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Ensaios em Políticas Macroprudenciais

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Resumo

Beppler, Lucas Souza. **Ensaios em Políticas Macroprudenciais**. Orientador(a): Prof. Dr. Regis Augusto Ely. 2024. 93 f. Tese (Doutorado em Economia)[1] - Programa de Pós-Graduação em Organizações e Mercados, Universidade Federal de Pelotas, Pelotas.

O objetivo desta Tese é contribuir para a literatura sobre os efeitos das políticas macroprudenciais em variáveis econômicas, mediante a elaboração de dois ensaios. No primeiro ensaio, é avaliada a eficácia das ferramentas macroprudenciais e sua interação com as políticas monetárias, utilizando-se de uma base de dados abrangente de 37 países. São calculadas regras de Taylor e índices de política macroprudencial para cada país, aplicando-se estes em análises de regressões de painel de dados com efeito fixo e regressões com dados em painel dinâmico. Observa-se que as políticas macroprudenciais exercem um impacto assimétrico no risco bancário, com efeitos mais acentuados quando se utiliza um conjunto diversificado de instrumentos. Contudo, identifica-se que medidas de aperto são menos eficazes para promover a estabilidade financeira em contextos de política monetária restritiva, tendo em vista que estas tendem a diminuir a rentabilidade bancária, comprometendo, assim, a estabilidade financeira. No segundo ensaio, examinam-se os efeitos do aperto das políticas macroprudenciais sobre a taxa de inadimplência, a inadimplência total e o volume de crédito total para micro e pequenas empresas no Brasil, por meio de regressões de painel de dados com efeito fixo. Os resultados indicam que o aperto das políticas aumenta a taxa de inadimplência nessas empresas devido a uma redução no volume total de crédito que excede a diminuição da inadimplência total. Isso sugere uma reestruturação do mercado em que créditos anteriormente viáveis são excluídos, levando a uma maior concentração de créditos de maior risco.

Palavras-Chave: Estabilidade Financeira; Políticas Macroprudenciais; Política Monetária; Taxas de Inadimplência.

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Abstract

Beppler, Lucas Souza. **Essays in Macroprudential Policies**. Advisor: Prof. Dr. Regis Augusto Ely. 2024. 93 f. Thesis (PhD in Economics) – Postgraduate Program in Organizations and Markets, Federal University of Pelotas, Pelotas.

The objective of this Thesis is to contribute to the literature on the effects of macroprudential policies on economic variables through the elaboration of two essays. 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. In the second essay, we examine the effects of tightening macroprudential policies on the default rate, total amount of defaults, and credit volumes for micro and small enterprises in Brazil, through fixed effects panel data regressions. Our results indicate that the tightening of macroprudential policies increases the default rate in these enterprises, primarily due to a reduction in the total credit volume that exceeds the decrease in total amount of defaults. This situation suggests a market shift where viable credit is forced out, leaving behind a higher concentration of riskier credit.

Keywords: Financial Stability; Macroprudential Policies; Monetary Policy; Default Rates.

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Sumário

1 Introdução

A crise financeira global de 2007-2008 evidenciou as deficiências do antigo quadro regulatório financeiro, especificamente sua incapacidade de lidar com a estabilidade do sistema financeiro como um todo. Antes da crise, as regulamentações para bancos e outras instituições do setor financeiro enfatizavam ferramentas destinadas a reduzir riscos individuais, não sistêmicos, com a política monetária sendo o principal meio de controle de risco financeiro. A crise destacou a necessidade de mudar de uma visão puramente microprudencial dos requisitos de capital para uma perspectiva mais abrangente e macroprudencial do capital (Bedayo, Estrada e Saurina, 2020). Assim, o objetivo final das políticas macroprudenciais é mitigar o risco financeiro sistêmico (Kahou e Lehar, 2017; Poghosyan, 2020; Tang *et al*., 2021). Após a crise, essas políticas tornaram-se um ponto focal para formuladores de políticas, bancos centrais e pesquisadores (Gauthier, Lehar e Souissi, 2012; Tang *et al*., 2021).

Com essa perspectiva renovada, discussões sobre medidas como limites de crédito, reservas de capital e restrições de balanço patrimonial, abriram caminho para o acordo de Basileia III. Anos depois, a literatura empírica sobre a eficácia dos instrumentos macroprudenciais, em geral, confirma que instrumentos como *loan-to-value ratios*, *buffers* de capital anticíclicos, requerimentos de reserva e outros têm efeitos favoráveis sobre o risco bancário e a resiliência do sistema financeiro (Claessens e Laeven, 2004; Claessens, Ghosh e Mihet, 2013; Moraes, Montes e Antunes, 2016; Jiménez *et al*., 2017; Altunbas, Binici e Gambacorta, 2018; Bruno, Shim e Shin, 2017; Akinci e Olmstead-Rumsey, 2018; Ely, Tabak e Teixeira, 2021). Autores como Tang *et al*. (2021) argumentam que existe um consenso entre os formuladores de políticas econômicas de que uma abordagem macroprudencial para regulação e supervisão deve ser adotada no sistema financeiro em relação à sua estabilidade geral, afastando-se do cenário pré-crise financeira global em que a política monetária era a principal ferramenta de controle de risco. Tanto países desenvolvidos quanto emergentes adotaram essas medidas para mitigar o risco de desequilíbrios no sistema financeiro e os possíveis custos para o lado real da economia. Segundo a base de dados de políticas macroprudenciais integradas do FMI (iMaPP), originalmente construído por Alam *et al*. (2019), em uma amostra de 104

países, 68% das políticas macroprudenciais adotadas desde 1990 foram implementadas por países emergentes, enquanto 32% foram adotadas por países desenvolvidos.

A implementação e avaliação de políticas macroprudenciais, no entanto, ainda apresentam desafios. Revelo, Lucotte e Pradines-Jobet (2020) destacam um desses desafios: a avaliação da interação entre as políticas macroprudenciais e a política monetária. Kim e Mehrotra (2018) e Revelo, Lucotte e Pradines-Jobet (2020) sugerem que alcançar os objetivos de estabilidade de preços e financeira requer a coordenação de ambas as políticas. A pesquisa empírica sobre a interação entre essas duas políticas ainda está em seus estágios iniciais, e os resultados permanecem inconclusivos. Estudos que examinaram essa interação, como os de Aiyar, Calomiris e Wieladek (2016), Bruno, Shim e Shin (2017), Kim e Mehrotra (2018), Revelo, Lucotte e Pradines-Jobet (2020), Gambacorta e Murcia (2020) e Altavilla, Laeven e Peydró (2020), investigam a eficácia das políticas macroprudenciais em conter o crescimento do crédito e sua suscetibilidade às condições da política monetária. Além disso, Takáts e Temesvary (2021) demonstram como essa interação influencia o empréstimo bancário *cross-border*.

A literatura recente introduz outro desafio ao sugerir que as políticas macroprudenciais podem ter um impacto significativo na economia real, o que, por sua vez, poderia potencialmente comprometer seu objetivo principal de estabilidade financeira. Há evidências de que as políticas macroprudenciais podem afetar negativamente indicadores econômicos chaves, como consumo e investimento, e podem exacerbar as disparidades de renda e riqueza (Teixeira, 2023; Teixeira e Venter, 2023; Belkhir *et al*., 2022; Ahnert *et al*., 2021; Forbes, 2021; Gurrea-Martínez e Remolina, 2019).

O primeiro ensaio desta tese aborda o desafio mencionado de entender a interação entre as políticas macroprudenciais e a política monetária. Explora-se o possível conflito entre essas duas políticas no que diz respeito aos seus impactos na estabilidade financeira. Para isso, utiliza-se uma base de dados abrangente de 37 países, aplicando-se estes em análises de regressões de painel de dados com efeito fixo e regressões com dados em painel dinâmico. Os resultados encontrados sugerem a existência de conflitos potenciais entre as políticas em termos de estabilidade financeira.

O segundo ensaio aborda o segundo desafio mencionado, que são as consequências não intencionais das regulamentações macroprudenciais em setores econômicos que não são diretamente alvo dessas políticas. O ensaio investiga o impacto das políticas macroprudenciais nas taxas de inadimplência de micro e pequenas empresas no Brasil, analisando mais detalhadamente os dois componentes das taxas de inadimplência: os montantes totais de *default* e os volumes totais de crédito. Nossos resultados indicam que o aperto das políticas macroprudenciais aumenta a taxa de inadimplência nas empresas em questão, principalmente devido a uma redução no volume total de crédito que excede a diminuição no montante total de *defaults*.

Esta tese está dividida em quatro seções principais. Além desta introdução geral, a segunda seção discute a interação entre a política macroprudencial e a política monetária. A terceira seção apresenta uma análise do impacto do aperto da política macroprudencial nas taxas de inadimplência de micro e pequenas empresas brasileiras. Finalmente, a quarta e última seção oferece as considerações finais da tese.

2 Systemic Risk and the Interaction Between Monetary and Macroprudential Policies

Resumo: Este ensaio investiga a eficácia das ferramentas macroprudenciais e sua interação com a política monetária utilizando uma base de dados abrangente de 37 países. Para este fim, são calculadas regras de Taylor e índices de política macroprudencial para cada país, aplicando-se estes em análises de regressões de painel de dados com efeito fixo e regressões com dados em painel dinâmico. Os resultados encontrados indicam que as políticas macroprudenciais exercem um impacto assimétrico no risco bancário, com efeitos mais acentuados quando se utiliza um conjunto diversificado de instrumentos. Contudo, identifica-se que medidas de aperto são menos eficazes para promover a estabilidade financeira em contextos de política monetária restritiva. Esse resultado está associado ao fato de que, neste contexto, medidas macroprudenciais tendem a reduzir a lucratividade dos bancos, comprometendo assim a estabilidade financeira. Os resultados deste ensaio trazem novas evidências do possível conflito entre políticas monetárias e macroprudenciais ao lidar com o risco sistêmico.

Palavras-Chave: Estabilidade Financeira; Políticas Macroprudenciais; Política Monetária.
Classificação JEL: E52; E58; G18; G28.

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 Code: E52, E58, G18, G28.

2.1 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 highlighted the importance of macroprudential instruments in containing a set of systemic events that could compromise financial stability. The recent COVID-19 pandemic crisis posed the same challenges. However, the design and coordination of macroprudential and monetary policies present two major challenges.

The first is an assessment of the effectiveness of macroprudential policies. The empirical literature on the effectiveness of macroprudential instruments, in general, confirms that instruments such as loan-to-value ratios, countercyclical capital buffers, reserve requirements, and others have favorable effects on banking risk, financial system resilience, house prices, and transmission of monetary policy (Claessens and Laeven, 2004; Claessens, Ghosh and Mihet, 2013; Montes e Peixoto, 2014; Moraes, Montes and Antunes, 2016; Cerutti, Claessens and Laeven, 2017; Jiménez *et al*., 2017; Altunbas, Binici and Gambacorta, 2018; Bruno, Shim and Shin, 2017; Akinci, Olmstead-Rumsey, 2018; Ely, Tabak and Teixeira, 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. The empirical literature on 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, Calomiris and Wieladek (2016), Bruno, Shim and Shin (2017), Kim and Mehrotra (2018), Revelo, Lucotte and Pradines-Jobet (2020), Gambacorta and Murcia (2020) and Altavilla, Laeven and Peydró (2020), which investigate the effectiveness of macroprudential policies to curb credit growth and whether they are affected by monetary policy conditions, Takáts and Temesvary (2021) which show that this interaction affects cross-border bank lending, and Bekiros, Nilavongse and Uddin (2020), which investigate 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) Does this effect change when both macroprudential and monetary policies are restrictive? (iv) What is the transmission channel for the relationship between macroprudential and monetary policies?

To 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, Lucotte and Pradines-Jobet (2020) and Takáts and Temesvary (2021). Revelo and Levieuge (2022) investigate the relationship between these policies and financial stability but does so within a DGSE model with financial frictions. Zhang *et al*. (2020) study the interaction between policy on systemic risk, but only analyzes the case of China, employing a different methodology and measure of systemic risk compared to our study. Revelo, Lucotte and Pradines-Jobet (2020) and Takáts and Temesvary (2021) utilize methodologies similar to ours; however, they analyze the interaction effects of these policies on credit growth and cross-border bank lending.

Our results support the findings that macroprudential tools can effectively enhance financial system stability (Altunbas, Binici and Gambacorta, 2018; Ely, Tabak and Teixeira, 2021), but we find a more pronounced effect when a diverse set of instruments is used. Altunbas, Binici and Gambacorta (2018) also show that macroprudential tools are more effective during tightening cycles than loosening ones. However, we find that this asymmetry is more pronounced when a larger number of macroprudential instruments are used. While Revelo and Levieuge (2022), Revelo, Lucotte and Pradines-Jobet (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 help to shed light on the results of Revelo and Levieuge (2022). Finally, while Ely, Tabak and Teixeira (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), thus 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 the monetary policy stance, we use the well-known Taylor rule, such as Hofmann and Bogdanova (2012) and Revelo, Lucotte and Pradines-Jobet (2020). To assess the macroprudential policy stance, we build four indices that follow the existing literature as well (Cerutti, Claessens and Laeven, 2017; Revelo, Lucotte and Pradines-Jobet, 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 2.2 reviews the relevant literature. Section 2.3 presents data and methods used to determine the stances of macroprudential and monetary policies and the relationship between both policies and financial stability. Section 2.4 presents and discusses the results. The final section concludes this essay.

2.2 Literature Review

Our study relates to several strands of literature. In the first strand, we highlight studies of the effectiveness of macroprudential policies in general. When it comes to bank risk, certain macroprudential instruments have proven successful in reducing it. Altunbas, Binici and Gambacorta (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, Tabak and Teixeira (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, thus reducing risk exposure[2]. Claessens, Ghosh and Mihet (2013) showed that the maximum limits of LTV, debt service-to-income ratios (DSTI) and foreign-currency loans were effective in reducing the growth of bank leverage and asset prices.

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

Recent research, however, has pointed to the possibility that macroprudential policies might have important implications for the real economy, potentially undermining financial stability. Evidence suggests these measures could negatively affect key economic indicators such as consumption and investment (Teixeira and Venter, 2023). Additionally, there's an increasing body of work indicating that these policies could exacerbate income, wealth and welfare disparities (Teixeira, 2023; Ahnert *et al*., 2021}. Moreover, Gurrea-Martínez and Remolina (2019) argued that the implementation of capital requirements could be socially undesirable, at least in certain countries. Further research by Mirzaei and Moore (2021), Scalco, Tabak and Teixeira

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

(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[3] because both policies aim at different objectives that could conflict with each other. Generally, macroprudential policy aims to promote financial stability, while 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, Calomiris and Wieladek (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 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, Shim and Shin (2017) use a sample of 12 Asian-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 countries in the euro area, 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 that interact with LTV and the interest rate gap calculated using a Taylor rule.

Revelo, Lucotte and Pradines-Jobet (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

[3] This is the initial discussion that we recommend regarding the interaction between macroprudential and monetary policy: Ireland (2005), Claessens *et al*. (2013) and Beyer (2017). Ngambou Djatche (2022) provide a review of the literature on the interaction of monetary and macroprudential policies through their impacts on bank risk-taking. Additionally, it examines the challenges related to their coordination.

that a restrictive monetary policy influences the impact of macroprudential tightening action on domestic credit growth. Furthermore, the study suggests that monetary policy helps reduce the transmission delay of macroprudential policy actions. Finally, they confirm the complementarities between the two policies and the benefits of coordination. The empirical 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 the impacts of monetary and macroprudential policies 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 use of macroprudential policy as its primary tool and monetary policy as a supplement to restrain the outbreak of systemic risk. Recently, Bekiros, Nilavongse and Uddin (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[4].

Furthermore, within the second strand of literature, our article contributes to studies that highlight the potential for conflicts between the two policies, which can negatively impact the real side of the economy (Richter, Schularick and Shim, 2019; Fraisse; Le; Thesmar, 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, Guerrieri and Labriola (2019), which show the benefits of 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 to address 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

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

contractions (expansions) caused by tightening (loosening) capital requirements. Aikman *et al*., (2023) developed a simple and calibrated new Keynesian model to explore how monetary and macroprudential policies affect the economy. The calibrated results suggest that the deployment of countercyclical capital buffers improves the outcomes when monetary policy is the only instrument. However, instruments are typically substitutes and the policy message is that the benefits of coordinating these policies are small and that similar economic performance can be achieved by different policymakers pursuing different 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, Laeven and Peydró, 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, Dell'ariccia and Marquez (2010) investigate the link between monetary policy and excessive risk taking in lending, but also 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.

2.3 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 2.3.1 provides an overview of the implementation of macroprudential instruments over the past decade, and Section 2.3.2 defines the macroprudential policy stance. Section 2.3.3 deals with the definition of the stance of monetary policy. Finally, Section 2.3.4 deals with the relationship between both stances and financial risk.

2.3.1 Macroprudential Instruments

To define the macroprudential policy position, we use the IMF's integrated macroprudential policy database (iMaPP), originally constructed by Alam *et al*. (2019). We consider the 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

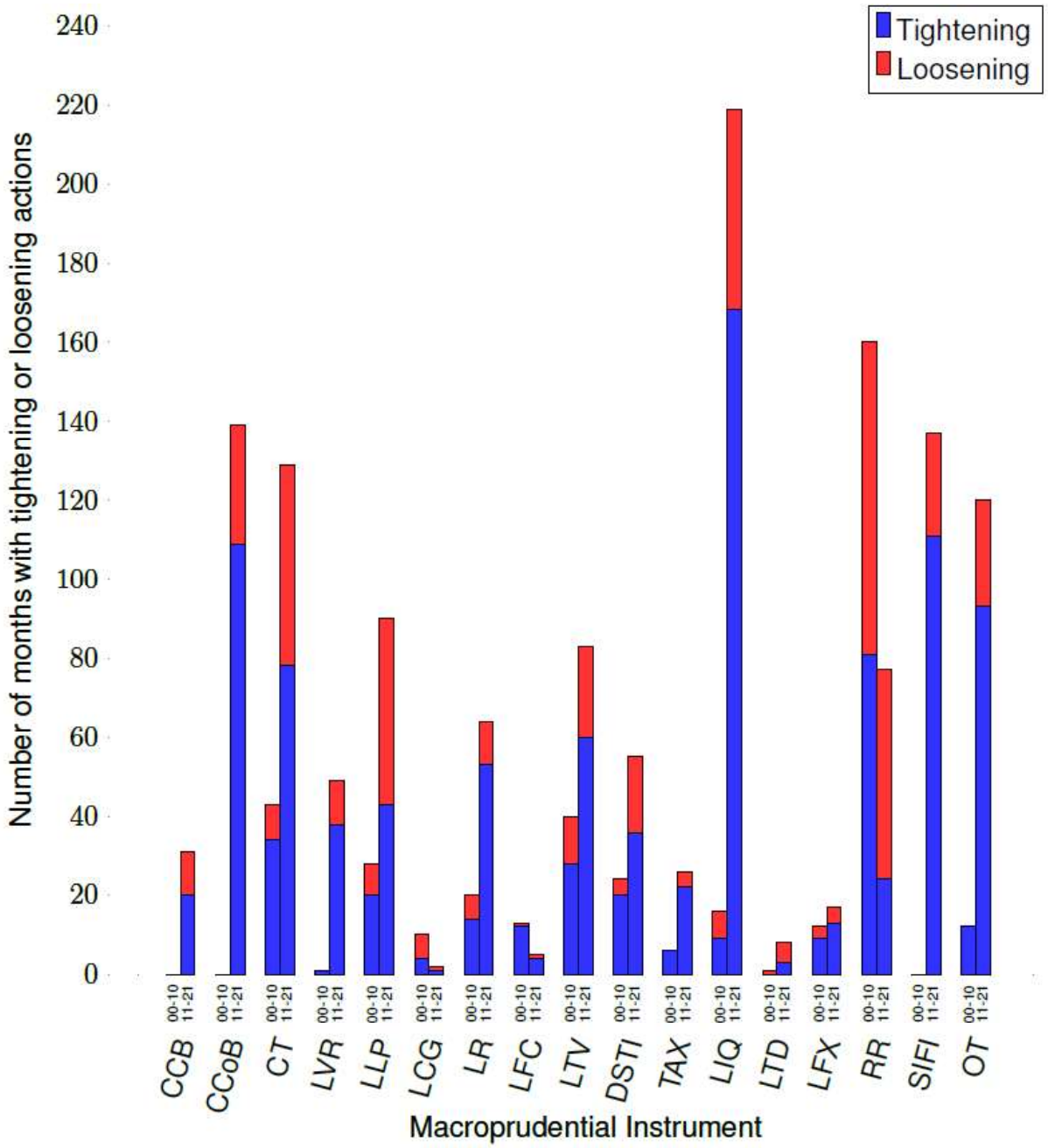
Instrument	Description
Countercyclical Capital Buffer (CCB)	A Capital buffer is the capital that a bank must hold beyond the minimum required amount. The countercyclical capital buffer is a type of buffer imposed on banks that would increase (decrease) requirements on capital during economic expansions (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 Bank Leverage (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 in 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 possible defaults (ELY; TABAK; TEIXEIRA, 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 and size
Limits on Foreign Currency (LFC)	Foreign currency lending 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 to guarantee a minimum collateral for a loan (ELY; TABAK; TEIXEIRA, 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 considered systematically important
Others (OT)	Measures not captured in previous categories, such as exposure limits between financial institutions

Note: 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.

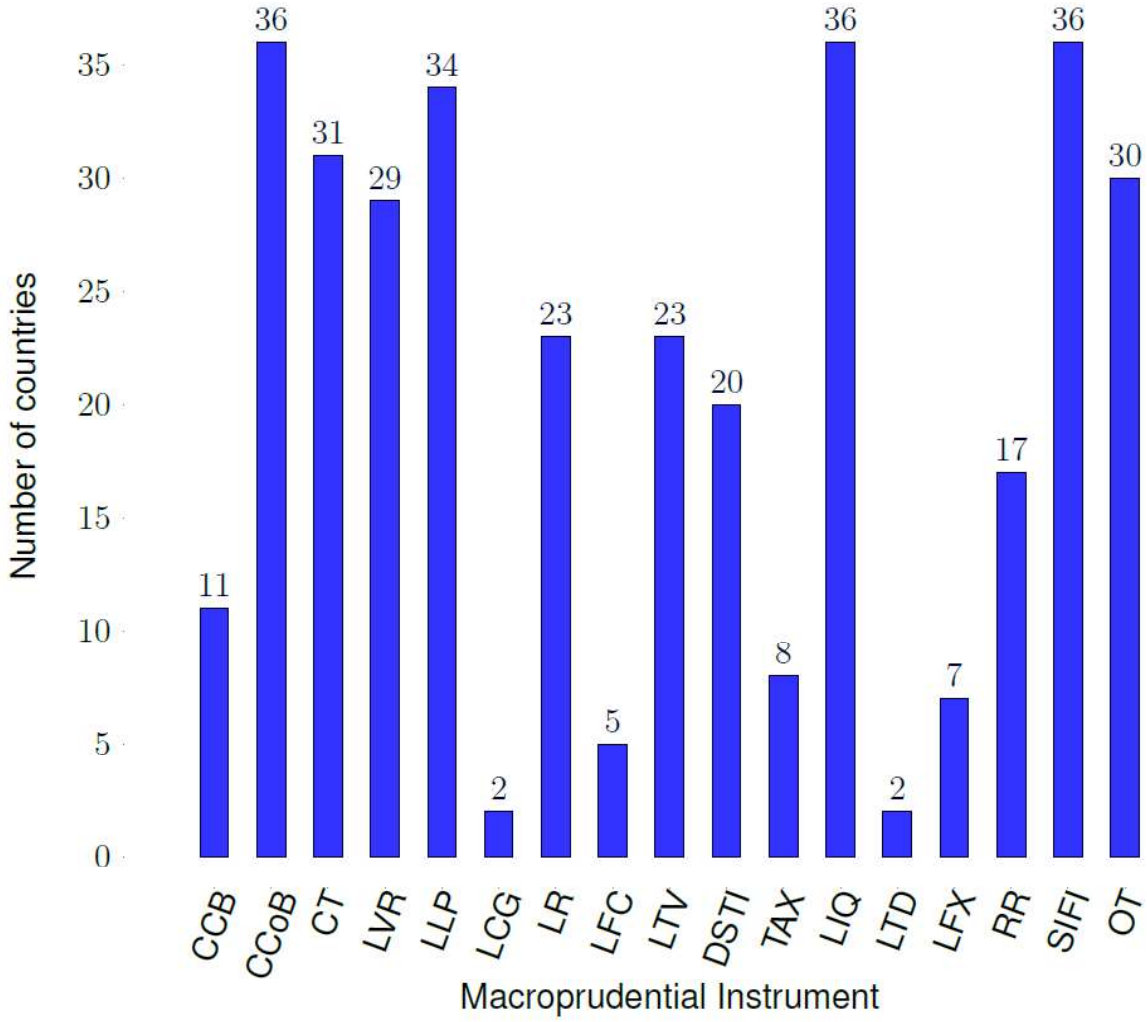
Figure 1. Number of months with more tightening or loosening actions by macroprudential instrument from 2000 to 2010 and from 2011 to 2021 across 37 countries



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

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



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

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

2.3.2 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, Claessens and Laeven (2017) and Revelo, Lucotte and Pradines-Jobet (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:

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

$y_{a,i,t}$ 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:

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

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.

2.3.3 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, Lucotte and Pradines-Jobet (2020):

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

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, Lucotte and Pradines-Jobet, 2020; Ouerk, Boucher and Lubochinsky, 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, Gali and Gertler (2000) and Revelo, Lucotte and Pradines-Jobet (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, β_π, β_y 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 3 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.

Table 3. 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.

2.3.4 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. In our database, we add 0.5 to individual Z-Scores so that we can take the logarithm of all values, including those that were originally negative.

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

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

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:

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

where *i* stands for country and *t* for year.

$MP_{i,t-k}^{(n)}$ is one of the four macroprudential indices described in Section 2.3.2. $Covid_i$ 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:

- GDP growth rate is calculated using the nominal GDP available in the IMF's IFS database;
- The lending rate is taken from the IFS database whenever available. In cases where data are not accessible from the IFS database, we use averages of

monthly interest rates on loans to nonfinancial 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;

- Bank Concentration (CR3) data is obtained from the GFD database (World Bank);
- 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;
- 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;
- Deposits Ratio is the ratio of the sum of total deposits and the sum of total assets of individual banks for each country *i* at time *t*, calculated using data from the Thomson Reuters Database;
- 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.

Building on Altunbas, Binici and Gambacorta (2018), we include GDP growth rate as a macroeconomic control variable to account for the procyclicality of financial stability. By controlling for the cyclical nature of the economy, we aim to better understand how macroprudential policies influence financial stability independently of the economic cycle. Following Revelo, Lucotte and Pradines-Jobet (2020), we also include lending rate as a macroeconomic control variable recognizing its direct influences on credit conditions and risk-taking behavior of banks and other financial institutions. Additionally, following Ely, Tabak and Teixeira (2021), we include bank concentration as a macroeconomic control variable and different variables to control for specific characteristics of the banks related to management and decision making that could change over time.

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

quarterly data for banks to see 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 are grouped by year and country. Size is the sum of the 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 improve financial stability.

The eight asymmetric regressions have the following specifications:

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

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

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

In these equations, we isolate the effects of a macroprudential index tightening $MP_{i,t-k}^{+(n)}$ and a macroprudential index loosening $MP_{i,t-k}^{-(n)}$ 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:

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

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. $MP_{i,t-k}^{+(n)} \times TG_{i,t}$ is then the interaction term between restrictive macroprudential and monetary policies.

The main coefficients of interest in this specification are β_k and ω_k. 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 $MP_{i,t-k}^{+(n)} \times TG_{i,t}$ is the use of a dummy variable to represent monetary policy instead of using the actual value of the Taylor Gap. This approach helps us mitigate potential inaccuracies arising from GMM instrumentalization, as well as variations in monetary policy rules across countries, which may not necessarily align with the rule specified in Equation 5.

As fixed-effects models can potentially have a significant correlation with the lagged dependent variable, we proceed to estimate Equation 11 using system GMM, as proposed by Arellano and Bover (1995). We reduce the possible endogeneity bias by introducing the lagged dependent variable on the right side of Equation 11.

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

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 shaped the banking industry. Bank concentration may be influenced by regulatory policies, merger and acquisition activities and changes in the competitive landscape of the industry. The point is that such factors are long-lasting and are 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 is not influenced by current or future events. 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, the balance sheets of banks. 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 sheets. As a result, we consider both policy variables to be predetermined.

Lastly, to better understand how macroprudential and monetary policies affect financial stability, we investigate 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 the system GMM. We use the same set of endogenous, predetermined, and exogenous variables as in Equation 1.

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

Table 4 show the mean values by country of the variables utilized from equation 7 to 12.

Table 4. 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.

2.4 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) Does this effect change 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 2.4.1 reports the results of the impact of macroprudential instruments on banks' risk-taking behavior in Tables 5 and 6. Section 2.4.2 reports the asymmetric effects of macroprudential policies in Tables 7, 8, 9 and 10 Section 2.4.3 present the effects of the interaction between macroprudential and monetary policies on banks' risk-taking behavior in Tables 11, 12 and 13. Finally, in Section 2.4.4, Table 14 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 2.3.2. 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 2.3.3. 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 2.3.4.

2.4.1 Macroprudential tools and systemic risk

Tables 5 and 6 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 5 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), while the results for $MP^{(2)}$ are reported in columns 3 and 4. Table 6 shows the results for the 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 improve financial system stability. Tables 5 and 6 show that a macroprudential policy tightening positively affects financial stability. Macroprudential tightening increases the stability of the banking system 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 as macroprudential instruments are, by design, constructed to enhance financial stability. Our results are also in line with recent literature (Apergis, Aysan and Bakkar, 2022; Ben-Gad, Pearlman and Sabuga, 2022; Claessens, Ghosh and Mihet, 2013; Fernandez-Gallardo, 2023; Meuleman and Vander Vennet, 2020; Altunbas, Binici and Gambacorta, 2018; Ely, Tabak and Teixeira, 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 impact a bank's profits by diminishing net interest margins. This affects 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, Fazio and Cajueiro, 2013).

Table 5. Impact of macroprudential policies ($MP^{(1)}$ and $MP^{(2)}$) 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 2.3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Impact of macroprudential policies ($MP^{(3)}$ and $MP^{(4)}$) 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 2.3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

2.4.2 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 7 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 8, 9 and 10, which give the results for the other indices.

We see that the effects of macroprudential tools on systemic risk are indeed asymmetrical. 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, Binici and Gambacorta (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 Covid variable also has a negative relationship with banking stability. This negative correlation can be attributed to factors such as loan losses, loan defaults, liquidity constraints and market's volatility stemming from the pandemic.

Table 7. Asymmetric impact of macroprudential policies ($MP^{+(1)}$ and $MP^{-(1)}$) 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 2.3.2. 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 ($MP^{+(2)}$ and $MP^{-(2)}$) 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 2.3.2. 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 ($MP^{+(3)}$ and $MP^{-(3)}$) 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 2.3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 10. Asymmetric impact of macroprudential policies ($MP^{+(4)}$ and $MP^{-(4)}$) 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 2.3.2. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.4.3 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 11 and 12, 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 11, 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 12, 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 13. 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 5.7%, as presented in Table 7, to 2.7%. When a diverse set of instruments is used, the positive effect decreases from 6.6%, as shown in Table 8, to 3.7%. For each month in which tightening actions prevail during the year, the positive effect on financial stability decreases from 1.7%, as presented in Table 9, 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%, as shown in Table 10, 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-19 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). Ensuring the ability to fulfill withdrawal demands, funding operations and financial obligations 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, Fazio and Cajueiro, 2013).

Table 11. Impact of macroprudential tightening ($MP^{+(1)}$ and $MP^{+(2)}$) during restrictive monetary

	(1)	(2)	(3)	(4)
$MP^{+(1)}$	0.076***	0.069***		
	(0.027)	(0.023)		
$(MP^{+(1)} \times TG)$	-0.049***	-0.035**		
	(0.018)	(0.016)		
L.$MP^{+(1)}$		0.063		
		(0.037)		
L.$(MP^{+(1)} \times TG)$		-0.026		
		(0.026)		
$MP^{+(2)}$			0.082***	0.075***
			(0.027)	(0.022)
$(MP^{+(2)} \times TG)$			-0.045**	-0.030*
			(0.017)	(0.016)
L.$MP^{+(2)}$				0.063
				(0.038)
L.$(MP^{+(2)} \times TG)$				-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 2.3.2. TG is the Taylor Gap dummy constructed in Section 2.3.3. 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. Impact of macroprudential tightening ($MP^{+(3)}$ and $MP^{+(4)}$) during restrictive monetary

	(1)	(2)	(3)	(4)
$MP^{+(3)}$	0.023***	0.020***		
	(0.006)	(0.005)		
$(MP^{+(3)} \times TG)$	-0.016***	-0.012***		
	(0.005)	(0.004)		
L.$MP^{+(3)}$		0.018***		
		(0.006)		
L.$(MP^{+(3)} \times TG)$		-0.004		
		(0.006)		
$MP^{+(4)}$			0.028***	0.023***
			(0.007)	(0.006)
$(MP^{+(4)} \times TG)$			-0.018***	-0.012***
			(0.005)	(0.004)
L.$MP^{+(4)}$				0.020**
				(0.008)
L.$(MP^{+(4)} \times TG)$				-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 2.3.2. TG is the Taylor Gap dummy constructed in Section 2.3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13. 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)			
$(MP^{+(1)} \times TG)$	-0.060**			
	(0.029)			
$MP^{+(2)}$		0.108*		
		(0.055)		
$(MP^{+(2)} \times TG)$		-0.060**		
		(0.028)		
$MP^{+(3)}$			0.027**	
			(0.013)	
$(MP^{+(3)} \times TG)$			-0.018*	
			(0.009)	
$MP^{+(4)}$				0.035**
				(0.015)
$(MP^{+(4)} \times TG)$				-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 2.3.2. TG is the Taylor Gap dummy constructed in Section 2.3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.4.4 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. 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, Tabak and Teixeira (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 2.4.3 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 measures that tighten credit conditions and elevate borrowing costs. Consequently, this can result in higher funding costs and a decline in loan demands, which can potentially lead 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 14. 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, Tabak and Teixeira (2021). Second, we find that a combination of restrictive monetary and macroprudential stances reduces banks' ROA. Table 14 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 14. 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)			
$(MP^{+(1)} \times TG)$	-0.222*			
	(0.121)			
$MP^{+(2)}$		0.328		
		(0.197)		
$(MP^{+(2)} \times TG)$		-0.212*		
		(0.123)		
$MP^{+(3)}$			0.051	
			(0.044)	
$(MP^{+(3)} \times TG)$			-0.082*	
			(0.047)	
$MP^{+(4)}$				0.054
				(0.053)
$(MP^{+(4)} \times TG)$				-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 2.3.2. TG is the Taylor Gap dummy constructed in Section 2.3.3. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2.5 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 bring new evidence of the interaction between both policies and help to shed light on recent findings of articles such as Revelo and Levieuge (2022), Revelo, Lucotte and Pradines-Jobet (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.

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3 Impact of Macroprudential Policies on Credit Default Rates Among Brazil's Micro and Small Enterprises

Resumo: Este ensaio investiga os efeitos do aperto das políticas macroprudenciais sobre a taxa de inadimplência, a inadimplência total e o volume de crédito total para micro e pequenas empresas no Brasil. Para este fim, utiliza-se uma base de dados por Unidade Federativa do país e cria-se um índice macroprudencial, aplicando-se estes em análises de regressões de painel de dados com efeito fixo. Os resultados indicam que o aperto das políticas macroprudenciais aumenta a taxa de inadimplência nas micro e pequenas empresas devido a uma redução no volume total de crédito que excede a diminuição da inadimplência total. Isso sugere uma reestruturação do mercado de crédito, na qual créditos anteriormente viáveis são excluídos, levando a uma maior concentração de créditos de maior risco.

Palavras-Chave: Políticas Macroprudenciais; Economia Real; Taxa de Inadimplência.
Classificação JEL: E51; E58; G18; G28.

Abstract: This essay investigates the effects of tightening macroprudential policies on the default rate, total defaults, and total credit volume for micro and small enterprises in Brazil. For this purpose, a database by Brazilian Federal Units is utilized, and a macroprudential index is created. These are applied in fixed effect panel data regression analyses. The results indicate that the tightening of macroprudential policies increases the default rate among micro and small enterprises due to a reduction in the total credit volume that exceeds the decrease in total defaults. This suggests a restructuring of the credit market, where previously viable credits are excluded, leading to a higher concentration of higher-risk credits.

Keywords: Macroprudential Policy; Real Economy; Default Rates.
JEL Code: E51; E58; G18; G28

3.1 Introduction

In the aftermath of the Global Financial Crisis, financial regulation has increasingly concentrated on the deployment of macroprudential instruments. These policies are designed to mitigate systemic vulnerabilities that threaten financial stability, including procyclical feedback loops between asset prices and credit, excessive leverage and volatile funding patterns (IMF, 2013; Ayyagari, Beck and Peria, 2018).

A substantial body of literature attests to the effectiveness of macroprudential policies. The empirical literature, in general, confirms that macroprudential instruments have favorable effects when it comes to diminishing bank risk, increasing financial system resilience and reducing the growth of bank leverage and asset prices (Altunbas, Binici and Gambacorta, 2018; Meuleman and Vander Vennet, 2020; Ely, Tabak and Teixeira, 2021; Adrian and Shin, 2010; Borio and Zhu, 2012; Claessens, Ghosh and Mihet, 2013).

Mitigating and preventing excessive growth in credit is also crucial for maintaining the integrity of financial systems (Revelo, Lucotte and Pradines-Jobet, 2020). The empirical literature shows that macroprudential policies are important to reduce credit supply to firms and households, curb housing credit and house price and reduce pro-cyclical banking lending to companies. (De Jonghe, Dewachter and Ongena, 2020; Vandenbussche, Vogel and Detragiache, 2015; Kuttner and Shim, 2016; Cerutti, Claessens and Laeven (2017), Alam *et al*., 2019; Aiyar, Calomiris and Wieladek, 2014; Jimenez *et al*., 2017).

Recent research, however, has pointed to the possibility that macroprudential policies might have important implications for the real economy, potentially undermining financial stability. Evidence suggests these measures could negatively affect key economic indicators such as consumption and investment and could exacerbate income and wealth disparities (Teixeira, 2023, Teixeira and Venter, 2023; Belkhir *et al*., 2022; Ahnert *et al*., 2021, Forbes, 2021; Gurrea-Martínez and Remolina 2019).

Our findings are related to growing literature regarding the unintended consequences of macroprudential regulation on the non-financial sectors of the economy. Our study investigates the impact of macroprudential policies on the default

rates of micro and small businesses in Brazil, further dissecting the impact on both components of default rates: the total amounts of default and the volumes of credit. Moreover, our analysis extends to exploring how the COVID-19 pandemic has influenced these dynamics.

Focusing on Brazil's micro and small enterprises offers an insightful exploration of the credit market dynamics within an emerging economy. Often, emerging economies are marked by tighter credit constraints and less efficient mechanisms for credit distribution (Varela, 2017), making them valuable case studies for empirical research. Brazil, in particular, is notable for its substantial credit market among these economies. According to data from the Bank for International Settlements (BIS), Brazil ranks fourth in credit market volume to non-financial sectors among emerging economies, following China, India, and South Korea.

This distinction underscores potential insights that an analysis of Brazil's credit market can provide, shedding light into the dynamics of credit distribution and the impact of economic policies on credit accessibility and financial health. Given that micro and small enterprises form the backbone of Brazil's domestic economy, which account for about 99% of all businesses in Brazil, embodying 55% of formal employment and nearly 30% of the GDP[5], they serve as an important lens through which to examine these credit dynamics. Their reliance on the credit market for growth and sustainability makes them particularly susceptible to shifts in credit availability and regulatory changes (Ayyagari, Beck and Peria, 2018), thereby providing fresh insights into the broader implications of macroprudential policies.

Our results indicate that macroprudential policies increase default rates for micro and small enterprises. we theorize that these policies may unintentionally create adverse effects in the credit market for micro and small firms through a mechanism of adverse selection that affects such business. Specifically, across both categories, macroprudential policy tightenings are associated, as mentioned, with increased default rates, but also with reduced credit volume. Not only that, for micro firms total defaults remain unchanged, whereas for small firms, total defaults decrease, albeit less significantly than the reduction in total credit. Our results, then, indicate that credit likely to be repaid is exiting the market, whereas credit prone to default remains.

[5] https://www.sebrae-sc.com.br/blog/qual-o-papel-das-pequenas-empresas-na-economia-brasileira

The observed reduction in total credit aligns with existing literature that extensively documents a contraction in credit across the economy following the tightening of macroprudential policies (De Jonghe, Dewachter and Ongena, 2020; Vandenbussche, Vogel and Detragiache, 2015; Kuttner and Shim, 2016; Cerutti, Claessens and Laeven, 2017; Alam *et al*., 2019; Jimenez *et al*., 2017). This finding also aligns with more recent literature that highlight a reduction in credit to smaller firms (Ayyagari, Beck and Peria, 2018; Ćehajić and Košak, 2022; Bhargava, Górnicka and Xie, 2021). The literature, however, lacks consensus regarding credit default. Specifically, Belkhir *et al*. (2022) note a decrease in default risk within non-financial sectors following macroprudential tightening. Yet, when focusing solely on increased macroprudential capital requirements, the authors report an observed increase in default risk within these sectors.

To carry out our study, we use a quarterly dataset spanning from 2012 to 2021, covering all 27 Federative Units of Brazil. This dataset includes data from IMF's integrated macroprudential policy database (iMaPP), Brazil's Central Bank Credit Service Information (SCR), IBGE's Continuous National Household Sample Survey (PNAD Contínua). We estimate fixed effects panel regressions to investigate the effects of macroprudential tightenings on default rates, total default and total credit for micro and small firms. To assess the macroprudential policy stance, we build an index inspired by those established in the literature (Cerutti, Claessens and Laeven, 2017; Revelo, Lucotte and Pradines-Jobet, 2020). The use of state-level panel data enables us to account for heterogeneity across states.

The remainder of this paper is organized as follows. Section 3.2 reviews the relevant literature. Section 3.3.1 presents an overview of the data used to perform our empirical analysis, while section 3.3.2 presents the methods and identification strategy. Section 3.4 presents and discusses the results. Finally, Section 3.5 section concludes this paper.

3.2 Literature Review

The primary aim of macroprudential policies is to mitigate systemic financial risk (Kahou and Lehar, 2017; Poghosyan, 2020; Tang *et al*., 2021). Following the global financial crisis of 2007-2008, these policies have become a focal point for

policymakers, central banks, and researchers (Gauthier, Lehar and Souissi, 2012; Tang *et al*., 2021). Numerous studies have highlighted the effectiveness of macroprudential policies in achieving their core goal. For example, Altunbas, Binici and Gambacorta (2018), employing a dynamic generalised method of moments panel approach across 61 developed and emerging countries, suggest that macroprudential tools have a significant impact in reducing bank risk. Furthermore, they find that macroprudential policies are more effective in a tightening than in an easing episode.

Moreover, Meuleman and Vander Vennet (2020) use a dynamic panel framework at a monthly frequency to assess the impact of macroprudential tools and their design on banks' systemic risk both in the short and the long run. They support the consensus that macroprudential measures contribute to a reduction in banks' systemic risk. Ely, Tabak and Teixeira (2021) investigate the transmission mechanisms of macroprudential policies on bank risk-taking. The authors estimate a system-GMM model and find that the leverage channel has a considerable effect in reducing systemic risk. The authors conclude that macroprudential measures tend, in general, to limit bank leverage, reducing risk exposure. Finally, Claessens, Ghosh and Mihet (2013), using panel data regressions, analyze how changes in balance sheets of 2,800 banks in 48 countries over 2000–2010 respond to specific macro-prudential policies. Their results show that the maximum limits of LTV, debt service-to-income ratios (DSTI) and foreign-currency loans were effective in reducing the growth of bank leverage and asset prices.

Significantly, numerous studies also explore the effect of macroprudential policies on credit, which is closely linked to financial stability. Cerutti, Claessens and Laeven (2017), using an IMF survey covering the use of 12 macroprudential measures in 119 countries, show that instruments such as LTV and others that limit the level of indebtedness are associated with a decline in credit growth. Gambacorta and Murcia (2020) employ meta-analysis techniques to examine credit data from Brazil, Argentina, Colombia, Mexico, and Peru, ultimately concluding that macroprudential policies have played a significant role in stabilizing credit cycles. The authors emphasize that propagation of effects to credit growth is more rapid for policies aimed at curbing the cycle than for policies aimed at fostering financial stability.

Aiyar, Calomiris and Wieladek (2014), using fixed effects panel regressions, suggest a strong effect of capital requirements on loans to UK banks. Finally, Revelo,

Lucotte and Pradines-Jobet (2020) also examine the influence of a collection of macroprudential instruments on credit growth using fixed effects and system-GMM methodologies. The authors conclude that the use of these instruments help curb credit growth. Furthermore, using a Taylor Gap estimate as a measure of different monetary policy stances, they confirm the complementarities between the monetary and macroprudential policies regarding credit growth and the benefits of coordination.

Recent research, however, has pointed to the possibility that macroprudential policies might have important implications for the real economy, potentially undermining financial stability. Belkhir *et al*. (2022) study the transmission of macroprudential policies across both financial and non-financial sectors of the European economy using a dynamic panel setting. Regarding the non-financial sector, the authors results indicate that tighter macroprudential regulations implemented in Europe over the period 2008–2017 lowered default risk not only in the financial, but also in non-financial sectors. However, when considering only capital requirements, higher capital requirements raise long-term default risk in non-financial sectors. Teixeira and Venter (2023) assess the impact of macroprudential policy on aggregate demand in the European Union between 2000 and 2019. Using a difference-in-differences approach, the authors find that macroprudential policies reduce household consumption. Moreover, this effect is relatively mild in the short run but become more pronounced in the long run. According to the authors, their findings point to a weaker macroeconomic impact than suggested in previous studies.

Expanding on the influence of macroprudential policies on areas beyond their direct targets, Ahnert *et al*. (2021) assess the impact of macroprudential FX regulations by developing a model of bank versus market lending in domestic or foreign currency. They incorporate asymmetric information between lenders and borrowers, with banks as special lenders because of their ability to screen for firm productivity at a cost. The authors conclude that the incorporation of macroprudential FX regulations results in a welfare trade-off, in which banks are less sensitive to currency movements so that a lower risk of bank failure exists after depreciations, but this is balanced by lower aggregate investment, a lower productivity of investment, and an increased sensitivity of investors to currency movements. Teixeira (2023) examines the effects of macroprudential policy on wealth inequality using a synthetic control approach in a large dataset of 171 countries. The author finds that, after the adoption of

macroprudential instruments, wealth concentration in the treated countries increases by 3.4 percentage points in a decade. Moreover, Gurrea-Martínez and Remolina (2019) argued that the implementation of capital requirements could be socially undesirable, at least in certain countries.

According to data from IMF's integrated macroprudential policy database (iMaPP), originally constructed by Alam *et al*. (2019), in a sample of 104 countries, 68% of macroprudential policies adopted since 1990 were implemented by emerging countries, while 32% were adopted by developed countries. Emerging nations such as Brazil serve as important testing grounds for the evaluation of the effectiveness of macroprudential instruments due to their relatively extensive history of implementation in such environments (Agénor and Silva, 2016; Gambacorta and Murcia, 2020).

Regarding studies that examine the effects of these policies in Brazil's economy, Silva Vinhado and Divino (2015) investigate the relationships between such instruments and the stability of the national banking sector. Using impulse-response functions, the authors compute panel VAR estimations for more than 50 institutions that operated in the Brazilian banking market between 2001 and 2013 to confirm the importance of capital requirements as a tool for maintaining a stable financial system. Brandi and Andrade (2018) seek to assess the effects of certain macroprudential instruments on macroeconomic and financial variables. The authors employ a DSGE model with credit supply frictions. Their findings suggest a better suitability of countercyclical macroprudential instrument in the case of shocks originating within the financial system. However, when dealing with supply and demand shocks, the use of the macroprudential instruments showed a conflicting role with the objectives of the monetary authority. Carvalho and Castro (2017) also employ a DSGE model that incorporates heterogeneous financial frictions and foreign capital flows. The authors apply Bayesian estimation techniques to Brazilian data. Their investigation focuses on identifying optimal mixes of macroprudential, fiscal, and monetary policy rules responsive to business and financial cycles. Their findings suggest that the benefits of enacting a cyclical fiscal policy become substantial only when macroprudential policy is applied countercyclically in response to the financial cycle.

An additional consideration about emerging economies is their characteristic tighter credit constraints and less efficient credit distribution mechanisms (Varela, 2017), aspects that significantly contribute to their utility as case studies for empirical

research. Brazil, in particular, is notable for its substantial credit market among these economies. According to data from the Bank for International Settlements (BIS), Brazil ranks fourth in credit market volume to non-financial sectors among emerging economies, following China, India, and South Korea.

In discussing credit default in Brazil, we draw attention to the research conducted by Correa *et al*. (2014) and Barthman, Moura and Norden (2024). Correa *et al*. (2014) empirically explore whether the default rates of borrowing companies in the Brazilian market increase during economic downturns. Utilizing a probit model to assess the probability of default, their findings reveal a negative correlation between the business cycle and default rates, aligning with existing literature on the subject. Barthman, Moura and Norden (2024) conduct a differences-in-differences regression analysis to investigate the role of lending technologies in consumer credit defaults in Brazil before and during the COVID-19 pandemic. Their results suggest that relationship borrowers are less likely to default than others before the pandemic and this effect persists during the pandemic, but in a much smaller scale. The authors also concluded that relationship borrowers of appliance finance default less during the pandemic than the ones of general-purpose cash loans.

Our research seeks to merge the topics of macroprudential policies and credit default, recognizing their significance for developing economies and their connection to credit dynamics and the real economy. Our primary objective is to explore how macroprudential tightening influences default rates of micro and small enterprises.

3.3 Data and Methods

In this article, we undertake an empirical examination of the potential impacts of macroprudential policies on default rates and their two key components: total default amounts and credit volumes, focusing on micro and small enterprises across Brazil's 27 states. A description of the data utilized is provided in Section 3.3.1, and our empirical approach is outlined in Section 3.3.2.

3.3.1 Data

This article uses quarterly panel data for the 27 Brazilian's UF from the second quarter of 2012 to the fourth quarter of 2021. Data regarding default rates and credit volume was taken from Brazil's Central Bank Credit Service Information (SCR). We use the default rate of 90 days past due loans by state and the natural logarithm of credit operations outstanding by state as volume of credit. Default rate is the ratio between 90 days past due loans and total credit. Hence, using this ratio, we can derive the total value of 90-day past due loans (expressed in natural logarithm) from the available data. The Central Bank of Brazil (BCB) follows the criteria of annual consolidated gross operating revenue to define micro and small companies (Boligan and Montani, 2022). According to this criterion, micro-enterprises are those with annual revenues up to R$360,000, and small companies are those with revenues ranging from R$360,000 to R$4.8 million. Total defaults and credit volumes are deseasonalized using STL decomposition to account for seasonal patterns.

We develop and index that registers the tightening actions of all macroprudential instruments employed in Brazil throughout the study period. Data comes from the IMF's integrated macroprudential policy database (iMaPP), originally constructed by Alam *et al*. (2019). The iMaPP database assigns dummy variables to represent the tightening actions of macroprudential instruments, with a value of +1 indicating a tightening action in a given month and 0 otherwise. These monthly values are aggregated on a quarterly basis to construct our MP index. A higher value of the index indicates a more restrictive macroprudential policy framework in the given quarter.

Our analysis incorporates three state-varying control variables. Firstly, for the Deseasonalized Regional Economic Activity Index (IBCR), data comes from the Economics Department of the Brazilian Central Bank, covering 13 states and 5 regions. For states lacking specific data, we utilize corresponding regional data. Secondly, the unemployment rate and actual earnings variation data are obtained from the Continuous National Household Sample Survey (PNAD Contínua) conducted by IBGE. Both sets of data are deseasonalized using STL decomposition. Lastly, our analysis incorporates three national control variables. We derive the accumulated monthly SELIC rate, which serves as the interest rate indicator, and the CR4 index, indicating the market concentration of the four largest banks, from data provided by the Central

Bank of Brazil (BCB). The IPCA inflation rate is sourced from the Brazilian Institute of Geography and Statistics (IBGE).

3.3.2 Methods

We aim to investigate the potential effects of macroprudential policies on the default rates, the total default amounts and credit volumes for micro and small enterprises across Brazil's 27 states. To achieve this, we utilize fixed effects estimation to control for the unobservable time-invariant state characteristics. We conduct separate baseline regressions for micro and small enterprises, with the following overarching specification:

$$Y_{i,t} = \alpha_i + \beta MP_{i,t} + \gamma\, StateControls_{i,t} + \phi NationalControls_{i,t} + \varepsilon_{i,t} \quad (13)$$

in which *i* stands for state and *t* for quarter.

$Y_{i,t}$ is one of the three dependent variables: default rate, total default amount and credit volume. $MP_{i,t}$ is the macroprudential index described in Section 3.3.1 The model incorporates $StateControls_{i,t}$, which are variables varying by state, including the Index of Regional Economic Activity (IBCR), the Unemployment Rate, and the Variation of Actual Earnings. $NationalControls_{i,t}$ consists of variables that are uniform at the national level, such as the Interest Rate, the Inflation Rate, and the Bank Concentration Ratio (CR4). Lastly, α_i represents the fixed effects for Brazil's states.

Taking into account both firm sizes and the different dependent variables, our analysis comprises six distinct regressions based on the full sample. To incorporate the effects of the COVID-19 pandemic, we have segmented our analysis into two subsamples: pre-COVID and post-COVID. The post-COVID period encompasses the quarters of 2020 and 2021. We apply Equation 13 to estimate the impacts across these subsamples for each firm size category.

3.4 Results

In this section, we investigate the potential effects of macroprudential policies on default rates, total defaults and credit volumes for micro and small enterprises across

Brazil's 27 states. Table 15 presents the descriptive statistics of our dataset. The decision to utilize state-level panel data is driven by the observed heterogeneity in default rates across states. As Table 15 reveals, Espírito Santo (ES), the Federal District (DF), Mato Grosso (MT), Rio Grande do Sul (RS), and Santa Catarina (SC) — primarily located in the South, Southeast, and Central West regions — exhibit the lowest default rates for micro enterprises, with figures between 5-6%. This contrasts sharply with Acre (AC), Amapá (AP), Maranhão (MA), Pará (PA), and Piauí (PI) — mostly in the North and Northeast regions — where default rates approach 11-12%. This pattern of variation extends to total credit volumes, with states such as Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), and São Paulo (SP) — situated in the South and Southeast — showing the highest levels for both micro and small firms.

Table 15. Mean values by Brazilian's States for Micro Enterprises (ME) and Small Enterprises (SE)

	Default Rate ME	Default Rate SE	ln Total Default ME	ln Total Default SE	ln Total Credit ME	ln Total Credit SE	IBCR	Unemployment Rate	Actual Earning Var	Interest Rate	Inflation Rate	CR4
AC	12.011	7.650	2.030	3.469	4.235	6.137	162.955	11.576	-0.073	0.717	1.475	60.741
AL	9.980	6.854	3.209	4.313	5.549	7.040	140.672	13.725	0.557	0.717	1.475	60.741
AM	9.793	7.913	3.482	4.838	5.940	7.424	147.616	12.105	-0.226	0.717	1.475	60.741
AP	13.924	9.013	2.035	3.392	4.072	5.889	162.955	14.501	0.415	0.717	1.475	60.741
BA	8.909	7.230	4.999	6.240	7.456	8.932	138.865	15.051	0.112	0.717	1.475	60.741
CE	6.939	7.107	4.159	5.548	6.896	8.264	145.864	10.335	0.404	0.717	1.475	60.741
DF	5.622	7.457	4.089	5.532	7.248	8.221	170.970	11.571	-0.014	0.717	1.475	60.741
ES	5.780	5.807	3.995	5.325	6.917	8.267	147.220	9.643	0.478	0.717	1.475	60.741
GO	7.528	6.087	4.797	6.092	7.490	8.958	169.252	8.524	0.409	0.717	1.475	60.741
MA	11.163	7.217	3.787	5.069	6.148	7.793	140.672	11.533	0.506	0.717	1.475	60.741
MG	6.283	6.161	5.689	6.943	8.533	9.824	136.621	9.295	0.569	0.717	1.475	60.741
MS	7.017	5.041	3.697	5.071	6.456	8.132	170.970	6.801	0.608	0.717	1.475	60.741
MT	5.148	4.939	3.985	5.490	7.047	8.595	170.970	6.750	0.307	0.717	1.475	60.741
PA	12.637	7.159	4.000	5.354	6.271	8.077	162.913	9.769	0.485	0.717	1.475	60.741
PB	9.511	6.389	3.187	4.607	5.582	7.415	140.672	11.159	0.793	0.717	1.475	60.741
PE	7.335	7.635	4.311	5.646	7.006	8.272	145.209	13.769	0.087	0.717	1.475	60.741
PI	11.413	6.980	3.120	4.404	5.415	7.132	140.672	10.238	1.057	0.717	1.475	60.741
PR	7.009	5.854	5.414	6.760	8.133	9.666	152.147	6.923	0.283	0.717	1.475	60.741
RJ	8.115	8.772	5.673	6.992	8.328	9.458	124.750	11.921	0.526	0.717	1.475	60.741
RN	7.783	7.598	3.381	4.815	6.044	7.437	140.672	12.864	0.510	0.717	1.475	60.741
RO	6.935	5.246	3.000	4.335	5.732	7.359	162.955	6.951	0.237	0.717	1.475	60.741
RR	10.735	5.770	1.632	2.703	4.140	5.657	162.955	9.885	0.211	0.717	1.475	60.741
RS	5.613	5.207	5.318	6.576	8.251	9.599	133.128	6.958	0.484	0.717	1.475	60.741
SC	4.893	4.448	4.923	6.300	7.982	9.500	144.389	4.912	0.295	0.717	1.475	60.741
SE	8.783	7.117	2.892	4.116	5.354	6.819	140.672	13.271	0.186	0.717	1.475	60.741
SP	6.411	7.037	6.910	8.165	9.709	10.862	144.546	10.669	0.309	0.717	1.475	60.741
TO	7.396	6.365	2.732	4.198	5.607	7.152	162.955	9.593	0.392	0.717	1.475	60.741

Note: This table shows the averages of the main variables by Federative Unit of Brazil from 2012Q2 to 2021Q4.

Table 16 present our regression results for micro enterprises and Table 17 present the results for small firms. Both tables are structured with three columns. The first columns present results for the default rate, while the second and third columns present the results for total default and credit volume, respectively.

Subsequently, we examine how the COVID-19 pandemic has influenced these results, using sub samples for analysis. Table 18 illustrates the impact of macroprudential policies on micro enterprises pre-COVID and post-COVID, while Table 19 display the results for small enterprises. Both tables are structured with six columns. The first and second columns relate to the default rate, with the first column

representing the pre-COVID period and the second column the post-COVID period. Similarly, the third and fourth columns are dedicated to total default, while the fifth and sixth columns focus on credit volume.

As presented in Table 16, our findings indicate that the tightening of macroprudential instruments is associated with an increase in the default rate for micro enterprises. Specifically, a tightening action leads to an increase in the default rate by 0.33 percentage points. To gain a clearer understanding of this outcome, we examine the impact of macroprudential policies on both the total amount of defaults and total credit for micro enterprises. Our findings indicate that the tightening of macroprudential instruments is associated with a decrease in credit volume for micro firms. A tightening action results in a 3.2% decrease in credit volume. However, regarding the total default, the effect is not statistically significant. Thus, the increase in the default rate stems from a reduction in total credit, rather than from a decrease in the total amount of defaults.

Regarding small enterprises, results presented in Table 17 show that macroprudential tightenings contribute to an increase in the default rate, consistent with our results for micro enterprises. Specifically, a tightening action results in a 0.19 percentage point increase in the default rate for small firms. Furthermore, the tightening of macroprudential instruments is also correlated with a reduction in credit volume, with this decrease amounting to approximately 5.1%. Unlike micro firms, we observe a reduction in the credit default amount for small firms, amounting to 1.4%. Therefore, the increase in the default rate for small firms is attributed to a greater decrease in total credit than in the total amount of defaults.

For both types of firms, we observe a reduction in credit volume. These results align with existing literature that extensively documents a contraction in credit across the economy following the tightening of macroprudential policies (De Jonghe, Dewachter and Ongena, 2020; Vandenbussche, Vogel and Detragiache 2015; Kuttner and Shim 2016; Cerutti, Claessens and Laeven 2017; Alam *et al*. 2019; Jimenez *et al*. 2017) and allign with studies that specifically highlight a reduction in credit to micro and small firms (Ayyagari, Beck and Peria 2018; Ćehajić and Košak 2022; Bhargava, Górnicka and Xie, 2021). The literature, however, lacks consensus regarding credit default. Specifically, Belkhir *et al*. (2022) notes a decrease in default risk within non-financial sectors following macroprudential tightening. Yet, when focusing solely on

increased macroprudential capital requirements, the authors report an observed increase in default risk within these sectors.

Table 16. Effect of Macroprudential Policies on Default Rate, Total Default Amount and Credit Volume of Micro Enterprises

	Default Rate	Total Default	Credit Volume
MP Index	0.330***	-0.009	-0.032***
	(0.074)	(0.006)	(0.007)
IBCR	-0.084	-0.006	0.007**
	(0.066)	(0.006)	(0.003)
Unemployment Rate	0.257*	0.030**	-0.002
	(0.127)	(0.011)	(0.007)
Actual Earnings Variation	-0.021	-0.004	-0.003*
	(0.024)	(0.002)	(0.002)
Interest Rate	4.999***	0.612***	0.068
	(1.237)	(0.092)	(0.088)
Inflation Rate	-0.674***	0.011	0.081***
	(0.237)	(0.018)	(0.015)
CR4	0.131***	0.037***	0.021***
	(0.040)	(0.004)	(0.005)
Observations	1053	1053	1053

Note: This table presents the results of the fixed-effects model defined in Equation 13 for micro enterprises. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 17. Effect of Macroprudential Policies on Default Rate, Total Default Amount and Credit Volume of Small Enterprises

	Default Rate	Total Default	Credit Volume
MP Index	0.193***	-0.014*	-0.051***
	(0.057)	(0.008)	(0.003)
IBCR	-0.052**	-0.004	0.005**
	(0.019)	(0.003)	(0.002)
Unemployment Rate	0.383***	0.034***	-0.009**
	(0.051)	(0.008)	(0.004)
Actual Earnings Variation	0.034**	0.002	-0.002
	(0.016)	(0.002)	(0.002)
Interest Rate	7.105***	0.949***	-0.115**
	(0.456)	(0.054)	(0.041)
Inflation Rate	-0.694***	0.022**	0.143***
	(0.065)	(0.008)	(0.007)
CR4	-0.063***	-0.002	0.013***
	(0.016)	(0.002)	(0.002)
Observations	1053	1053	1053

Note: This table presents the results of the fixed-effects model defined in Equation 13 for small enterprises. The coefficient of the constant was omitted for space considerations. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Macroprudential policies are designed to enhance financial stability and reduce systemic risks. Mitigating and preventing excessive growth in credit is crucial for maintaining the integrity of financial systems (Revelo, Lucotte and Pradines-Jobet, 2020). Our analysis indicates that macroprudential policies, while aimed at curbing credit, may inadvertently create adverse effects in the credit market for micro and small enterprises through a form of adverse selection targeting these firms. Our findings contribute to the expanding literature on the unintended effects of macroprudential regulations on sectors of the economy not targeted by these policies (Teixeira, 2023; Teixeira and Venter, 2023; Belkhir *et al*. 2022; Ahnert *et al*., 2021; Forbes 2021; Gurrea-Martínez and Remolina, 2019).

In essence, our results show that, for both sizes of firms, macroprudential policies tightenings are associated with increased default rates, but also with reduced credit volume. Not only that, for micro firms total defaults remain unchanged, whereas

for small firms, total defaults decrease, albeit less significantly than the reduction in total credit. Our findings, then, indicate that credit likely to be repaid is exiting the market, whereas credit prone to default remains.

By tightening credit conditions, macroprudential policies could disproportionately affect creditworthy or low-risk borrowers. Credit that would have been repaid is being reduced, while the amount of credit that is likely to default either remains unchanged or decreases less significantly than the total credit volume. In such a restrictive landing environment, financial institutions might become more risk-averse, potentially reducing credit availability to businesses that would otherwise be deemed low-risk but are now considered less favorable. Consequently, a larger share of the market's loans may be allocated to higher-risk borrowers. This situation suggests a market shift where viable credit is forced out, leaving behind a higher concentration of riskier credit.

Overall, this interpretation suggests that the tightening of macroprudential policies could be making it more difficult for more creditworthy micro and small enterprises to access credit, possibly because the policies make lending to these enterprises less attractive or more difficult for financial institutions. At the same time, the amount of credit at risk of default remains relatively stable or decreases less significantly than the total credit volume, possibly because this portion of the credit market is less sensitive to the policy tightening or because these loans were already at such a high risk that the policy changes have little additional effect.

A notable observation is that small firms experience a more significant decrease in both total credit and total default amounts compared to micro firms. This could be attributed to small enterprises potentially having better access to alternative financing sources than micro firms. When faced with tightened macroprudential policies, small firms may be able to more quickly lessen their dependence on debt, resulting in a larger reduction in credit volume. This adaptability might also enable them to slightly decrease their default volumes by utilizing alternative financial resources to mantain their business operations.

Finally, to account for the effects of the COVID-19 pandemic, we have divided our analysis into two subsamples: pre and post-COVID. Tables 18 and 19 present the results for micro and small enterprirses respectively.

Table 18. Effect of Macroprudential Policies on Default Rate (DR), Total Default Amount (TD) and Credit Volume (CV) of Micro Enterprises Pre and Post COVID-19

	DR Pre	DR Post	TD Pre	TD Post	CV Pre	CV Post
MP Index	0.203**	1.750*	-0.011	0.339***	-0.010**	0.085
	(0.095)	(0.890)	(0.007)	(0.086)	(0.005)	(0.069)
IBCR	-0.124	0.141***	-0.001	0.008	0.015**	0.000
	(0.103)	(0.046)	(0.008)	(0.005)	(0.006)	(0.006)
Unemployment Rate	0.428**	0.033	0.056***	0.026**	-0.002	-0.008
	(0.198)	(0.119)	(0.016)	(0.012)	(0.010)	(0.011)
Actual Earnings Variation	-0.020	0.022	-0.001	0.004	-0.002	-0.000
	(0.034)	(0.023)	(0.002)	(0.004)	(0.002)	(0.002)
Interest Rate	3.481**	10.031***	0.705***	1.911***	0.404***	0.219
	(1.592)	(2.592)	(0.124)	(0.306)	(0.144)	(0.205)
Inflation Rate	-0.167	-2.458***	0.043***	-0.217***	0.035***	0.061*
	(0.159)	(0.488)	(0.011)	(0.038)	(0.012)	(0.033)
CR4	0.133**	-1.889***	0.029***	-0.284***	0.012**	-0.052
	(0.054)	(0.463)	(0.005)	(0.054)	(0.005)	(0.041)
Observations	837	216	837	216	837	216

Note: This table presents the results of the fixed-effects model defined in Equation 13 for micro enterprises pre and post COVID. The first and second columns relate to the default rate, with the first column representing the pre-COVID period and the second column the post-COVID period. Similarly, the third and fourth columns are dedicated to total default, while the fifth and sixth columns focus on credit volume. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

For micro enterprises, we observe an increase in default rate in both periods, with a more significant increase in the post-COVID period. In the pre-COVID period, this rise was driven by a reduction in total credit, consistent with our findings for the entire sample. However, in the post-COVID period, this increase was lead by a rise in total amount of default.

Table 19. Effect of Macroprudential Policies on Default Rate (DR), Total Default Amount (TD) and Credit Volume (CV) of Small Enterprises Pre and Post COVID-19

	DR Pre	DR Post	TD Pre	TD Post	CV Pre	CV Post
MP Index	-0.027	0.686	-0.009	0.018	-0.005*	-0.103***
	(0.064)	(0.430)	(0.008)	(0.066)	(0.003)	(0.035)
IBCR	-0.144***	0.026	-0.011**	-0.004	0.012***	-0.005*
	(0.041)	(0.025)	(0.005)	(0.004)	(0.003)	(0.003)
Unemployment Rate	0.445***	0.075	0.025**	0.052***	-0.026***	0.017*
	(0.092)	(0.075)	(0.012)	(0.016)	(0.006)	(0.009)
Actual Earnings Variation	0.031**	0.021	0.004**	-0.002	0.001	-0.004*
	(0.015)	(0.029)	(0.002)	(0.005)	(0.001)	(0.002)
Interest Rate	4.024***	6.111***	0.909***	1.652***	0.423***	-0.059
	(0.531)	(0.895)	(0.063)	(0.212)	(0.057)	(0.112)
Inflation Rate	-0.176**	-1.097***	0.008	-0.047*	0.029***	0.226***
	(0.068)	(0.109)	(0.009)	(0.025)	(0.005)	(0.014)
CR4	0.007	-1.060***	-0.001	-0.144***	0.000	0.137***
	(0.024)	(0.116)	(0.003)	(0.027)	(0.002)	(0.016)
Observations	837	216	837	216	837	216

Note: This table presents the results of the fixed-effects model defined in Equation 13 for micro enterprises pre and post COVID. The first and second columns relate to the default rate, with the first column representing the pre-COVID period and the second column the post-COVID period. Similarly, the third and fourth columns are dedicated to total default, while the fifth and sixth columns focus on credit volume. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The COVID-19 pandemic represents an external shock that affected many smaller firms' operations and revenue streams (Yao and Liu, 2023), leading to increased financial distress. Micro firms are often more vulnerable to economic downturns like the COVID-19 pandemic due to their limited access to capital markets, lower cash reserves, and less diversified business activities. This increased vulnerability could lead to a higher amount of defaults in such scenarios as firms struggle to meet their financial obligations. Macroprudential tightening can also have a broader impact on economic activity (Teixeira and Venter, 2023; Beck, Levine and Levkov, 2010; Teixeira, 2023; Hasan, Horvath and Mares, 2020). In circumstances such as the pandemic, micro enterprises might face diminished demand for their products and services, leading to lower revenues and cash flows. This reduction in income can make it more challenging for these businesses to meet their debt obligations.

For small firms, neither the default rate nor total default shows statistically significant results. A reduction in total credit, however, is observed in both periods, which alignings with our previous findings for the entire sample.

3.5 Conclusions

Since the financial crisis of 2008, nations have significantly enhanced their macroprudential frameworks, leading to a robust body of evidence supporting the efficacy of macroprudential policy. Specifically, this growing body of research indicates that macroprudential tools are, in general, successful in meeting their short term objectives, such as curbing credit growth, as well as being effective in achieving their broader goal of enhancing financial stability. However, more recent findings present a nuanced view of the unintended effects of macroprudential regulation on sectors not directly targeted by these policies. Macroprudential instruments can lead to notable leakages and spillovers, creating side effects that might dilute the positive impacts of macroprudential measures (Teixeira, 2023).

Our study contributes to this new body of literature by investigating the impact of macroprudential policies on the default rates of micro and small businesses in Brazil. We further dissect the impact on both components of default rates: the total amount of defaults and the total volume of credit. To carry out our study, we use a quarterly dataset spanning from 2012 to 2021, covering all 27 Federative Units of Brazil. We estimate fixed effects panel regressions to investigate the mentioned effects.

Overall, our results indicate that macroprudential policies increase default rates for micro and small enterprises. we theorize that these policies may unintentionally create adverse effects in the credit market for micro and small firms through a mechanism of adverse selection that affects such business. Specifically, we observe that tightening of macroprudential policies is linked to higher default rates in both firm sizes. However, it is also linked to a decline in credit volume. Moreover, while total defaults for micro firms stay constant, small firms see a reduction in total defaults, though this decrease is not as significant as the drop in total credit. For both firms, these findings imply that credit which would likely have been repaid is leaving the market, while credit at higher risk of default persists.

Even if macroprudential policies are calibrated and implemented to bolster system resilience and mitigate the likelihood of a new financial crisis, they are not designed to eliminate all forms of volatility and completely smooth out the business cycle. There could be unexpected spillovers and leakages, potentially transferring certain vulnerabilities from the regulated banking sector to less-regulated areas, thus creating new risks that are currently less scrutinized and less comprehended (Forbes, 2021).

Enhancing this emerging body of research is crucial, as it's important to thoroughly evaluate the effects of macroprudential policies and other variables on the real economy. Overlooking these impacts might worsen potential problems within the real economy, which, in turn, could threaten financial stability. Future research should explore novel data methodologies to examine the effects on different firm sizes and individual consumers. Additionally, future studies could broaden the scope to include other variables from the real side of the economy.

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4 Conclusão

A Crise Financeira Global destacou a importância da estabilidade financeira. A crise ressaltou a necessidade de mudança de uma visão puramente microprudencial dos requisitos de capital para uma perspectiva mais abrangente e macroprudencial do capital (Bedayo, Estrada e Saurina, 2020). Após a crise, as políticas macroprudenciais tornaram-se um ponto central para formuladores de políticas, bancos centrais e pesquisadores (Gauthier, Lehar e Souissi, 2012; Tang *et al*., 2021).

A implementação e avaliação das políticas macroprudenciais, entretanto, ainda apresentam desafios. Primeiramente, é necessário coordenar as ações das políticas monetária e macroprudencial (Revelo, Lucotte e Pradines-Jobet, 2020). O principal objetivo da política monetária é a estabilidade de preços. Por outro lado, a política macroprudencial foca em limitar a tomada de riscos, especialmente por parte de bancos maiores e mais interconectados. Tanto a instabilidade de preços quanto a tomada de riscos podem levar a riscos financeiros sistêmicos, exigindo uma coordenação na implementação das políticas. Em segundo lugar, pesquisas recentes sugerem que as políticas macroprudenciais podem impactar significativamente a economia real, o que por sua vez, poderia potencialmente comprometer seu objetivo primário de estabilidade financeira (Teixeira, 2023; Teixeira e Venter, 2023; Belkhir *et al*., 2022; Ahnert *et al*., 2021; Forbes, 2021; Gurrea-Martínez e Remolina, 2019).

O primeiro ensaio desta tese aborda o desafio de compreender os efeitos da interação entre políticas macroprudenciais e política monetária sobre a estabilidade financeira. Os resultados apresentados indicam que a política macroprudencial tem um efeito assimétrico sobre a tomada de risco pelos bancos e é mais eficaz na redução do risco sistêmico quando um conjunto diversificado de instrumentos é utilizado. No entanto, medidas de aperto são menos eficazes em melhorar a estabilidade financeira quando um país já se encontra em uma postura de política monetária restritiva. Este resultado está associado ao fato de que, nessas circunstâncias, essas medidas tendem a reduzir a lucratividade dos bancos, comprometendo assim a estabilidade financeira através do canal de lucro. Esses resultados trazem novas evidências sobre a interação entre ambas as políticas e ajudam a esclarecer descobertas recentes de artigos como Revelo e Levieuge (2022),

Revelo, Lucotte e Pradines-Jobet (2020), Takáts e Temesvary (2021), Kim e Mehrotra (2018) e Zhang *et al*. (2020).

O segundo ensaio aborda as consequências não intencionais das regulamentações macroprudenciais em setores econômicos que não são diretamente alvo dessas políticas. Especificamente, analisa-se o impacto das políticas macroprudenciais nas taxas de inadimplência de micro e pequenas empresas. Os resultados encontrados indicam que as políticas macroprudenciais aumentam as taxas de inadimplência para ambos os grupos de empresas. Apertos nas políticas macroprudenciais também estão associados à redução do volume de crédito para micro e pequenas empresas. Além disso, enquanto as inadimplências totais para as microempresas permanecem inalteradas, para as pequenas empresas, as inadimplências totais diminuem, embora menos significativamente do que a redução no crédito total. Portanto, créditos que provavelmente seriam pagos estão saindo do mercado, enquanto créditos propensos à inadimplência permanecem. A redução observada no crédito total (após o aperto das políticas macroprudenciais) está alinhada com a literatura existente que documenta extensivamente uma contração no crédito em toda a economia e para empresas menores (De Jonghe, Dewachter e Ongena, 2020; Vandenbussche, Vogel e Detragiache, 2015; Kuttner e Shim, 2016; Cerutti, Claessens e Laeven 2017; Alam *et al*. 2019; Jimenez *et al*., 2017; Ayyagari, Beck e Peria, 2018; Ćehajić e Košak, 2022; Bhargava, Górnicka e Xie, 2021). No entanto, a literatura não possui consenso sobre inadimplência de crédito, conforme evidenciado em Belkhir *et al*. (2022).

A partir dos *insights* empíricos desenvolvidos em ambos os ensaios, destaca-se, primeiramente, a necessidade de ações coordenadas e cooperativas entre as políticas monetária e macroprudencial ao abordar o risco financeiro sistêmico. Quando os países já estão em uma postura de política monetária restritiva, é importante considerar os efeitos de condições macroprudenciais mais apertadas sobre a lucratividade dos bancos. Os lucros dos bancos são uma variável fundamental para a estabilidade financeira, pois podem afetar a liquidez e propagar crises financeiras para o setor real da economia. Em segundo lugar, destaca-se a necessidade de expandir a literatura emergente relacionada aos efeitos não intencionais da regulamentação macroprudencial em setores que não são diretamente alvo dessas políticas. É importante avaliar minuciosamente os efeitos das políticas macroprudenciais e outras

variáveis na economia real. Ignorar esses impactos pode agravar problemas potenciais dentro da economia real, o que, por sua vez, poderia ameaçar a estabilidade financeira.

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