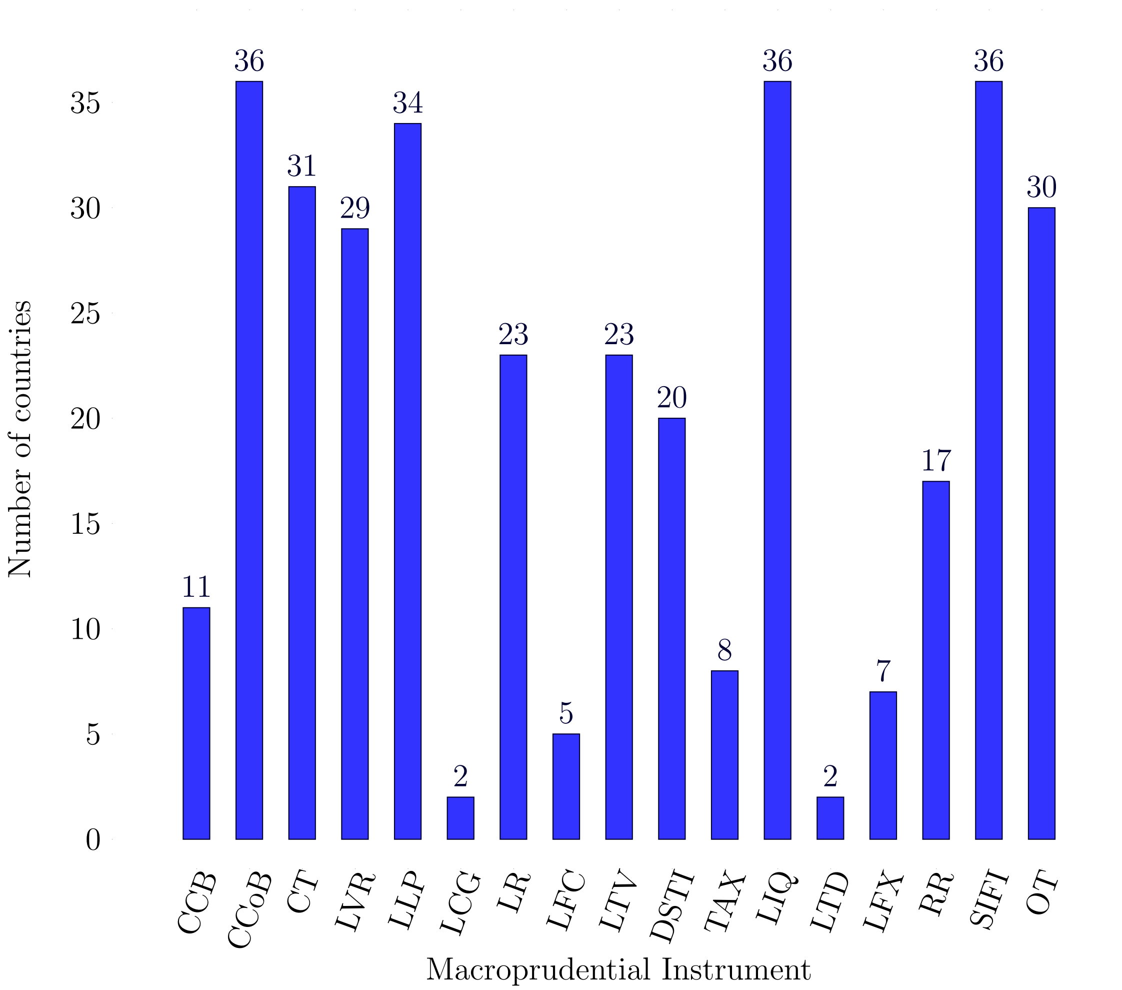
Note: For every month and for every country, a value of +1, -1 or 0 is attributed for each of the 17 macroprudential instruments. If an instrument had more tightening actions (loosening actions) than loosening actions (tightening actions) during the month, the value assigned for that month is +1 (-1). If the macroprudential instrument was not used at all in the month or the number of tightening actions is the same as the number of loosening actions, the value is 0. Data were obtained from the iMaPP database.

Table 2. Number of months with more tightening or loosening actions across 37 countries from 2011 to 2021.

Instruments	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CCB	0	0	0	1	1	2	2	5	9	11	1
CCoB	1	0	4	6	5	24	26	24	22	25	2
CT	7	4	12	14	9	9	10	11	6	41	6
LVR	0	0	0	3	4	4	0	8	2	10	18
LLP	5	1	4	4	3	1	1	23	1	35	1
LCG	0	0	0	0	0	0	0	1	0	1	0
LR	7	3	7	3	5	6	3	6	5	16	3
LFC	2	0	1	1	0	0	0	1	0	0	0
LTV	8	8	7	5	8	9	7	8	5	13	5
DSTI	5	3	6	5	4	4	3	7	5	8	5
TAX	7	4	3	0	0	3	3	3	1	1	1
LIQ	0	3	2	1	31	30	34	36	17	41	24
LTD	1	1	1	0	1	0	0	0	0	1	3
LFX	2	0	2	1	2	4	1	0	1	4	0
RR	19	20	1	4	2	5	7	4	4	5	6
SIFI	0	0	2	4	2	18	20	24	24	33	10
OT	7	4	4	6	2	2	4	5	4	60	22
All	71	51	56	58	79	121	121	166	106	305	107

Note: For every month and for every country, a value of +1, -1 or 0 is attributed for each of the 17 macroprudential instruments. If an instrument had more tightening actions (loosening actions) than loosening actions (tightening actions) during the month, the value assigned for that month is +1 (-1). If the macroprudential instrument was not used at all in the month or the number of tightening actions is the same as the number of loosening actions, the value is 0. Data were obtained from the iMaPP database.

Figure 2. Number of countries that have tightened or loosened an instrument at least once from 2011 to 2021 in our sample



Note: For every month and for every country, a value of +1, -1 or 0 is attributed for each of the 17 macroprudential instruments. If an instrument had more tightening actions (loosening actions) than loosening actions (tightening actions) during the month, the value assigned for that month is +1 (-1). If the macroprudential instrument was not used at all in the month or the number of tightening actions is the same as the number of loosening actions, the value is 0. Data were obtained from the iMaPP database.

3.2 Macroprudential Policy Behavior

Utilizing the values available in the iMaPP database, we construct four indices that enable us to determine the macroprudential policy stance. We aggregate the database's monthly values into annual values so that we can create annual macroprudential policy behavior indices. The indices $MP^{(1)}$, $MP^{(2)}$ and $MP^{(3)}$ were originally developed by Cerutti et al. (2017) and Revelo et al. (2020). We then compute an additional index $MP^{(4)}$.

The first index, $MP^{(1)}$, is:

$$MP_{i,t}^{(1)} = \begin{cases} +1: & if \sum_a x_{a,i,t} > 0 \\ 0: & if \sum_a x_{a,i,t} = 0 \\ -1: & if \sum_a x_{a,i,t} < 0 \end{cases} \quad (1)$$

where the subscript i refers to country, subscript t refers to year and subscript a refers to one of the macroprudential instruments.

$x_{a,i,t}$ corresponds to the difference between the number of months with more tightening actions and the number of months with more loosening actions in instrument a along year t for country i. Positive values of $x_{a,i,t}$ indicate that, for country i and year t, months with more tightening actions of the macroprudential instrument a prevail over loosening ones of the same instrument. Negative values indicate that months with more loosening actions prevail over tightening ones. If $x_{a,i,t}$ is zero, it means that tightening and loosening measures cancel each other out in year t, or that no action takes place during the months of year t.

$\sum_a x_{a,i,t}$ is simply the sum of $x_{a,i,t}$ for all the 17 instruments available. The result of the sum can be positive (+1, +2, +3, +4, ...), negative (-1, -2, -3, -4, ...) or zero. If the sum is positive, $MP^{(1)}$ equals +1, and the overall macroprudential policy framework is considered restrictive during year t for country i. If the result of the sum is negative, $MP^{(1)}$ is equal to -1, and the policy is considered accommodative in year t for country i. If it is 0, no action whatsoever took place during year t or tightening measures and loosening measures canceled each other out in year t.

The second index, $MP^{(2)}$, is:

$$MP_{i,t}^{(2)} = \begin{cases} \text{+1:} & if \sum_a y_{a,i,t} > 0 \\ \text{0:} & if \sum_a y_{a,i,t} = 0 \\ \text{-1:} & if \sum_a y_{a,i,t} < 0 \end{cases} \quad (2)$$

$y_{a,i,t}$ can assume three values: +1, -1 or 0. For a given year and country, an instrument takes the value of +1 if there are more months with tightening than loosening actions. If the value is -1, there are more months with loosening than tightening actions. If $y_{a,i,t}$ is zero, it means that tightening and loosening measures cancel each other out in year t, or that no action takes place during the months of year t.

$\sum_a y_{a,i,t}$ is simply the sum of $y_{a,i,t}$ for all the 17 instruments available. The result of the sum can be positive (+1, +2, +3, +4, ...), negative (-1, -2, -3, -4, ...) or 0. If the sum is positive, $MP^{(2)}$ equals +1, indicating that the number of tightened instruments used during year t is greater than the number of loosened instruments used during the same period. If negative, $MP^{(2)}$ equals -1, indicating that the number of loosened instruments used during year t is greater than the number of tightened instruments used. A value of 0 indicates that either no action took place or that the number of instruments used in tightening actions was equal to the number of instruments used in loosening actions. Unlike $MP^{(1)}$, $MP^{(2)}$ assigns equal weight to each instrument adopted within a year, regardless of the number of tightening or loosening months associated to the instrument.

The $MP^{(3)}$ index is defined as:

$$MP_{i,t}^{(3)} = \sum_a x_{a,i,t} \quad (3)$$

As mentioned before, it corresponds to the difference between the number of months with more tightening actions and the number of months with more loosening actions in year t for country i for all the instruments. A higher value of the index indicates a more restrictive macroprudential policy framework in the given year, while a lower value signifies a more accommodative policy stance.

The $MP^{(4)}$ index is defined as:

$$MP_{i,t}^{(4)} = \sum_a y_{a,i,t} \tag{4}$$

As mentioned before, it corresponds to the difference between the number of tightened and loosened instruments. A higher value of the index indicates a higher number of tightened instruments in the given year, while a lower value signifies a higher number of loosened instruments.

3.3 Monetary Policy Behavior

To evaluate the conduct of monetary policy, we compare the actual value of the policy-related interest rate with an estimated interest rate derived from a Taylor Rule, which serves as an approximation of central bank behavior. If the observed interest rate is higher than the estimated value, we consider monetary policy as restrictive during the period. Conversely, if the observed rate is lower than the estimated value, it signals an accommodative monetary policy.

To calculate the interest rate via Taylor Rule, Equation 5 is estimated for each individual country and the Eurozone, following Hofmann and Bogdanova (2012) and Revelo and Levieuge (2022):

$$i_t = \rho i_{t-1} + (1-\rho)[\alpha + \beta_\pi \pi_t + \beta_y (y_t - \hat{y}_t)] + \varepsilon_t \tag{5}$$

where i_t is the observed monetary policy-related interest rate and i_{t-1} is its lagged value; π_t is the inflation rate; $y_t - \hat{y}_t$ is the output gap and ε_t is the error term.

A positive relationship is expected between the inflation rate, output gap and interest rate. Therefore, β_π and β_y are expected to be positive. As we collect quarterly data, the estimated Taylor gap has quarterly frequency. Averages are taken to compute the Taylor Gap estimates by year for each country and Eurozone.

Data series for interest rates, inflation rates, and real GDP are collected from the IMF's International Financial Statistics (IFS) Database when available. For the Eurozone, inflation and seasonally adjusted real GDP are taken from FRED's economic data. For India and Sweden, policy rates are taken from the respective central banks of each country. Because of the unconventional monetary policies adopted by some developed countries after the 2007 financial crisis, we decide to use shadow rates instead of regular monetary policy rates when possible (Revelo et al., 2020; Ouerk et al., 2020; Lombardi and Zhu, 2014). Negative values of shadow rates enable a more accurate representation of unconventional monetary policy actions. Shadow rates are available in the LJK Limited database for Canada, Eurozone, Switzerland, the United Kingdom, and the United States of America. Finally, to calculate the output gap, the Hodrick-Prescott filter was used with λ equal to 1600, which is the recommended value for a quarterly series (Hodrick and Prescott, 1997).

To estimate Equation 5, we use the Generalized Method of Moments (GMM) following Clarida et al. (2000) and Revelo et al. (2020). This method was selected to overcome possible endogeneity problems. Two points require clarification. Firstly, each country has its unique data time range. Secondly, and most importantly, we utilize a varying number of instruments for estimation via GMM in each country. This way we can account for country-specific factors and data availability.

Consistent with existing literature, lags of the dependent and independent variables were chosen as instruments. The selection of the number of instruments for each nation was based on the following criteria:

i) The chosen instruments must have their validity corroborated by the overidentification test developed by Hansen (1982);

ii) The lags of all three variables must be used. Considering the three variables as instruments can reduce endogeneity problems associated with a possible relationship between inflation and the output gap;

iii) We should not expect negative and statistically significant values for ρ, $\beta\pi$, βy and α. In addition, we aim at values of ρ lower than 0.95 if possible.

Subject to the aforementioned conditions, we conduct regressions using the minimum number of instruments required. Using a large number of instruments can overestimate endogenous variables while weakening the Hansen test (Roodman, 2009).

Table A1 shows the estimation results of Equation 5, along with the p-value of the Hansen test, the number of observations for each country and the estimation period for each country. Taylor Gap estimates fared better for developing countries. These countries tend to use monetary policy in its traditional sense, in which interest rates are seen as the main financial return of economic policy. In contrast, many developed countries, after the 2007-08 financial crisis, are much closer to a "zero lower bound" environment while adopting unconventional monetary policies, such as quantitative easing.

3.4 Bank Z-Score and Macroprudential and Monetary Policies

Using a sample of 37 advanced and emerging economies from 2011 to 2021, we investigate what is the effect of macroprudential policies (represented by $MP^{(1)}$, $MP^{(2)}$, $MP^{(3)}$ and $MP^{(4)}$) on financial stability and how monetary policy (represented by the Taylor Gap) changes this effect. Financial stability is measured by the banks Z-Score, in line with existing literature (Cihák and Hesse, 2007, Demirgüç-Kunt and Detragiache, 2011, Demirgüç-Kunt and Maksimovic, 2002; Sysoyeva, 2020). We use an aggregate measure of the Z-score, available at the World Bank's Global Financial Development (GFD) Database. It is calculated as the weighted average of the Z-Scores of individual banks in a country, in which the weights are based on the total assets of each bank.

The calculation of the Z-Score for an individual bank, according to the World Bank, is:

$$\text{Z-Score} = \frac{ROA + \text{ER}}{\sigma(ROA)} \tag{6}$$

where ROA is the bank's Return on Assets, ER is the bank's Equity Ratio, and $\sigma(ROA)$ is the standard deviation of ROA. A higher Z-Score value indicates greater financial stability.

Our empirical analysis proceeds in four steps: i) Four baseline regressions are estimated via fixed effects to asses the effect of each macroprudential index on banks' Z-Score ; ii) Eight asymmetric regressions are estimated via fixed effects considering the effect of a macroprudential index tightening on banks' Z-Score separately from the effect of a macroprudential index loosening; iii) Eight interaction regressions are conducted, with four estimated via fixed effects and four via system GMM, to explore the effect of a macroprudential index tightening and restrictive monetary policy on Z-Score ; iv) Four interaction regressions are estimated via system GMM to examine the effect of a macroprudential index tightening and restrictive monetary policy on ROA;

Initially, we employ fixed effects estimation to control for unobservable time-invariant country characteristics. Recognizing the possibility of significant correlation between fixed effect panel specifications and the lagged dependent variable, we further employ dynamic panels estimated using the system GMM estimator, following the approach of Arellano and Bover (1995).

The four baseline regressions have the following specification:

$$lnZScore_{i,t} = \alpha_i + \sum_{k=0}^{1} \beta_k MP_{i,t-k}^{(n)} + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{7}$$

where i stands for country and t for year.

$MP_{i,t-k}^{(n)}$ is one of the four macroprudential indices described in Section 3.2. $Covid_i$ is a dummy variable for the 2020/2021 Covid-19 pandemic. α_i are country-fixed effects and $X_{i,t}$ includes a set of macroeconomic and financial control variables:

i. GDP growth rate is computed using the nominal GDP available in the IMF's IFS database.

ii. Lending Rate is taken from the IFS database whenever available. In cases where data is not accessible from the IFS database, we use averages of monthly interest rates on loans to non-financial corporations. Specifically, data for Serbia, Turkey, and the United Kingdom is obtained from the Central Bank of each respective country and, for the remaining European nations, we utilize data from the European Central Bank Statistical Data Warehouse.

iii. Bank Concentration (CR3) data is obtained from the GFD database (World Bank)

iv. Size is the natural logarithm of the sum of the total assets of individual banks from each country i at time t, calculated using data from the Thomson Reuters Database.

v. Liquid Assets is the ratio of the sum of liquid assets and the sum of total assets from individual banks for each country i at time t, calculated using data from the Thomson Reuters Database.

vi. Deposits Ratio is the ratio of the sum of total deposits and the sum of total assets from individual banks for each country i at time t, calculated using data from the Thomson Reuters Database.

vii. Cost Ratio is the ratio of the sum of interest expense and the sum of interest income from individual banks for each country i at time t, calculated using data from the Thomson Reuters Database.

The Thomson Reuters Database is a quarterly database of cash flows, balance sheets and income metrics for joint stock banks. Our objective is to construct an annual database for each country based on this quarterly dataset. First, we collect the quarterly data for banks whether they are active or inactive during the period 2011-2020. We then drop banks with missing values or zeros in the variables of interest derived from the balance sheet. We proceed to compute a new variable: total interest expense (the difference between Interest Income and Net Interest Income). The next step is to group the data per year and bank. For variables derived from the balance sheet, we use the last available value of each fiscal year; for variables derived from the income statement, we compute an annualized average. From there, we compute the Liquid Assets Ratio (Cash and Due from Banks/Total Assets), Deposits Ratio (Total Deposits/Total Assets) and Cost Ratio (Interest Expense/Interest Income) for each bank. Finally, the data is grouped by year and country. Size is the sum of total assets of all banks in a country per year. For the other three ratios, we have annual averages weighted by total assets.

For Equation 7, the main coefficient of interest is β_k. We expect a positive value for this coefficient. Our hypothesis is that a restrictive macroprudential policy should enhance financial stability.

The eight asymmetric regressions have the following specifications:

$$lnZScore_{i,t} = \alpha_i + \sum_{k=0}^{1} \beta_k MP^{+(n)}_{i,t-k} + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{8}$$

$$lnZScore_{i,t} = \alpha_i + \sum_{k=0}^{1} \beta_k MP^{-(n)}_{i,t-k} + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{9}$$

where $MP^{+(n)}_{i,t-k}$ is equal to $MP^{(n)}_{i,t-k}$ when $MP^{(n)}_{i,t-k} > 0$ or zero otherwise (tightening). $MP^{-(n)}_{i,t-k}$ is equal to -$MP^{(n)}_{i,t-k}$ when $MP^{(n)}_{i,t-k} < 0$ or zero otherwise (loosening)

In these equations, we isolate the effects of tightened ($MP^{+(n)}_{i,t-k}$) and loosened ($MP^{-(n)}_{i,t-k}$) macroprudential policies on Bank Z-Score. β_k is the main coefficient of interest. For tightened policies, β_k is expected to be positive. For loosened ones, it is expected to be negative.

The four interaction regressions, estimated via fixed-effects, have the following specification:

$$lnZScore_{i,t} = \alpha_i + \sum_{k=0}^{1} \beta_k MP^{+(n)}_{i,t-k} + \sum_{k=0}^{1} \omega_k (MP^{+(n)}_{i,t-k} \times TG_{i,t}) + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{10}$$

where $TG_{i,t}$ is a dummy variable equal to 1 when the Taylor Gap is greater than 0, that is, when we have a restrictive monetary policy, and 0 otherwise. $MP^{+(n)}_{i,t-k} \times TG_{i,t}$ is then the interaction term between restrictive macroprudential and monetary policies.

The main coefficients of interest in this specification are β and ω. Comparing the signs and magnitudes of these coefficients will provide us insights into how monetary policy influences the impact of macroprudential policy on the Z-Score. One important aspect of the interaction term $MP^{+(n)}_{i,t-k} \times TG_{i,t}$ is the use of a dummy variable to represent monetary policy instead of utilizing the actual value of the Taylor Gap. This approach helps us mitigate potential inaccuracies stemming from GMM instrumentalization as well as the variations in monetary policy rules across countries, which may not necessarily align with the rule specified in Equation 5.

We proceed to estimate Equation 11 using system GMM. We reduce the possible endogeneity bias by introducing the lagged dependent variable on the right side of Equation 11:

$$lnZScore_{i,t} = \alpha_i + \gamma lnZScore_{i,t-1} + \beta MP_{i,t}^{+(n)} + \omega(MP_{i,t}^{+(n)} \times TG_{i,t}) + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{11}$$

This model allows us to use lagged variables as instruments for characteristics that are considered endogenous or predetermined. While we treat $Covid$ as an exogenous variable, Bank Concentration, $MP^{+(n)}$ and the interaction term are considered predetermined variables and the rest of the covariates are considered endogenous variables. Regarding Bank Concentration, the reason we consider it as predetermined is grounded in the historical and institutional factors that have over time shaped the banking industry. Bank concentration may be influenced by regulatory policies, merger and acquisition activities, changes in the competitive landscape of the industry and other things. The point is that such factors are typically long-lasting and not easily affected by short-term fluctuations in bank risk. Therefore, we consider that bank concentration is determined by factors that are fixed before the start of the time period under consideration and are not influenced by current or future events. Now, regarding the two policy variables, $MP^{+(n)}$ and the interaction term, it is known that the implementation decisions of macroprudential and monetary policies are made by the monetary authority using, among other information, banks' balance sheets. These balance sheets, however, have a release delay, making their data non contemporary. The authority, therefore, makes decisions today based on data already realized in the banks' balance sheet. As a result, we consider both policy variables as predetermined.

Lastly, to better understand how macroprudential and monetary policies affect financial stability, we investigate what is the effect of restrictive macroprudential policies on one of the Z-Score's components, namely banks' return on assets (ROA), and how restrictive monetary policy changes this effect. We estimate Equation 12 using system GMM. We use the same setup of endogenous, predetermined and exogenous variables as in Equation 11.

$$ROA_{i,t} = \alpha_i + \gamma ROA_{i,t-1} + \beta MP_{i,t}^{+(n)} + \omega(MP_{i,t}^{+(n)} \times TG_{i,t}) + \phi X_{i,t} + \zeta Covid_i + \varepsilon_{i,t} \tag{12}$$

Table 3. Mean values by country

	ln Z-Score	ROA	ΔGDP	Lending Rate	Bank Concentration	ln Total Assets	Liquid Assets	Deposits Ratio	Cost Ratio
Austria	3.415	0.649	2.953	1.878	59.236	20.071	0.155	0.727	0.319
Belgium	2.750	0.606	3.034	2.428	70.754	19.996	0.079	0.563	0.404
Bulgaria	2.198	0.469	5.878	5.682	52.685	15.878	0.195	0.860	0.381
Brazil	2.795	1.213	7.900	38.047	67.993	21.141	0.092	0.323	0.576
Canada	2.669	1.108	3.881	2.816	60.633	22.055	0.020	0.667	0.369
Chile	2.180	1.311	7.165	5.979	63.121	19.320	0.069	0.541	0.424
Colombia	1.837	2.087	6.775	11.729	75.660	19.376	0.096	0.655	0.378
Cyprus	2.008	-0.129	2.081	5.159	80.040	17.700	0.180	0.830	0.283
Czech Republic	2.450	1.415	4.598	2.774	62.023	17.751	0.229	0.816	0.310
Denmark	3.091	0.620	3.005	2.573	83.002	20.381	0.071	0.405	0.484
Estonia	2.339	1.541	6.651	2.770	93.076	14.324	0.371	0.846	0.180
Finland	2.572	0.484	2.690	1.712	90.774	20.476	0.082	0.395	0.407
Germany	2.805	0.053	3.155	2.657	75.350	21.756	0.075	0.425	0.446
Greece	1.659	-2.093	-1.738	4.792	88.351	19.708	0.079	0.820	0.326
Hungary	2.140	0.960	6.597	4.689	66.830	17.761	0.130	0.747	0.301
India	2.871	0.674	10.426	9.710	34.388	20.917	0.077	0.764	0.628
Indonesia	1.686	2.436	8.653	11.223	40.860	19.757	0.134	0.749	0.372
Israel	3.442	1.005	5.106	3.569	75.534	19.933	0.177	0.795	0.228
Italy	2.609	-0.157	0.980	3.337	62.957	21.729	0.095	0.641	0.367
Kenya	3.156	4.116	11.695	14.954	38.851	17.022	0.129	0.761	0.281
Korea Republic	2.462	0.654	4.095	3.747	60.368	21.222	0.049	0.593	0.409
Lithuania	1.910	1.243	7.100	2.298	93.528	14.756	0.089	0.851	0.135
Mexico	3.008	1.520	6.237	5.513	48.748	19.107	0.071	0.440	0.410
Netherlands	2.463	0.573	3.091	2.380	86.035	21.135	0.079	0.592	0.580
Poland	2.272	1.177	5.688	4.415	44.802	19.525	0.053	0.774	0.271
Portugal	2.567	-0.712	1.709	3.334	73.652	18.645	0.052	0.762	0.414
Romania	2.366	0.754	7.498	7.869	61.524	17.132	0.188	0.824	0.239
Russia	1.991	1.496	7.196	9.874	46.499	20.378	0.115	0.718	0.462
Serbia	2.599	0.952	6.216	5.111	44.608	11.738	0.324	0.580	0.217
Singapore	3.442	1.130	4.653	5.323	84.557	20.485	0.131	0.729	0.359
Spain	2.911	0.042	1.188	2.615	61.763	21.893	0.090	0.643	0.422
Sweden	3.540	0.931	3.937	2.738	91.355	20.725	0.147	0.425	0.422
Switzerland	2.783	0.210	1.469	2.661	75.157	21.245	0.068	0.522	0.475
Thailand	2.105	1.391	3.714	4.406	45.205	19.919	0.017	0.752	0.317
Turkey	2.379	1.668	18.332	15.717	42.311	20.111	0.104	0.618	0.536
United Kingdom	2.694	0.385	3.208	3.083	51.925	22.696	0.106	0.472	0.344
USA	3.524	1.478	4.095	3.714	38.570	23.344	0.062	0.638	0.177

Note: This table shows the averages of the main variables by country from 2011 to 2021.

Table 3 exhibits the mean values by country of the variables utilized from equation 7 to 12.

4 Results

In order to investigate whether there is a possible conflict between macroprudential and monetary policy in terms of their effects on financial stability, we examine four key questions: (i) What is the effect of macroprudential tools on systemic risk? (ii) Is there an asymmetry between tightening and loosening macroprudential measures? (iii) How this effect changes when both macroprudential and monetary policies are restrictive? (iv) What is the transmission channel for the relationship between macroprudential and monetary policies? To properly address this set of questions, we have divided this section into four parts. Section 4.1 reports the results of the impact of macroprudential instruments on banks' risk-taking behavior in Tables 4 and 5. Section 4.2 reports the asymmetric effects of macroprudential policies in Tables 6, 7, 8 and 9. Section 4.3 presents the effects of the interaction between macroprudential and monetary policies on banks' risk-taking behavior in Tables 10, 11 and 12. Finally, in Section 4.4, Table 13 explores the mechanisms behind the interactions between these two policies.

To determine the macroprudential policy stance, we use the $MP^{(n)}$ indices described in Section 3.2. These indices have been constructed on a yearly and country-specific basis. $MP^{(1)}$ equals +1 when there are more months in which tightening actions prevail over loosening actions. It is -1 when loosening actions prevail. $MP^{(2)}$ equals +1 when there are more tightened instruments than loosened instruments and -1 when there are more loosened ones. $MP^{(3)}$ corresponds to the difference between the number of months with more tightening actions and the number of months with more loosening actions. Finally, $MP^{(4)}$ corresponds to the difference between the number of tightened instruments and loosened ones. We also construct versions of these indices that segregate macroprudential tightenings from macroprudential loosenings. The index that only considers tightenings, $MP^{+(n)}$, is equal to $MP^{(n)}$ when $MP^{(n)} > 0$ and zero otherwise. The index that only considers loosenings, $MP^{-(n)}$, is equal to -$MP^{(n)}$ when $MP^{(n)} < 0$ and zero otherwise. For the monetary policy stance, we use the Taylor Gap described in Section 3.3. A positive Taylor Gap indicates that the monetary policy was restrictive, while a negative Taylor Gap indicates that the policy was accommodative. Finally, as a measure of financial stability, we use the logarithm of Bank Z-Score described in Section 3.4.

4.1 Macroprudential tools and systemic risk

Tables 4 and 5 evaluate the effect of macroprudential policies on banks' risk-taking behavior using the logarithm of Z-score as a measure of bank stability. For this purpose, we first estimate the fixed effects panel data model of Equation 7, using the four indices described in Equations 1, 2, 3 and 4. Table 4 shows the results for indices $MP^{(1)}$ and $MP^{(2)}$. The results for $MP^{(1)}$ are reported in columns 1 (without lagged values) and 2 (with lagged values), whereas the results for $MP^{(2)}$ are reported in columns 3 and 4. Table 5 shows the results for indices $MP^{(3)}$ and $MP^{(4)}$. The results for $MP^{(3)}$ are reported in columns 1 (without lagged values) and 2 (with lagged values), while the results for $MP^{(4)}$ are reported in columns 3 and 4.

Our findings demonstrate that macroprudential tools can effectively enhance financial system stability. Tables 4 and 5 show that a macroprudential policy tightening positively affects financial stability. Macroprudential tightening increases banking system stability by approximately 3.3%. When a diverse set of instruments is used, this effect increases to, approximately, 4.1%. For each month in which tightening actions prevail during the year, the effect on financial stability increases by approximately 0.9%. For each month in which the number of tightening instruments prevails during the year, the effect on financial stability increases by approximately 1.4%. These results align with the core principle of macroprudential policy. Macroprudential tools are, by design, constructed to enhance financial stability. They allow policymakers to identify and address specific risks and vulnerabilities in the financial system, they enable adjustments to the regulatory framework in response to changing economic conditions and they promote resilience and safeguards against external shocks. Our results are also in line with recent literature (Apergis et al., 2022; Ben-Gad et al., 2022; Claessens et al., 2013a; Fernandez-Gallardo, 2023; Meuleman and Vander Vennet, 2020; Meuleman and Vander Vennet, 2020; Altunbas et al., 2018 and Ely et al., 2021).

As for the control variables, higher interest expenses (i.e. higher cost ratio), are associated with a decrease in bank stability, which is in line with the literature (Kumar, 2014). Interest expenses can affect bank's profitability by reducing its net interest margin. This impacts the bank's ability to generate earnings, which leads to a decline in profitability, and, consequently, to a lower Z-Score (higher financial risk). Our results also show that banking size has a negative effect on financial stability. Results from the empirical literature regarding the effects of banking size on systemic risk are still ambiguous. (Varotto and Zhao, 2018; Tabak et al., 2013).

Table 4. Impact of macroprudential policies $\left(MP^{(1)} \text{ and } MP^{(2)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{(1)}$	0.033**	0.036**		
	(0.015)	(0.016)		
L.$MP^{(1)}$		0.042		
		(0.031)		
$MP^{(2)}$			0.041***	0.044***
			(0.014)	(0.015)
L.$MP^{(2)}$				0.044
				(0.033)
ΔGDP	-0.004	-0.002	-0.004	-0.002
	(0.004)	(0.006)	(0.004)	(0.006)
Lending Rate	-0.001	-0.001	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)
Covid	-0.038	-0.005	-0.031	0.002
	(0.036)	(0.054)	(0.036)	(0.054)
Bank Concentration	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.168***	-0.162***	-0.169***	-0.164***
	(0.060)	(0.053)	(0.059)	(0.053)
Liquid Assets	0.223	0.188	0.214	0.209
	(0.249)	(0.265)	(0.249)	(0.264)
Deposits Ratio	-0.060	-0.083	-0.059	-0.091
	(0.252)	(0.248)	(0.251)	(0.253)
Cost Ratio	-0.807***	-0.746***	-0.791***	-0.720***
	(0.212)	(0.184)	(0.210)	(0.177)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equation 7. $MP^{(n)}$ is one of the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Impact of macroprudential policies $\left(MP^{(3)} \text{ and } MP^{(4)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{(3)}$	0.009*	0.009*		
	(0.005)	(0.005)		
L.$MP^{(3)}$		0.009		
		(0.006)		
$MP^{(4)}$			0.014**	0.013**
			(0.006)	(0.006)
L.$MP^{(4)}$				0.014*
				(0.008)
ΔGDP	-0.004	-0.002	-0.004	-0.001
	(0.005)	(0.006)	(0.005)	(0.006)
Lending Rate	-0.001	-0.000	-0.001	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Covid	-0.036	-0.007	-0.026	0.008
	(0.036)	(0.047)	(0.037)	(0.050)
Bank Concentration	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.169***	-0.165***	-0.173***	-0.170***
	(0.059)	(0.055)	(0.059)	(0.055)
Liquid Assets	0.236	0.223	0.234	0.244
	(0.242)	(0.243)	(0.239)	(0.239)
Deposits Ratio	-0.094	-0.126	-0.101	-0.145
	(0.256)	(0.262)	(0.257)	(0.265)
Cost Ratio	-0.813***	-0.772***	-0.796***	-0.742***
	(0.221)	(0.207)	(0.219)	(0.199)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equation 7. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.2 The asymmetrical effects of macroprudential tools on systemic risk

To assess if the effects of macroprudential tools are asymmetrical, we decompose the four overall indices ($MP^{(1)}$, $MP^{(2)}$, $MP^{(3)}$ and $MP^{(4)}$), into tightening only instruments ($MP^{+(1)}$, $MP^{+(2)}$, $MP^{+(3)}$ and $MP^{+(4)}$) and loosening only instruments ($MP^{-(1)}$, $MP^{-(2)}$, $MP^{-(3)}$ and $MP^{-(4)}$). We then estimate the fixed effects panel data of Equations 8 and 9 to study the effect of tightened policies only and loosened policies only on banks' risk behavior. Table 6 shows the results for $MP^{+(1)}$ and $MP^{-(1)}$. Columns 1 and 2 show the results for macroprudential policy tightenings, without lagged values in the first column and with lagged values in the second column. Columns 3 and 4 show the results for macroprudential policy loosenings, without lagged values in the third column and with lagged values in the fourth column. The same structure applies to Tables 7, 8 and 9, which give the results for the other indices.

We see that the effects of macroprudential tools on systemic risk are indeed assymetrical. Macroprudential instruments are more effective during restrictive stances than accommodative ones. First, all four tightened indices have statistically significant effects, including lagged values, while loosened indices have no statistical significance. Therefore, reducing the loosening actions (when $MP^{-(n)}$ goes from -1 to 0) does not have the same effect as increasing the tightening actions (when $MP^{+(n)}$ goes from 0 to +1). Second, the effects on bank stability when we consider macroprudential instruments tightenings only are all higher than those derived from their overall macroprudential instruments counterparts. For $MP^{+(1)}$ and $MP^{+(2)}$, compared to $MP^{(1)}$ and $MP^{(2)}$, the effect is, approximately, 2.5 percentage points higher. For $MP^{+(3)}$ and $MP^{+(4)}$, compared to $MP^{(3)}$ and $MP^{(4)}$, it is around 0.8 percentage points higher. Given that macroprudential tools are designed to mitigate systemic risks and vulnerabilities within the financial system, it is desirable that restrictive policy stances are generally more effective than accommodative stances. Our evidence aligns with the findings of Altunbas et al. (2018) in which tightening scenarios also have more statistical significance in general than loosening scenarios.

The control variables of the regressions once again indicate a negative relationship between Cost Ratio and Z-Score, as well as Total Assets and Z-Score. The dummy variable for Covid Pandemic during the years of 2020 and 2021 also has a negative relationship with banking stability. Worldwide economic contraction, loan losses and defaults, liquidity strains and market's volatility are the main reasons for this negative correlation.

Table 6. Asymmetric impact of macroprudential policies $\left(MP^{+(1)}\text{ and }MP^{-(1)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{+(1)}$	0.057**	0.055**		
	(0.023)	(0.022)		
L.$MP^{+(1)}$		0.058*		
		(0.032)		
$MP^{-(1)}$			-0.022	-0.044
			(0.036)	(0.029)
L.$MP^{-(1)}$				-0.071
				(0.085)
ΔGDP	-0.003	-0.002	-0.002	-0.001
	(0.004)	(0.005)	(0.005)	(0.006)
Lending Rate	-0.001	-0.001	-0.001	-0.001
	(0.004)	(0.004)	(0.005)	(0.004)
Covid	-0.043	-0.026	-0.059*	-0.019
	(0.036)	(0.043)	(0.030)	(0.059)
Bank Concentration	0.001	0.001	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.163***	-0.157***	-0.166***	-0.166***
	(0.059)	(0.054)	(0.059)	(0.057)
Liquid Assets	0.190	0.142	0.269	0.281
	(0.252)	(0.268)	(0.263)	(0.258)
Deposits Ratio	-0.039	-0.057	-0.097	-0.121
	(0.241)	(0.233)	(0.259)	(0.270)
Cost Ratio	-0.783***	-0.721***	-0.855***	-0.835***
	(0.204)	(0.183)	(0.218)	(0.202)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equations 8 and 9. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7. Asymmetric impact of macroprudential policies $\left(MP^{+(2)} \text{ and } MP^{-(2)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{+(2)}$	0.066***	0.063***		
	(0.023)	(0.021)		
L.$MP^{+(2)}$		0.059*		
		(0.033)		
$MP^{-(2)}$			-0.028	-0.046
			(0.038)	(0.029)
L.$MP^{-(2)}$				-0.065
				(0.091)
ΔGDP	-0.004	-0.002	-0.003	-0.001
	(0.004)	(0.005)	(0.005)	(0.007)
Lending Rate	-0.001	-0.001	-0.001	-0.001
	(0.004)	(0.004)	(0.005)	(0.004)
Covid	-0.038	-0.021	-0.057*	-0.024
	(0.036)	(0.043)	(0.030)	(0.057)
Bank Concentration	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.165***	-0.160***	-0.167***	-0.166***
	(0.059)	(0.054)	(0.059)	(0.057)
Liquid Assets	0.184	0.160	0.268	0.296
	(0.252)	(0.270)	(0.262)	(0.255)
Deposits Ratio	-0.052	-0.077	-0.093	-0.114
	(0.242)	(0.238)	(0.262)	(0.275)
Cost Ratio	-0.775***	-0.711***	-0.850***	-0.821***
	(0.201)	(0.179)	(0.221)	(0.197)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equations 8 and 9. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8. Asymmetric impact of macroprudential policies $\left(MP^{+(3)} \text{ and } MP^{-(3)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{+(3)}$	0.017***	0.015***		
	(0.006)	(0.005)		
L.$MP^{+(3)}$		0.017***		
		(0.006)		
$MP^{-(3)}$			0.005	0.008
			(0.010)	(0.008)
L.$MP^{-(3)}$				0.009
				(0.013)
ΔGDP	-0.003	-0.001	-0.001	-0.002
	(0.004)	(0.005)	(0.006)	(0.006)
Lending Rate	-0.000	-0.000	-0.001	-0.001
	(0.004)	(0.004)	(0.005)	(0.005)
Covid	-0.037	-0.018	-0.078***	-0.100**
	(0.034)	(0.038)	(0.028)	(0.038)
Bank Concentration	0.001	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.170***	-0.173***	-0.162**	-0.167***
	(0.059)	(0.056)	(0.060)	(0.058)
Liquid Assets	0.211	0.182	0.270	0.263
	(0.240)	(0.235)	(0.269)	(0.265)
Deposits Ratio	-0.105	-0.168	-0.106	-0.111
	(0.252)	(0.254)	(0.261)	(0.260)
Cost Ratio	-0.778***	-0.727***	-0.863***	-0.872***
	(0.212)	(0.199)	(0.218)	(0.215)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equations 8 and 9. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9. Asymmetric impact of macroprudential policies $\left(MP^{+(4)} \text{ and } MP^{-(4)}\right)$ on Z-Score

	(1)	(2)	(3)	(4)
$MP^{+(4)}$	0.021***	0.018***		
	(0.006)	(0.006)		
L.$MP^{+(4)}$		0.020***		
		(0.007)		
$MP^{-(4)}$			0.005	0.008
			(0.018)	(0.014)
L.$MP^{-(4)}$				0.007
				(0.021)
ΔGDP	-0.003	-0.001	-0.001	-0.002
	(0.004)	(0.005)	(0.006)	(0.007)
Lending Rate	-0.001	-0.000	-0.001	-0.001
	(0.004)	(0.005)	(0.005)	(0.005)
Covid	-0.034	-0.015	-0.076**	-0.091*
	(0.035)	(0.040)	(0.032)	(0.046)
Bank Concentration	0.001	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.173***	-0.175***	-0.162***	-0.164***
	(0.059)	(0.056)	(0.058)	(0.056)
Liquid Assets	0.221	0.209	0.270	0.259
	(0.240)	(0.239)	(0.268)	(0.265)
Deposits Ratio	-0.119	-0.193	-0.105	-0.111
	(0.252)	(0.257)	(0.264)	(0.254)
Cost Ratio	-0.766***	-0.712***	-0.862***	-0.868***
	(0.209)	(0.196)	(0.218)	(0.213)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equations 8 and 9. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.3 The effects of restrictive monetary policy

As macroprudential tools are more effective in reducing systemic risk during periods of tightening, we proceed to evaluate how the impact of macroprudential tools tightenings on systemic risk is influenced by a restrictive monetary policy. In Tables 10 and 11, we estimate the fixed effects panel data model of Equation 10 using the four indices described in Equations 1, 2, 3 and 4. In Table 10, the results for $MP^{+(1)}$ are reported in columns 1 (without lagged values) and 2 (with lagged values), whereas the results for $MP^{+(2)}$ are reported in columns 3 and 4. In Table 11, the results for $MP^{+(3)}$ are reported in columns 1 (without lagged values) and 2 (with lagged values), while the results for $MP^{+(4)}$ are reported in columns 3 and 4. We then proceed to estimate Equation 11 via system GMM, the results of which are shown in Table 10. The results for $MP^{+(1)}$ are reported in column 1, for $MP^{+(2)}$ are reported in column 2, for $MP^{+(3)}$ are presented in column 3 and those for $MP^{+(4)}$ are presented in column 4.

Our results reveal a conflict between the two policies in dealing with systemic risk. Macroprudential tightenings are less effective in enhancing financial stability when a country is already in a restrictive monetary policy stance. The positive effect of a macroprudential policy tightening on bank stability decreases from a 5.7% increase to a 2.7% increase. When a diverse set of instruments is used, the positive effect decreases from 6.6% to 3.7%. For each month in which tightening actions prevail during the year, the positive effect on financial stability decreases from 1.7% to 0.7%. Finally, for each month in which the number of tightening instruments prevails during the year, the positive effect on financial stability decreases from 2.1% to 1%. Correcting for potential endogeneity bias does not affect our findings. Indeed, GMM estimation results show that restrictive monetary policy reduces restrictive macroprudential policy power in strengthening financial stability.

Our results are in line with recent empirical literature. Revelo and Levieuge (2022), Aikman et al. (2023) and Collard et al. (2017) emphasize the potential for conflict between the two policies when dealing with financial stability and the need for coordination. They suggest that both policies can exhibit divergent movements during the economic cycle, as their primary targets, financial stability and price stability, may move in opposite directions. However, according to Revelo and Levieuge

(2022), stronger monetary policy responses to the output gap result in fewer frequent conflicts, while Aikman et al. (2023) indicate that there are parameter configurations where a possible complementarity relationship between policies appears, although such configurations are less plausible.

Regarding control variables, higher GDP variations are associated with developing countries, which have, in general, lower Z-Scores. Thus, a negative relationship between ΔGDP and Z-Score is observed. The dummy variable for the Covid pandemic once again has a negative relationship with banking stability. Our findings also support the notion that higher bank liquidity is associated with greater stability (Diamond and Rajan, 2001). The possibility of meeting withdrawal demands, funding operations and payments and managing unforeseen events are some of the reasons for this positive correlation. Finally, contrary to the fixed effects model, bank size has a positive relationship in bank stability. As mentioned before, the effects of banking size on financial stability are still ambiguous (Varotto and Zhao, 2018; Tabak et al., 2013).

Table 10. Impact of macroprudential tightening $\left(MP^{+(1)} \text{ and } MP^{+(2)}\right)$ during restrictive monetary stances

	(1)	(2)	(3)	(4)
$MP^{+(1)}$	0.076***	0.069***		
	(0.027)	(0.023)		
$\left(MP^{+(1)} \times TG\right)$	-0.049***	-0.035**		
	(0.018)	(0.016)		
L.$MP^{+(1)}$		0.063		
		(0.037)		
L.$\left(MP^{+(1)} \times TG\right)$		-0.026		
		(0.026)		
$MP^{+(2)}$			0.082***	0.075***
			(0.027)	(0.022)
$\left(MP^{+(2)} \times TG\right)$			-0.045**	-0.030*
			(0.017)	(0.016)
L.$MP^{+(2)}$				0.063
				(0.038)
L.$\left(MP^{+(2)} \times TG\right)$				-0.026
				(0.026)
ΔGDP	-0.004	-0.002	-0.004	-0.002
	(0.004)	(0.005)	(0.004)	(0.005)
Lending Rate	0.001	0.001	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Covid	-0.033	-0.021	-0.030	-0.018
	(0.038)	(0.043)	(0.038)	(0.043)
Bank Concentration	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.161***	-0.153***	-0.163***	-0.156***
	(0.058)	(0.053)	(0.058)	(0.053)
Liquid Assets	0.218	0.155	0.211	0.163
	(0.246)	(0.268)	(0.247)	(0.271)
Deposits Ratio	-0.034	-0.040	-0.040	-0.053
	(0.240)	(0.229)	(0.241)	(0.235)
Cost Ratio	-0.773***	-0.700***	-0.764***	-0.690***
	(0.202)	(0.180)	(0.200)	(0.178)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equation 10. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. TG is the Taylor Gap dummy constructed in Section 3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11. Impact of macroprudential tightening $\left(MP^{+(3)}\text{ and }MP^{+(4)}\right)$ during restrictive monetary stances

	(1)	(2)	(3)	(4)
$MP^{+(3)}$	0.023***	0.020***		
	(0.006)	(0.005)		
$\left(MP^{+(3)} \times TG\right)$	-0.016***	-0.012***		
	(0.005)	(0.004)		
L.$MP^{+(3)}$		0.018***		
		(0.006)		
L.$\left(MP^{+(3)} \times TG\right)$		-0.004		
		(0.006)		
$MP^{+(4)}$			0.028***	0.023***
			(0.007)	(0.006)
$\left(MP^{+(4)} \times TG\right)$			-0.018***	-0.012***
			(0.005)	(0.004)
L.$MP^{+(4)}$				0.020**
				(0.008)
L.$\left(MP^{+(4)} \times TG\right)$				-0.004
				(0.007)
ΔGDP	-0.003	-0.001	-0.003	-0.001
	(0.004)	(0.005)	(0.004)	(0.005)
Lending Rate	0.001	0.001	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.005)
Covid	-0.032	-0.016	-0.028	-0.013
	(0.035)	(0.038)	(0.036)	(0.040)
Bank Concentration	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
ln Total Assets	-0.169***	-0.171***	-0.172***	-0.173***
	(0.059)	(0.056)	(0.059)	(0.056)
Liquid Assets	0.214	0.181	0.231	0.211
	(0.234)	(0.233)	(0.233)	(0.236)
Deposits Ratio	-0.103	-0.156	-0.112	-0.176
	(0.252)	(0.253)	(0.252)	(0.256)
Cost Ratio	-0.768***	-0.717***	-0.751***	-0.699***
	(0.211)	(0.199)	(0.208)	(0.196)
Observations	389	389	389	389

Note: This table presents the results of the fixed effects model defined in Equation 10. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. TG is the Taylor Gap dummy constructed in Section 3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12. Interaction between macroprudential and monetary policies using System-GMM on Z-Score

	(1)	(2)	(3)	(4)
L.ln Z-Score	0.370**	0.366**	0.369*	0.390**
	(0.179)	(0.176)	(0.194)	(0.189)
$MP^{+(1)}$	0.101*			
	(0.056)			
$\left(MP^{+(1)} \times TG\right)$	-0.060**			
	(0.029)			
$MP^{+(2)}$		0.108*		
		(0.055)		
$\left(MP^{+(2)} \times TG\right)$		-0.060**		
		(0.028)		
$MP^{+(3)}$			0.027**	
			(0.013)	
$\left(MP^{+(3)} \times TG\right)$			-0.018*	
			(0.009)	
$MP^{+(4)}$				0.035**
				(0.015)
$\left(MP^{+(4)} \times TG\right)$				-0.018*
				(0.009)
ΔGDP	-0.012*	-0.012*	-0.010*	-0.013**
	(0.007)	(0.007)	(0.006)	(0.007)
Lending Rate	0.005	0.004	0.003	0.002
	(0.016)	(0.016)	(0.018)	(0.015)
Covid	-0.093*	-0.088*	-0.103*	-0.106*
	(0.050)	(0.050)	(0.053)	(0.053)
Bank Concentration	-0.010	-0.011	-0.010	-0.010
	(0.007)	(0.007)	(0.007)	(0.007)
ln Total Assets	0.126**	0.122**	0.137**	0.132**
	(0.056)	(0.054)	(0.066)	(0.060)
Liquid Assets	1.867**	1.812**	1.705**	1.612*
	(0.827)	(0.830)	(0.810)	(0.810)
Deposits Ratio	0.038	0.041	0.246	0.381
	(0.575)	(0.544)	(0.731)	(0.643)
Cost Ratio	-0.501	-0.500	-0.457	-0.478
	(0.370)	(0.363)	(0.375)	(0.381)
Observations	389	389	389	389
Instruments	32	32	32	32
Hansen test p-value	0.591	0.581	0.693	0.784
Arellano-Bond AR(2) test p-value	0.471	0.459	0.591	0.625

Note: This table presents the results of the system-GMM model defined in Equation 11. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. TG is the Taylor Gap dummy constructed in Section 3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.4 The transmission channel for the relationship between macroprudential and monetary policies

To better understand how monetary policy changes the effect of macroprudential policy on financial stability, it is important to investigate what is the transmission channel for the relationship between the two policies when dealing with systemic risk, represented by the banks' Z-Score. Equation 6 shows us that the Z-Score is composed of two main components: Return on Assets (ROA) and Equity Ratio (ER). ROA is a key indicator linked to the profit channel, as it measures the profitability of a financial institution by assessing its ability to generate earnings from its assets. ER is associated with the leverage channel as it measures the proportion of a financial institution's equity in relation to its total assets.

The work of Ely et al. (2021) demonstrates that macroprudential measures primarily reduce systemic risk through the leverage channel rather than the profit channel. In general, macroprudential measures tend to limit bank leverage, thereby reducing the exposure to risk. The influence of the profit channel, on the other hand, may be explained through the implementation of a restrictive monetary policy. Our findings in Section 4.3 indicate that the tightening effects of macroprudential tools are reduced during restrictive monetary policy stances. We assume that, under restrictive monetary policy, the profit channel comes into play, leading to a reduction in financial stability through a decrease in banks' ROA. Restrictive changes in monetary policy are typically characterized by central banks implementing measures to tighten credit conditions and increase borrowing costs. This leads to higher funding costs for banks, a decline in loan demand from other sectors and an overall economic slowdown, leading to a decrease in banks' ROA.

Therefore, our analysis examines whether macroprudential tools tend to affect stability through the profit channel when monetary policy is restrictive. We estimate regression 12 with the same specification as 11, but with ROA as a dependent variable. Results are shown in Table 13. Results for $MP^{(1)}$ are listed in column 1, while results for $MP^{(2)}$ are reported in column 2, results for $MP^{(3)}$ are presented in column 3 and results for $MP^{(4)}$ are presented in column 4.

First, we find evidence that macroprudential policies alone do not affect ROA, indicated by the non-significant coefficients of all $MP^{+(n)}$ indices. This is consistent with the results reported by Ely et al. (2021). Second, we find that a combination of restrictive monetary and macroprudential stances reduces banks' ROA. Table 13 shows that all interactive terms exhibit negative and statistically significant coefficients.

Our results show that a macroprudential tightening coupled with a restrictive monetary policy leads to a decrease in ROA by 0.22 percentage points. When we consider a diverse set of instruments, the decrease in ROA is 0.21 percentage points. Furthermore, when we combine a month in which tightening actions prevail with a restrictive monetary policy, the decrease in ROA is 0.08 percentage points. Lastly, an additional tightened instrument in a year, paired with a restrictive monetary policy, results in a decrease in ROA by 0.09 percentage points. When policies are tightened, it decreases bank profitability, which compromises bank stability. In essence, our findings indicate that tightened macroprudential tools alone do not significantly affect ROA. However, during monetary restrictive stances, they affect financial stability through the profit channel.

Table 13. Interaction between macroprudential and monetary policies using System-GMM on ROA

	(1)	(2)	(3)	(4)
L.ROA	0.317*	0.316*	0.303*	0.294*
	(0.161)	(0.159)	(0.156)	(0.155)
$MP^{+(1)}$	0.318			
	(0.206)			
$\left(MP^{+(1)} \times TG\right)$	-0.222*			
	(0.121)			
$MP^{+(2)}$		0.328		
		(0.197)		
$\left(MP^{+(2)} \times TG\right)$		-0.212*		
		(0.123)		
$MP^{+(3)}$			0.051	
			(0.044)	
$\left(MP^{+(3)} \times TG\right)$			-0.082*	
			(0.047)	
$MP^{+(4)}$				0.054
				(0.053)
$\left(MP^{+(4)} \times TG\right)$				-0.095*
				(0.054)
ΔGDP	0.018	0.017	0.031**	0.025*
	(0.019)	(0.019)	(0.014)	(0.014)
Lending Rate	0.035	0.035	0.040	0.041
	(0.039)	(0.040)	(0.041)	(0.044)
Covid	-0.111	-0.101	-0.167	-0.213
	(0.151)	(0.155)	(0.123)	(0.132)
Bank Concentration	-0.040*	-0.040*	-0.033*	-0.033*
	(0.021)	(0.021)	(0.018)	(0.018)
ln Total Assets	0.091	0.089	0.072	0.033
	(0.144)	(0.141)	(0.189)	(0.207)
Liquid Assets	0.782	0.822	-0.100	-0.455
	(2.618)	(2.752)	(2.407)	(2.596)
Deposits Ratio	3.268	3.215	3.441	3.774
	(2.422)	(2.331)	(2.224)	(2.242)
Cost Ratio	-0.971	-0.949	-1.034	-1.401
	(1.243)	(1.202)	(1.217)	(1.296)
Observations	389	389	389	389
Instruments	33	33	35	35
Hansen test p-value	0.822	0.850	0.717	0.689
Arellano-Bond AR(2) test p-value	0.450	0.452	0.455	0.449

Note: This table presents the results of the system-GMM model defined in Equation 12. $MP^{(n)}$ is one the macroprudential policy indices constructed in Section 3.2. TG is the Taylor Gap dummy constructed in Section 3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusions

The Global Financial Crisis has highlighted the importance of financial stability. Therefore, it is necessary to coordinate the actions of monetary and macroprudential policies. The first objective of monetary policy is to maintain price stability. On the other hand, macroprudential policy focuses on limiting risk-taking, especially for larger and more interconnected banks. Both price instability and risk-taking behavior lead to systemic risk and require coordinating policy implementations.

In this article, we study the effectiveness of macroprudential tools and their interaction with monetary policy using a comprehensive cross-country database. We find that macroprudential policy has an asymmetric effect on banks' risk-taking, and it is more effective in reducing systemic risk when a diverse set of instruments is used. However, tightening measures are less effective in enhancing financial stability when a country is already in a restrictive monetary policy stance. This result is associated with the fact that, in such stances, these measures tend to reduce banks' profitability, thereby compromising financial stability through the profit channel. These results brings new evidence on the interaction between both policies and help to shed light on recent findings of articles such as Revelo and Levieuge (2022), Revelo et al. (2020), Takáts and Temesvary (2021), Kim and Mehrotra (2018) and Zhang et al. (2020).

Based on our empirical findings, the policy recommendations that emerge from the results of this article suggest the need for coordinated and cooperative actions between monetary and macroprudential policies to address systemic financial risk. When countries are already in a restrictive monetary policy stance, it is important to take into consideration the effects of tighter macroprudential conditions on banks' profitability. Banks' profits are a fundamental characteristic variable for financial stability, as it can affect liquidity and propagate financial crises to the real sector of the economy.

Some macroprudential policies can substantially reduce banks' risk-taking and can also produce some unintended consequences. Thus, the propagation of systemic shocks into the financial markets can be managed on a case-by-case basis over the multiple phases of the economic cycle. The recent contagion events from the collapse of the Silicon Valley Bank and other US regional banks, as well as Credit Suisse in

Switzerland, have shown the success of central banks and regulators in reaching their goals via coordinated actions, suggesting that they could act to mitigate the transmission channels of financial instability in future financial stress episodes. Finally, future research could investigate the interaction between both policies using other systemic risk measures such as SRISK and CoVar, in order to compare to the results of this article.

Appendix A

Table A1. Taylor Gap Estimates

Countries	ρ	$\beta\pi$	βy	α	Hansen Test	Obs	Period
Brazil	0.894***	2.299***	2.657***	-3.860	0.159	76	1999Q2-2021Q4
Bulgaria	0.697***	0.043***	0.086***	-0.027	0.776	53	2005Q2-2021Q4
Canada	0.873***	0.282	0.392**	0.768	0.363	84	1995Q1-2021Q4
Chile	0.774***	0.559***	0.646***	1.991***	0.538	99	1996Q1-2021Q4
Colombia	0.853***	1.061***	1.181***	1.009	0.252	66	2005Q1-2021Q4
Costa Rica	0.828***	0.509***	0.538***	1.640***	0.332	47	2006Q2-2021Q4
Czech Republic	0.843***	0.589***	0.367***	0.241	0.160	98	1996Q1-2021Q4
Denmark	0.967***	0.165	1.650**	0.413	0.528	93	1995Q1-2021Q4
Euro Area	0.956***	-0.936	2.061	2.073	0.423	89	1999Q1-2021Q4
Hungary	0.932***	0.762***	1.864***	0.180	0.280	100	1995Q1-2021Q4
India	0.893***	0.946***	0.579***	0.117	0.661	41	2011Q2-2021Q4
Indonesia	0.813***	0.593***	0.277***	2.976***	0.394	53	2005Q3-2021Q4
Israel	0.899***	1.165***	0.172	-0.009	0.490	96	1995Q1-2021Q4
Kenya	0.713***	0.843***	0.655**	3.350***	0.493	40	2009Q1-2021Q4
Mexico	0.864***	0.815***	1.052***	1.666	0.296	65	2002Q1-2021Q4
Poland	0.882***	0.382***	0.887***	1.623***	0.217	81	1998Q1-2021Q4
Romania	0.859***	0.407***	0.652***	1.846***	0.117	70	2003Q1-2021Q4
Russia	0.790***	0.449***	0.431***	5.132***	0.141	70	2003Q1-2021Q3
Serbia	0.874***	1.214***	1.511***	-0.074	0.177	57	2002Q1-2021Q4
Singapore	0.812***	-0.154	0.170***	1.379***	0.576	106	1987Q3-2021Q3
South Korea	0.874***	0.388*	0.972***	1.067***	0.863	57	1999Q3-2021Q4
Sweden	0.835***	-0.283	0.521***	0.381	0.152	53	2002Q3-2021Q4
Switzerland	0.925***	1.784*	-0.227	-1.059	0.574	95	1995Q1-2021Q4
Thailand	0.855***	0.519***	0.135***	0.935***	0.511	52	2003Q1-2021Q4
Turkey	0.408***	1.155***	1.458***	-0.268	0.208	93	1998Q1-2021Q4
United Kingdom	0.955***	-1.394	1.148**	2.191	0.372	79	1995Q1-2021Q4
USA	0.899***	0.318	1.944***	0.377	0.368	86	1995Q1-2021Q4

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

References

Acharya, V., and Naqvi, H. (2012). The seeds of a crisis: A theory of bank liquidity and risk taking over the business cycle. *Journal of Financial Economics*, *106*, 349–366.

Adrian, T., and Shin, H. S. (2010). Financial intermediaries and monetary economics. In *Handbook of monetary economics* (pp. 601–650). Elsevier volume 3.

Aikman, D., Giese, J., Kapadia, S., and McLeay, M. (2023). Targeting financial stability: Macroprudential or monetary policy? *International Journal of Central Banking*, *19*, 159–242.

Aiyar, S., Calomiris, C. W., and Wieladek, T. (2014). Does macro-prudential regulation leak? evidence from a uk policy experiment. *Journal of Money, Credit and Banking*, *46*, 181–214.

Aiyar, S., Calomiris, C. W., and Wieladek, T. (2016). How does credit supply respond to monetary policy and bank minimum capital requirements? *European Economic Review*, *82*, 142–165.

Akinci, O., and Olmstead-Rumsey, J. (2018). How effective are macroprudential policies? an empirical investigation. *Journal of Financial Intermediation*, *33*, 33–57.

Alam, Z., Alter, M. A., Eiseman, J., Gelos, M. R., Kang, M. H., Narita, M. M., Nier, E., and Wang, N. (2019). *Digging deeper–Evidence on the effects of macroprudential policies from a new database*. International Monetary Fund.

Allen, F., and Gale, D. (2000). Financial contagion. *Journal of political economy*, *108*, 1–33.

Allen, F., and Gale, D. (2009). *Understanding financial crises*. OUP Oxford.

Allen, F., and Gale, D. (2011). *Asset price bubbles and stock market interlinkages*. SSRN.

Altavilla, C., Laeven, L., and Peydró, J.-L. (2020). Monetary and macroprudential policy complementarities: evidence from european credit registers. *ECB Working Paper*, *2504*.

Altunbas, Y., Binici, M., and Gambacorta, L. (2018). Macroprudential policy and bank risk. *Journal of International Money and Finance*, *81*, 203–220.

Angelini, P., Neri, S., and Panetta, F. (2014). The interaction between capital requirements and monetary policy. *Journal of money, credit and Banking*, *46*, 1073–1112.

Angeloni, I., and Faia, E. (2013). Capital regulation and monetary policy with fragile banks. *Journal of Monetary Economics*, *60*, 311–324.

Apergis, N., Aysan, A. F., and Bakkar, Y. (2022). Borrower-and lender-based macroprudential policies: What works best against bank systemic risk? *Journal of International Financial Markets, Institutions and Money*, *80*, 101648.

Arellano, M., and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The review of economic studies*, *58*, 277–297.

Arellano, M., and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, *68*, 29–51.

Bailliu, J., Meh, C., and Zhang, Y. (2015). Macroprudential rules and monetary policy when financial frictions matter. *Economic Modelling*, *50*, 148–161.

Bekiros, S., Nilavongse, R., and Uddin, G. S. (2020). Expectation-driven house prices and debt defaults: The effectiveness of monetary and macroprudential policies. *Journal of Financial Stability*, *49*, 100760.

Ben-Gad, M., Pearlman, J., and Sabuga, I. (2022). An analysis of monetary and macroprudential policies in a dsge model with reserve requirements and mortgage lending. *Economic Modelling*, *116*.

Beyer, A. (2017). *The Transmission Channels of Monetary, Macro- and Microprudential Policies and Their Interrelations*. Occasional paper series / European Central Bank. European Central Bank.

Blundell, R., and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*, 115–143.

Bodenstein, M., Guerrieri, L., and LaBriola, J. (2019). Macroeconomic policy games. *Journal of Monetary Economics*, *101*, 64–81.

Borio, C., and Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *Journal of Financial stability*, *8*, 236–251.

Bruno, V., Shim, I., and Shin, H. S. (2017). Comparative assessment of macroprudential policies. *Journal of Financial Stability*, *28*, 183–202.

Cerutti, E., Claessens, S., and Laeven, L. (2017). The use and effectiveness of macroprudential policies: New evidence. *Journal of Financial Stability*, *28*, 203–224.

Cihák, M., and Hesse, H. (2007). Cooperative banks and financial stability. *IMF Working Papers*, *7*.

Claessens, S., Ghosh, S. R., and Mihet, R. (2013a). Macro-prudential policies to mitigate financial system vulnerabilities. *Journal of International Money and Finance*, *39*, 153–185.

Claessens, S., Habermeier, K., Nier, E., Kang, H., Mancini-Griffoli, T., and Valencia, F. (2013b). *The interaction of monetary and macroprudential policies*. Technical Report IMF.

Claessens, S., and Laeven, L. (2004). What drives bank competition? some international evidence. *Journal of money, credit and banking*, (pp. 563–583).

Clarida, R., Gali, J., and Gertler, M. (2000). Monetary policy rules and macroeconomic stability: evidence and some theory. *The Quarterly journal of economics*, *115*, 147–180.

Collard, F., Dellas, H., Diba, B., and Loisel, O. (2017). Optimal monetary and prudential policies. *American Economic Journal: Macroeconomics*, *9*, 40–87.

De Jonghe, O., Dewachter, H., and Ongena, S. (2020). Bank capital (requirements) and credit supply: Evidence from pillar 2 decisions. *Journal of Corporate Finance*, *60*, 101518.

Demirgüç-Kunt, A., and Detragiache, E. (2011). Basel core principles and bank soundness: does compliance matter? *Journal of Financial Stability*, *7*, 179–190.

Demirgüç-Kunt, A., and Maksimovic, V. (2002). Funding growth in bank-based and market-based financial systems: evidence from firm-level data. *Journal of financial Economics*, *65*, 337–363.

Diamond, D. W., and Rajan, R. G. (2001). Liquidity risk, liquidity creation, and financial fragility: A theory of banking. *Journal of political Economy*, *109*, 287–327.

Diamond, D. W., and Rajan, R. G. (2012). Illiquid banks, financial stability, and interest rate policy. *Journal of Political Economy*, *120*, 552–591.

Ely, R. A., Tabak, B. M., and Teixeira, A. M. (2021). The transmission mechanisms of macroprudential policies on bank risk. *Economic Modelling*, *94*, 598–630.

Farhi, E., and Tirole, J. (2012). Collective moral hazard, maturity mismatch, and systemic bailouts. *American Economic Review*, *102*, 60–93.

Fernandez-Gallardo, A. (2023). Preventing financial disasters: Macroprudential policy and financial crises. *European Economic Review*, *151*, 104350.

Fraisse, H., Le, M., and Thesmar, D. (2020). The real effects of bank capital requirements. *Management Science*, *66*, 5–23.

Freixas, X., Laeven, L., and Peydró, J.-L. (2015). *Systemic risk, crises, and macro-prudential regulation*. Mit Press.

Gambacorta, L., and Murcia, A. (2020). The impact of macroprudential policies in latin america: An empirical analysis using credit registry data. *Journal of Financial Intermediation*, *42*, 100828.

Gelain, P., and Ilbas, P. (2017). Monetary and macroprudential policies in an estimated model with financial intermediation. *Journal of Economic Dynamics and Control*, *78*, 164–189.

Gonzalez, F. (2022). Macroprudential policies and bank competition: International bank-level evidence. *Journal of Financial Stability*, *58*, 100967.

Gropp, R., Mosk, T., Ongena, S., and Wix, C. (2019). Banks response to higher capital requirements: Evidence from a quasi-natural experiment. *The Review of Financial Studies*, *32*, 266–299.

Gurrea-Martínez, A., and Remolina, N. (2019). The dark side of implementing basel capital requirements: theory, evidence, and policy. *Journal of international economic law*, *22*, 125–152.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the econometric society*, (pp. 1029–1054).

Hodrick, R. J., and Prescott, E. C. (1997). Postwar us business cycles: an empirical investigation. *Journal of Money, credit, and Banking*, (pp. 1–16).

Hofmann, B., and Bogdanova, B. (2012). Taylor rules and monetary policy: a global'great deviation'? *BIS quarterly review September*, (pp. 37–49).

Ireland, P. N. (2005). *The monetary transmission mechanism*. Working Papers 06-1 Federal Reserve Bank of Boston.

Jiménez, G., Ongena, S., Peydró, J.-L., and Saurina, J. (2017). Macroprudential policy, countercyclical bank capital buffers, and credit supply: Evidence from the spanish dynamic provisioning experiments. *Journal of Political Economy*, *125*, 2126–2177.

Juelsrud, R. E., and Wold, E. G. (2020). Risk-weighted capital requirements and portfolio rebalancing. *Journal of Financial Intermediation*, *41*, 100806.

Kannan, P., Rabanal, P., and Scott, A. M. (2012). Monetary and macroprudential policy rules in a model with house price booms. *The BE Journal of Macroeconomics*, *12*.

Kim, S., and Mehrotra, A. (2018). Effects of monetary and macroprudential policies—evidence from four inflation targeting economies. *Journal of Money, Credit and Banking*, *50*, 967–992.

Kumar, R. (2014). *Strategies of banks and other financial institutions: Theories and cases*. Elsevier.

Kuttner, K. N., and Shim, I. (2016). Can non-interest rate policies stabilize housing markets? evidence from a panel of 57 economies. *Journal of Financial Stability*, *26*, 31–44.

Laeven, M. L., Dell'Ariccia, M. G., and Marquez, M. R. (2010). *Monetary policy, leverage, and bank risk taking*. International Monetary Fund.

Lazopoulos, I., and Gabriel, V. (2019). Policy mandates and institutional architecture. *Journal of Banking & Finance*, *100*, 122–134.

Lombardi, M. J., and Zhu, F. (2014). A shadow policy rate to calibrate us monetary policy at the zero lower bound, .

Mendicino, C., and Punzi, M. T. (2014). House prices, capital inflows and macroprudential policy. *Journal of Banking & Finance*, *49*, 337–355.

Meuleman, E., and Vander Vennet, R. (2020). Macroprudential policy and bank systemic risk. *Journal of Financial Stability*, *47*, 100724.

Mirzaei, A., and Moore, T. (2021). Do macro-prudential policies jeopardize banking competition? *International Review of Finance*, *21*, 1511–1518.

Montes, G. C., and Peixoto, G. B. T. (2014). Risk-taking channel, bank lending channel and the "paradox of credibility": Evidence from brazil. *Economic Modelling*, *39*, 82–94.

de Moraes, C. O., Montes, G. C., and Antunes, J. A. P. (2016). How does capital regulation react to monetary policy? new evidence on the risk-taking channel. *Economic Modelling*, *56*, 177–186.

Ngambou Djatche, M. J. (2022). Monetary policy, prudential policy and bank's risk-taking: A literature review. *Journal of Economic Surveys*, *36*, 1559–1590.

Ouerk, S., Boucher, C., and Lubochinsky, C. (2020). Unconventional monetary policy in the euro area: Shadow rate and light effets. *Journal of Macroeconomics*, *65*, 103219.

Revelo, J. D. G., and Levieuge, G. (2022). When could macroprudential and monetary policies be in conflict? *Journal of Banking & Finance*, *139*, 106484.

Revelo, J. D. G., Lucotte, Y., and Pradines-Jobet, F. (2020). Macroprudential and monetary policies: The need to dance the tango in harmony. *Journal of International Money and Finance*, *108*, 102156.

Richter, B., Schularick, M., and Shim, I. (2019). The costs of macroprudential policy. *Journal of International Economics*, *118*, 263–282.

Roodman, D. (2009). A note on the theme of too many instruments. *Oxford Bulletin of Economics and statistics*, *71*, 135–158.

Rubio, M., and Carrasco-Gallego, J. A. (2016). The new financial regulation in basel iii and monetary policy: A macroprudential approach. *Journal of Financial Stability*, *26*, 294–305.

Scalco, P. R., Tabak, B. M., and Teixeira, A. M. (2021). Prudential measures and their adverse effects on bank competition: The case of brazil. *Economic Modelling*, *100*, 105495.

Stein, J. C. (2012). Monetary policy as financial stability regulation. *The Quarterly Journal of Economics*, *127*, 57–95.

Sysoyeva, L. (2020). Financial stability of the banking sector in european countries: A comparative analysis. *Panoeconomicus*, *67*, 491–508.

Tabak, B. M., Fazio, D. M., and Cajueiro, D. O. (2013). Systemically important banks and financial stability: The case of latin america. *Journal of Banking & Finance*, *37*, 3855–3866.

Takáts, E., and Temesvary, J. (2021). How does the interaction of macroprudential and monetary policies affect cross-border bank lending? *Journal of International Economics*, *132*, 103521.

Tayler, W. J., and Zilberman, R. (2016). Macroprudential regulation, credit spreads and the role of monetary policy. *Journal of Financial Stability*, *26*, 144–158.

Vandenbussche, J., Vogel, U., and Detragiache, E. (2015). Macroprudential policies and housing prices: A new database and empirical evidence for central, eastern, and southeastern europe. *Journal of Money, Credit and Banking*, *47*, 343–377.

Varotto, S., and Zhao, L. (2018). Systemic risk and bank size. *Journal of International Money and Finance*, *82*, 45–70.

Zhang, A., Pan, M., Liu, B., and Weng, Y.-C. (2020). Systemic risk: The coordination of macroprudential and monetary policies in china. *Economic Modelling*, *93*, 415–429.

Zhang, Y., and Tressel, T. (2017). Effectiveness and channels of macroprudential policies: lessons from the euro area. *Journal of Financial Regulation and Compliance*, *25*, 271–306.