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Dedico ésta tesis a mis hermanos,
mis padres y abuelos...

Mi brujula sigue apuntando a mi norte.

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Contents

List of Figures v

List of Tables viii

General Introduction 5

1 Chapter 1: Macroprudential Policies: Issues and Challenges 23

1.1 Introduction . . . 23

1.2 Macroprudential regulation: objectives and instruments . . . 25

1.3 The effectiveness of macroprudential policy . . . 30

1.4 Interactions between macroprudential and monetary policy . . . 32

1.5 The institutional architecture of macroprudential policy . . . 36

1.6 International coordination of macroprudential policies . . . 37

1.7 Concluding remarks . . . 42

2 Chapter 2: When Could Macroprudential and Monetary Policies be in Conflict? 47

2.1 Introduction . . . 47

2.2 Literature review . . . 49

2.3 The model . . . 51

2.3.1 Overview . . . 51

2.3.2 Households . . . 52

2.3.3 Entrepreneurs . . . 53

2.3.4 The banking sector . . . 54

2.3.5 Macroprudential and monetary policy rules . . . 56

2.3.6 Calibration . . . 57

2.4 Responses of the model to a selection of representative shocks . . . 58

2.5 Identifying conflicts . . . 60

2.5.1 Conflicts stemming from countercyclical capital requirements . . . 61
2.5.2 Conflicts stemming from loan-to-value caps . . . 62
2.5.3 Conflicts stemming from monetary policy . . . 63
2.6 Assessment and discussion . . . 64
2.7 Extension to extreme vulnerabilities . . . 66
2.7.1 Another financial objective: Crisis probability . . . 66
2.7.2 Another real objective: Growth-at-Risk . . . 68
2.8 Concluding remarks . . . 68

Appendix **71**

2.A The rest of the model . . . 71
2.B Equilibrium conditions . . . 73
2.B.1 Patient households . . . 73
2.B.2 Impatient Households . . . 73
2.B.3 Entrepreneurs . . . 73
2.B.4 Capital Goods Producers . . . 74
2.B.5 Final Goods Producers . . . 74
2.B.6 Labour unions . . . 75
2.B.7 Banks . . . 75
2.B.8 Monetary policy and macroprudential policy . . . 76
2.B.9 Market clearing conditions . . . 77
2.B.10 Shocks . . . 77
2.B.11 Crisis probability . . . 77
2.C The leverage ratio and its link with the capital adequacy ratio . . . 78
2.D Loan-to-value and countercyclical capital buffer in practice . . . 79
2.E Model-consistent output gap and credit-to-GDP gap . . . 80
2.F Calibration . . . 81
2.G Impulse response functions (w/ and w/o macroprudential rules) . . . 83
2.H Policy frontiers . . . 87

3 Chapter 3: Macroprudential and Monetary Policies: The Need to Dance the Tango in Harmony **95**

3.1 Introduction . . . 95
3.2 Literature review . . . 97
3.3 Measuring the stance of macroprudential and monetary policies . . . 99

3.3.1 Measuring the stance of macroprudential policy. . . . 99
3.3.2 Measuring the stance of monetary policy. . . . 103
3.4 Empirical analysis . . . 105
3.4.1 Preliminary findings . . . 105
3.4.2 Econometric approach . . . 107
3.4.3 Results . . . 110
3.5 Robustness checks . . . 115
3.6 Concluding remarks . . . 121

Appendix **123**

4 Chapter 4: Macroprudential Policies and Bank Risk-taking under Persistently Low-interest-rate Environment **131**

4.1 Introduction . . . 131
4.2 Literature review . . . 133
4.3 Assessing the accommodative monetary policy . . . 136
4.4 Macroprudential measures . . . 137
4.5 Empirical strategy . . . 140
4.5.1 Methodology . . . 142
4.5.2 Identifying the risk-taking channel . . . 142
4.5.3 What can do macroprudential policies under persistently low-rate environments . . . 144
4.6 Results . . . 145
4.6.1 Risk-taking channel and monetary policy . . . 146
4.6.2 What can do macroprudential policies? . . . 150
4.7 Extensions and robustness . . . 156
4.8 Concluding remarks . . . 158

Appendix **161**

General Conclusion **175**

Bibliography **179**

Résumé en Français **193**

List of Figures

1 Tools of Macroprudential Policy 8

2 Number of Publications per Term 11

1.1 Evolution of the financial and trade openness of economies from 1865 to 2015 40

2.1 Real side effects of the CCyB 61

2.2 Real side effects of the LTV cap for households 63

2.3 Real side effects of the LTV cap for firms 64

2.4 Financial side effects of monetary policy 65

2.5 Probability of a crisis conditional on the monetary policy rule 67

2.6 Growth-at-Risk conditional on the CCyB 69

2.7 Growth-at-Risk conditional on LTV limits for households and firms 70

D1 Loan-to-value restriction and countercyclical capital buffer requirements in Europe 79

G1 Negative housing preference shock 83

G2 Positive productivity shock 84

G3 Negative bank capital shock 85

G4 Positive collateral shock 86

H1 Real side effects of the CCyB: Illustration with policy frontiers 87

H2 Real side effects of LTV for households: Illustration with policy frontiers 88

H3 Real side effects of LTV for firms: Illustration with policy frontiers 89

H4 Financial side effects of monetary policy: Illustration with policy frontiers 90

3.4.1 Descriptive statistics on macroprudential policy stance 106

3.4.2 Correlation between the macroprudential stance and credit growth 107

3.4.3 Synchronisation of the stances of macroprudential and monetary policies 108

3.4.4 Partial correlation between the macroprudential stance and credit growth 109

3.5.1 Robustness checks: results obtained with the median of the alternative Taylor gaps 116

3.5.2 Robustness checks: results obtained with the first difference of the median of the alternative Taylor gaps . . . 117

3.5.3 Robustness checks: Taylor gap computed as the difference between the alternative shadow rate series and the estimated Taylor rate . . . 119

3.5.4 Robustness checks: first difference of the Taylor gap computed as the difference between the alternative shadow rate series and the estimated Taylor rate . . . 119

3.5.5 Robustness checks: Taylor gap computed as the difference between the alternative shadow rate series and the median of Taylor rates . . . 120

3.5.6 Robustness checks: first difference of the Taylor gap computed as the difference between the alternative shadow rate series and the median of Taylor rates . . . 120

4.1.1 Interest Rates . . . 132

4.3.1 Monetary Conditions . . . 138

4.4.1 Total Policy Actions by Macroprudential Policy Tool . . . 139

4.4.2 Policy Actions by Macroprudential Category . . . 140

4.4.3 Policy Actions per Year by Category . . . 141

4..1 Number of Observations per Country . . . 170

4..2 Comparison of shadow rate series . . . 171

4.0.3 Nombre de publications par terme . . . 199

List of Tables

1 Monetary Policy Side-effects on Financial Stability 12

1.1 Intermediate objectives and instruments of macroprudential policy 31

2.1 Summary of the responses of output, inflation and the credit gap to four alternative shocks 59

2.2 Summary of the conflicts stemming from macroprudential policies 65

2.3 Summary of the conflicts stemming from monetary policy 66

F1 Calibration of the structural parameters and shocks 81

F2 Baseline calibration of the policy framework 82

3.3.1 Macroprudential policy instruments: number of events 101

3.3.2 Changes in the macroprudential indexes: country case studies 103

3.4.1 Results obtained with $PruC$ and $PruC2$ 112

3.4.2 Results obtained with $PruC3$ and $PruC4$ 113

3.4.3 Results obtained with $PruC5$ and $PruC6$ 114

3.5.1 Alternative measures of the monetary policy stance 116

3..1 Results obtained with the policy interest rate variation 123

3..2 Results obtained with the policy interest rate variation 124

3..3 Results of the Taylor rule estimates. 125

3..4 Summary of shadow rate estimates 126

4.6.1 Profitability Related to Interest Income 147

4.6.2 Gross Loans 148

4.6.3 Loan-Loss Reserves and Loan-Loss Provisions 149

4.6.4 Non-Performing Loans 150

4.6.5 MaP Instruments Related to Borrowers 152

4.6.6 MaP Instruments Related to Bank Capital 153

4.6.7 Bank Capital instruments and Banks' Exposure to Risk 154

4.6.8 MaP Instruments Related to Credit Management 155

4..1 Level of Capitalization (TE/TA) 162
4..2 Level of Liquidity (Liquid Assets/TA) 163
4..3 Share of Deposits (Deposits/Liabilities) 164
4..4 Market Concentration (Lerner) 165
4..5 Level of the Slope of the Yield Curve 166
4..6 First Difference of the Slope of the Yield Curve 167
4..7 Asymmetric Effects of Macroprudential Policies 168
4..8 Alternative Measure of Risk: Z-score 169
4..9 Number of Banks per Country 170
4..10 Summary Statistics of the Variables Used in the Regressions 171

General Introduction

"Every crisis that Seldon had planned
had come at its appropriate time and had been solved,
and with each solution the Foundation had taken another
giant stride toward Second Empire and peace."
Isaac Asimov, Foundation

This doctoral thesis focuses on the post Global Financial Crisis (GFC) macroeconomic policy framework to study the interactions between macroprudential and monetary policies. *How do these interactions take place? Do both policies complement each other? or do they conflict? Are these complementarities or conflicts always present? If not, when do they take place? Are both policies capable to mutually compensate for their side effects? or do they always hinder their task?* These are some research questions that we attempt to answer throughout this document. The main contribution of this research is threefold. First, it proposes a comprehensive analysis of the interactions and the possible scenarios when the objectives of the macroprudential policy and the monetary policy may conflict. Second, it presents empirical evidence, at a macroeconomic level, of how monetary policy can support macroprudential policy in containing credit procyclicality. Finally, it presents empirical evidence, at a microeconomic level, of how macroprudential policy tools can help to contain the negative externalities "too-low for too-long" monetary environments, the current and potential future economic scenario.

This general introduction aims to depict the institutional context, highlight the most relevant results so far in the literature, and present the origins and the context under which the main research questions are asked. In this perspective, the section Origins of macroprudential policy describes the origins, objectives, the theoretical foundations and the effectiveness of macroprudential policy. The two following sections, Macroprudential policy and the institutional framework and Interactions between macroprudential policy and other policies, describe the main concerns at the core of the current policy and academic debates. The section Macroprudential policy and monetary policy interactions describes the main transmission channels and the potential side-effects between both policies; it presents a short literature review on the main topic of the thesis and the main concerns motivating this research. Finally, the Thesis Contribution describes the four essays presented in the chapters assembled in this document.

Origins of macroprudential policy

Throughout human history, extreme events have been the turning points of several aspects of our society. Political, social and economic crises are not only critical but needed for the progress of humanity. They have shaped our social structure and the way we understand and interact with our environment. Therefore, it is not surprising that the Great Depression during the '30s, the stagflation of the '70s and recently, the GFC of 2008-2009, had put pressure on academics and policymakers alike to rethink and transform the conduct and the interactions of macroeconomic policies.

The Great Depression of the '30s instructed economists on conducting fiscal and monetary policy and laid the foundations of macroeconomics, with fiscal policy as the main pillar. Four decades latter, the stagflation of the '70s disrupt the previous conduct of macroeconomic policies. In place, monetary policy gained more relevance for macroeconomic stability, restricting fiscal policy to a secondary role politically constrained. More recently, the GFC was an exceptional opportunity of rethinking macroeconomic policies. It brought back the importance of the financial sphere in terms of overall economic stability and welfare, extended the implementation and utilisation of macroprudential policy, expanded

the monetary policy toolkit, and incentivised the potential coordination and interactions within the new macroeconomic policy framework.

The wake and the aftermath of the GFC taught policymakers and academics a lesson in the worst possible way; beneath an apparently calm and stable macroeconomic environment, insidious financial imbalances can build up. The main concern of such build ups is that financial crisis are deeper and slower in recovery than normal recessions. Under financial crisis, shocks are amplified rather than damped as they propagate to the real sector and the different agents of the economy. The latter highlighted indeed the limitations of the monetary policy to avoid these scenarios. As a result, it triggered a global rethinking of the way of conducting macroeconomic policies.

The GFC brought back the importance of financial stability for macroeconomic stability, emphasizing the great cost in terms of welfare. It showed that monetary policy interest rate was no longer a sufficient instrument for addressing these imbalances. Moreover, the past, current and potential future environment of low nominal and real interest rates raised (and still raises) concerns on the behaviour of financial intermediaries. Concerns particularly related to the agents' risk-taking behaviours, leverage decisions, and the capabilities of the economic policy framework to counteract undesirable side-effects of such an environment (Borio and Zhu, 2012). To address these issues unconventional monetary policies, fiscal stimulus, and a "brand new" macro-approach of financial regulation (i.e., macroprudential policy) were put in place at the front-line of the economy.

Prior the crisis, the resilience and soundness of financial institutions were entrusted to microprudential regulation. However, this period proved that the regulation of individual institutions does not always secure the robustness of the financial system as a whole due to its procyclicality. Therefore, the countercyclical nature of macroprudential regulation and its implementation with the Basel III accord was an important improvement to secure financial stability.

Macroprudential policy aim to safeguard the stability of the financial system as a whole by strengthening its resilience and preventing the build-up of systemic risk. In particular, according to the European Systemic Risk Board (ESRB), this means to mitigate and prevent excessive credit growth and leverage; mitigate and prevent excessive maturity mismatch and market illiquidity; limit direct and indirect exposure concentrations; limit the systemic impact of misaligned incentives (reduce moral hazard); and strengthen the resilience of financial institutions.

Although macroprudential regulation was considered as a novel approach aiming at mitigating the build-up of vulnerabilities in the financial system as a whole, the term "macroprudential" dates from the '70s and the use of such instruments began decades ago in advanced economies and later in emerging market economies. According to Kenç (2016), the United States was probably the first country to implement macroprudential policy to control credit growth in aggregate or in a major economic sector such as housing. Emerging market economies also implemented numerous macroprudential policy measures to mitigate the effects of excessive capital inflows to their countries in the 2000s.

The theoretical foundations of macroprudential regulation originate from the fact that agents tend to propagate risks through increasing their own leverage, expanding balance sheets and depending mainly on shot-term liquidity. Moreover, given the natural interconnection inside the financial system and the strategic complementarities between financial intermediaries, the risk propagation inside of the whole system intensifies. Therefore, increasing the systemic risk in both the time and the cross-sectional dimensions. The time dimension refers to the build-up of financial imbalances over time and the procyclicality of the financial system. Meanwhile, the cross-sectional dimension encompasses the common exposures,

risk concentrations, linkages and interdependencies across financial institutions at a given point in time. The externalities explaining these behaviours and giving the fundamental rationales for macroprudential policy are the interconnectedness, with a cross-sectional nature; and the strategic complementarities and pecuniary externalities, with a time-series nature.

The interconnectedness externalities refer to the interconnected nature of the financial system. In particular in the banking sector given their business model. Indeed, banks' portfolios are correlated and balance sheets are strongly interconnected, as we could see during the GFC and posterior Europe's Sovereign Debt Crisis. The main issue of this interconnection between banks is that they can jeopardize financial stability by excessively exposing the whole system to shocks and increasing the contagion. An idiosyncratic shock affecting a single bank may be very likely to impact the whole banking sector.

The negative externalities related to strategic complementarities arise from the strategic interactions between the different agents of the financial system. These externalities induce the build-up of vulnerabilities during financial cycle booms and their magnification in downturns. In the presence of interconnectedness externalities, a bank run on one single bank can potentially lead to a complete shut-down of the system because other depositors would expect that their own bank presents similar difficulties. Then, the best option is to withdraw as well. For instance, in Cyprus all banks remained closed during three days to prevent run on deposits during the panic in 2013, freezing the entire Cypriot banking system. Another source of strategic complementarities may also be the increased competition and government guaranties, increasing the risk-taking and exposure through asset commonality. By being exposed to similar risk, similar portfolio quality, and asset co-movements, financial intermediaries build-up vulnerabilities, and potentially leading to the downside of a financial cycle.

Finally, the pecuniary externality is related to fire sales during downturns and can be significantly strong for banks given their business model of liquidity, maturity and credit transformation.

Without frictions, fire sales of an asset decrease its price below its fundamental value and also may depress the prices of similar assets. These dynamics cause losses to the seller and to other agents holding these assets, affecting the distribution of wealth among agents, but without implications on welfare. However, under incomplete market it may have welfare losses. Indeed, the inefficiencies characterizing the financial system (limited liability, asymmetric information and limited enforcement) are at the origin of endogenous risk. To protect themselves from from limited information about the risk profile of their clients, banks demand collateral from borrowers and limit the amount of debt regarding the value of their collateral. Hence, a shock resulting in banks selling these particular assets can lead to a fall in the value of collaterals, making borrowers reduce their credit affordability and become credit-constrained. As a result, the possibilities of investment diminishes and, therefore, a loss on welfare and the real economy.

The main issue here is that agents do not internalize these externalities and do not account for the potential spill-overs on other agents, the financial system and the real economy as a whole. Macroprudential regulation exists, therefore, to account for the social cost of market failures in the private cost of failure of financial intermediaries and economic agents.

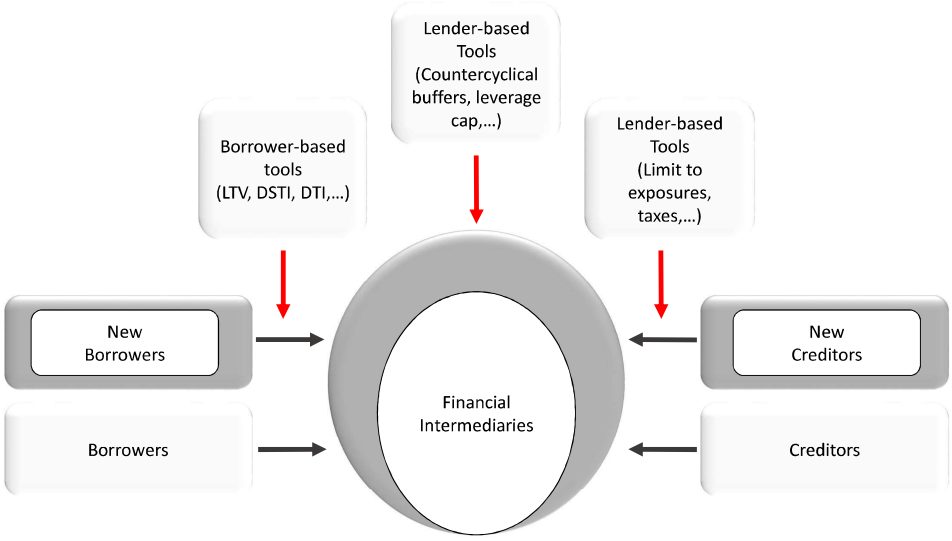
Since the re-apparition of macroprudential policy, one of the debates that emerged was whether the macroprudential policy was to be the third leg of macroeconomic policy or just a crutch to support the fiscal and monetary policy. The GFC made clear that fiscal and monetary policies were not the best suited to deal with financial imbalances, and time had the last word in that debate.

In the light of these changes in the global macroeconomic policy framework, several questions arose regarding the effectiveness and the calibration of macroprudential instruments. The first question that

came up in the policy and academic debate was whether these policies were effective in meeting their objectives, thus economies can rely on them. The literature has grown considerably fast over the last decade regarding this question, and academics and policymakers have gained knowledge and experience regarding the effectiveness and calibration of the instruments.

A challenge to assess the effectiveness of macroprudential policy was that it possesses a wide number of tools at its disposal in order to achieve its objectives. These tools may affect either specific sector vulnerabilities or the entire financial system. It can be broadly classified as lender-based instruments seeking to influence lenders' behaviour (e.g., countercyclical buffers, capital requirements, limits to credit growth, limits to specific exposures or liquidity requirements) and borrower-based instruments seeking to influence borrowers' behaviour (e.g., housing-related taxes, loan-to-value ratios, debt-service-to-income ratios or debt-to-income ratios). In order to tackle this issue, the literature focuses on individual instruments or makes use of an overall policy index to study the effectiveness of macroprudential in handling specific intermediate objectives. The conclusions drawn regarding the overall effectiveness is rather mixed.

Figure 1: Tools of Macroprudential Policy



Source: Caruana and Shim (2016)
Note: Shaded portions represent what is outside the scope of macroprudential policy tools.

On the one hand, results concerning the instruments targeting the borrowers are rather favourable. It seems that these instruments are effective in reducing booms in real estate markets,which are a major source of financial and real instability. For instance, loan-to-value (LTV) and debt-service-to-income (DSTI) ratios are associated with lower house price growth, mortgage credit growth, credit to households (Nabar and Ahuja, 2011; Kuttner and Shim, 2016; Zhang and Zoli, 2016; Cerutti et al., 2017a).

On the other hand, conclusions on lender-based instruments are rather mixed. For instance, results for emerging market economies seems to prove that these instruments are associated with lower credit growth. However, it seems not to be the case for advanced economies and Asian countries (Zhang and Zoli, 2016; Cerutti et al., 2017a).

When using an overall index as a measure, it appears that macroprudential policy tightening is associated with lower growth in loans, housing credit, and house prices.

However, their effect is not symmetrical when the financial cycle busts, they are less effective (Lim et al., 2011; Claessens et al., 2013; Kuttner and Shim, 2016; Cerutti et al., 2017a,b; Akinci and Olmstead-Rumsey, 2018). The latter is an important result with regard to the credit procyclicality and it demonstrates the preventive nature of macroprudential policy.

While the need for macroprudential policy is now largely accepted, many questions remain. The lack of conclusive result on the effectiveness of macroprudential tools led to much more further investigations. Some possible reasons may be the institutional framework and the possible interactions with other economic policies. The literature has not provided clear answers on both issues and with this doctoral thesis we attempt to contribute to fill this gap.

Macroprudential policy and the institutional framework

Concerning the institutional design, the main candidates to be in charge of the macroprudential policy are the central bank, an existing supervisory agency (microprudential regulator), a new macroprudential regulator or a committee composed of different institutions. The idea behind an adequate institutional framework is that it may avoid any obstruction regarding the implementation of policies, assure independence and prompt reaction, access to information allowing to identify beforehand the financial imbalances, and avoid the inaction bias. In fact, there is no particular optimal framework. Each country has its own configuration, which includes the instruments, the institutional organization and governance rules that best suits its economy and the structure of its financial system. For instance, in countries like New Zealand, Norway and Switzerland, the central bank is in charge of the supervision and prudential regulation. In the United Kingdom, the Financial Policy Committee within the Bank of England fulfils this role, while in countries like France and Germany the committee is outside the central bank. Particular is the case in the European Union. The ESRB is responsible for macroprudential supervision of the entire financial system and is presided by the president of the ECB, the governors of the central banks of member states, a member of the European Commission and representatives of the different regulatory authorities at the European level.

Even though all the different configurations have their own advantages, some are susceptible to be exposed to outside pressures, jeopardize credibility of the macroprudential authority and suffer from inaction bias. Moreover, a design in which the central bank is the host institution may also raise relevant issues. Indeed, the conduct of macroprudential policy may interfere with the ultimate objective of the monetary authority (i.e., price stability), originating conflicts between both policies. With this doctoral thesis, we shed light on the situations where conflicts may occur.

Interactions between macroprudential policy and other policies

At the same time with the debate on the appropriate institutional structure, policymakers questioned how macroprudential policy would be integrated with other economic policies. The latter prompted the development of literature on the interactions of macroprudential and other economic policies. For instance, interactions with the microprudential, fiscal and monetary policy are the most concerned in this debate.

Interaction with the microprudential policy. In normal times, both policies' objectives are aligned

but in bad times it is a different story. In downturns, the microprudential regulation seeks to protect depositors and investors by tightening or keeping unchanged regulatory requirements, which increase the procyclicality of the financial system. Meanwhile, the macro-prudential policy's global view of the financial system demands relaxing these requirements to avoid fire-sales and the credit flow to the real economy to stops (Angelini et al., 2013). For instance, during the GFC, microprudential regulation was criticized for this procyclical nature.

Interaction with the fiscal policy. Fiscal policy in general may be favourable or detrimental for the effectiveness of macroprudential policy. The way fiscal policy is conducted can counter or be at the origin of financial system procyclicality and may increase systemic risk (Caruana and Shim, 2016). In addition, tax policies can encourage leverage or resources misallocation in the financial system (i.e., tax deductions or asset prices distortions). For instance, real state taxes and subventions may pass through to house prices, which in turn may affect households' credit affordability, probably endangering financial stability (Van den Noord, 2005).

Interaction with the monetary policy. By nature, both policies are countercyclical but with different ultimate goals, which raises questions about potential conflicts and complementarities. The interaction between both policies are complex and can alter their ultimate objectives. The macroprudential policy may affect aggregate demand and then the real economy and price stability. Conversely, monetary policy affects agents' risk-taking behaviours and leverage decisions affecting financial stability.

In recent years and in a much more comprehensive way, the heart of the policy debate has shifted to interactions between the macroprudential and the monetary policy. In Figure 2 we can observe the relevance that this topic has gained among academics during the last decade. The number of publications has increased significantly. Nevertheless, the number of publications related to the interaction and the coordination between both policies is still scarce, which increases the relevance of this doctoral thesis. As these interactions constitute the core of this research, The section below explains in more detail their relevance and implications for macroeconomic stability and policy concerns.

Macroprudential policy and monetary policy interactions

Interactions between the macroprudential policy and monetary policy have attracted quite a lot of attention recently because both of them may have side effects on each other's objectives through similar channels. For instance, the asset price channel, the banks' balance sheet channel, the exchange rate channel, the risk-shifting channel and the risk-taking channel.

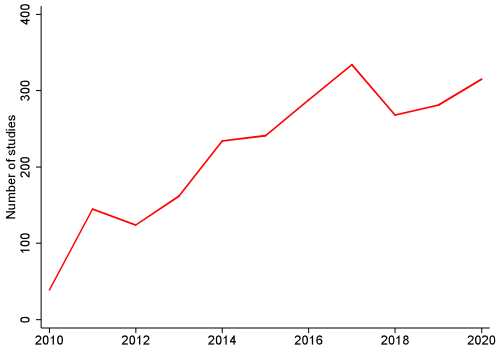
Through the asset price channel, monetary policy can affect asset prices, unbind collateral constraints or induce fire sales, depending on whether monetary conditions are loosening or tightening, respectively. Consequently, it can affect the supply and demand of credit. For instance, when interest rates are low, it may lead to increasing asset prices and exacerbate the financial cycle by the financial accelerator and its self-reinforcing mechanism (Bernanke and Gertler, 1989, 1995).

When interest rates start hiking, restrictive monetary conditions pass through the balance sheet channel increase default rates and debt repayment charges in the case of variable rate loans. Therefore, tightening monetary policy can result in a higher default rate, reduced bank profits, increase the non-performing loans, hence, destabilizing the financial system. In addition, increasing interest rates rise capital inflows which causes the local currency to appreciate. The exchange rate channel increases credit growth, leverage and excessive borrowing in foreign currency, especially in emerging markets and small

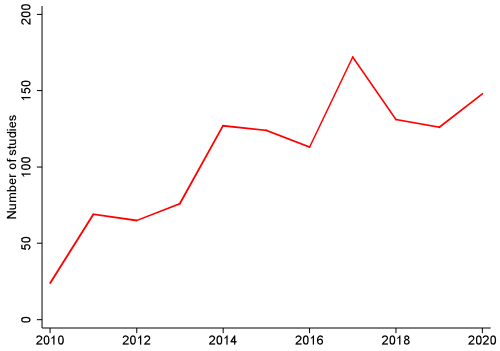
open economies.

Figure 2: Number of Publications per Term

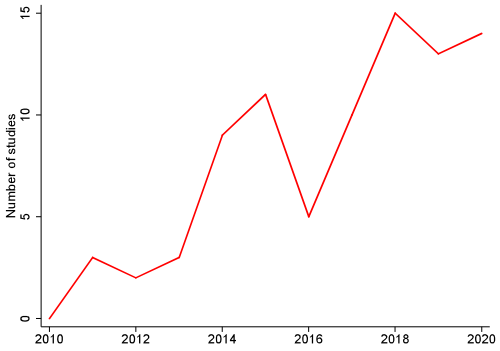
(a) Macroprudential policy



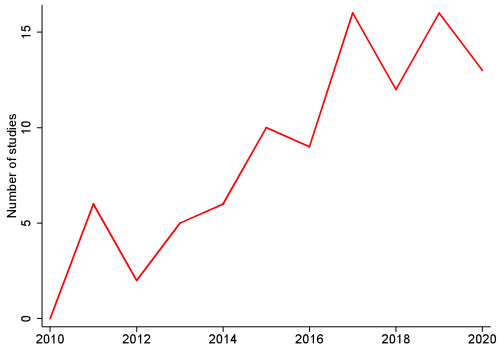
(b) Macroprudential policy + Monetary policy



(c) Macroprudential policy + Monetary policy + Interaction



(d) Macroprudential policy + Monetary policy + Coordination



Note: Each plot represents the number of publications and working papers per year including terms (a), (b), (c) or (d) in their title. Data are collected form the IDEAS website.

In addition, since traditional banks' business model consists of taking in short-term deposits and grant long-term loans, tightening monetary conditions may increase risk-taking through the risk-shifting channel as well. Due to long-term contracts, increasing the policy interest rate tends to affect more short-term rates (deposits) than long-term rates (loans), which reduces banks' interest margins and leads financial intermediaries to seek more risk in order to maintain their profits.

Contrary to the risk-shifting channel, the risk-taking channel operates when the monetary conditions are loosening, and it exacerbates when these conditions remain for a relatively long period. During these periods, financial intermediaries expand their balance sheets, engage in riskier activities and reduce the strictness with which banks screen borrowers. According to Borio and Zhu (2012), this behaviour results from the increase of risk tolerance, the reduction of the risk perception and the effort from banks to compensate squeezed interest margins (search for yield).

Table 1: Monetary Policy Side-effects on Financial Stability

Sources of Financial Instability	Channel	Predicted Effect	
		↓r	↑r
Borrowing Constraints	Balance Sheet Channel	↑	↓
Risky Behaviour of Financial institutions	Risk-taking Channel	↓	↑
	Risk-shifting Channel	↑	↓
Externalities through Aggregate Prices	Asset price Channel	↓	↑
	Exchange rate Channel	↑	↓

Source: IMF (2013)
Note: r stands for the policy interest rate. ↑ means that the monetary policy action improves financial stability. ↓ means that the monetary policy action deteriorates financial stability.

Similarly, macroprudential policy is also likely to have side effects on inflation. For instance, borrower-based instruments have proven to be effective in weakening the financial accelerator, hence in containing fluctuations in aggregate demand and then in inflation. However, if these instruments are tightened very sharply and quickly, agents subject to these regulations may find it complicated to adapt and then revise their demand or supply of credit. In this case, aggregate demand may be affected accordingly to previous responses, disturbing monetary policy conduct.

Throughout the last decade, the literature has attempted to untangle the complicated interactions between the macroprudential and the monetary policies. At the early stages, the literature focused on how both policies interact (side effects), how the optimal articulation should be and whether a coordination was needed. Due to the current macroeconomic environment, which may persist in the years to come, the literature has started to question what macroprudential policy can do to support a monetary policy bound at low rates without room for manoeuvre.

Indeed, the persistently accommodative stance of monetary policy in the developed world has raised concerns regarding health and stability of the financial system because of its side effects. In general, low policy interest rates ease financial conditions and affect the behaviour of financial markets, which can lead to misperception of risk and excessive risk-taking. In fact, the self-reinforcing interaction between risk perceptions and risk tolerance, on the one hand, and financial constraints, on the other hand, can exacerbate the financial cycle and lead to financial distress and macroeconomic dislocations. In addition, looser financial conditions can predict lower downside risk in the near-term, reducing economic growth volatility. However in the medium-term it can signal greater downside risk and higher volatility of economic growth (Liang, 2017).

Regarding the interactions of both policies in normal times, the literature used at the beginning a theoretical approach in order to give some guidelines about the optimality and coordination. For instance, Collard et al. (2017) suggest it is optimal to assign the goal of financial stability to prudential policy and the goal of macroeconomic stabilization to the interest rate policy, in line with the Tinbergen principle. Some studies demonstrated that macroprudential tools (i.e., capital requirements, countercyclical buffers and LTV ratios) improve social welfare by dealing with the procyclicality of credit (Benes and Kumhof, 2015; Alpanda and Zubairy, 2017; Gersbach and Rochet, 2017; Mendicino et al., 2018). However, if the economy is subject to a bank capital shock or a technology shock, these improvements have as well side effects on inflation and output volatility Angelini et al. (2014). Other studies focused on the reduction of the probability of crisis, as an ultimate objective of the macroprudential policy. Their essential findings

show that the optimal responses of macroprudential policy reduce the probability and the magnitude of the crisis. Nevertheless, it is costly in terms of output and inflation in the short run (Bianchi and Mendoza, 2018; Aikman et al., 2019). Regarding the optimal coordination, results remain non conclusive. Some advocates that a non-cooperative interaction in which the macroprudential policy is the leader delivers higher welfare (Rubio and Carrasco-Gallego, 2014; De Paoli and Paustian, 2017). However, cooperation may be better suited when the institutional framework has two independent authorities for each policies and when the output stabilization gains relevance for both policy mandates (Gelain and Ilbas, 2017; Bodenstein et al., 2019; Lazopoulos and Gabriel, 2019).

Subsequently, the empirical studies attempted to validate these previous findings still with mixed results. For instance, some studies find that capital requirements have no effects that outweigh the side effects of the monetary policy on bank lending (Aiyara et al., 2016). Meanwhile, more recent studies found complementary effects from the monetary policy. That is, macroprudential policy improves its effectiveness on dampening credit growth when the monetary policy supports them (Bruno et al., 2017; Gambacorta and Murcia, 2020). Nevertheless, it is more likely that these complementarities vanish when the macroeconomic environment presents low inflation followed with strong credit growth (Kim and Mehrotra, 2018).

"Among the surprises of 2019 was the extension of highly accommodative monetary policies, while many expected - hoped? - to normalise. And so, low rates that will last: "low for longer"; a growing number of people fear the consequences for banks, insurance companies and savers. That monetary policy is the subject of debate is legitimate, but that it even interests the general public is new"
François Villeroy de Galhau, Governor of the Banque de France (2020).

Nowadays, the assessment of the interactions between both policies has evolved accordingly to the current macroeconomic environment. Since the aftermath of the GFC, interest rates have remained low throughout the decade, and the recent Covid-19 pandemic crisis has also shown that these low-interest rates will last even longer. The above extract from the speech of François Villeroy de Galhau in 2020 clearly demonstrates the concerns of policymakers, academics and society in general about low rates and their implications for financial stability. Such an environment potentially has created incentives for banks to expand their balance sheet, reduce the strictness when screening borrowers and lead to intensifying risk-taking behaviours to achieve higher returns. Under the hypothesis that the downward trend of interest rates reverses one day, it may carry undesirable consequences regarding the borrowers' quality, default rates and, potentially, trigger a crisis. Consequently, concerns of academics and policymakers alike regarding the risk-taking channel have increased significantly. In response, some recent works attempted to shed light to this matter but the literature remains at its infancy. For instance, some research recommends the implementation of macroprudential tools in order to compensate for the limits and the side effects of the monetary policy bound at the Zero Lower Bound (Farhi and Werning, 2016; Korinek and Simsek, 2016; Rubio and Yao, 2020).

Thesis Contribution

With this doctoral thesis we attempt to shed light and answer some of the main questions of the current policy and academic debate. To be more precise, this doctoral thesis contributes to the existing literature by studying the interactions between macroprudential policy and monetary policy under three different approaches. First, it contributes to the existing literature by identifying scenarios or circumstances

where potentially both policies may generate conflicts or complement each other. Then, it identifies how the monetary policy, when it works well and has room for manoeuvre, may support or hinder a macroprudential policy aiming to dampen the excessive credit growth. Finally, this thesis studies the current environment where the monetary policy is bound and has no room for manoeuvre other than the unconventional instruments. The latter sheds lights on how macroprudential policy may complement the monetary policy by weakening the adverse effects of the risk-taking channel. The thesis consists of four articles presented in a chapter format, an introductory chapter and three chapters that complement each other.

In the Introductory chapter, published in the *Revue Française d'Économie*, we discuss the advances in the literature over the last decade and the main debates since the broad implementation of macroprudential policy.[1] Among the conclusions we identify interactions with the monetary policy as one of the main challenges for macroprudential policy, which will justify the development of this thesis. In the Second chapter, we develop a theoretical framework to study these interactions more closely. Our analysis allows us to identify theoretically when coordination between the two policies would be preferable. Thus, this chapter sets the theoretical basis for the next two chapters. In the Third chapter, published in the *Journal of International Money and Finance*, we assess empirically at the macroeconomic level the effectiveness of macroprudential policy in reducing excessive credit growth, and whether their effectiveness is affected by monetary conditions, i.e. loose or tight.[2] We find that the synchronization of both policies enhances financial stability. Finally, in the Fourth chapter we account for the current monetary environment where a restrictive monetary policy is not on the near horizon. We study empirically using bank-level data the effectiveness of macroprudential policy in complementing a persistent accommodative monetary policy and in mitigating the adverse side effect on banks risk-taking behaviour. We find that borrower-based and credit-management tools are effective in attenuating the side effects of persistently accommodative monetary conditions. Each of the chapters are described in more detail below.

Chapter 1: Macroprudential policies: Issues and challenges

Chapter 1, entitled "Macroprudential Policies: Issues and Challenges", is the introductory chapter of this doctoral thesis and focuses on the first decade after the outbreak of the GFC. Compared to previous literature reviews focusing on the instruments and the effectiveness of macroprudential policy (Galati and Moessner, 2018; Lubis et al., 2019), we present an overview of the progress of knowledge and what remains unknown about the main debates related to macroprudential policy implementation. This chapter also provides the main concepts definitions and the state of the art of the macroprudential policy literature.

As was stated before, macroprudential was not a new concept when the crisis started in 2007, however, it was in the wake of the crisis that academics and policymakers agreed that a prudential policy is macroprudential if it combines two characteristics: it needs to adopt a macroeconomic perspective of the financial system accounting for the feedback loops between the real and the financial sector; and characterized with a preventive nature when addressing the systemic risk. Based on this clarification, four aspects have aroused great interest among academics and policymakers and have been the subject of further studies. The first aspect was the definition of objectives and instruments in its toolbox, a crucial stage before the broad implementation of macroprudential instruments. Second, the effectiveness of these

[1] Garcia Revelo, J. D., Leroy, A., and Lucotte, Y. (2018). Les politiques macroprudentielles: enjeux et défis. *Revue française d'économie*, 33(4):127–174.

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

instruments. Third, how macroprudential policy and the other economic policies are interwoven, particularly with the monetary policy. And fourth, the identification of international coordination concerns related to possible cross-border spill-over effects. This chapter addresses these four issues to take a wider view of the progress of literature and what still remains to delve deeper.

From this chapter, one of the main conclusions is that the interaction between macroprudential policy and monetary policy implies in fact to open two fronts of questioning. First, whether applying macroprudential tools interferes with monetary policy objectives, and second, whether macroprudential policy has secondary effects on monetary policy. These interactions have been the focus of the liveliest debates and contributions in recent years. However, as it is stated in this chapter, the proliferation of theoretical and empirical research has not reached a definitive conclusion, which explain why the following chapters propose a significant contribution for the current state of the art of macroprudential policy literature. Chapter 2, we assess these two-side interactions between monetary and macroprudential policies. In Chapter 3, we show how potential coordination between monetary and macroprudential authorities may improve financial stability. And in Chapter 4, we demonstrate how macroprudential policy may also come to complement the monetary policy by reducing its negative externalities on the financial system in the case of low interest rates environments.

Chapter 2: When could macroprudential and monetary policies be in conflict?

Chapter 2, entitled "When Could Macroprudential and Monetary Policies be in Conflict", provides a comprehensive analysis of the potential conflicts (complementarities) between the macroprudential policy and the monetary policy. As was stated in Chapter 1, there exist two-side interactions between both policies, and conflicts may arise from both sides. In this chapter, we use a DSGE model to uncover the scenarios where these conflicts may arise, and we propose a taxonomy of the interactions between macroprudential and monetary policies. Compared to the previous literature (Angelini et al., 2014; Aikman et al., 2019; Silvo, 2019) we identify specific scenarios where conflicts may arise. We use shocks of different nature, different policy objectives and different instruments. This overall assessment may enlighten monetary and prudential authorities on the potential spill-overs of their policies and when the coordination would be needed.

The theoretical framework is built on the DSGE model developed by Gerali et al. (2010). This model has been widely used in the literature for several reasons. First, it is a realistic model, with nominal and real rigidities. Second, the model embeds a banking sector that provides intermediation between patient households, on the one hand, and firms and impatient households, on the other hand. Third, it features financial frictions stemming from collateral constraints.

We then introduce to the model three macroprudential rules pursuing the resilience of financial institutions and taming the procyclicality of the financial system. Hence, we introduce a countercyclical capital buffer (CCyB) and two state-dependent LTV caps, one for households and one for firms. In the case of the monetary policy, we introduce a standard interest rate rule responding to deviations of inflation from its target and to the output gap.

In order to uncover the potential scenarios where conflicts may arise, we follow a descriptive approach which is agnostic regarding policymakers' preferences. In addition, the aim of our analysis is not to determine optimal monetary and macroprudential policies per se, we seek to identify cases in which conflicts may spontaneously arise. Therefore, we consider this chapter as a prerequisite to the analysis

of optimal coordination. To this end, we consider different types of shock scenarios and then we uncover the circumstances where the monetary policy has side effects on the macroprudential policy's objective, dampen the excess of credit; and where the macroprudential policy has side effects on the monetary policy's objectives, stabilize inflation and business cycle.

Among the main results we find that conflicts between macroprudential and monetary policies are fairly frequent but not systematic. They are especially likely to arise in cases of technology and bank capital shocks. When we look instrument by instrument, it appears that CCyB and the policy interest rate generate conflicts in several cases. In contrast LTV ratios cause few conflicts. These results suggest that LTV limits can be easily implemented without concerns about potential spillovers. In contrast, the implementation of CCyB and of monetary policy requires a smooth coordination.

Chapter 2 proves theoretically that there are indeed conflicts and complementarities between the macroprudential policy and the monetary policy. In the following two chapters, we propose two different empirical approaches to analyse how both policies may complement or generate conflicts to each other form a macroeconomic and microeconomic point of view.

Chapter 3: Macroprudential and monetary policies: The need to dance the tango in harmony

Chapter 3, entitled "Macroprudential and monetary policies: The need to dance the tango in harmony", empirically examines the effectiveness of macroprudential policy in curbing excessive domestic credit growth at the macroeconomic level. Moreover, compared to previous researches (Akinci and Olmstead-Rumsey, 2018; Gambacorta and Murcia, 2020) the core of our analysis focuses on how the monetary policy stance (i.e., tight or loose) affects this effectiveness. The latter allows us to understand how monetary policy conditions may hinder or enhance macroprudential policy pursuit for financial stability. In the last decade a growing number of theoretical studies address this issue and confirm the benefits of coordination between the two policies, but little was known from an empirical standpoint. Research carried in this chapter fills this gap in the existing literature by providing the first empirical evidence on how monetary policy conditions impact the effectiveness of macroprudential policy for a large sample of economies.

We consider a sample of 37 emerging and advanced economies from 2000Q1 to 20014Q4, for which we compute indexes of macroprudential and monetary policy stance. For the macroprudential policy stance, we use the database provided by Cerutti et al. (2017b) to calculate six different measures of stance. These measures aim to give a better view of cross-country differences in terms of macroprudential policy framework and its conduct. For the monetary policy stance, we follow the existing literature (see, e.g., Bogdanova and Hofmann, 2012; Bruno et al., 2017) and estimate a Taylor rule. In order to account for countries implementing unconventional monetary policies (UMP) after the GFC, we do not consider the gap between the actual policy rate and the Taylor rate, but the difference between the shadow rate provided by Krippner (2015) and the Taylor rate.

Then, our empirical analysis proceeds in two steps. First we follow the existing literature by reinvestigating how our different measures of the macroprudential policy stance affect credit growth. To this end we consider two alternative measures of domestic credit, which are total credit to the private non-financial sector from banks and total credit to households and non-profit institutions serving households. The GDP growth rate is included to control for the procyclicality of credit (Athanasoglou et al., 2014)

allowing us to capture excess credit growth, the part of credit that is not driven by real economic activity. In the second step, we extend the previous baseline model to know whether a tighter macroprudential policy along with a restrictive monetary policy is more likely to curb domestic credit growth.

Among the main results, we find that an overall tightening in macroprudential policy is associated with a reduction in credit growth. Furthermore, we observe that macroprudential policy actions take about two to three quarters to curb domestic credit growth effectively. When we account for the monetary policy stance, we find that the effectiveness of tightening in macroprudential policy is enhanced when conducted along with a restrictive monetary policy. This result confirms the benefits of macroprudential and monetary policies synchronisation. Finally, we find evidence that monetary policy may help to reduce the transmission delay of macroprudential policy actions on the excessive private sector credit growth.

This chapter shows that monetary and macroprudential policies are complementary even though they pursue different primary objectives. Our results particularly emphasise the importance of implementing a monetary policy that supports and complements the macroprudential policy by tightening in unison, and then, attenuating its potential side effects on financial stability.

Even though conclusions in this chapter give helpful insights about the benefits of synchronization of monetary and macroprudential policies, in the actual macroeconomic environment, a tightening monetary policy is not conceivable. For more than a decade, interest rates have steadily declined until reaching their effective floor and even becoming negative in some regions. In addition, the recent pandemic crisis has shown that current low interest rates will stay low for longer. This challenging economic scenario brought "low-for-long" interest rates and risk-taking behaviour of financial institutions to become one of the main fronts of policy and academic debates. For that reason, in the last chapter, we attempt to uncover what macroprudential policy can do to support a constrained monetary policy and avoid excessive risk-taking behaviours.

Chapter 4: "Macroprudential policies and bank risk-taking under persistently low-interest-rate environment"

Chapter 4, entitled "Macroprudential policies and bank risk-taking under persistently low-interest-rate environment", empirically investigates whether macroprudential policy could effectively mitigate the banks risk-taking behaviour under scenarios of extended periods of accommodative monetary policy at the bank-level. In addition, this chapter presents evidence on which macroprudential tools are better suited to this purpose. Regarding the closest literature, this chapter reinforces and complements previous finding from Maddaloni and Peydró (2013) given that the specific risk-taking variables used in the analysis are directly linked with the consequences of softening lending standards due to accommodative monetary environments. Compared to the research of (Altavilla et al., 2020), this chapter focuses on the impact of eased monetary conditions and how tighter financial conditions might mitigate that banks excessive risk-taking, while Altavilla et al. (2020) focus on the effects of both eased financial and monetary conditions.

To do so, this research exploits an unbalanced panel data set covering 1074 commercial banks from 38 countries from 2010 to 2018. Compared to previous literature that uses the Z-score or the expected default frequency as measures of banks risk-taking (Altunbas et al., 2018; Delis et al., 2017; Segev, 2020), this research considers better-suited variables directly related to the build-up of systemic risk and risk materialization linked to the past excessive banks risk-taking behaviour. For instance, the banks

excessive credit supply, non-performing loans, loans-loss reserves and loan-loss provisions. In addition, this investigation accounts for monetary conditions with changes in the slope of the yield curve. Indeed, changes in the slope of the yield curve measures more accurately monetary conditions under environments where policy rates are bounded at the zero lower bound. For the macroprudential policy, we include capital targetting, credit management and borrower-based measures.

This chapter updates and complements previous results in the literature of risk-taking by presenting evidence that banks risk-taking behaviour has increased during the post-crisis period for many countries. Regarding the literature of macroprudential policy effectiveness and the interactions with the monetary policy, this analysis extends previous studies threefold. First, it shows that more stringent macroprudential tools targeting the borrowers, banks' capital and banks' credit management might reduce and even offset the effects of accommodative monetary policy conditions on the banks risk-taking behaviour. Second, it identifies the borrower-based instruments and measures targeting banks' credit management as the most effective instruments to counteract the effects of persistently accommodative monetary policy environments. Moreover, when accounting for banks' specific characteristics, it appears that capital-based and borrower-based instruments are more effective on banks weakly capitalized and with limited liquidity. Meanwhile, instruments targeting banks' credit management are more effective on banks heavily capitalized with abundant liquidity. Finally, the three groups of macroprudential tools seem to be effective when the financial system is highly concentrated (strong competition). Nevertheless, when the monetary conditions are extremely accommodative, the borrower-based and the credit-management measures are more effective.

This chapter provides meaningful insights for policymakers on how, when and on which macroprudential tool implement or take policy actions in order to dampen the risk-taking behaviour of financial institutions. Moreover, it confirms the abilities of macroprudential tools to mitigate banks risk-taking under persistently low rates environments. Environments that have characterized the last decade, and are very likely to persist for longer. The latter provides evidence of the potential complementarities between macroprudential and monetary policy.

Chapter 1

Chapter 1

Macroprudential Policies: Issues and Challenges

1.1 Introduction

It is the fundamental nature of crises that paradigms are created and dismantled. Thus the 1929 crisis led a new theory of economic interdependence to emerge that became the root of macroeconomics. The 2007-2008 crisis is no exception to this tradition as it profoundly disrupted the earlier way of thinking about regulation of the financial sphere. The analogy with other crisis is not only about their circumstances, but also about their modalities. The new provisions of prudential regulation that arose are based on the recognition of interdependencies in how prudential regulation is viewed and on a desire to contain system-wide risk developments. This marks an unequivocal break with the pre-crisis paradigm, which held that individually stable institutions ensured financial stability in law, which the crisis episode rejected in reality.

A crisis is not however, the mother of macroprudential policies. The bodies in charge of macroeconomic stabilisation policies have long used macroprudential tools. While the term first appeared in the 1970s, during a forum in 1979 of the Cooke Committee, the body in charge of setting standards for the prudential supervision of banks macroprudential policies actually have a more distant origin.[1] The review of American macroprudential policies proposed by Elliot et al. (2013) allows us to date their beginnings to the start of the 20th century. It is probably best to give some illustration of these secular policies.The first macroprudentially oriented regulatory frameworks appeared in the Federal Reserve Act of 1913 and consisted of normative limits on loans, with a cap on the loan-to-value ratio and requirements setting maximum maturities. At the end of the Second World War, macroprudential policies changed register quite drastically. The central government no longer simply created and maintained a normative framework that was conducive to financial stability because this approach had failed but it instead intervened much more in credit allocation. In France, for example, the passage of the Direction du crédit law led to the creation of the Conseil National du Crédit as the institute in charge of supervising the credit

[1] "The Chairman [W P Cooke, Bank of England] said that micro-economic problems (which were of concern to the Committee) began to merge into macro-economic problems (which were not) at the point where micro-prudential problems became what could be called macro-prudential ones. The Committee had a justifiable concern with macro-prudential problems and it was the link between those and macro-economic ones which formed the boundary of the Committee's interest."

distribution policy. In the United States, the Federal Housing Administration (FHA) was put in charge of controlling the distribution of housing loans and any associated imbalances, mainly by changing its criteria over the cycle for the minimum contributions or maximum loan maturity that would benefit from its guarantee programme (Grebler, 1960). While macroprudential arrangements have gradually become lost in the toolboxes of the authorities in developed countries, they have not disappeared from contemporary economies. Central banks in developing countries in particular have developed macroprudential mechanisms since the 1990s to address the systemic instability that by nature confronts them very offten. These policies, which were in place when the crisis started though they were not necessarily identified as macroprudential supervision took very different forms. Before considering their forms, we should define the concept of macroprudential policy more precisely by clarifying its contours.

To be blunt, it is difficult to describe these contours precisely. However, it is generally agreed that a policy is macroprudential if it combines the two characteristics of (i) adopting a macroeconomic perspective by appreciating that systemic risk does not necessarily correspond to the sum of the risks taken individually by the different components of the system and, at the same time, that there are two-way interactions between the financial and non-financial spheres; and (ii) seeking to contain systemic risk before it occurs. Macroprudential policy should not be confused with crisis resolution policies, though those may embrace a macroeconomic approach. These criteria are sufficiently broad to leave some uncertainty and to allow a wide range of policies to be associated with them.

This is one reason why a distinction is usually made between the temporal dimension and the cross-sectional dimension of systemic risk. What differentiates in fact the two dimensions is the nature of the problems they raise and the way they address them. The temporal dimension of systemic risk focuses on the economic mechanisms that lead to the development of financial imbalances over time. These cumulative imbalances result from the pro-cyclical behaviour of agents up to a certain threshold where the process is reversed, and this emerges as financial cycles. The cross-sectional analysis of systemic risk focuses on how aggregate risk is distributed within the financial system by analysing interactions between financial entities. This then illuminates contagion phenomena like domino effects, and dependencies on common shocks. Whatever its size, the risk is endogenous in nature, which runs contrary to what microprudential regulation tacitly implies.[2] In the temporal dimension macroprudential policy aims to contain the upward phase of the financial cycle and make the economy more resilient to a negative financial shock, while in the cross-sectional dimension it must find appropriate mechanisms for internalising the systemic externalities caused by certain institutions.

The fairly uncontroversial observation can be made that most macroprudential tools address both dimensions of systemic risk simultaneously. In this regard, the work of the International Monetary Fund (IMF) to identify the macroprudential measures adopted since the early 2000s is extremely instructive.[3] The IMF classifies the 18 macroprudential tools it isolates not by the dimension likely to be covered by systemic risk, but by the type of agents that the measures apply to, whether borrowers or financial institutions. Particularly, interesting in this work is the confirmation of what we had previously stated that the practice of macroprudential measures predates the last crisis.

As in many areas, practice has therefore preceded the interest from economists, which essentially flourished after the crisis. That practice offers a welcome set of experiences that can guide the development of a theoretical framework and the standards of good practice in macroprudential policy. At a minimum,

[2]Microprudential regulation is defined as a policy with the immediate objective of limiting the individual difficulties of banks so as to protect savers and investors.

[3]This work is the Global Macroprudential Policy Instruments (GMPI) project.

four aspects of macroprudential policy have been examined and clarified in recent years. Efforts have been made to (i) define the objectives and instruments of macroprudential policy; (ii) assess the effectiveness of macroprudential tools; (iii) analyse interactions with economic policies, particularly monetary policy; and (iv) identify possible problems in international coordination. It is these themes that our article addresses with the objective of taking a wider view of the progress of knowledge and what remains unknown about these issues a decade after the outbreak of the crisis.

1.2 Macroprudential regulation: objectives and instruments

In the wake of the global financial crisis of 2007-2008, both industrialised and emerging economies were made to pay greater attention to financial stability when defining their economic policies. While all economic policies, whether monetary, fiscal or exchange rate policy, can contribute to promoting financial stability, macroprudential policy has the explicit objective of preventing and limiting systemic risk, which is the risk of "major disruptions in the provision of financial services with serious consequences for the real economy" (CGFS, 2012). In contrast to the microprudential perspective, this implies a top-down approach that responds to the level of safety required for the system as a whole and, from there, to the level of safety of individual institutions within the system (Borio, 2011).

However, as mentioned above, there is no single agreed definition of macroprudential policy. Each country now has its own macroprudential policy framework that covers how the related instruments are applied and the institutional organisation and governance rules of this policy. However, there is agreement that an important feature of macroprudential policy is its preventative and proactive nature. The aim of the policy is to prevent financial imbalances from emerging and systemic risks from accumulating because of excessive procyclicality and the interdependence and common exposures of financial institutions.

To achieve this aim, the European Systemic Risk Board (ESRB) recommends that macroprudential authorities define and pursue intermediate objectives to guide macroprudential action in a more manageable way while ensuring the ultimate objective of the policy of maintaining the stability of the financial sector as a whole. These intermediate objectives should be to (ESRB, 2013): (i) mitigate and prevent excessive credit and leverage growth, as this can contribute to the emergence of asset price bubbles; (ii) mitigate and prevent excessive maturity mismatches and market illiquidity, as this can lead to fire sales of assets during cycle reversals; (iii) limit the concentration of direct and indirect exposures, whether interconnections between financial actors or the exposure of a number of actors to a common risk factor; (iv) limit the systemic consequences of the moral hazard that arises from the propensity of systemically important financial institutions to take more risks because they benefit from implicit government guarantees; (v) strengthen the resilience of financial infrastructures, which are all the actors needed for the financial system like payment systems, clearing houses and settlement infrastructures, and also all the institutions that play a more intangible role, such as rating agencies or deposit guarantee schemes.

The scope of application for macroprudential policy is therefore in principle very broad. Borio (2011) points out that macroprudential policy is not simply a regulatory or supervisory policy that targets the problem of financial institutions being too big to fail and systemically important, but it also concerns smaller institutions whose correlated behaviours are likely to have a collective systemic effect. Above all, it is not limited simply to supervision of the banking sector, but encompasses all the actors and sectors that make up the financial system, including insurance companies and institutional investors. However, the rapid expansion of shadow banking highlights the importance of extending the scope of supervision

and the coverage of macroprudential policy to entities in the parallel financial system like investment funds, money market funds and securitisation vehicles. In the absence of prudential regulation extended to the entire financial system, there is a risk that circumvention and regulatory arbitrage will increase, resulting in a rapid and massive shift of intermediation from regulated banks to the parallel financial system. There are however many reasons to be concerned about how entities in the parallel financial sector contribute to systemic risk. Abad et al. (2017) recently highlighted that European banks in particular are relatively highly exposed to the shadow financial system.[4] They show from their sample of 131 European banks that the exposure to all non-bank or insurance entities represents nearly 52% of the total exposures of the banks. Of these exposures, 60% are to entities outside the European Union and these are mainly concentrated in three types of entity, as securitisation vehicles provide 26% of exposures, non-monetary investment funds 22%, and finance companies 18%.

In order to achieve the intermediate objectives set out above, macroprudential authorities have at their disposal a wide range of macroprudential instruments that they can mobilise. An instrument qualifies as a macroprudential instrument when it is specifically designed to prevent or mitigate systemic risk. Bennani et al. (2017) point out that it is not so much the nature of the instrument as its objective that matters. This explains why a significant proportion of the macroprudential instruments available to the authorities have been created by directly adapting existing microprudential tools to the objective of preventing systemic risk (Scialom, 2011). Capital overloads for systemically important financial institutions are a typical example of the calibration of a microprudential instrument for macroprudential purposes. In the same vein, minimum reserves were originally a monetary policy instrument, but are increasingly being used in emerging economies for financial stability purposes. A change in the reserve requirement ratios has a direct influence on the growth of credit in the economy, and the example of China suggests how differentiated rates can be applied depending on the nature of these credits, or on how large or how systemic a financial institution is. For this reason, the Bank for International Settlements now recognises that minimum reserves can be considered a macroprudential instrument (BIS, 2010).

In addition to calibrating microprudential and monetary policy instruments for macroprudential purposes like this, the authorities have specifically designed a number of other instruments for macroprudential policy. Some of these instruments have been activated and calibrated in a harmonised fashion at international or European level, particularly under the Basel 3 agreements, while other instruments are country-specific and depend particularly on the nature of the risk factors that individual economies face. Foreign currency debt is a relatively major systemic vulnerability for some emerging economies for example, while it is almost non-existent as a risk in industrialised economies. However, it is clearly impossible to neutralise all sources of systemic risk with a single macroprudential instrument, and so the macroprudential authority must be able to adapt its macroprudential policy framework and the instruments at its disposal to match the financial fragilities and risks it has identified (Lim, 2011). The main macroprudential instruments can be classified in various ways (Bennani et al., 2017) by the type of actors involved as lenders or borrowers, by their nature using capital ratios, liquidity ratios or financing unit ratios, by whether they are price-based or quantity-based, or by the intermediate objective pursued. In this article, we opt for the latter classification by objective.[5]

[4] See also Clerc (2013) for a detailed presentation of the evolution of shadow banking in Europe.

[5] Price-based instruments aim to influence the cost of credit directly and so correct excessive risk-taking, while quantity-based instruments aim to control the amount or nature of credit (Caruana and Shim, 2016).

Mitigating and preventing excessive credit growth

Table 1 illustrates that several instruments can be used for a single intermediate objective, reflecting the different ways in which an objective can be pursued (Knot, 2014). Thus a macroprudential authority wanting to prevent exceptionally strong credit growth or a credit-related surge in asset prices, such as house prices, has equity and borrower instruments at its disposal. The countercyclical capital buffer is one of the key instruments of the Basel 3 reform and has been used in the European Union as a macroprudential tool since 1 January 2016. It requires financial institutions to increase their capital when the macroprudential authority considers that excessive credit growth is causing system-wide risks to accumulate.[6] Creating modular equity buffers has a dual effect. By making it more expensive for banks to raise equity capital, it helps raise prices and reduce credit growth, while at the same time it provides the banking sector with additional capital so it can better withstand a cyclical downturn, thereby reducing the risk of a costly credit crunch. The capital surcharge, expressed as a percentage of risk-weighted assets, should therefore be adjusted over time across the financial cycle. The countercyclical buffer rate is within the range of 0% to 2.5%, calibrated in increments of 0.25 percentage point or multiples of 0.25 percentage point, though a rate above 2.5% can be set in the event of very high risk. The activation and calibration of the countercyclical buffer is left to the discretion of the national authority responsible for macroprudential policy.[7] On 29 June 2018, the High Council for Financial Stability (HCSF), which is the French macroprudential authority, decided to raise the countercyclical bank capital buffer rate to 0.25%. Banks had to comply with the new requirement from 1 July 2019.

Unlike the countercyclical buffer, which aims to prevent excessive growth in total credit, sectoral capital requirements target a specific sector of the economy, such as residential or commercial real estate. These sectoral capital requirements can take different forms. They may result in additional capital charges targeted specifically at certain sectors, or they may lead the risk weightings of assets to be modified to match the sectoral risks identified. Additional capital requirements may also have a more structural scope like the systemic risk buffer, which is an instrument specific to the European framework. This buffer, whose rate is not capped, is designed to address structural vulnerabilities that would not be covered by other macroprudential instruments. It specifically aims to prevent and mitigate non-cyclical systemic or macroprudential risks in the long term. Finally, macroprudential authorities may also use instruments targeting borrowers to curb credit growth. These instruments set conditions for granting loans and nowadays mainly concern household credit, and particularly residential mortgage credit. They include the loan-to-value ratio, the loan-to-income ratio, the debt-to-income ratio, or the debt service-to-income ratio. By setting limits on these ratios, macroprudential authorities seek to prevent economic agents becoming excessively indebted and so reduce the probability of default, which in turn improves the resilience of lenders. By influencing the borrowing capacity of economic agents, such limits also make it possible to curb credit growth that is considered excessive and thus to influence the credit cycle.

[6] The Basel Committee recommends that macroprudential authorities use the deviation of the total credit-to-GDP ratio from its long-term trend as the basis for judging excessive credit growth. Many studies have shown that this variable is a good leading indicator of banking crises (see, for example, Drehmann and Juselius, 2014; Giese et al., 2014).

[7] The institutional architecture and governance of macroprudential monetary policy differ from country to country. In some countries, macroprudential policy has been entrusted to the central bank, while others have chosen to entrust macroprudential mandates to a council outside the central bank bringing together the various authorities involved in macroprudential policy. This is particularly the case in France with the High Council for Financial Stability (HCSF), which is chaired by the government. See Knot (2014, Table 2) and Bennani et al. (2017) for a detailed description of macroprudential policy governance frameworks in Basel Committee member countries.

Mitigating and preventing liquidity risk

The macroprudential authorities now have two main instruments at their disposal for avoiding systemic liquidity crises and preventing the externalities associated with the liquidation of distressed assets, and these are the short-term liquidity coverage ratio and the long-term structural liquidity ratio. Both instruments are microprudential in nature but can be used for macroprudential purposes, and they are now part of the Basel 3 regulatory framework. The short-term liquidity coverage ratio aims to strengthen the short-term resilience of banks by ensuring that they maintain an adequate level of liquidity, including through a buffer of liquid assets. It specifically requires banks to have sufficient outstanding high-quality liquid assets in the form of cash or other assets that can be converted into liquidity in private markets to cover liquidity needs without losing their value, or with very little loss, in a liquidity crisis that lasts one month. The Basel Committee's standards require that this ratio should not be less than 100%, except during times of financial tension, which means that the outstanding amount of high quality liquid assets is at least equal to the total net cash outflows over the next 30 calendar days. In times of financial stress, banks can use their outstanding amounts of high-quality liquid assets and so fall below the 100% threshold. The long-term structural liquidity ratio aims to strengthen the longer-term resilience of the banking sector by reducing funding risks over a longer period. It requires banks to maintain a stable funding profile in order to reduce the likelihood that any incident that could dry up or reduce a bank's sources of funding would erode its liquidity position to the point of increasing the risk of default and so potentially create stress at the level of the system as a whole. More specifically, the long-term structural liquidity ratio is the amount of stable funding available compared to the amount of stable funding required. Available stable funding is the portion of equity and liabilities that is expected to be reliable over a one-year period, while the amount of stable funding required depends on the liquidity characteristics and residual maturity of the bank's assets and off-balance sheet positions. The less liquid a bank's assets are, the more they must be covered by stable funding. The long-term structural liquidity ratio must be equal to or greater than 100%, which means that the bank has at least the required amount of stable funding available.

Limiting the concentration of exposures

Beyond these lending limits on borrowers, macroprudential authorities may also impose lending limits on banks in order to limit significant exposures to certain products or sectors. Such restrictions can require that exposure to an individual counterparty or group of counterparties not exceed a certain threshold. This threshold is generally expressed as a percentage of the institution's own funds. The "major risks" measure adopted by the HCSF on 11 May 2018 is an example of this, as it limits the exposures of French systemic banks to the most heavily indebted large companies to a maximum of 5% of their eligible own funds. This both preserves the resilience of the banks to the risk of default by the most heavily indebted companies, and aims to contain the debt of large companies, particularly given the prospect that interest rates could rise. The measure applies to the global systemically important institutions and other systemically important institutions listed by the Autorité de contrôle prudentiel et de résolution (ACPR), which are BNP Paris, Société Générale, Groupe Crédit Agricole, Groupe BPCE, Groupe Crédit Mutuel and Banque Postale.

Limiting the risk taking of systemic banking institutions

Systemically important financial institutions may also be subject to a capital charge to limit the systemic impact of lagged incentives from these institutions. These institutions, which are often said to be too big to fail, may be encouraged to take excessive risks because they benefit from an implicit guarantee from the state in the event of bankruptcy. Equity overloads for systemic institutions should make it possible to limit this moral hazard while strengthening the resilience of these institutions to any shock. There are two types of systemically important institution, classed as global systemically important institutions and other systemically important institutions. The methodology for identifying these institutions and their additional capital requirements is different for the two categories of systemically important institution. The methodology for identifying global systemically important institutions was developed by the Financial Stability Board (FSB) and the Basel Committee. It assesses how systemic a bank is using five categories of indicators that reflect the size of the banks, their interdependence, the availability of direct substitutes or financial infrastructure for the services they provide, their global cross-border activity, and their commercial, structural and operational complexity (BCBS, 2013). Each of these categories has the same weight of 20% in the calculation of the final score that the macroprudential authorities use to determine whether an institution is globally systemically important, and the amount of additional capital required from it if it is. The higher the score, the larger the amount of capital required as a percentage of risk-weighted assets. The additional capital requirements are classified into five tranches and range from 1% to 3.5% of risk-weighted assets. The latest CSF ranking of November 2017 shows that 30 banks are now considered to be global systemically important institutions, with three French institutions, BNP Paris, Société Générale and, Crédit Agricole Group, among them. A similar approach is used for institutions of domestic systemic importance, although the indicators considered in calculating the systemic score and their weighting are different from those in the methodology developed by the FSB and the Basel Committee. In France, it is the ACPR that is responsible for assessing how systemic the banks are at the domestic level. Like those for the global systemically important institutions, the additional capital requirements are calibrated in tranches, with the maximum buffer currently capped at 2% of risk-weighted assets.

Strengthening the resilience of financial infrastructure

Finally, the fifth intermediate objective of macroprudential policy, which has a much broader scope and is still relatively undefined, is to strengthen the resilience of financial infrastructures. To achieve this, the macroprudential framework must be extended beyond the banking sector and must target all players in the financial system. According to the ESRB (2013), the objective of financial infrastructure resilience can be achieved in two main ways, either by addressing externalities within the financial system infrastructure, or by addressing the moral hazard that can arise from how institutions are organised. However, the instruments available to the macroprudential authorities for achieving this objective are still few and far between. A recent report by the ESRB (2017) examines the possible use of margins and haircuts as macroprudential tools for limiting systemic risk that arises from excessive debt and the procyclicality of collateral requirements. Margins and haircuts in markets such as derivatives markets, or temporary sales of securities, can contribute to financial stability by absorbing losses in the event of default and allowing better risk management, but they can also lead to excessive indebtedness in the upward phase of the cycle if they are low, and conversely to debt reduction during slowdowns if they increase. One way to mitigate these pro-cyclical behaviours and curb the excessive accumulation of leverage in boom times

would be to introduce countercyclicality into haircuts and margins, especially to avoid them declining too steeply in the upward phase of the cycle. The higher the margin and discount are, the lower the leverage is. Another way to reduce the procyclicality of margin rules would be to make them less dependent on short-term market conditions using a data set covering long periods of time to set the required margin rates. This would result in lower variability of margin rates and higher average margins, thereby reducing leverage.

Of course, the range of macroprudential instruments available to macroprudential regulators is much wider than that presented in this section. Here we have focused mainly on the principal macroprudential instruments used at the European level, but some emerging countries have adopted macroprudential measures that specifically target the sources of systemic risk they face. This is particularly the case for limits on net foreign currency positions, which aim to reduce the exposure of banks to foreign exchange risk and their dependence on foreign currency financing. Since the early 2000s for example, this measure has been applied by Argentina, Colombia, Iceland, Jordan, Moldova, Morocco and Paraguay (Cerutti et al., 2017).

1.3 The effectiveness of macroprudential policy

A number of recent empirical studies have sought to assess how effective macroprudential policies are (Galati and Moessner, 2018). These studies, mainly based on panel data, have focused particularly on how macroprudential policies affect developments in credit and asset prices. One of the first major studies of this was by Cerutti et al. (2017). They use the IMF's GMPI survey to examine the evolution of macroprudential policy frameworks in 119 countries over the period 2000-2013. They do this by considering 12 macroprudential instruments that they classify into two sub-categories as measures targeting borrowers and those targeting financial institutions. Cerutti et al. (2017) note that many emerging and developing countries adopted macroprudential measures, including foreign exchange measures, at an early stage, while industrialised countries made greater use of measures targeting borrowers, such as limits on the loan-to-value and debt-to-income ratios. Their estimates suggest that a comprehensive macroprudential policy framework with a large number of instruments is effective at containing private sector credit growth, though the effect seems more pronounced in emerging countries. Cerutti et al. (2017) also find that instruments targeting borrowers are generally associated with lower credit growth than instruments targeting lenders. This is in line with the conclusions of Claessens et al. (2013) that the debt service-to-income and debt-to-value ratios are more effective than equity surcharges at curbing asset growth and, in some ways, with the work of Buch and Prieto (2014), which shows that there is no long-term statistical link between bank capitalisation and credit developments in Germany. At the same time, it appears that macroprudential measures appear to be relatively more effective during the expansion phase of the financial cycle when credit growth is strong. However, Cerutti et al. (2017) achieve much more mixed results for real estate price growth. They find no statistically significant relationship between this variable and the adoption of macroprudential measures in either emerging or industrialised countries.

Other studies have also examined how macroprudential measures affect the dynamics of housing credit and house prices, but unlike Cerutti et al. (2017) they do not focus only on the application of macroprudential measures. They also consider the evolution of the macroprudential policy framework and the extent to which the instruments introduced by the authorities have been tightened or made more flexible during a given period. McDonald (2015) considers a sample of 17 industrialised and emerging

Table 1.1: Intermediate objectives and instruments of macroprudential policy

Intermediate objective	Underlying market failures	Main instruments	Transmission channels
Mitigate and prevent excessive credit expansion and leverage	- Externalities of a credit crunch during a downturn in the economic cycle: sudden tightening of the conditions for obtaining a loan resulting in a reduction in credit available to the non-financial sector	- Countercyclical equity cushion	- Robustness of banks and borrowers: reduction in (sectoral) credit growth and reduction in procyclicality of credit
	- Endogenous risk-taking: excessive risk-taking and relaxation of lending conditions in recovery periods	- Sectoral capital requirements	
	- Misperception of risk: collective underestimation of risk due to short memory and the rarity of financial crises	- Leverage ratio	
	- Banking panic: withdrawals on wholesale or retail financing in the event of actual or perceived insolvency	- Cushion for systemic risk	
	- Interconnection externalities: contagion effect of the uncertainty surrounding the evolution of an establishment or market	- Capping of loan-to-value, loan-to-revenue, debt-to-revenue, debt-to-revenue, debt-service/revenue ratios	
	- Externalities of forced asset sales due to excessive asymmetry between assets and liabilities	- Short-term liquidity ratio	
Reduce and prevent excessive maturity mismatches and market illiquidity	- Banking panic	- Long-term structural liquidity ratio	- Robustness of banks' funding base in the face of a liquidity crisis
	- Market illiquidity: drying up of interbank or capital markets as a result of a general loss of confidence or very pessimistic expectations	- Loan-to-deposit ratio cap	
Limit the concentration of direct and indirect exposures	- Interconnection externalities	- Restrictions on significant exposures	- Robustness to counterparties and sector concentration
	- Externalities of forced sales: externalities arising from the forced sale of assets at an incorrect price, due to the distribution of exposures within the financial system		
Limit the systemic impact of delayed incentives	- Link between moral hazard and institutions "too large to fail": excessive risk-taking due to bailout expectations due to the perceived systemic importance of an institution	- Capital overhang of systemically important financial institutions	- Decrease in the probability and impact of failure of systemically important financial institutions

Source: ESRB (2013) and Knot (2014)

economies over the period 1990-2012 and analyses how a tightening of the ceiling on the loan-to-value and debt-to-income ratios affects housing credit growth and house price growth. The results suggest that measures that tighten macroprudential policy influence credit and house prices more than measures that ease policy do. The author finds that tightening the ceiling on the loan-to-value and debt-to-income ratios has a negative and statistically significant effect on housing credit growth and house price growth, while relaxing those measures has no significant effect on the two variables. In addition, in line with Cerutti et al. (2017), he finds that tightening such macroprudential measures is more effective when credit is expanding strongly and house prices are relatively high. Tightening these measures during bull market phases, by reducing the loan-to-value ratio ceiling for example, reduces the trend in housing credit and house prices more than can be done during bear market phases. McDonald (2015) shows that the explanation for this result is that the differences between the effects from tightening these measures and those from easing them are relatively small during bearish phases, when credit growth and house prices are low.

Kuttner and Shim (2016) and Akinci and Olmstead-Rumsey (2018) extend McDonald's (2015) analysis to a much broader range of countries, and they obtain similar results to those of McDonald (2015). However, Kuttner and Shim (2016) go further by seeking to compare the ability of macroprudential policy to influence housing credit and house prices and the ability of fiscal policy to do so. They seek to analyse the extent to which a relaxation of housing tax policy can undermine the effectiveness of macroprudential policy. They show for mortgage lending that including tax measures in the estimate does not call into question the negative and significant effect of tightening the ceiling on the loan-to-value ratio and the debt service-to-income ratio on the growth of mortgage lending. Lowering the ceiling of the debt service-to-income ratio allows the quarterly growth rate of real estate credit to come down by around 4 to 6 percentage points. However, the results for house prices are very different as Kuttner and Shim (2016) observe that none of the macroprudential measures considered has a significant effect on house prices, while the tax measures remain significant. Kuttner and Shim (2016) explain this result by arguing that relaxing tax measures, say be introducing deductibility for mortgage interest payments, makes it possible to reduce the marginal costs of buying a home, which has a positive impact on the demand for real estate and on price trends in the sector.

This result is a reminder that macroprudential policy alone is not enough to curb excessive credit and asset price growth and for maintaining financial stability. Active coordination between macroprudential policy and microprudential policy, and also with other economic policies, is essential. The authorities must ensure that macroprudential, fiscal and monetary policies are used in a complementary and countercyclical manner to reduce financial imbalances and prevent systemic risk. Macroprudential policy is all the more effective in slowing credit and asset price growth if it is accompanied by monetary tightening and appropriate fiscal policy. It is also all the more effective if there is international coordination of macroprudential policies, limiting the effects of spillover and circumvention of regulation in particular. These issues are now at the heart of the macroprudential policy debate and are discussed in more detail later in this article.

1.4 Interactions between macroprudential and monetary policy

To ask questions of the interactions between macroprudential policy and monetary policy is in fact to open two fronts of questioning. The first is whether applying macroprudential tools interferes with monetary

policy objectives, and the second is whether macroprudential policy has secondary effects on monetary policy. The effects that monetary policy can have on the ultimate objective of macroprudential policy, which is financial stability, show there to be three different channels that link the two policies, and these are the balance sheet channel, the risk-taking and risk-shifting channel, and the asset price and exchange rate channel (IMF, 2013).

First, financial stability can be weakened when monetary policy affects the financial conditions of agents. A more restrictive monetary policy increases debt repayment charges for variable-rate borrowers, and it also affects economic activity by reducing income flows and the ability to repay loans. Moreover, a fall in asset prices caused by a rise in interest rates makes information asymmetry issues more acute, reducing access to credit. As a result, tightening monetary policy can result in a higher default rate, reduced bank profits, and a rise in the number of non-performing loans (Borrower balance sheet channel). In addition, the rise in interest rates resulting from the tighter monetary policy reduces intermediation margins, leading financial intermediaries to seek riskier assets and operate with greater leverage to preserve constant returns on capital (Risk-shifting channel).

Second, when monetary policy is accommodative over a relatively long period, it has been observed that financial intermediaries expand their balance sheets, increase their leverage, and become less choosy about borrowers. This behaviour results from the decrease in the probability of borrowers defaulting in a low interest rate environment, which reduces risk measurement and perception (Risk-taking channel).

Third, when monetary policy is accommodative, the value of lenders' assets and the net worth of borrowers improve, stimulating demand and the supply of loans. The financial accelerator mechanism intensifies this process and makes it self-reinforcing until it is reversed (Asset price channel). Finally, changes in monetary policy in an open economy can affect the exchange rate and capital flows. A rise in the interest rate attracts foreign capital if there is a positive gap between the domestic rate and the foreign rate, and causes the local currency to appreciate, which leads to excessive borrowing in foreign currency also contributing to an increase in agent leverage (Exchange-rate channel).

Macroprudential policy is also likely to have side effects and to affect the objectives of stabilising inflation, and monetary policy activity. The introduction of a countercyclical capital buffer shows a good illustration of these effects in action. The loan-to-value and debt-to-income ratios are useful in containing fluctuations in aggregate demand, mainly as they reduce the feedback loop between credit and house prices and limit the rises in them that contribute to the increase in aggregate demand. These ratios are also useful if the cycle goes into reversal since they reduce the intensity of recessions by limiting the credit cycle.

This might suggest that macroprudential policy only has positive side effects but this is not actually the case, particularly for capital buffers and the loan-to-value ratio, which can have adverse effects. If capital buffers are tightened very quickly, financial institutions may find it difficult to respond to them, particularly in economies where access to the capital market is difficult. This would then tighten the supply of credit, pushing the central bank to change its policy to be more accommodating in order to cushion the depressing effects on activity. For the loan-to-value ratio, a cap on it can effectively limit house price growth and household debt, but can also reduce aggregate demand, which can be counter to the monetary policy stance. That there are two-way side-effects between macroprudential and monetary policies has led practitioners and academics to question the principle of separating these policies. The reflections on this subject draw mainly on the confrontation between the two monetary policy doctrines of leaning against the wind and cleaning up afterwards. The first doctrine invites central banks to act

pre-emptively against financial imbalances using their main tool of interest rates, while the second one recommends that central banks act only retrospectively after the effects on price stability or activity have materialised. This means at the same time both rejecting and defending the principle of separating macroprudential and monetary policies. This debate puts the Tinbergen and Mundell principles, which are the two fundamental principles in macroeconomics, at the centre of the game and opposes a flexible reading of these principles against a strict one.[8] While these different elements make it possible to set the debate, they do not provide a practical answer. Indeed, this has paved the way for a new field of literature analysing how effective macroprudential and monetary policies are at preventing vulnerabilities accumulating and at mitigating the consequences of financial shocks for the real economy depending on whether the policies are independent or combined, whether they share common objectives, and whether they are conducted by the same or different authorities (Adrian and Liang, 2018, Svensson, 2018).

The current state of the literature only provides a beginning to clarification of these various issues. This is because the vast majority of theoretical contributions, which are generally based on dynamic stochastic general equilibrium models (DSGE models), assume that the two policies are separate. These studies include the analytical frameworks of Rubio and Carrasco-Gallego (2014) and Collard et al. (2017). While these contributions do not provide any answers to the question of whether policies should be separated or combined, they are nevertheless rich in lessons about the co-existence of these policies.

Rubio and Carrasco-Gallego (2014) explicitly analyse the interactions and effectiveness of monetary and macroprudential policies by isolating two scenarios of coordination and a lack of coordination.[9] Their analysis shows that introducing a macroprudential policy rule based on a loan-to-value ratio improves welfare in both scenarios. Furthermore, the welfare losses suffered by savers as macroprudential policy increases inflation volatility are more than offset by the welfare gains of borrowers, who benefit from a more stable financial environment that allows them to smooth their consumption. These overall gains are greater in a non-cooperative environment, which is finally in line with the conclusions of Beau et al. (2014). This means society benefits by having each authority focus on its own objective because it reduces the volatility in the economy (Svensson, 2017). The DSGE model developed by Collard et al. (2017) also supports the Tinbergen separation principle, where financial stability must be the responsibility of macroprudential policy and macroeconomic stability falls to monetary policy. However, this does not imply there is no interaction, as monetary policy takes account of the effects of prudential policy on the economy.

Nevertheless, there are some exceptions in the literature to this strict principle of policy separation. This is particularly the case in the contributions of Angeloni and Faia (2013), Angelini et al. (2014) and Tayler and Zilberman (2016). In the first, the authors reject the idea that monetary and macroprudential policy should be defined in isolation from each other. Specifically their model highlights how increasing the monetary policy rule of a financial stabilisation component improves well-being and macroeconomic stability in a case where financial stability is ensured exclusively by countercyclical capital requirements. The approach is different in Angelini et al. (2014), who analyse the effect of technological and financial shocks when the interaction between monetary policy and macroprudential policy is cooperative and when it is not. In the cooperative case, both authorities minimise a common loss function, and this corresponds to an institutional environment where macroprudential policy is under the control of the

[8] The Tinbergen principle stipulates that any economic policy with set objectives must have at least as many instruments as it has set objectives (Tinbergen, 1952). The Mundell principle states that an instrument should be assigned to the purpose for which it has the greatest benefit (Mundell, 1962).

[9] The coordination situation implies that both the monetary and macroprudential authorities jointly reduce the same loss function. In the absence of coordination, the central bank and the macroprudential authority each optimise their own policy rule and take the behaviour of the other authority as given (Nash equilibrium).

central bank. The non-cooperative case corresponds to a situation where the authorities are independent of one another, which leads them to minimise each other's loss functions by taking each other's policy rule as a given. The comparison of these two arrangements shows that the cooperative case makes economic policy instruments in the form of the interest rate and capital requirements less volatile in the event of technological shocks. This is the only gain from cooperation, as in the event of financial shocks, cooperation does not have any benefits over non-cooperation.

Tayler and Zilberman (2016) go further by analysing the optimal mix of monetary and macroprudential policies. They do this using a DSGE model in which the monetary and macroprudential authorities agree to maximise a common collective welfare function, and they consider different alternative scenarios depending particularly on the objectives pursued by monetary policy. That policy is modelled using a Taylor rule whose objectives and weights vary with the scenario chosen. Tayler and Zilberman (2016) allow the central bank to respond to financial instability by defining a Taylor rule that is increased by the credit spread. Macroprudential policy is modelled relatively simply using countercyclical capital requirements. In addition, the economy can cope with two types of shock as either a supply shock or a financial shock, which is defined as an exogenous change in the proportion of assets used to guarantee the loans that the bank can seize in the event of default. Whatever the shock considered, Tayler and Zilberman (2016) observe that introducing financial stability as an additional objective of monetary policy does not improve well-being in the economy. This would even tend to amplify instability in prices and activity in the economy. This result, in contrast to that of Angeloni and Faia (2013), therefore supports an obvious complementarity between monetary and macroprudential policies. Moreover, as the results of Rubio and Yao (2017) and Ferrero et al. (2018) suggest, this complementarity is reinforced by macroprudential policy reducing the risk of nominal interest rates moving closer to the zero bound.

In line with these various theoretical studies, a few recent empirical studies have sought to analyse how well monetary policy supports the objectives of macroprudential policy. One of the first studies of this was Aiyar et al. (2014). Using British banking data, Aiyar et al. (2014) analyse how the credit supply of banks evolves after changes in monetary policy and regulatory capital requirements. The results they obtain differ with the size of the banks and they show that the credit supply of the major banks responds strongly to an increase in additional capital requirements, but is not influenced by changes in the monetary stance. Conversely, their results suggest that small banks are very sensitive to developments in both policies. Their credit supply falls significantly if monetary or macroprudential policy are tightened. However, Aiyar et al. (2014) find no significant interaction between monetary and macroprudential policies. Indeed their results suggest that a simultaneous tightening of the macroprudential instrument and the key interest rate does not have a statistically significant effect on credit supply of the banks.

Bruno et al. (2017) and Zhang and Tressel (2017) address the issue of monetary and macroprudential policy coordination by mobilising aggregate data. Considering a panel of 12 Asia-Pacific economies over the period 2004-2013, Bruno et al. (2017) analyse how consistent monetary policies in these countries are with macroprudential policy guidelines and capital flow management measures. The authors estimate the monetary policy stance using a Taylor gap, which is the difference between the policy rate and the rate obtained from an estimate of a Taylor rule, and they regress it to a variable measuring the tightening of macroprudential and capital flow management instruments. The results are different for different periods. Before 2007, Bruno et al. (2017) observed that monetary policies in these countries support macroprudential policies, and a tightening of macroprudential and capital flow management instruments is accompanied by a tightening of monetary policy. The opposite result is obtained after 2007, which suggests that monetary and macroprudential policies diverge during this period. More importantly,

Zhang and Tressel (2017) analyse for a sample of euro area countries how well monetary policy can support macroprudential policy in containing growth in housing credit and house prices. However, the results they achieve do not clearly show that these two policies are mutually reinforcing.

1.5 The institutional architecture of macroprudential policy

Divine coincidence was the cornerstone of pre-crisis monetary theory and for a long time led to an extremely convenient response to the coordination of monetary and macroprudential policies. This is because in the divine case, where stabilising inflation makes it possible to ensure macroeconomic stability and thus contain financial imbalances, macroprudential policy has no place, and so coordination is not an issue. However, the turbulence of the crisis overthrew this idea. The inflation targeting practised, however successfully, by central banks around the world did not ensure financial stability. The question of the institutional framework for these policies was raised very quickly and concerned particularly the legal provisions defining the actor responsible for the conduct, the structure and the decision-making bodies of those policies, the alleged missions and the hierarchy with regard to other economic policies. The main principles laid down and shared on this subject are that the institutional architecture must guarantee the independence of the macroprudential regulator, access to information allowing systemic risks to be identified, and the power to act promptly, and it must make it possible to avoid inaction bias (IMF-CSF-BRI, 2016).[10] However, there has so far been no consensus on the optimal architecture for defining the scope of the monetary and macroprudential policy bodies. This lack of consensus, which is partly due to a lack of the perspective required for the evaluation, means that the institutional architecture in practice differs significantly from one country to another. This is because of differences in political and cultural structures, but also, and perhaps most importantly, because of the variety of financial systems that there are and the previous choices of prudential architecture (ECB, 2010). The IMF, together with the FSB and the Bank for International Settlements (BIS) have developed a typology of institutional architectures, and have identified three models.

- First model. The central bank is in charge of macroprudential functions and its governor, or the decision-making committee, takes all decisions about prudential regulation. This type of architecture is particularly found in economies where the central bank previously had broad supervisory and prudential regulation powers. This pattern can be observed in Argentina, Estonia, Italy (where there is a board that welcomes other supervisors), New Zealand, Norway and Switzerland.

- Second model. The role of macroprudential authority is entrusted to a committee within the central bank that is dedicated specifically to macroprudential policy. One of the advantages of this type of structure is that it enhances transparency, so limiting conflicts of credibility that can arise when the dual mandate is given to the central bank. Moreover, this architecture encourages debate since other prudential authorities or external experts may participate. This is the model used by the United Kingdom, South Africa, Morocco or Thailand, for example.

- Third model. Although a committee outside the central bank is responsible for macroprudential supervision and regulation in this model, the central bank retains a leading role because it is generally the main provider of information and because of the need for policy coordination. In

[10] Inaction bias can affect how effective the macroprudential authority is when the mandate given is unclear, when it can be influenced by the political cycle or by pressure from the sector for which it is responsible, or when the costs of action are immediate and easily measurable and the socio-economic benefits are uncertain.

general, this type of committee is chaired by the Minister of Finance or the Governor of the Central Bank. The advantages of this model are that it has greater political legitimacy and that it offers a wider range of actions by involving public decision-makers who are in charge of other economic policies. However, the downside is that the committee is likely to lose credibility, which explains why the central bank may have a right of veto, as in Germany, or an exclusive right to propose binding macroprudential measures, as in France, so avoiding the bias of inaction.

However, not all institutional architectures find their place in this typology, as Australia, Canada, Japan and Sweden have an institution in charge of macroprudential policy that is independent of the central bank. Finally, it should not be forgotten that there are also institutional arrangements at the supranational level. This is particularly the case in the European Union with the European Systemic Risk Board (ESRB), which is responsible for macroprudential supervision of the entire financial system. It may be noted that the ESRB is steered by the President of the ECB, the governors of the central banks of the Member States, a member of the European Commission and representatives of the regulatory authorities of the banking sector (the European Banking Authority), the insurance sector (the European Insurance and Occupational Pensions Authority) and the financial markets (the European Securities and Markets Authority).

1.6 International coordination of macroprudential policies

Naturally, the issue of coordinating macroprudential policies is not limited solely to the intra-jurisdictional dimension, as it goes beyond national borders and has an international dimension too. Regardless of economic policies chosen, this needs the potential benefits and costs of coordination to be compared with a state of autonomy and of competition between policies. It is not self-evident that international policy coordination is desirable (see Rogoff (1985) for monetary policy). It emerges from the abundant literature that has flourished on the subject over the past three decades that economic policy coordination has two main purposes. The first is to provide and preserve global public goods, and the second is to correct the external effects caused by autonomous economic policies with a national focus.

On the first point, the question arises as to whether financial stability as the ultimate object of macroprudential policies meets the definition of an intangible public good. Two conditions must be met for it to do so. The effect must be non-rival, so that an economy can benefit from it without hurting other economies, and it must be non-exclusive, so that the effect can irrigate all economies. On the second point, the question arises as to whether national macroprudential actions, or the absence of such actions, can have external consequences. Depending which purpose is prioritised, coordination will have to take a distinct form as coordination of a public good in the first case, or strategic coordination in the second case.

Financial stability: a global public good?

The notion of a global public good goes far beyond that of a common public good with non-rivalry and non-exclusion, by including a jurisdictional dimension in the reflection. Kindleberger (1986) defines global public goods as "all goods accessible to all States that do not necessarily have an individual interest in producing them". This definition explicitly points to an additional difficulty that global public goods have but conventional public goods do not, which is economic coordination. While this definition can

cover all public goods, they do not form a monolithic block. The distinction is traditionally drawn between natural global public goods, those of human origin, and those that result from global policies (Kaul et al., 1999). This typology divides between issues and consequently between distinct public policy responses. The problem posed by natural global public goods is of their overuse, while the problem for public goods of human origin is of their underuse and that of public goods that result from global policies is of underproduction. Financial stability is in the latter category, as is health, for example. In both these areas, the financial or human interactions between economies through globalisation have led to a deficiency in strictly national policies and argue for more global policies to be put in place.

Rey's (2015) work helps to defend this idea by highlighting the existence of a global financial cycle. More precisely, Rey (2015) shows that capital flows, asset prices and credit at the global level move in the opposite direction to the VIX, a measure of financial instability, and that the main determinant of the resulting global financial cycle is US monetary policy. This observation not only underlines the universal nature of financial stability, but it also leads above all to a questioning of Mundell's trilemma in which, in a world where the free movement of capital is the norm, choosing a floating exchange rate ensures the de facto independence of monetary policy. The existence of a global financial cycle guided by US monetary policy subordinates the monetary policy of all economies to that of the United States, whatever exchange rate regime is in place. The trilemma is thus transformed into a dilemma, where the independence of monetary policy requires control of the capital account. Rey (2015) then recommends that, in order to limit imported financial instability, capital control policies should be followed together with national macroprudential policies aimed at limiting the indebtedness of financial and non-financial agents. However, this solution is a second-rate optimum, and Pareto's optimum would be for the US Federal Reserve to internalise the impact of its policy on the global financial cycle, but this requires at a minimum a strengthening of central bank coordination. Many efforts, orchestrated by the BIS in particular, have been made in this direction since the crisis. However, we are still far from witnessing the emergence of true global governance in this field, like in many others. Although coordination bodies have multiplied, many factors acting against it limit the scope of coordination. The first is that coordination may conflict with the national objectives pursued by central banks and regulatory authorities. It must also be noted that the definition of common objectives, the policies to achieve them and the mechanisms for verifying the commitments made by the parties are difficult, and they remain very confusing given the current state of knowledge, which does not encourage countries to abandon their sovereignty.

What has not been mentioned is that the recognition of financial stability as a global public good is not new. The creation of the Basel Committee in 1974 was already a response to the idea that financial stability did not have strict national boundaries. And it is following from this diagnosis that the coordination of microprudential regulation and the production of uniform prudential standards have been legitimised. The work of Acharya (2003), Dell'Ariccia and Marquez (2006) and Kara (2016) provides interesting insights into the modalities of regulation and whether harmonisation of the regulatory framework is desirable. The elements of the question are whether a single regulatory policy makes it possible to internalise the interdependencies between economies linked to their financial integration, but at the same time presents a cost in the form of a lack of flexibility, which makes a space for arbitration. Dell'Ariccia and Marquez (2006) highlight that coordination ensures greater stability if the preferences of regulators are identical. This is because centralisation first of all prevents the national regulator from agreeing on looser policies that would give the banks in its jurisdiction a competitive advantage in their international development. Secondly, the superiority of centralisation is that a national regulator does not necessarily consider the external impacts of its policy on the stability of other economies through international

bank flows, and this in practice, leads national regulators to set lower capital requirements than a single regulator would. Financial stability thus suffers from underproduction of competitive regulatory policies, a situation that is like the tragedy of the commons. In a sense, Schoenmaker (2011) also achieves the same result by developing the idea that an increase in financial integration, particularly an increase in cross-border banking activities, leads national regulators strategically to limit the scope of their rescue plans, or the anticipation of them by agents, in the event of an idiosyncratic crisis. This is easily explained by the divergence between the benefit area and the cost area of the rescue plan. The result is an increase in the risk of contagion and therefore in financial instability. This draws what Schoenmaker (2011) calls the financial incompatibility triangle. Financial integration can only be coupled with financial stability if national regulators give up their autonomy and coordinate.

The idea that financial stability could be equated with a global public good is even more clearly reflected in Kara's (2016) work. Unlike in the models of Acharya (2003) and Dell'Ariccia and Marquez (2006), banks in Kara (2016) do not have cross-border activities. National banking markets become interdependent only when banks are confronted with simultaneous liquidity shocks. When this happens, the banks are forced to liquidate their assets jointly and hastily on international markets, leading to fire sales, and in so doing they increase systemic risk in international financial markets. National regulators respond to this systemic risk through capital requirements. However, strategic interactions between regulators lead to an inefficient macroprudential policy because it is insufficiently restrictive. National regulators internalise the effects of their policies on systemic risk but have an incentive to behave as freeloaders. Thus if one regulator raises its macroprudential standards, the other has an interest in lowering its own. This perfectly reflects how the state of international financial markets is similar to a global public good and argues for the establishment of a central regulatory authority if economies are homogeneous; this is also the conclusion reached by the Bengui (2014) macroeconomic model.

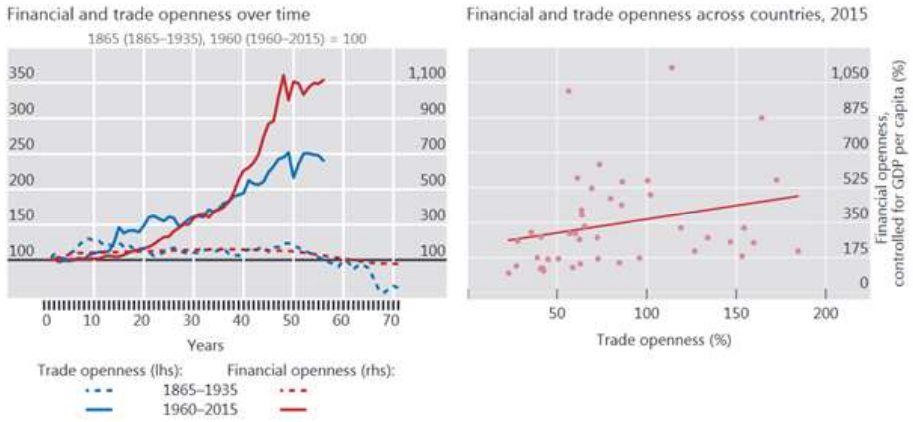
The cross-border effects of macroprudential policies

Beyond serving our argument of presenting financial stability as a public good, the work of Dell'Ariccia and Marquez (2006) illustrates the cross-border externalities that can arise from national prudential policies. The externalities angle is certainly more popular in defending economic policy coordination, and it is from this perspective that the literature generally studies the benefits of coordination. In this context, coordination is no longer a response to a balance of underproduction, but becomes a response to economic interdependence between countries.

For us, it is the interdependencies of financial systems that are of interest. A simple and widely documented way to measure them is to take account of the intensity of trade links or cross-border banking flows. It is probably useful to provide an illustration of these interdependencies here, and it should be noted that the interdependencies have grown tremendously since the 1960s. The global financial openness index measured by the BIS has increased by a factor of 11 since that date, while the trade openness index has increased sevenfold in parallel (see Figure 1).

In mechanical terms, the rise in interdependence has caused the spillover effects of financial shocks to be amplified, and this is not difficult to highlight. A convincing illustration is provided by Choi et al. (2016), who observe that the probability of an economy experiencing a systemic banking crisis increases ceteris paribus very significantly when at least one of its main trading or financial partners is itself affected by a banking crisis of a systemic nature. The lesson to be drawn from this illustration is that the financial stability of an economy is not independent of the stability of its partners, or by extension of the economic

Figure 1.1: Evolution of the financial and trade openness of economies from 1865 to 2015



Source: BIS (2017)

policies, particularly prudential policies, that are followed there.

Overly hasty reflection on this subject could suggest the conclusion that improving prudential standards in an economy is a source of positive cross-border externalities. The reasoning seems solid, as applying a more restrictive prudential policy increases financial stability and so reduces the probability of a crisis being propagated. This then would not require specific macroprudential responses from partner countries. However, there is an important obstacle to this in reality, since it assumes that the behaviour of financial actors is indifferent to environmental change, but there are plenty of reasons to doubt this. It has been particularly argued that international banks would react to local prudential restrictions by revising their intra-group liquidity policy. The work of Cetorelli and Godberg (2012) is interesting in this respect, as they highlight how international banks pass on the domestic liquidity shocks they face to their branches. In practice, the branches provide the parent company with extra liquidity, meaning that the domestic liquidity shock has less local impact, but spreads internationally. Generalising these results to the spillover effects of regulation would be highly speculative, and so a dedicated literature has emerged. This literature argues that (i) strengthening domestic prudential regulation encourages international banks to invest more abroad (Houston et al., 2012; Karolyi and Taboada, 2015; Avdjiev et al., 2017; Kang et al., 2017); (ii) domestic regulation also leads those banks to take more risk (Ongena et al, 2013); (iii) the prudential policy of host countries affects allocations, as international banks invest, ceteris paribus, more in countries where prudential policy is less strict, potentially causing a race to the bottom to attract the favour of international banks (Houston et al, 2012); and (iv) spillover effects are not systematic but depend on the characteristics of international banks and are, empirically, small in economic magnitude (Buch and Goldberg, 2017).

In addition to spillover effects, interdependencies can also lead to bypass effects (Clerc, 2015). The sequence is as follows: (1) a tightening of prudential requirements for the banks, (2) a reduction in the credit supply of domestic banks and the subsidiaries of foreign banks, and (3) an increase in the credit supply of foreign bank branches and loans made abroad, possibly by subsidiaries of the domestic banks. This however greatly impacts how effective macroprudential measures are. The study by Aiyar et al. (2014) illustrates such leakages perfectly. The sequence presented can be traced perfectly in the experience of tightening prudential requirements in the United Kingdom, and it is corroborated by studies based on panel data that, moreover, highlight how sensitive the results are to the prudential instruments

considered (see Cerutti et al., 2015; Akinci and Olmstead-Rumsey, 2018; Reinhart and Sowerbutts, 2016; Kang et al., 2017).

Even if all these results shed light on the situation, they must be taken with great caution. This is partly because the estimates were made from observations taken in a period when macroprudential policies were not generalised, and partly because regulatory measures have recently been taken to limit the effects of spillover and circumvention. The ability that supervisors now have to change the macroprudential requirements for foreign bank branches and foreign-based banks operating in their jurisdiction is generally enough to limit the spillover effects. Jeanne's (2014) contribution extracts from this the limitations that are inherent in the empirical economy. The model compares the welfare effects of domestic prudential policies and capital account supervision and yields interesting results by arguing that these prudential policies have spillover effects, but that this does not in itself lead to coordination by the authorities in charge of these policies, nor to the creation of supranational supervisory authorities. This is because spillover effects do not necessarily constitute externalities in the sense that they are integrated into market prices through the world interest rate. According to Jeanne (2014), the only reason for establishing a coordination mechanism is the possible depressive effects of a simultaneous tightening of macroprudential policies. In theory, central bank action should compensate for the depressive effect, but in practice, the action by the central bank may be constrained by the zero interest rate limit on the nominal interest rate. Thus the world may find itself in a global liquidity trap (Jeanne, 2010), inviting economies to relax their macroprudential policies in a coordinated manner in order to stimulate aggregate demand. In the end, however, Jeanne (2014) concludes that it is quite illusory to expect voluntary coordination of economies in the absence of international transfers.

How to coordinate macroprudential policies

This is not a call to abandon coordination, but rather a warning about its operational difficulties and the scale of the challenges to be met.

Some recent provisions show though that the problems raised are not insoluble. The recognition of the principle of reciprocity, referred to above, is a major step forward that could make macroprudential measures more effective. It allows prudential authorities to avoid the circumvention effects that undermine their measures by replacing loans from domestic banks and foreign bank subsidiaries with loans from foreign bank branches and banks located abroad. This gives the prudential authorities tighter control over the loans issued and so also over financial stability in their jurisdiction. This principle, it should be noted, is not general but applies only to the countercyclical capital buffer. The system is enshrined in the Basel III agreements and is subject to a reciprocity obligation within the limit of a threshold of 2.5% of capital. In practice, it leads national prudential authorities to recognise the rate set by foreign regulators for the transnational exposures of the banks for which they are responsible. Coordination, or rather the creation of conciliation forums, is essential in this in order to avoid this principle of reciprocity being used to distort competition. The framework also introduces other provisions that may limit the spillover effects of macroprudential policies by allowing the national regulator to require a counter-cyclical buffer that is greater than that set by foreign authorities. This then partially addresses the possible spillover effects that could result from any mismatch in the macroprudential policies of partner economies, through a race to the bottom for example.

It may be noted that the principle of reciprocity applies only to the countercyclical capital buffer, which is the only macroprudential measure that results from international agreements. This observation

indicates that multilateral coordination requires international governance bodies, and the Basel Committee, as the meeting place for central bankers, is a natural governance body with credibility. However, it cannot be sufficient because its scope of action is limited as it stands to regulating banks. The Financial Stability Board (FSB), which was created in the wake of the crisis under the impetus of the G20, covers a broader field and has an explicit mandate to fight regulatory competition, and to act for international coordination and international regulatory standards. These ambitions have partially been met as the FSB has acted to strengthen the coordination of banking regulators in synchronisation with both the Basel Committee and also with market regulators. The identification and mutual recognition of global systemically important institutions (G-SIIs) is an example of the FSB's work and underlines how effective it can be in developing international standards. This suggests that it may in the future take on the coordination of macroprudential regulators.

In addition to promoting coordination between national decision-making bodies, international bodies from the IMF to the BIS and the FSB have also taken on the role of issuing opinions and recommendations, providing statistical data, and helping countries to build the institutions needed to implement the policies recommended, and this is undoubtedly an excellent way of ensuring stronger and less costly coherence between macroprudential policies.

1.7 Concluding remarks

The proliferation of both theoretical and empirical research reflected in this article provides a number of clarifications about the purpose of macroprudential policies and their effectiveness, and a number of debates and difficulties with implementing them.

The article focused its discussion on the issues that have been the subject of the liveliest debates and contributions, which are those relating to coordination with monetary policy and those relating to international coordination. However, it is not only these two aspects of macroprudential policies that raise questions and therefore deserve research. One aspect omitted in this article is the challenge of coordination with fiscal policy. A second aspect that deserves attention is the effectiveness of macroprudential policies given the development of shadow banking and the acceleration of financial innovations. Finally, prudential policies, whatever their perspective, inevitably provoke questions about how they affect long-term economic growth, as Boar et al. recently pointed out (2017).

In these three areas, research has been started but still needs to be expanded, and so they are a focus for future research.

The first step should be to understand better the many interactions between macroprudential and fiscal policies. There is too much uncertainty about how the automatic stabilisers impact financial stability, about the trust in the authorities and their means of action with current and accumulated deficits, and about the role of tax policies that favour indebtedness, such as tax deductibility for interest payments, or that can serve as a macroprudential tool, like property tax rises. In the other direction, financial bubbles tend to cover some structural fiscal weaknesses, causing an increase in aggregate demand and reducing the burden of government debt. When this occurs, macroprudential policy may conflict with the interests of the budgetary authorities, which raises some issues of political economy that have so far been neglected.

On the second point, the growth of shadow banking and the way that it is increasingly replacing the

players in the regulated sphere, driven by the development of FinTechs, calls for urgent macroprudential regulation that reflects the nature of this sector and does not just directly copy the tools used for regulated institutions. However, this subject remains embryonic for the time being both from the point of view of academic research and from the operational point of view of macroprudential policy.

Finally, work is also needed to assess the effects of macroprudential policies on how risky activities are financed. It must be ensured that the prudential arsenal put in place does not restrict the financing of viable risky projects, as this would risk reducing the prospects for future growth. In the same spirit, we must ensure that these new restrictions do not act against the objectives of financial inclusion and inclusive growth, particularly in developing countries.

Chapter 2

Chapter 2

When Could Macroprudential and Monetary Policies be in Conflict?

2.1 Introduction

Macroprudential policy has become a full-fledged tool of economic policy in recent years, as shown by the prompt relaxation of financial requirements in response to the COVID-19 crisis in many countries. This trend emerged in the wake of the global financial crisis, when many countries started implementing macroprudential policies to tame lending practices and build buffers for greater resilience. Such measures are supported by both theoretical foundations (Bianchi and Mendoza, 2018; Mendicino et al., 2018; Farhi and Werning, 2016) and empirical evidence of their effectiveness (Altunbas et al., 2018; Cerutti et al., 2017a). Nevertheless, these new arrangements raise the question of potential conflicts arising between macroprudential and monetary policies. Macroprudential measures may have side effects in terms of inflation and output stabilization, which are the main objectives of monetary policy. Similarly, monetary policy can prevent macroprudential policy from achieving its objectives of ensuring financial stability and resilience, which in practice often involves dampening the credit cycle. However, literature on these conflicts is still scarce.

Hence, the aim of this paper is to provide a comprehensive analysis of the conditions under which such policy conflicts may arise. These conditions are evaluated based on (i) different types of shocks (real vs financial, demand vs supply-side, global vs sectoral), (ii) different policy instruments (interest rate, countercyclical loan-to-value limits and capital requirements) and (iii) different policy objectives (volatility of the output gap, inflation, and the credit gap, but also the probability of crisis and Growth-at-Risk).

Our theoretical investigation builds on a realistic DSGE model, with nominal and real rigidities. This model embeds a banking sector that provides intermediation between patient households, on the one hand, and firms and impatient households, on the other hand. Moreover, it features financial frictions stemming from collateral constraints à la Iacoviello (2005). Such constraints may generate a debt-deflation mechanism that makes the financial sector amplify the severity of shocks. Last, the banking sector in the model duly reproduces the sluggish adjustment of bank interest rates. This is important for assessing the effects of monetary policy, as well as those of capital requirements, which both impact retail interest

rates, as we will see.

In this model, we introduce three macroprudential rules pursuing two common and representative regulations objectives, i.e., building buffers and taming lending practices. In line with the Basel III framework[1] and the recommendations of the European Systemic Risk Board (ESRB/2014/1)[2], the first policy is a regulatory countercyclical capital buffer (CCyB) that supplements, conditionally on the context, the regulatory fixed capital that banks are required to hold. This lender-based instrument has been increasingly used by regulators in recent years. It consists of building and releasing buffers to safeguard the banking sector's resilience and ability to function effectively under any circumstances. For example, the vast majority of countries with a positive CCyB before year-end 2019 rapidly cut them in March 2020 to deal with the adverse economic effects of the COVID-19 pandemic.[3] Macroprudential authorities have explicitly advised banks to use the additional space created by relaxing the buffer to address increases in expected losses and support credit. In addition, we incorporate two state-dependent loan-to-value (LTV) caps, for households and for firms, into the model. LTV limits are the most commonly used borrower-based measures. They aim to dampen the credit cycle by reducing procyclical feedback between asset prices and credit. We assume that these three macroprudential instruments react to excess credit, in line with regulatory recommendations. Finally, we model monetary policy as a standard interest rate rule.

Next, we follow a descriptive approach that is agnostic regarding policymakers' preferences. One reason is that there is no consensus on the sharing of objectives between monetary and macroprudential authorities in the literature. Some analyses are based on ad hoc loss functions (Angelini et al., 2014). Others rely on a welfare-based loss function that is arbitrarily split into two parts, assigning ad hoc objectives to both policy authorities (See, e.g., Rubio and Yao, 2020; De Paoli and Paustian, 2017). A second - corollary - reason is that the aim of our analysis is not to determine optimal monetary and macroprudential policies per se. Instead, we conduct an upstream investigation that seeks to identify cases in which conflicts may spontaneously arise. To this end, we separately focus on several variables that are likely to enter policymakers' objective functions (inflation, output gap, credit-to-GDP gap) without imposing policy preferences.[4] We examine the sensitivity of each of these variables to the reaction parameters of the macroprudential and monetary policy rules. This approach is better suited to identifying the source of policy conflicts in a shock-by-shock analysis. More precisely, a conflict is identified when increasing the strength of macroprudential (resp., monetary) policy rules leads to higher inflation volatility and a larger output gap (resp., credit-to-GDP gap) in the contexts depicted by four alternative shocks. We also consider extreme vulnerabilities as alternative objectives of policymakers by studying the effects of monetary policy on the likelihood of a financial crisis as well as the effects of macroprudential policies on the downside risk of GDP growth (Growth-at-Risk).

We find that conflicts between macroprudential and monetary policies are fairly frequent but not systematic. They are especially likely to arise in cases of technological and bank capital shocks. These two supply-side shocks have a more widespread impact on the economy than that of sector-specific shocks such as housing shocks. Regarding policy instruments, it appears that CCyB and monetary policy generate conflicts in many cases. While they both "get in all the cracks" by widely impacting the economy through adjustments to retail rates, their main respective targets – i.e., inflation and the credit gap – often move in opposite directions. Nonetheless, it appears that the stronger the reaction of monetary

[1] https://www.bis.org/bcbs/ccyb/index.htm.

[2] See also the transposition of the Basel III standards on bank capital adequacy into the Capital Requirements Directive (Art. 136 CRD IV) of European Union law (2013/36/EU).

[3] In the euro area, France, Germany, Ireland and Lithuania followed this recommendation emanating from the ECB.

[4] Nonetheless, in margin of our analysis, we show that adverse side effects identified with our approach actually give rise to policy trade-offs in the optimising framework used by Angelini et al. (2014).

policy to the output gap, the less frequent are conflicts stemming from monetary policy, as credit and output gaps are often positively correlated. In contrast, LTV caps, as sector-specific instruments, cause few conflicts. Moreover, even when LTV caps are found to increase real volatility, they eventually reduce downside risks to GDP. These results thus suggest that LTV limits can be easily implemented without concerns about potential spillovers. In contrast, the implementation of CCyB and of monetary policy requires a smooth coordination.

Our paper contributes to the emerging literature on macroprudential-monetary policy interactions.[5] This study is related to Angelini et al. (2014), but with different motivations and a different approach. Nonetheless, at the margins of our analysis, we employ their optimizing framework to illustrate the conflicts that we find in terms of policy trade-offs. This work is also close to that of Silvo (2019), who investigates policy interactions but by applying a different approach (Ramsey-optimal policy) in a model with different financial frictions (based on Holmstrom and Tirole, 1997). However, we find quite similar results in the case of supply-side shocks. Aikman et al. (2019) also deal with this issue in a very different two-period model incorporating the possibility of a financial crisis. We retain the way they compute the probability of a crisis. Our analysis can also be linked to the research on the financial side effects of monetary policy, despite the fact that such negative financial externalities do not precisely rely on the so-called risk-taking channel in our model. Finally, by examining potential conflicts, we also contribute to the literature on coordination of monetary and macroprudential policies (Bodenstein et al., 2019; Collard et al., 2017; Gelain and Ilbas, 2017; De Paoli and Paustian, 2017; Rubio and Carrasco-Gallego, 2014).

Generally, we propose an assessment of conflicts that is more global than what can be found in the existing literature. We first go a step further than other analyses by considering several countercyclical macroprudential rules, reacting to model-consistent credit-to-GDP gaps. In addition, we cover a wider set of shocks. Third, we depart from the usual ad hoc split of the welfare-based loss function by considering a large range of plausible calibrations for the policy rules. We also consider a broader set of potential objectives, from the usual volatilities of key variables to more extreme vulnerabilities such as the probability of a crisis or Growth-at-Risk.[6] Finally, the originality of our contribution lies in the new results that we obtain. We identify the instruments and circumstances that are most prone to conflicts, and we provide explanations based on the transmission channel of these different policy tools. This overall assessment may enlighten monetary and prudential authorities on the potential spillovers of their policies and the need for coordination.

The remainder of this paper is structured as follows. Section 2 reviews the main theoretical and empirical contributions of the related literature. Section 3 presents the DSGE model that we use. Section 4 shows the response of our model to four shocks chosen to cover a set of interesting contexts. Section 5 is devoted to the identification of conflicts and the interpretation of their main causes. Section 6 extends the analysis to extreme vulnerabilities. Finally, section 7 concludes.

2.2 Literature review

Macroprudential tools have been progressively implemented for approximately a decade in most developed countries.[7] This section reviews the justifications for such instruments and the way they are supposed to

[5] See details below in the literature review.

[6] Hence, any policymaker can evaluate the (side) effects of his policy by picking out the variables that enter his loss function and assigning to each of them the relative weight corresponding to his preferences.

[7] See, e.g., Alam et al. (2019) and Cerutti et al. (2017a) for details on these measures.

interact with monetary policy.

First, the implementation of macroprudential policies is supported by theoretical foundations. Gersbach and Rochet (2017) demonstrate how capital requirements improve social welfare by dealing with the procyclical lending behaviour of banks. This is confirmed by analyses based on DSGE models featuring financial imperfections and constraints. In this vein, Bianchi and Mendoza (2018) show, in a framework embedding a debt-deflation mechanism, that the optimal macroprudential policy increases social welfare by reducing the probability and magnitude of crises. Regarding the measures that we consider in our analysis, the optimality of (countercyclical) capital requirements is demonstrated by Mendicino et al. (2018) and Benes and Kumhof (2015). Countercyclical regulatory LTV ratios are also found to be welfare-improving by Alpanda and Zubairy (2017) and Rubio and Carrasco-Gallego (2014), although the benefits may differ for borrowers and savers (Lambertini et al., 2013). Another branch of the literature provides a foundation for macroprudential tools by demonstrating that they generate Pareto improvements when monetary policy is stuck at the zero lower bound (Rubio and Yao, 2020; Farhi and Werning, 2016; Korinek and Simsek, 2016).

Empirical studies validate these favourable effects. Macroprudential measures have been proven to reduce banking risk through balance-sheet adjustments (Altunbas et al., 2018; Claessens et al., 2013), especially due to the impact on credit growth (Cerutti et al., 2017a). Regarding the two macroprudential tools that we consider in our model, De Jonghe et al. (2020) and Vandenbussche et al. (2015) find that capital requirements are effective in lowering credit supply to firms and to households, while Alam et al. (2019) find strong effects of LTV limits on household credit.[8]

However, macroprudential tools can have side effects on the targets of monetary policy, and *vice versa*. This interaction issue has arisen recently as macroprudential measures have been progressively implemented. Therefore, this literature is still in its infancy and includes only a few studies.[9] Some of them demonstrate or suggest that macroprudential decisions can conflict with the objectives of monetary policy. The contribution of Angelini et al. (2014) can be appreciated through the lens of the potentially adverse side effects of countercyclical capital requirements. These authors find that the latter are conducive to higher inflation volatility in the case of a bank capital shock and to higher output volatility in the case of a technology shock. Based on a slightly different DSGE model, Silvo (2019) also find that countercyclical capital requirements may work against monetary policy in the case of a technology shock. In a simple two-period model, Aikman et al. (2019) show that reducing the probability of a crisis is costly in terms of output and inflation, at least in the short run. In addition, we can deduce from the literature on the risk-taking channel, which states that policy rates that are "too low for too long" create financial instability[10], that monetary policy can go against macroprudential objectives.

Empirical evidence on interdependencies is rather mixed. Some studies conclude that there is little interaction between the two types of policies. Aiyara et al. (2016), for example, find that the effect of monetary policy on lending is not significantly affected by simultaneous changes in capital requirements. Others conclude that the two policies are complementary: Gambacorta and Murcia (2020), Garcia Revelo and Levieuge (2021) and Bruno et al. (2017) find that macroprudential tools have a greater effect on credit growth when reinforced by the use of monetary policy. However, according to Kim and Mehrotra (2018), this complementarity is challenged at times of low inflation and buoyant credit growth, which implies

[8] See Galati and Moessner (2018) for a global assessment on the effectiveness of macroprudential policy tools.

[9] Note that we exclude from this review papers that concentrate on the "leaning against the wind" strategy, as they focus more on augmented Taylor rules than on macroprudential measures *per se*.

[10] See Brunnermeier and Sannikov (2014) and Farhi and Tirole (2012), *inter alia*.

that macroprudential and monetary policies are working at cross-purposes. Indeed, another part of the literature reveals the existence of conflicts. Richter et al. (2018), for instance, show that a decrease in the LTV ratio reduces output. Fraisse et al. (2020), Juelsrud and Wold (2020) and Gropp et al. (2018) find that capital requirements negatively affect investment, consumption and employment. In addition, many studies validate the adverse side effects of monetary policy through the risk-taking channel (See, e.g., Colletaz et al., 2018; Jiménez et al., 2014).

Despite the lack of solid theoretical and empirical evidence on interdependencies between monetary and macroprudential policies, an emerging literature focuses on how to articulate them optimally. In line with the Tinbergen separation principle, Collard et al. (2017) find that it is optimal to assign the goal of financial stability to prudential policy and the goal of macroeconomic stabilization to the interest rate policy. Moreover, optimal interaction would require cutting (raising) interest rates to moderate the contractions (expansions) caused by tightening (easing) of capital requirements. Likewise, Aikman et al. (2019) find that it is optimal to tighten CCyBs in response to a credit boom and to cushion the macroeconomic impact by loosening monetary policy. These required adjustments of the policy rate contrast with the aforementioned literature that recommends the implementation of macroprudential measures to compensate for the shortcomings and the adverse effects of monetary policy at the ZLB. Nonetheless, at least these two different views agree on the need to coordinate policies. A demonstration of the gains from cooperation is provided by Lazopoulos and Gabriel (2019) and Bodenstein et al. (2019) in different setups.

In contrast, De Paoli and Paustian (2017) demonstrate that a noncooperative setting in which the macroprudential authority acts as a leader can be superior to cooperation. Rubio and Carrasco-Gallego (2014) find that the non-coordination configuration delivers higher social welfare, as each authority focusing on its own objective is more effective in achieving it. According to Gelain and Ilbas (2017), the relative gains of coordination may depend on the importance given to the output gap in the policies' mandates.

We contribute to the scarce theoretical literature on macroprudential-monetary policy conflicts by providing a comprehensive assessment of the conditions under which each policy may spontaneously prevent the other from achieving its objectives. We consider this as a prerequisite to the analysis of optimal coordination.[11] To this end, we follow a descriptive and agnostic approach. This involves considering more policy tools, more shocks and a broader set of potential objective variables than those that appear in the existing literature. Furthermore, we adopt an original way of identifying conflicts, based on the effects of the strength of monetary (resp., macroprudential) policy response to its targets on the macroprudential (resp., monetary) objectives, shock by shock. Finally, explanations of adverse side effects are based on the transmission channel of the different policy tools. The next section presents the model used for this analysis.

2.3 The model

2.3.1 Overview

Our analysis builds on the model developed by Gerali et al. (2010), which offers both tractability and realism. It embeds the usual nominal and real rigidities as well as financial frictions in an explicit banking

[11] We do not investigate how coordination should be managed but under which circumstances it may be needed.

sector. In this section, we describe its main features to understand the main mechanisms at stake as well as the effects of macroprudential and monetary policies.

The economy is populated by two groups of households (patient P and impatient I) of unit mass, who consume final goods, work and accumulate housing (in fixed supply). The discount factor of patient households is higher than that of impatient households. This implies positive financial flows in equilibrium, with patient households as savers and impatient households as net borrowers. The latter face a loan-to-value (LTV) constraint imposed by the macroprudential authority. Households supply their differentiated labour services through unions that set nominal wages. Labour services are finally sold to competitive employment agencies that assemble them into a homogenous labour input and sell it to entrepreneurs.

Entrepreneurs produce homogenous intermediate goods using labour and capital bought from capital-good producers. Entrepreneurs are net borrowers, with the same discount factor as impatient households. They also face an LTV constraint.

The banking sector is made up of monopolistically competitive banks, which set interest rates on deposits and loans to maximize their profits. The amount of loans offered to households and entrepreneurs is financed by deposits and bank capital. The latter comes from retained profits. Banks must comply with a regulatory capital to risk-weighted assets ratio and with a statutory leverage ratio imposed by the macroprudential authorities. This means that bank lending is constrained.

The programmes of the households, entrepreneurs and banks are detailed below, whereas the rest of the model, namely, the union (the source of wage rigidity), retail (the source of price rigidity) and capital goods sectors, is presented in Appendix 2.A. The full set of equations is provided in Appendix 2.B.

2.3.2 Households

The representative household j maximizes its expected utility given by

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left[\left(1-a^i\right) \log\left(c_t^i(j) - a^i c_{t-1}^i\right) + \varepsilon_t^h \log h_t^i(j) - \frac{l_t^i(j)^{1+\phi}}{1+\phi} \right], \text{ for } i \in \{P, I\} \tag{2.1}$$

where E_t denotes the mathematical expectation operator upon information available at t, $a^i \in [0,1]$ denotes the degree of habit formation, and $\phi > 0$ is the inverse of the Frisch labour supply elasticity. $c_t^i(j)$ denotes individual consumption, c_{t-1}^i is lagged aggregate consumption, $h_t^i(j)$ is housing services and l_t^i represents hours worked. In addition, ε_t^h captures exogenous real demand shocks affecting preferences for housing. It can be interpreted as a variation in the availability of resources needed to purchase housing relative to other goods or as other social and institutional changes that shift preferences toward housing (Iacoviello and Neri, 2010). The subjective discount factor for the patient households (P) is higher than that of the impatient (I) ones, i.e., $\beta_P > \beta_I$.

Patient household i's period budget constraint is given by

$$c_t^P(i) + q_t^h \Delta h_t^P(i) + d_t^P(i) \leq w_t^P l_t^P(i) + (1 + r_{t-1}^d) d_{t-1}^P(i)/\pi_t + \tau_t^P(i). \tag{2.2}$$

Its expenses include consumption, accumulation of housing with q_t^h designating the real house price, and real deposits in period t. Its resources consist of real wage earnings, gross interest income on the last period's deposits, with $\pi_t \equiv P_t/P_{t-1}$ as gross inflation, and lump-sum transfers (τ_t^P). The latter include

labour union membership net fees and dividends from firms and banks (of which patient households are the only owners).

Impatient household i's period budget constraint is given by

$$c_t^I(i) + q_t^h \Delta h_t^I(i) + (1 + r_{t-1}^{bH}) b_{t-1}^I / \pi_t \leq w_t^I l_t^I(i) + b_t^I(i) + \tau_t^I(i), \tag{2.3}$$

where the flow of expenses is partly composed of gross reimbursement of the last period's borrowing b_{t-1}^I, with r_{t-1}^{bH} being the corresponding lending rate. Its resources include new loans, as well as lump-sum transfers $\tau_t^I(i)$ that are only composed of union membership net fees. In addition, impatient households face a borrowing constraint stating that they cannot borrow more (in terms of repayment amount plus interest) than a given proportion LTV_t^H of the expected value of their housing:

$$(1 + r_t^{bH}) b_t^I(i) \leq LTV_t^H \, \mathrm{E}_t \left[q_{t+1}^h h_t^I(i) \pi_{t+1} \right] \varepsilon_t^m \tag{2.4}$$

where LTV_t^H is a mandatory time-varying loan-to-value limit on mortgages to households imposed by the macroprudential authority. At the macroeconomic level, this LTV cap determines the amount of credit that banks can provide to impatient households for a given (discounted) value of their housing stock. This policy instrument follows a countercyclical rule that depends on a measure of excess mortgage credit (see details below). As in Iacoviello (2005), $1 - LTV_t^H$ can be interpreted as the proportional cost of collateral repossession for banks in case of default. The value of collateral is subject to a stochastic shock denoted ε_t^m, which can be interpreted as a non-fundamental shock to housing price expectations, in line with Burlon et al. (2018) and Dupor (2005). Optimistic (pessimistic) expectations on the future price of housing loosen (tighten) the lending constraint. This gives scope for representing a financial demand-side shock.

2.3.3 Entrepreneurs

Entrepreneur i's utility only depends on her own consumption $c_t^E(i)$ and on lagged aggregate consumption:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_E^t \log \left(c_t^E(i) - a^E c_{t-1}^E \right) \tag{2.5}$$

where a^E measures the degree of consumption habits and the discount factor β_E is assumed to be strictly lower than β_P. Entrepreneur i maximizes her lifetime utility under the budget constraint:

$$c_t^E(i) + w_t^P l_t^{E,P}(i) + w_t^I l_t^{E,I}(i) + (1 + r_{t-1}^{b^E}) b_{t-1}^E(i) / \pi_t + q_t^k k_t^E(i) \leq \frac{y_t^E(i)}{x_t} + b_t^E(i) + q_t^k (1 - \delta) k_{t-1}^E(i) \tag{2.6}$$

where expenses are composed of consumption, labour inputs from patient $l_t^{E,P}(i)$ and impatient households $l_t^{E,I}(i)$, gross repayment of the last period's borrowing $b_{t-1}^E(i)$, with r_{t-1}^{bE} being the corresponding lending rate, and physical capital k_t^E, whose price in terms of consumption is denoted q_t^k. Her resources consist of new loans, non-depreciated physical capital resold to capital producers, with δ being the depreciation rate of physical capital, and wholesale good y_t^E, which is sold at the inverse relative competitive price $x_t = P_t / P_t^W$ and produced according to the following technology:

$$y_t^E(i) = \varepsilon_t^a \left[k_{t-1}^E(i) \right]^{\alpha} \left[l_t^E(i) \right]^{1-\alpha} \tag{2.7}$$

where ε_t^a is an exogenous process for total factor productivity. The labour of the two types of households is combined as $l_t^E = (l_t^{E,P})^{\mu}(l_t^{E,I})^{1-\mu}$, where μ measures the labour income share of patient households. Finally, like mortgage borrowers, entrepreneurs are subject to a regulatory borrowing constraint, given by

$$(1 + r_t^{bE}) b_t^E(i) \leq LTV_t^E \, \mathrm{E}_t \left((1-\delta) q_{t+1}^k \pi_{t+1} k_t^E(i) \right) \tag{2.8}$$

which states that the gross borrowing of entrepreneur i cannot exceed a proportion LTV_t^E of the expected value of her (depreciated) physical capital. The macroprudential instrument LTV_t^E is set with respect to a countercyclical rule that depends on a measure of firms' excess credit (see details below).

2.3.4 The banking sector

The banking sector is composed of a continuum of banking groups, indexed by $j \in [0, 1]$, which carry out their intermediation activities under monopolistic competition. Each group is made up of a wholesale unit (management branch) and two retail branches. The retail loan and deposit branches are in charge of granting loans to impatient households and firms and collecting deposits from patient households, respectively, for the group. In doing so, they endure adjustment costs, which are at the origin of bank lending and deposit rates rigidity. The wholesale unit manages the bank's capital position, as the banking group balance sheet is subject to a mandatory capital adequacy and leverage ratios. Deviations from these regulatory ratios imply quadratic costs. In this way, bank capital has a key role in determining supply-side credit and deposit conditions. As banks slowly accumulate capital through retained earnings, policy changes or exogenous shocks to bank capital create a feedback loop between the real and financial sides of the economy.

The retail deposit branch. The retail deposit branch j, operating in a monopolistic competition context, collects deposits $d_t^P(j)$ from households at rates $r_t^d(j)$ and transfers quantity $D_t(j)$ to the management branch, which remunerates these funds at internal rate $R_t^d(j)$. Each deposit retail unit faces quadratic adjustment costs for changing its deposit rate over time. These adjustment costs, denoted as $\mathcal{A}_d(r_t^d(j))$, are parameterized by κ_d and are supposed to be proportional to the aggregate interest paid on deposits, such as $\mathcal{A}_d(r_t^d(j)) \equiv \frac{\kappa_d}{2} \left(r_t^d(j)/r_{t-1}^d(j) - 1 \right)^2 r_t^d d_t$, where d_t represents aggregate deposits in the economy and $r_t^d = [\int_o^1 r_t^d(j)^{1-\varepsilon^d} dj]^{\frac{1}{1-\varepsilon^d}}$ is the deposit rate, with $\varepsilon^d < -1$ representing the elasticity of demand for deposits. Then, the objective of the retail deposit branch j is to solve

$$\max_{\{r_t^d(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[R_t^d(j) D_t(j) - r_t^d(j) d_t^P(j) - \mathcal{A}_d(r_t^d(j)) \right], \tag{2.9}$$

subject to a Dixit-Stiglitz deposit demand curve $d_t^P(j) = \left(r_t^d(j)/r_t^d \right)^{-\varepsilon^d} d_t$. The first-order condition of this programme defines the way the retail deposit branch optimally sets the retail deposit rate with respect to the adjustment costs, the policy rate and a markdown over the wholesale deposit rate, denoted $\varepsilon^d/(\varepsilon^d - 1)$, as indicated in Eq. (B38) in Appendix 2.B.

The retail loan branch. Retail loan branches operate under monopolistic competition. They obtain wholesale loans $B_t^s(j)$, in real terms, at rates $R_t^{bs}(j)$, from the management branch, which pre-allocates wholesale funds for mortgage ($s = H$) and corporate lending ($s = E$), given regulatory constraints on the balance sheet. Then, retail loan branches resell these funds to households and entrepreneurs at lending

rates $r_t^{bH}(j)$ and $r_t^{bE}(j)$, respectively, after differentiating them at no cost but facing quadratic adjustment costs for changing them. These costs are parameterized by κ_{bH} and κ_{bE} and are proportional to aggregate returns on loans. They are denoted $\mathcal{A}_{bs}(r_t^{bs}(j)) \equiv \frac{\kappa_{bs}}{2}\left(r_t^{bs}(j)/r_{t-1}^{bs}(j)-1\right)^2 r_t^{bs} b_t^s$, for $s \in \{H,E\}$, with $r_t^{bs} = [\int_o^1 r_t^{bs}(j)^{1-\varepsilon^{bs}} dj]^{\frac{1}{1-\varepsilon^{bs}}}$ and with b_t^s representing aggregate loans in the economy. The objective of the retail loan branch j is to solve

$$\max_{\{r_t^{bH}(j), r_t^{bE}(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[\sum_{s=H,E} \left(r_t^{bs}(j) b_t^s(j) - \mathcal{A}_{bs}(r_t^{bs}(j)) \right) - \sum_{s=H,E} R_t^{bs}(j) B_t^s(j) \right], \tag{2.10}$$

subject to Dixit-Stiglitz loan demand curves $b_t^s(j) = \left(r_t^{bs}(j)/r_t^{bs}\right)^{-\varepsilon^{bs}} b_t^s$. Units of loan contracts, bought by households and entrepreneurs, are a composite constant elasticity of substitution basket of differentiated financial products, with elasticity terms equal to $\varepsilon^{bH} > 1$ and $\varepsilon^{bE} > 1$, respectively. The first-order conditions give the dynamics of the lending rates r_t^{bs} with respect to both their past and expected values and to a markup $(\varepsilon^{bs}/(\varepsilon^{bs}-1))$ over the wholesale lending rate, as given by Eq. (B39) in Appendix 2.B.

The management branch. The management branch is perfectly competitive. It combines bank capital (K_t^b) with retail deposits $D_t(j)$ on the liability side and total wholesale funds $B_t(j)$ to the retail loan branch, with $B_t(j) = B_t^H(j) + B_t^E(j)$, on the asset side. This branch manages the capital position of the group. Following the Basel III regulation, each bank is supposed to meet capital adequacy ratio (CAR) requirements. More precisely, banks' capital to risk-weighted assets ratio must be equal to υ_t, a contingent mandatory level set by the macroprudential authority (see details below). Differences in the risk weights for households and firms explain the differences in wholesale allocations $B^H(j)$ and $B^E(j)$ towards retail branches. The management activity entails quadratic adjustment costs whenever the actual CAR deviates from the required level.[12] These costs, proportional to outstanding bank capital, are denoted $\mathcal{D}_t^{\upsilon}(K_t^b(j))$. They are parameterized by κ_{car} and defined by

$$\mathcal{D}_t^{\upsilon}(K_t^b(j)) \equiv \frac{\kappa_{car}}{2}\left(\frac{K_t^b(j)}{\omega_t^H B_t^H(j) + \omega_t^E B_t^E(j)} - \upsilon_t \right)^2 K_t^b(j), \tag{2.11}$$

with ω_t^E and ω_t^H being the risk weights relative to entrepreneurs and household loans, respectively.[13] Following Angelini et al. (2014), these weights are procyclical, decreasing (increasing) when annual output growth $(Y_t - Y_{t-4})$ increases (decreases):

$$\omega_t^s = (1-\rho_s)\,\omega^s + (1-\rho_s)\,\chi_s\,(Y_t - Y_{t-4}) + \rho_s \omega_{t-1}^s \quad \text{with} \quad s \in \{H,E\} \quad \text{and} \quad \chi_s < 0, \tag{2.12}$$

where χ_s is the sensitivity of risk weights to the business cycle, ρ_s is the parameter of persistence, and ω^s (without time subscript) is the steady-state value of the corresponding weights.

For the sake of realism, we also include requirements for the leverage ratio of banks. Any deviation from the regulatory level (lev) implies a quadratic cost parameterized by κ_{lev}, proportional to outstanding bank capital and denoted $\mathcal{D}_t^{lev}(K_t^b(j))$. Details on the leverage ratio and its link with the CAR are provided in Appendix 2.C.

[12] Costs in case of negative deviations can be viewed as penalties. In the case of positive deviations, they may refer to the fact that it is costly to have idle capital.

[13] If $\omega_t^E = \omega_t^H$, $B_t^H(j) = B_t^E(j)$ and $R_t^{bH}(j) = R_t^{bE}(j) = R_t^b$, as in Gerali et al. (2010).

Bank capital is accumulated out of retained earnings, following

$$\pi_t K_t^b(j) = (1-\delta^b)\frac{K_{t-1}^b(j)}{\varepsilon_t^{Kb}} + \mathcal{P}_{t-1}^b(j), \tag{2.13}$$

where δ^b measures the resources used in managing bank capital and $\mathcal{P}_t^b$ represents overall bank profits. ε_t^{Kb} is a stochastic shock affecting bank capital. It represents a financial supply-side shock that is important to consider in a policy conflicts analysis, as we will see. After subtracting intra-group transactions, bank profits are given by

$$\begin{aligned}\mathcal{P}_t^b(j) = r_t^{bH}(j)b_t^H(j) + r_t^{bE}(j)b_t^E(j) - r_t^d(j)d_t^P(j) - \sum_{s=H,E}\mathcal{A}_{bs}(r_t^{bs}(j)) \\ - \mathcal{A}_d(r_t^d(j)) - \mathcal{D}_t^v(K_t^b(j)) - \mathcal{D}_t^{lev}(K_t^b(j))\end{aligned} \tag{2.14}$$

Finally, considering the balance-sheet constraint $B_t(j) = D_t(j) + K_t^b(j)$ and after some algebra, the problem for the wholesale branch can be reduced to:

$$\max_{\{B_t(j),D_t(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty}\Lambda_{0,t}^P\left[\sum_{s=H,E} R_t^{bs}(j)B_t^s(j) - R_t^d(j)D_t(j) - \mathcal{D}_t^v(K_t^b(j)) - \mathcal{D}_t^{lev}(K_t^b(j))\right] \tag{2.15}$$

where R_t^{bH} and R_t^{bE} are the internal wholesale loan rates to the households and firms retail loan branches, respectively. Assuming a monetary policy environment of fixed-rate full allotment, $R_t^d(j)$ corresponds to the policy rate r_t, which is exogenous to the banking group. According to the first-order conditions, the management branch sets the wholesale lending rates with respect to the policy rate and capital deviations from regulatory requirements:

$$\begin{aligned}R_t^{bs}(j) = r_t - \kappa_{car}\left(\frac{K_t^b(j)}{\omega_t^E B_t^E(j) + \omega_t^H B_t^H(j)} - \upsilon_t\right)\left(\frac{K_t^b(j)}{\omega_t^E B_t^E(j) + \omega_t^H B_t^H(j)}\right)^2 \omega_t^s \\ - \kappa_{lev}\left(\frac{K_t^b(j)}{B_t^E(j) + B_t^H(j)} - lev\right)\left(\frac{K_t^b(j)}{B_t^E(j) + B_t^H(j)}\right)^2, \text{ for } s \in \{H,E\}\end{aligned} \tag{2.16}$$

These wholesale credit conditions are finally passed on to retail lending rates to households and entrepreneurs (r^{bs}) through the retail branches of the banking groups, as indicated in the retail banks' programme given by Eq. (2.10), with the first-order conditions given by Eq. (B39) in Appendix 2.B.

2.3.5 Macroprudential and monetary policy rules

First, we consider that the objective of macroprudential policy is to dampen the credit cycle. To this end, the macroprudential authority can rely on lender- and borrower-based instruments by setting countercyclical CAR requirements and loan-to-value caps on agents' borrowing, respectively.

Countercyclical capital requirements consist of forcing banks to accumulate a capital buffer during good times, which they can draw down to absorb losses in bad times to ensure that credit does not collapse during a crisis. In line with the transposition of the Basel III standards on bank capital adequacy into the Capital Requirements Directive (CRD IV) of European Union law, the CAR requirements in the model are defined by a fixed component denoted υ and by a state-contingent component that is equivalent to a countercyclical buffer (CCyB). This time-varying buffer is increased or decreased with respect to the

credit-to-GDP gap, or "Basel gap", denoted $\frac{\widetilde{B_t}}{Y_t}$. Hence, the CAR rule is given by:

$$\upsilon_t = (\upsilon_{t-1})^{\rho_\upsilon} \left[\upsilon \left(\frac{\widetilde{B_t}}{Y_t} \right)^{\chi_{ccyb}} \right]^{(1-\rho_\upsilon)} \tag{2.17}$$

where $\chi_{ccyb} > 0$ represents the strength of the response of the CAR requirements to the Basel gap. The parameter ρ_υ captures the gradual adjustment of CAR requirements that is observed in practice, as shown in Figure D1 in Appendix 2.D. In the steady state, the CAR requirement is equal to the fixed component υ. One original feature of our approach is to consider a model-consistent Hodrick-Prescott (HP) filter for computing the credit-to-GDP gap. Technical details are provided in Appendix 2.E.

In addition, the macroprudential package in the model includes two state-dependent loan-to-value (LTV) caps: one for households and one for firms. Time-varying LTV caps for mortgage and business loans aim to dampen the credit cycle by reducing the procyclical link between asset (housing and physical capital) prices and credit. Hence, the caps are supposed to react countercyclically to the sectorial HP-based credit-to-GDP gap as follows:

$$LTV_t^s = \left(LTV_{t-1}^s\right)^{\rho_{ltv}^s} \left[LTV^s \left(\frac{\widetilde{B_t^s}}{Y_t} \right)^{\chi_{ltv}^s} \right]^{\left(1-\rho_{ltv}^s\right)}, \tag{2.18}$$

where χ_{ltv}^s is the reaction parameter assigned to the respective sectoral credit-to-GDP gap, with $s \in \{H, E\}$. $\chi_{ltv}^s < 0$, such that a positive sectoral credit-to-GDP gap would tighten the corresponding loan-to-value limit. The parameter ρ_{ltv}^s captures the gradual adjustment of LTV that is observed in practice, as shown in Figure D1 in Appendix 2.D. Note that the regulatory constraints are binding, as in most of the existing studies (see, e.g., Mendicino et al., 2018; Alpanda and Zubairy, 2017). It is crucial that macroprudential constraints are actually operational to identify potential conflicts.

Finally, the objective of monetary policy is to stabilize inflation and the business cycle. To this end, the central bank sets the nominal policy rate r_t following a Taylor-type rule such as

$$\frac{1+r_t}{1+r} = \left(\frac{1+r_{t-1}}{1+r} \right)^{\rho_r} \left(\frac{\pi_t}{\pi} \right)^{\chi_\pi(1-\rho_r)} \left(\widetilde{Y_t} \right)^{\chi_y(1-\rho_r)} \tag{2.19}$$

where χ_π and χ_y are the response parameters to deviations of inflation π_t from its steady state π and to the model-consistent HP-based output gap $\widetilde{Y_t}$, respectively. The parameter ρ_r captures the degree of interest-rate smoothing, and r is the steady-state value of the policy rate.

2.3.6 Calibration

The calibration of the structural parameters is reported in Table F1 in Appendix 2.F. Values are largely based on Gerali et al. (2010), with a few exceptions. Markups on lending rates $\varepsilon^{bs}/(\varepsilon^{bs} - 1)$ are set to 1.15. Absent consensus on the underlying elasticities, these values prevent the exaggeration of banks' reaction to monetary and macroprudential policies. Following Gambacorta and Karmakar (2018), the adjustment cost parameter related to the leverage ratio is set to 7.63, while that relative to the CAR requirements is fixed to 50. Next, combining banks' capital (Eq. B29) and profits (Eq. B33) implies a steady-state consistent value of 0.084 for δ^b, the proportion of resources used in managing bank capital.

The calibration of the macroprudential instruments, reported in Table F2, is based on official regu-

lations prevailing in the euro area, on empirical evidence and on the calibration used in previous studies (See, e.g., Iacoviello and Neri, 2010; Iacoviello, 2015; Rubio and Carrasco-Gallego, 2014). In this way, we set the steady state of the loan-to-value caps for households and firms to 0.8 and 0.9, respectively, while the steady-state capital adequacy ratio (υ) is set to 8%.[14] This implies a steady-state leverage ratio equal to 6.91%, as demonstrated by Eq. C2 of Appendix 2.C. Moreover, in line with the recommendations of the Basel Committee on Banking Supervision for computing risk-weighted assets, according to the standardized approach, the steady-state risk weights for claims on residential property and corporations, ω^H and ω^E, are equal to 0.35 and 1.0, respectively.[15] Last, following Angelini et al. (2014), the sensitivities of household and firm risk weights to the business cycle (χ_s) are set to -15 and 10, respectively, and the parameters of persistence (ρ_s) are calibrated to 0.94 and 0.92, respectively.

Finally, as our analysis consists of identifying some policy side effects conditionally on the strength of the reactions of policymakers, we do not set unique values but rather ranges of values for the reaction parameters of the policy rules. For the monetary policy rule, the range covers most of the empirical and optimized values found in the literature, namely, $[1.7; 5.0]$ for χ_π and $[0; 5.0]$ for χ_y. Benchmarks are missing for macroprudential policy parameters, as studies are scarce.[16] Hence, we consider wider intervals to be as exhaustive as possible: χ_{ccyb} varies between $[0; 20]$, while χ^s_{ltv} lies in the range $[-20; 0]$, as in Lambertini et al. (2013). Finally, the parameters ρ_υ and ρ^s_{ltv} are set to 0.99, in accordance with the very high gradualism of macroprudential decisions that is observed in practice (see Figure D1 in Appendix 2.D), and in line with Burlon et al. (2018).

2.4 Responses of the model to a selection of representative shocks

Our investigation of policy conflicts is based on the four different shocks embedded in the model. This section aims to justify the choice of these shocks by analysing in depth their transmission channels and macroeconomic effects.

Two of these shocks, i.e., housing preference (ε^h_t) and productivity (ε^a_t) shocks, can be viewed as real shocks. The two other, namely, bank capital (ε^{Kb}_t) and collateral (ε^m_t) shocks, are more financially oriented. This distinction is important given the nature of the objectives of monetary policy and macroprudential policies. From another perspective, productivity and bank capital shocks are both supply-side shocks, with widespread impacts on the economy. In contrast, housing preference and collateral shocks are demand-side shocks. Moreover, they can be viewed as sectoral shocks, as they are initially circumscribed to the housing market. Finally, as reported in Table 2.1, which summarizes the impulse response functions (IRFs) that are exhibited below, these four shocks are interesting because they embrace all possible configurations in terms of variation and correlations among the three objective variables.

Note that for a better understanding of the effects of the policies and for an easier comparison with the existing studies based on the Gerali et al. (2010) framework[17], two versions of the model are considered, namely, one with and one without countercyclical macroprudential rules (i.e., $\chi^E_{ltv} = \chi^H_{ltv} = \chi_{ccyb} \neq 0$ or $= 0$ in Eq. 2.17 and 2.18). Beyond the information that the IRFs provide on the dynamics of the model, they can deliver preliminary indications on potential policy conflicts.

[14] Setting a CAR to 8% means that the capital conservation buffer of 2.5% is ignored. However, this does not affect the dynamics of the model and hence the results that we find later on.

[15] See Calculation of RWA for credit risk.

[16] Angelini et al. (2014) find an optimal value of χ_{ccyb} between $[2.2-7.0]$, depending on the policy preferences and shocks. Lozej et al. (2018) and Gelain and Ilbas (2017) set this parameter to between $[0; 2]$ and $[2.5; 7.2]$, respectively. Rubio and Carrasco-Gallego (2014) find an optimal value of 0.8 for χ_{ltv}, while Burlon et al. (2018) set a value equal to 0.5.

[17] See, in particular, Gambacorta and Karmakar (2018); Chen and Columba (2016); Angelini et al. (2014).

Table 2.1: Summary of the responses of output, inflation and the credit gap to four alternative shocks

Shock type	Responses of			Correlations		
	Output	Inflation	Basel gap	Output Inflation	Output Basel gap	Inflation Basel gap
Housing preference shock (−)	↑	↑	↓	+	−	−
Productivity shock (+)	↑ (↓)	↓	↑	−	+	−
Bank capital shock (−)	↓	↑	↓	−	+	−
Collateral shock (+)	↑ (↓)	↑ (↓)	↑	+	+	+

Note: This table provides a summary of the initial responses (increase ↑ or decrease ↓) of output, inflation and the Basel gap, based on the IRFs of the model, following different shocks. It also provides the signs of the theoretical correlations between pairs of these 3 variables. +/− refer to a positive / negative shock or correlation. Arrows in parentheses indicate responses that are different in the model with macroprudential rules from the response obtained in the model with no macroprudential rules.

Housing preference shock The response of the model to a negative housing preference shock ($\varepsilon_t^h < 0$ in Eq. 2.1) is represented in Figure G1 in Appendix 2.G. Let us first consider the configuration with no macroprudential rule. Loans to households are reduced, as this negative shock makes the housing price decline, which represents a fall in households' collateral. The mortgage credit-to-GDP gap decreases, and the global Basel gap also decreases. Through the substitution effect, the consumption of (impatient) households increases, which stimulates total consumption and explains the rise in total output. Nevertheless, economic growth is dampened by a restrictive monetary policy, which leads to a hike in lending rates. Hence, investment drops. At the same time, bank capital increases as banking profits start rising two periods after the shock, because lending rates increase more than the deposit rate. Interestingly, this shock generates similar macroeconomic dynamics to those of a global demand shock but also has financial consequences, given the importance of housing as collateral.

With countercyclical macroprudential rules, we first observe that LTV requirements are relaxed in response to the decline of sectoral credit gaps. Similarly, the CAR is eased through a reduction in its countercyclical component (CCyB). This accommodative stance leads to a decrease in the lending rate, which stimulates lending. Hence, investment increases in this case, as does consumption. As a result, the increase in output may be even stronger than in the absence of macroprudential rules, but credit is better stabilized.

Productivity shock Figure G2 in Appendix 2.G reports the response of the model to a positive technology shock ($\varepsilon_t^a > 0$ in Eq. 2.7). As expected, this shock provokes an increase in GDP jointly with a decrease in inflation. The central bank, which reacts more to inflation than to the output gap, cuts its policy rate. This lowers retail rates and increases the credit-to-GDP gaps. As a consequence, investment and total consumption rise. Last, bank capital decreases because of the decline of the interest margin (deposit rates decrease less than lending rates).

When state-contingent macroprudential rules are implemented, the CCyB increases in response to the rise in the Basel gap. Hence, banks need to raise their profits to increase their capital. They do so by cutting their retail rates to a lesser extent than they would do in the absence of the CCyB. In this way, they benefit from a growing interest margin. However, this goes against the willingness of the central bank to lower interest rates. Thus, credit conditions are tighter and loans to households are lower than they would be in the absence of macroprudential rules. Furthermore, the debt-deflation mechanism is at work: the relatively higher real debt burden pushes housing demand down. As a consequence, housing prices and collateral values decline. This exacerbates the negative financial effects of the initial shock.

Finally, these developments lead to a loosening (tightening) of LTV for households (entrepreneurs), both contributing to smoothing the credit cycle. Note that total output may possibly decrease if the CCyB and corporate LTV tightening are readily aggressive. This is indicated in Table 2.1 by a downward arrow in parentheses. Hence, these IRFs already suggest the existence of policy conflicts.

Bank capital shock Figure G3 shows the response of the model to an exogenous decrease in bank capital (i.e., $\varepsilon_t^{Kb} > 0$ in Eq. 2.13). Interestingly, we find macroeconomic effects close to those obtained under the technological shock but with very different transmission channels. Banks have to raise their profits to meet the regulatory CAR by hiking their retail rates. This provokes a reduction in loans to entrepreneurs, which in turn leads to lower investment and consumption. Then, firms increase their labour demand to offset the decrease in capital. Benefiting from higher labour incomes, households consume and invest more in housing, which implies more collateral and ultimately more mortgage loans. However, this does not compensate for the fall in corporate lending. Finally, output and the aggregated Basel gap decrease. Simultaneously, monetary policy is slightly restrictive to fight inflation.

Turning now to active macroprudential policies, we see that the CCyB is diminished in response to the declining Basel gap. Moreover, LTV caps contribute to smoothing the credit cycle (its trough is halved) and supporting firms' investment and consumption. As a consequence, total consumption does no longer decrease. Monetary policy is initially more restrictive as the output gap and inflation increase. Then, the policy rate is cut, which makes output higher, whereas inflation remains subdued for a while.

Collateral shock Figure G4 shows that a positive collateral shock ($\varepsilon_t^m > 0$ in Eq. 2.4), which is Equivalent to a *de facto* increase in LTV, stimulates lending to households and provokes a rise in the Basel gap. Its stimulating macroeconomic effects induce a tightening of monetary policy. The inherent hike in lending rates makes banks' profit and capital increase.

Regarding macroprudential policies, the policymaker can immediately offset this collateral shock by restricting the mortgage LTV and tightening the CCyB. Meanwhile, impatient households reduce their labour supply, which lowers production. Hence, producers invest and consume less. The inherent fall in output is higher than that in loans, which explains the increase in firms' credit-to-GDP gap. This motivates a tightening of the corporate LTV. Finally, the contraction of economic activity pushes inflation down. As a consequence, monetary policy is relaxed. This shows that implementing countercyclical macroprudential rules can induce changes in the dynamics of the economy and in the stance of monetary policy, with consequences for the stabilization of inflation and output. Again, this illustrates possible policy side effects.

2.5 Identifying conflicts

While the IRFs give some preliminary intuitions concerning the side effects of each policy, this section aims to reveal the existence of policy conflicts more formally. To this end, we examine the volatility of the three main objective variables (output, inflation, Basel gap) as the reaction parameters of the macroprudential and monetary policy rules ($\chi_{ccyb}, \chi_{ltv}^E, \chi_{ltv}^H, \chi_\pi, \chi_Y$) are gradually increased, one by one. We consider a conflict to be a situation in which the theoretical variances of output or inflation increase as the reaction parameter of any macroprudential rule goes up, other reaction parameters being unchanged. In the same way, monetary policy is considered to be at the origin of conflicts when the theoretical

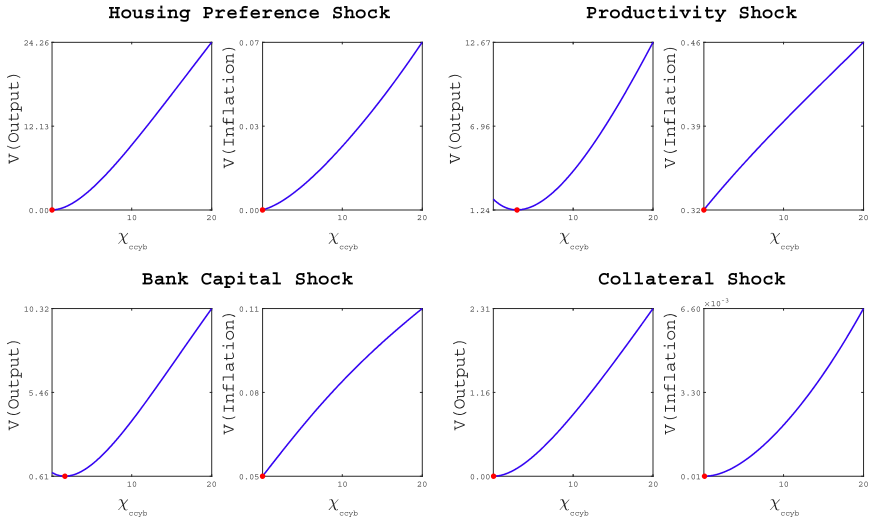
variance of the Basel gap increases as the reaction parameters of the monetary policy rule rise, *ceteris paribus*.

In doing so, we do not need to make any assumption on the preferences in policymakers' loss function, which is an advantage for our analysis since there is no consensus in the literature on the sharing of objectives between monetary and macroprudential authorities. Indeed, even the studies relying on a micro-founded loss function usually split it into two parts, assigning ad hoc objectives with arbitrary weights to both policy authorities. Moreover, the aim of our analysis is not to determine optimal monetary and macroprudential policies per se. Hence, the issue of goals settings and assignments is beyond the scope of this paper, which seeks to identify cases in which conflicts may arise. To this end, we rather focus on individual variables that are likely to enter policymakers' objective functions (inflation, output gap, credit-to-GDP gap) without imposing policy preferences. Nevertheless, we show that adverse side effects identified with our approach give rise to policy trade-offs when applying a policy frontier analysis based on a usual loss function, such as that used by Angelini et al. (2014).

2.5.1 Conflicts stemming from countercyclical capital requirements

Figure 2.1 reveals the potential conflicts arising from using the CCyB as the policy parameter χ_{ccyb} increases from 0 to 20. We observe that implementing a state-contingent CAR is detrimental to the stabilization of output and inflation in most cases. Possibly, in the case of a productivity shock, having a reaction parameter χ_{ccyb} lower than 3 makes the variances of output slightly decrease, which suggests complementarity between macroprudential and monetary policies' objectives. However, the CCyB generates adverse real side effects for values of χ_{ccyb} higher than 3. In the same way, a moderate response of the CCyB to the Basel gap, i.e., χ_{ccyb} lower than 1.6, is slightly beneficial for the stabilization of output in the case of a bank capital shock. However, this gain is tiny relative to the enormous increase in the variance of output that is observed as χ_{ccyb} increases beyond 1.6.

Figure 2.1: Real side effects of the CCyB



Note: Each plot represents the evolution of the theoretical variance of output or inflation as the reaction parameter χ_{ccyb} in the CAR rule increases from 0 to 20 in increments of 0.01, while the policy parameters in the other policy rules remain constant ($\chi_\pi = 1.98, \chi_y = 0.34, \chi^H_{ltv} = \chi^E_{ltv} = -1.0$).

The IRFs presented in the previous section can help us understand the source of the conflicts. For instance, in Figure G1, we observe that following a negative housing preference shock, the CCyB decreases in response to the fall in the credit gap. Easing banks' balance-sheet constraints should encourage banks to lower their retail rates. In contrast, monetary policy consists of hiking the policy rate in response to the increase in inflation and output. This should make retail rates increase. Hence, the two policies go in opposite directions. Figure 2.1 shows that the inherent conflicts are even more important as the CCyB responds much more strongly to financial imbalances. Similarly, as indicated in Figure G2, the CCyB is tightened in response to the increase in the Basel gap, following a favourable productivity shock. However, this macroprudential policy orientation conflicts with the accommodative monetary policy stance, motivated by the simultaneous fall in inflation. The higher the policy parameter χ_{ccyb}, the more banks must increase their lending rates to meet the stricter capital requirements, and the higher is the interference with the policy rate cut. This eventually affects the stabilization of inflation.

For illustration purposes, we can show that the conflicts that are identified here can be transposed into policy trade-offs. Following the optimization framework proposed by Angelini et al. (2014), Figure H1 in Appendix 2.H reports the policy frontiers related to the six clear-cut conflicting cases identified in Figure 2.1. As evidence of trade-offs between macroprudential and monetary policies' objectives, we can see that increasing the weight of credit gap stabilization in the loss function of the policymaker makes the variance of the Basel gap decrease, at the expense of higher volatility of output and/or inflation.

2.5.2 Conflicts stemming from loan-to-value caps

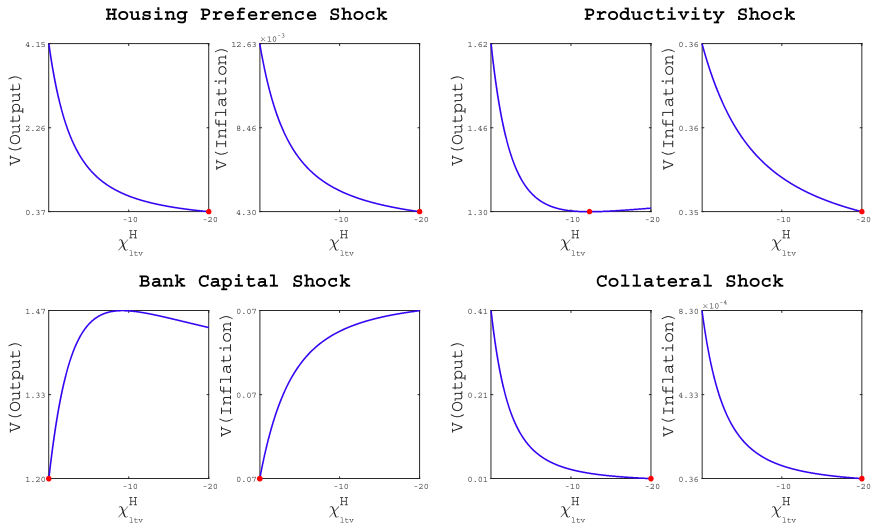
Figure 2.2 reports the evolution of the variances of output and inflation as the reaction parameter χ^H_{ltv} in the mortgage loan-to-value rule moves from 0 to -20. Interestingly, we observe that contrary to the CCyB, there are some cases in which the real side effects are clearly favourable: complementarity with monetary policy objectives is found in the case of housing and collateral shocks. For instance, as shown in Figure G1, the LTV cap for households is relaxed in response to the fall in the credit gap following a negative housing preference shock. By stimulating household demand for loans, this accommodative policy pushes lending rates up. This orientation is consistent with the increase in the monetary policy rate, which aims at curbing inflation and the output gap.[18] Next, inflation and output also benefit from LTV caps to households in the case of a productivity shock, while the variance of output slightly increases as χ^H_{ltv} exceeds 12 in absolute value. Finally, we find only one clear-cut conflict, which concerns the stabilization of inflation in the case of a bank capital shock. The variance of output also increases, but it tends to slightly decrease as χ^H_{ltv} becomes very high (higher than 10 in absolute value).

Some of the side effects found in Figure 2.2 are transposed in terms of policy frontiers in Figure H2 in Appendix 2.H. In this way, we can see, for instance, that the variances of output, inflation and the credit gap all decrease as the relative weight of the credit gap stabilization objective increases in the policymaker's loss function in the case of housing preference and collateral shocks. In addition, we can show that the stabilization of inflation benefits from a higher relative weight of the macroprudential objective in the case of a productivity shock. Finally, as evidence of a policy trade-off, we show that the variance of the credit gap is reduced at the expense of higher volatility of inflation in the case of a bank capital shock.

Next, in light of Figure 2.3, we find that the LTV cap for entrepreneurs also causes few conflicts.

[18] Furthermore, the stronger the reaction of the LTV cap, the more it compensates for the adverse real effects of the CCyB found in case of a housing preference shock.

Figure 2.2: Real side effects of the LTV cap for households



Note: Each plot represents the evolution of the theoretical variance of output or inflation as the reaction parameter χ^H_{ltv} in the LTV^H rule evolves from -20 to 0 in increments of 0.01, while the policy parameters in the other policy rules remain constant ($\chi_\pi = 1.98, \chi_y = 0.34, \chi^E_{ltv} = -1.0, \chi_{ccyb} = 5.0$).

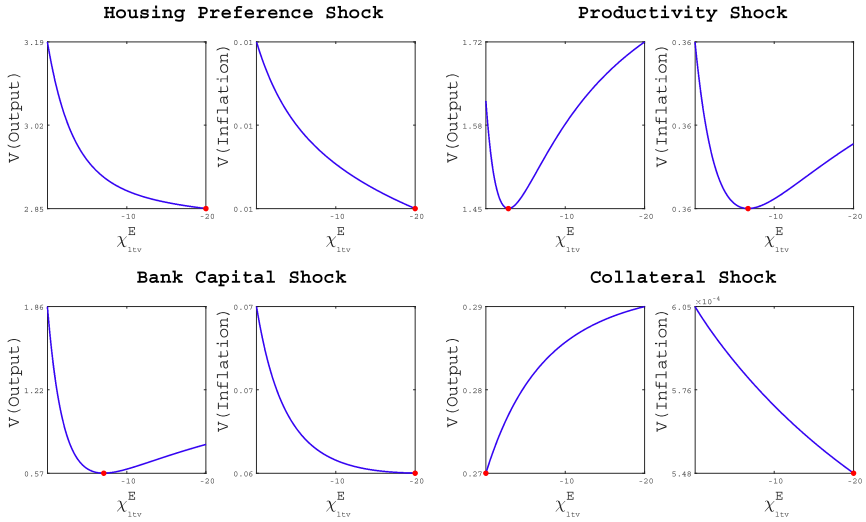
The only clear-cut adverse side effect concerns output stabilization in the case of collateral shocks. This conflict arises because monetary policy seeks to support inflation and output by encouraging demand from entrepreneurs. However, at the same time, the LTV cap for entrepreneurs is tightened, which brings investment and consumption down even more. Conflicts with monetary policy objectives may also arise in the case of productivity and bank capital shocks but only if the reaction of the corporate LTV rule is relatively aggressive. In contrast, inflation benefits from the LTV cap for entrepreneurs in the case of a bank capital shock. As shown in Figure G3, the corporate LTV is loosened in response to the fall in the entrepreneurs' sectoral Basel gap, following a negative bank capital shock. This intends to encourage loan demand and should push lending rates up. This stance is consistent with the policy rate hike intended to curb inflation. Similarly, complementarity is predicted in the case of a housing preference shock.

The policy frontiers in Figure H3 in Appendix 2.H illustrate this complementarity between the corporate LTV and monetary policy in the case of a housing preference shock: the variances of the credit gap and inflation decrease as the relative weight of the macroprudential objective in the policy loss function increases. In contrast, more weight given to the objective of credit gap stabilization is shown to be detrimental to the stabilization of output, evidencing a trade-off that occurs in the case of a collateral shock.

2.5.3 Conflicts stemming from monetary policy

Figure 2.4 represents the impact of the two policy parameters of the monetary policy rule on the variance of the credit gap. We first notice that the reaction to inflation changes creates conflicts in all cases. Let us consider the productivity shock as an example. The monetary policy rate is cut to support inflation (see Fig. G2). This accommodative monetary policy stance is likely to decrease retail rates and stimulate loans. However, macroprudential policy becomes more restrictive in response to the increase in the Basel

Figure 2.3: Real side effects of the LTV cap for firms



Note: Each plot represents the evolution of the theoretical variance of output or inflation as the reaction parameter χ^E_{ltv} in the LTV^E rule evolves from -20 to 0 in increments of 0.01, while the policy parameters in the other policy rules remain constant ($\chi_\pi = 1.98, \chi_y = 0.34, \chi^H_{ltv} = -1.0, \chi_{ccyb} = 5.0$).

gap. This aims to raise lending rates and reduce excess loans, which is opposite to the objective of monetary policy. Similarly, in the case of (negative) housing preference shocks (see Fig. G1), the interest rate hike (motivated by the increase in inflation and the output gap) counteracts the easing stance of macroprudential policy (justified by a decline in the credit gap). This conflict worsens as policymakers react more strongly to inflation.

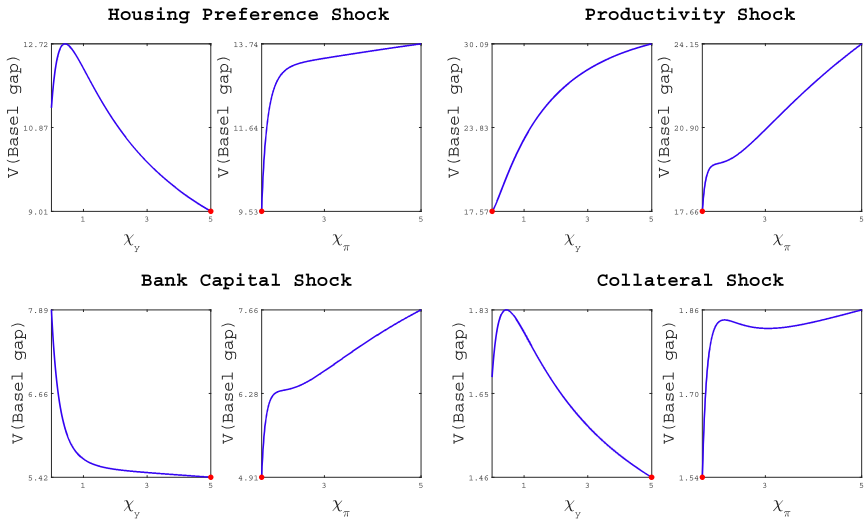
In contrast, the reaction to output changes is not very detrimental to the stabilization of credit. Complementarities are even found in the case of a bank capital shock, as well as following sectoral shocks, provided that the reaction parameter to output is higher than 0.5. Hence, contrary to the reaction to inflation, a strong reaction to output movements is beneficial for the stabilization of credit, except in the case of a productivity shock.

Figure H4 in Appendix 2.H transposes the four clear-cut conflicts identified in Figure 2.4 into policy trade-offs. These policy frontiers represent the trade-offs occurring between the two objectives of monetary policy and credit gap stabilization in the case of a productivity shock. We can also see how increasing the relative preference for the objective of inflation makes prices more stable at the expense of higher volatility of the credit gap in the case of housing preference and bank capital shocks.

2.6 Assessment and discussion

This section aims to provide an assessment of the results obtained so far and to reveal general trends governing the policy conflicts. First, Table 2.2 reports all the conflicts originating with macroprudential policy. We observe that the macroprudential instruments may be particularly detrimental to the stabilization of inflation and output in the case of technology and bank capital shocks. Both are supply-side and global shocks. It is as if the simultaneous and uncoordinated reaction of all the policy instruments

Figure 2.4: Financial side effects of monetary policy



Note: Each plot represents the evolution of the theoretical variance of the Basel gap as the reaction parameters χ_π or χ_y in the monetary policy rule evolve over $[1.70, 5.0]$ and $[0, 5.0]$, respectively, in increments of 0.01, while the policy parameters in the other policy rules remain constant ($\chi^H_{ltv} = \chi^E_{ltv} = -1.0, \chi_{ccyb} = 5.0$).

to such global shocks triggers cacophony. From the perspective of the instruments, we observe that the CCyB generates real side effects in most cases, particularly if it reacts strongly to its target.[19] In contrast, LTV caps cause few conflicts. They are even complementary to monetary policy in cases of sectoral shocks, such as housing and collateral shocks.

Table 2.2: Summary of the conflicts stemming from macroprudential policies

Shock:	Housing preference		Productivity		Bank capital		Collateral	
	$V(Y)$	$V(\pi)$	$V(Y)$	$V(\pi)$	$V(Y)$	$V(\pi)$	$V(Y)$	$V(\pi)$
χ_{ccyb}	●	●	◑	●	◑	●	●	●
χ^H_{ltv}			◑		◐	●		
χ^E_{ltv}			◑	◑	◑		●	

Note: ● indicates conflicts, i.e., an increase in the variance of inflation or output as the concerned macroprudential policy parameter increases. ◑ means that a conflict exists only above a given value of the concerned policy parameter. ◐ indicates negative side effects only below a certain threshold of the concerned policy parameter. No symbol means no conflit.

Second, Table 2.3 reports the conflicts originating with the monetary policy rule. We can see that the reaction to inflation is always detrimental to the credit cycle. In contrast, the response to the output gap can induce complementarity: the stronger the response, the greater is the stabilization of the credit-to-GDP gap[20], except in the case of a productivity shock (which is at the origin of the usual trade-off between inflation and output). However, as monetary policy is primarily driven by the objective of inflation, a trade-off between monetary and macroprudential policies is likely to occur most of the time.

[19]Note that the adverse real effects of the CCyB in the case of productivity and bank capital shocks are in line with the findings of Silvo (2019) and Angelini et al. (2014).

[20]This result can be related to that of Gelain and Ilbas (2017), who conclude that monetary policy should place a high weight on the output gap to achieve the best possible outcome in the absence of policy coordination.

Table 2.3: Summary of the conflicts stemming from monetary policy

Shock:	Housing preference		Productivity		Bank capital		Collateral	
	$V(B.gap)$	Prob.	$V(B.gap)$	Prob.	$V(B.gap)$	Prob.	$V(B.gap)$	Prob.
χ_y	◐	◐	●	●			◐	◐
χ_π	●	●	●	●	●	●	●	●

Note: "B.gap" means "Basel gap". ● indicates conflicts, i.e., an increase in the variance of the Basel gap as the concerned monetary policy parameter increases. ◐ indicates negative side effects only below a certain threshold for the concerned policy parameter. No symbol means no conflit.

Hence, our comprehensive assessment reveals that monetary policy and state-contingent capital asset requirement policies are responsible for conflicts in many circumstances. To understand why, it is worth noting that these two instruments share the same main transmission channel. Indeed, by influencing the wholesale (or intra-group) deposit rate, the policy rate impacts banks' balance sheets, which in turn implies variations in retail interest rates. In the same way, CCyB activation demands adjustment of banks' balance sheets through the adjustment of the interest margin. Then, by influencing retail rates, these two policies "get in all the cracks" of the economy.[21] As a consequence, they are more likely to generate side effects. However, as shown in the last column of Table 2.1, their respective targets – inflation for monetary policy and the credit gap for the CCyB – always move in the opposite directions from each other (except in the case of collateral shocks). Thus, most of the time, the side effects turn out to be conflicts. Finally, as output and credit gaps tend to move in the same direction, monetary policy would provoke fewer conflicts if a greater weight is assigned to the output stabilization target.

In contrast, mortgage and corporate LTV caps can be viewed as targeted measures. They can be set independently to regulate either household or corporate financing. Moreover, they affect credit volumes (and not interest rates directly). Thus, these sectoral policies are less likely to generate conflicts. This clearly appears in Table 2.2, where we can see that the LTV rules do not generate adverse real effects when the shocks are specific to the housing market (i.e., housing preference and collateral shocks), with the only exception being the corporate LTV in the case of a collateral shock. Therefore, from this perspective, it seems that taming lending practices provokes fewer conflicts than managing capital buffers.

2.7 Extension to extreme vulnerabilities

Extreme real and financial vulnerabilities, instead of or in addition to the stabilization of macroeconomic and credit cycles, may be a concern for policymakers. Theoretically, this is the case for a robust policymaker who aims to protect the economy against worst-case scenarios (see, e.g., Ajello et al., 2019). Therefore, we now consider crisis probability and Growth-at-Risk as two alternative objectives.

2.7.1 Another financial objective: Crisis probability

So far, we have considered the most commonly accepted financial objective for macroprudential policy: smoothing the credit cycle. However, dealing with financial vulnerability may refer to different objectives

[21] This is the way that J. Stein, the former Fed governor, describes the widespread transmission of monetary policy rate changes, which "may reach into the corners" of the economy and the financial markets through the impact on all market rates (Stein, 2013).

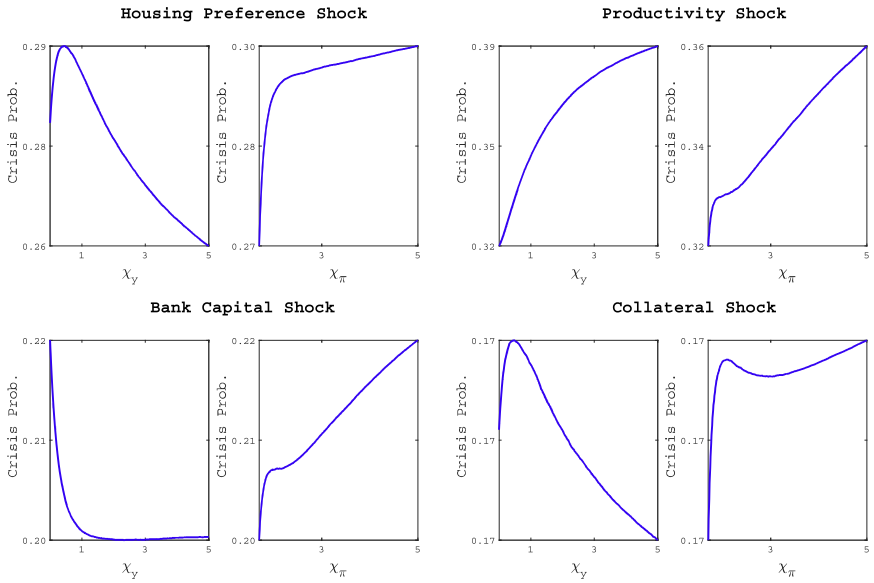
in practice.[22] One way of ensuring resilience may consist of reducing the risk of a crisis occurring. This is the macroprudential objective that we consider now. In line with Aikman et al. (2019) and Benigno et al. (2020), we assume that the probability of a financial crisis $\mathcal{P}_t^c$ follows a logistic function and increases as the credit gap rises and/or as banking capital decreases, with the respective elasticities denoted h_1 and h_2, such that

$$\mathcal{P}_t^c = \frac{\exp\left(\mathcal{C} + h_1\left(\frac{\widetilde{B_t}}{Y_t}\right) + h_2\left(\frac{K_t^b}{B_t} - lev\right)\right)}{1 + \exp\left(\mathcal{C} + h_1\left(\frac{\widetilde{B_t}}{Y_t}\right) + h_2\left(\frac{K_t^b}{B_t} - lev\right)\right)} \tag{2.20}$$

The constant $\mathcal{C}$ is calibrated such that the probability of a crisis in the steady state is 10,71%.[23] This probability can also be viewed as a simple indicator of financial vulnerabilities combining the credit gap and banks' leverage.

Then, we compute distributions of crisis probability, based on 1000 simulations of 200 periods, conditional on the ranges of values for the two policy parameters of the monetary policy rule and on the four key shocks considered so far. Instead of dealing with second moments, we now focus on the 95th percentile of crisis probability as a measure of extreme risk of a banking crisis. Figure 2.5 indicates that the results are exactly the same as those found with the variance of the Basel gap as an objective: while the reaction to the output gap may decrease extreme probabilities of crisis, a stronger reaction to inflation always worsens the worst-case scenario. This means that our previous results still hold while considering a mix of the Basel gap and banks' leverage, in a non-linear way, as a policy objective.

Figure 2.5: Probability of a crisis conditional on the monetary policy rule



Note: Each plot represents the evolution of the $95th$ percentile of the probability of a crisis as the reaction parameters of the interest policy rule, χ_π and χ_y, evolve over $[1.70, 5.0]$ and $[0, 5.0]$, respectively, in increments of 0.01. The policy parameters in the macroprudential policy rules remain constant ($\chi_{ltv}^H = \chi_{ltv}^E = -1.0, \chi_{ccyb} = 5.0$). Initial conditions are neutralized by excluding the first 100 periods.

[22] For instance, Kashyap and Siegert (2020) highlight that "absent any agreed upon summary indicators, different policymakers are free to cherry-pick their own preferred indicators of vulnerabilities".

[23] Note that the level of crisis probability *per se* is less important than the way it reacts to the parameters of the monetary policy rule.

2.7.2 Another real objective: Growth-at-Risk

Reducing extreme real risk may be an objective for central banks. It can, at least, hardly be neglected. For example, central banks dramatically cut their key rates and prompted packages of unconventional measures in response to the global financial crisis and the COVID-19 crisis, with the same objective of limiting economic depression and deflation, i.e., to mitigate the severely adverse scenario. This leads to a focus on Growth-at-Risk (GaR) as an alternative real objective of monetary policy. GaR is the probability of GDP growth (ΔY_t) falling below a given threshold α, such that

$$\text{Probability}\left(\Delta Y_t \leqslant \text{GaR}_t\right) = \alpha \tag{2.21}$$

with α often being equal to 5%. In other words, GaR measures the magnitude of a decline in GDP that occurs with a probability of 5%. Adrian et al. (2019) show that this downside risk increases as financial conditions – precisely those that rely on macroprudential policies – worsen. Hence, it is worth assessing how macroprudential measures interact with this possible objective of monetary policy. To this end, we examine whether the 5th percentile of simulated distributions of annualized GDP growth exhibits rightward (meaning complementarity) or leftward (meaning conflict) shifts as the reaction parameter of any macroprudential rule increases, *ceteris paribus*.[24]

We first evaluate the spillovers of the CCyB on GaR, conditional on the four shocks considered so far. The results, represented in Figure 2.6, are essentially the same as those found when we consider the second moments of output. The worst-case GDP outcome worsens (i.e., GaR decreases) as the response to the Basel gap increases within the CCyB rule in all cases except one (bank capital shock). When the economy is faced with a bank capital shock, the CCyB makes the 5th percentile of GDP growth move rightward, provided that χ_{ccyb} is not too high. Hence, apart from this case, the CCyB conflicts with monetary policy regarding the objective of controlling extreme real risk.

Next, we investigate the possible side effects of mortgage and corporate LTV. We focus on the cases for which we had previously found clear-cut adverse side effects. The results are represented in Figure 2.7. Interestingly, we no longer find negative side effects for either the mortgage LTV in the case of a bank capital shock or the corporate LTV in the case of a collateral shock.[25] This suggests that countercyclical LTV policies are likely to break the positive correlation between volatility and downside risk, which can be deduced from the literature on GaR. This means that these measures benefit the right tail of the distribution of GDP growth by opportunely making the upper quantiles less rigid over time. Therefore, these results confirm that LTV caps are unlikely to generate conflicts with the objectives of monetary policy.

2.8 Concluding remarks

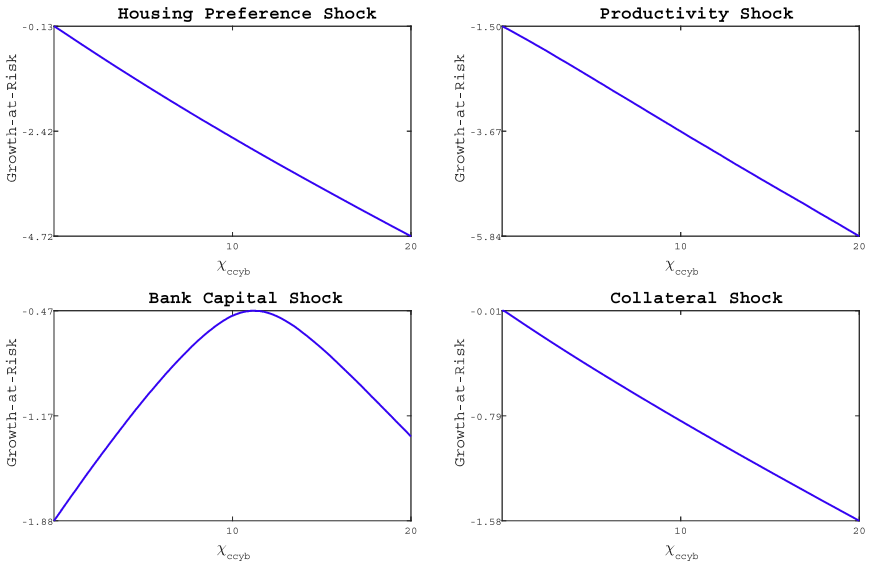
Macroprudential policy has recently become a full-fledged instrument of economic policy, as demonstrated by the prompt relaxation of capital requirements in many countries in response to the COVID-19 crisis. However, the widespread use of macroprudential tools raises the question of their interaction with monetary policy.

This paper offers an original approach to assessing the precise conditions under which macropru-

[24] As usual in the literature, our model is solved up to first-order only, so that financial vulnerabilities do not play a role in equilibrium. There is no crisis *per se* in our inherently linear model. However, strongly negative outcomes for GDP growth, which are partly governed by financial conditions, are still possible.

[25] From this point of view, we confirm the results found by Jensen et al. (2018).

Figure 2.6: Growth-at-Risk conditional on the CCyB



Note: Each plot represents the evolution of the 5th percentile of simulated distributions of annualized GDP growth as the reaction parameter in the CCyB rule, χ_{ccyb}, evolves over $[0, 20]$ in increments of 0.01. The policy parameters in the other policy rules remain constant ($\chi^H_{ltv} = \chi^E_{ltv} = -1.0$, $\chi_\pi = 1.98$, $\chi_Y = 0.34$). The distribution of GDP growth is based on 1000 simulations of 200 periods for each shock scenario. Initial conditions are neutralized by excluding the first 100 periods.

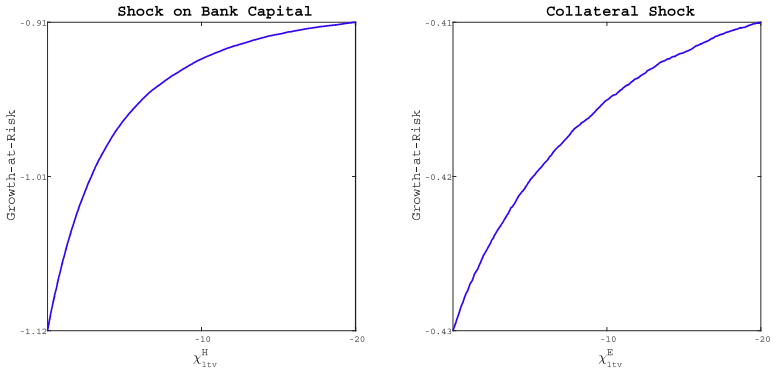
dential and monetary policies may be conflicting. These conditions are evaluated based on different types of shocks and different policy instruments, including countercyclical capital buffers (CCyBs) and loan-to-value (LTV) limits. Conflicts are identified when monetary policy has adverse side effects for macroprudential objectives and *vice versa*. Policy objectives refer not only to the usual volatilities of key variables but also to the probability of a financial crisis and Growth-at-Risk.

We find that conflicts are fairly frequent, especially in the case of technological and bank capital shocks, due to their widespread impact on the economy. Among the policy instruments, the CCyB and monetary policy are found to generate conflicts in many cases. They both "get in all the cracks" by widely impacting the economy through the adjustment of retail rates, albeit with targets often moving in opposite directions. Hence they work at cross-purposes. Nonetheless, a stronger reaction of monetary policy to the output gap should reduce the adverse side effects of monetary policy. In contrast, LTV caps, as more targeted instruments, cause few conflicts. Even when they are found to increase real-side volatility, they eventually reduce downside risks to GDP.

These results suggest that LTV limits can be easily implemented without worrying about potential spillovers. In contrast, the implementation of CCyBs and of monetary policy requires a smooth coordination.

Our results open the way for more formal analysis on the coordination of these policies and on the suitable institutional arrangements for the design of monetary and prudential regulation. Further research could focus on extending the analytical framework by inserting an endogenous risk-taking channel as an additional source of financial-side vulnerability caused by monetary policy. A second extension could embed explicit financial crises with feedback to real-side effects to further assess the real-side impact of

Figure 2.7: Growth-at-Risk conditional on LTV limits for households and firms



Note: The plot on the left represents the evolution of the 5th percentile of simulated distributions of annualized GDP growth as the reaction parameter χ^{H}_{ltv} in the corporate LTV rule evolves over $[-20, 0]$ in increments of 0.01 in the case of a bank capital shock. The policy parameters in the other policy rules remain constant ($\chi^{E}_{ltv} = -1.0$, $\chi_{ccyb} = 5.0$, $\chi_{\pi} = 1.98$, $\chi_{Y} = 0.34$). The plot on the right represents the evolution of the $5th$ percentile of simulated distributions of annualized GDP growth as the reaction parameter χ^{E}_{ltv} in the mortgage LTV rule evolves over $[-20, 0]$ in increments of 0.01, *ceteris paribus*. In both cases, the distributions of GDP growth are based on 1000 simulations of 200 periods. The initial conditions are neutralized by excluding the first 100 periods.

macroprudential tools.

Appendix

2.A The rest of the model

Employment agencies

Workers provide differentiated labour types sold by unions to perfectly competitive employment agencies, which assemble them in a CES aggregator with stochastic parameter ε_t^l and sell homogeneous labour to entrepreneurs. For each labour type m, there are two unions, one for patient households and one for impatient households. Each union sets nominal wages $W_t^i(m)$ for its members, with $i \in \{P, I\}$, by maximizing their utility subject to downward-sloping demand and to quadratic adjustment costs (parameterized by κ_w), with indexation ι_w to lagged inflation and $(1 - \iota_w)$ to steady-state inflation (denoted π). Unions charge their members lump-sum fees to cover adjustment costs with equal split. Hence, they seek to maximize the following expression:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_i^t \left\{ U_{c_t^i}(j,m) \left[\frac{W_t^i(m)}{P_t} l_t^i(j,m) - \frac{\kappa_w}{2} \left(\frac{W_t^i(m)}{W_{t-1}^i(m)} - \pi_{t-1}^{\iota_w} \pi^{1-\iota_w} \right)^2 \frac{W_t^i}{P_t} \right] - \frac{l_t^i(j,m)^{1+\phi}}{1+\phi} \right\}, \quad (2.22)$$

subject to demand from employment agencies

$$l_t^i(i,m) = l_t^i(m) = \left(\frac{W_t^i(m)}{W_t^i} \right)^{-\varepsilon^l} l_t^i, \quad (2.23)$$

with ε^l being the elasticity of labour demand.

Capital and final goods producers

Capital-producing firms act in a perfectly competitive market. They are owned by the entrepreneurs. They purchase last period's undepreciated capital $(1 - \delta)k_{t-1}$ from the entrepreneurs at a price Q_t^k and i_t units of final goods from retail firms at a price P_t. They combine them to produce new capital. The transformation of the final goods into capital is subject to quadratic adjustment costs. The new capital is then sold back to the entrepreneurs at the same price Q_t^k. Hence, capital producers maximize their expected discounted profits:

$$\max_{\{k_t(j), i_t(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^e \left(q_t^k [k_t(j) - (1-\delta)k_{t-1}(j)] - i_t(j) \right) \quad (2.24)$$

subject to

$$k_t(j) = (1-\delta)k_{t-1}(j) + \left[1 - \frac{\kappa_i}{2}\left(\frac{i_t(j)}{i_{t-1}(j)} - 1\right)^2\right] i_t(j) \tag{2.25}$$

where κ_i denotes the cost of adjusting investment, ε_{qk} is an investment shock, $q_t^k = Q_t^k/P_t$ is the real price of capital, and $\Lambda_{0,t}^e$ is the entrepreneurs' discount factor.

Final good producers are owned by patient households. They act in monopolistic competition, and their prices are sticky because of the existence of quadratic adjustment costs when prices are revised. They purchase the intermediate (wholesale) good from entrepreneurs in a competitive market and then slightly differentiate it at no additional cost. Each firm j chooses its price to maximize the expected discounted value of profits:

$$\max_{\{P_t(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[\left(P_t(j) - P_t^W\right) y_t(j) - \frac{\kappa_P}{2}\left(\frac{P_t(j)}{P_{t-1}(j)} - \pi_{t-1}^{\iota_p}\pi^{1-\iota_p}\right)^2 P_t y_t\right] \tag{2.26}$$

subject to the demand derived from consumers' maximization

$$y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon^y} y_t \tag{2.27}$$

where κ_p denotes the cost of adjusting prices, $\iota_p \in [0,1]$ is the degree of indexation to past inflation, ε^y is the demand price elasticity, P_t^W is the wholesale price and $\Lambda_{0,t}^P$ is the patient households' discount factor.

Market clearing and stochastic processes

The market clearing conditions for the final goods market are given by $y_t = c_t + q_t^k\left[k_t - (1-\delta)k_{t-1}\right]$, with $c_t = c_t^P + c_t^I + c_t^E$. Equilibrium in the housing market is given by $\bar{h} = h_t^P(i) + h_t^I(i)$, where $\bar{h}$ is the exogenous fixed housing supply. With the exception of monetary policy shocks, the exogenous variables follow an $AR(1)$ process such that $log(\varepsilon_t^x) = (1-\rho_x)log(\varepsilon^x) + \rho^x log(\varepsilon_{t-1}^x) + \xi_t^x$, with $x = \{h, a, Kb, m\}$, where $\xi_t^x \sim i.i.d.\ \mathcal{N}(0, \sigma_x^2)$.

2.B Equilibrium conditions

This part of the appendix reports the first-order conditions for the agents (optimizing problems and the other relationships that define the equilibrium of the model). The variables λ^x_{t+j}, $\forall x = \{I, P, E\}$ and $j = \{0, 1\}$, s^I_t and s^E_t are Lagrange multipliers. $\mathcal{P}^R_t$ and $\mathcal{P}^b_t$ represent the profits of final good producers and banks in t, respectively. Note that $L^i(x_t) = x_{t-i}$ and $F^i(x_t) = \mathrm{E}_t(x_{t+i})$, $\forall x_t$. Finally, a variable without a time subscript designates steady-state value.

2.B.1 Patient households

$$c^P_t + q^h_t\left(h^P_t - h^P_{t-1}\right) + d^P_t = w^P_t l^P_t + \left(1 + r^d_{t-1}\right) d^P_{t-1}/\pi_t + t^P_t \tag{B1}$$

$$\frac{1 - a^p}{c^p_t - a^p c^p_{t-1}} = \lambda^p_t \tag{B2}$$

$$\lambda^P_t q^h_t = \frac{\varepsilon^h_t}{h^P_t} + \beta_P \mathrm{E}_t\left(\lambda^P_{t+1} q^h_{t+1}\right) \tag{B3}$$

$$\lambda^P_t = \beta_P \mathrm{E}_t\left[\lambda^P_{t+1}\frac{\left(1 + r^d_t\right)}{\pi_{t+1}}\right] \tag{B4}$$

2.B.2 Impatient Households

$$c^I_t + q^h_t\left(h^I_t - h^I_{t-1}\right) + \left(1 + r^{bH}_{t-1}\right) b^I_{t-1}/\pi_t = w^I_t l^I_t + b^H_t + t^I_t \tag{B5}$$

$$\left(1 + r^{bH}_t\right) b^H_t \leq LTV^H_t E_t\left[q^h_{t+1} h^I_t \pi_{t+1}\right] \varepsilon^m_t \tag{B6}$$

$$\frac{1 - a^I}{c^I_t - a^I c^I_{t-1}} = \lambda^I_t \tag{B7}$$

$$\lambda^I_t q^h_t = \frac{\varepsilon^h_t}{h^I_t} + \beta_I \mathrm{E}_t\left[\lambda^I_{t+1} q^h_{t+1}\right] + \beta_I \mathrm{E}_t\left[s^I_t LTV^H_t q^h_{t+1}\pi_{t+1}\right]\varepsilon^m_t \tag{B8}$$

$$\lambda^I_t = \beta_I \mathrm{E}_t\left[\lambda^I_{t+1}\frac{\left(1 + R^{bh}_t\right)}{\pi_{t+1}}\right] + s^I_t\left(1 + r^{bh}_t\right) \tag{B9}$$

2.B.3 Entrepreneurs

$$c^E_t + w^P_t l^{E,P}_t + w^I_t l^{E,I}_t + \left(1 + r^{bE}_{t-1}\right) b^E_{t-1}/\pi_t + q^k_t k^E_t = \frac{y^E_t}{x_t} + b^E_t + q^k_t(1-\delta)k^E_{t-1} \tag{B10}$$

$$\left(1 + r^{bE}_t\right) b^E_t \leq LTV^E_t E_t\left[q^k_{t+1} k^E_t \pi_{t+1}(1-\delta)\right] \tag{B11}$$

$$\frac{1-a^E}{c_t^E - a^E c_{t-1}^E} = \lambda_t^E \tag{B12}$$

$$\lambda_t^E = \beta_E \mathrm{E}_t \left[\lambda_{t+1}^E \frac{\left(1 + r_t^{bE}\right)}{\pi_{t+1}} \right] + s_t^I \left(1 + r_t^{bE}\right) \tag{B13}$$

$$\begin{aligned} \lambda_t^E q_t^k =& \beta_E \mathrm{E}_t \lambda_{t+1}^E \left[r_{t+1}^k + q_{t+1}^k (1-\delta) \right] \\ &+ \mathrm{E}_t \left[s_t^E LTV_t^E q_{t+1}^k \pi_{t+1} (1-\delta) \right] \end{aligned} \tag{B14}$$

$$y_t^E = \varepsilon_t^a \left[k_{t-1}^E \right]^\alpha \left[\left(l_t^{E,P} \right)^\mu \left(l_t^{E,I} \right)^{1-\mu} \right]^{1-\alpha} \tag{B15}$$

$$w_t^P = \mu(1-\alpha) \frac{y_t^E}{l_t^{E,P}} \frac{1}{x_t} \tag{B16}$$

$$w_t^I = (1-\mu)(1-\alpha) \frac{y_t^E}{l_t^{E,I}} \frac{1}{x_t} \tag{B17}$$

$$r_t^k = \alpha \frac{y_t^E}{k_{t-1}^E} \frac{1}{x_t} \tag{B18}$$

2.B.4 Capital Goods Producers

$$k_t = (1-\delta) k_{t-1} + \left[1 - \frac{k_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t \tag{B19}$$

$$\begin{aligned} 1 =& q_t^k \left[1 - \frac{k_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 - k_i \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} \right] \\ &+ \beta_E E_t \left[\frac{\lambda_{t+1}^E}{\lambda_t^E} q_{t+1}^k \varepsilon_{t+1}^{qk} k_i \left(\frac{i_{t+1} \varepsilon_{t+1}^{qk}}{i_t} - 1 \right) \varepsilon_{t+1}^{qk} \left(\frac{i_{t+1}}{i_t} \right)^2 \right] \end{aligned} \tag{B20}$$

2.B.5 Final Goods Producers

$$\mathcal{P}_t^R = y_t \left(1 - \frac{1}{x_t} \right) - \frac{k_P}{2} \left(\pi_t - \pi_{t-1}^{l_P} \bar{\pi}^{1-t_P} \right)^2 \tag{B21}$$

$$\begin{aligned} & 1 - \varepsilon^y + \frac{\varepsilon^y}{x_t} - k_P \left(\pi_t - \pi_{t-1}^{t_P} \bar{\pi}^{1-t_P} \right) \pi_t \\ & + \beta_P E_t \left[\frac{\lambda_{t+1}^P}{\lambda_t^P} k_P \left(\pi_{t+1} - \pi_t^{t_P} \bar{\pi}^{1-t_P} \right) \pi_{t+1} \frac{y_{t+1}}{y_t} \right] = 0 \end{aligned} \tag{B22}$$

2.B.6 Labour unions

Patient households

$$\begin{aligned} k_w\left(\pi_t^{wP}-\pi_{t-1}^{\iota_w}\bar{\pi}^{1-\iota_w}\right)\pi_t^{wP} =& \beta_P E_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}k_w\left(\pi_{t+1}^{wP}-\pi_t^{\iota_w}\bar{\pi}^{1-\iota_w}\right)\frac{\left(\pi_{t+1}^{wP}\right)^2}{\pi_{t+1}}\right] \\ &+\left(1-\varepsilon^l\right)l_t^P+\frac{\varepsilon^l\left(l_t^P\right)^{1+\phi}}{w_t^{wP}\lambda_t^P} \end{aligned} \tag{B23}$$

$$\pi_t^{wP}=\frac{w_t^{wP}}{w_{t-1}^{wP}}\pi_t \tag{B24}$$

Impatient households

$$\begin{aligned} k_w\left(\pi_t^{wI}-\pi_{t-1}^{\iota_w}\bar{\pi}^{1-\iota_w}\right)\pi_t^{wI} =& \beta_I E_t\left[\frac{\lambda_{t+1}^I}{\lambda_t^I}k_w\left(\pi_{t+1}^{wI}-\pi_t^{\iota_w}\bar{\pi}^{1-\iota_w}\right)\frac{\left(\pi_{t+1}^{wI}\right)^2}{\pi_{t+1}}\right] \\ &+\left(1-\varepsilon^l\right)l_t^I+\frac{\varepsilon^l\left(l_t^I\right)^{1+\phi}}{w_t^{wI}\lambda_t^I} \end{aligned} \tag{B25}$$

$$\pi_t^{wI}=\frac{w_t^{wI}}{w_{t-1}^{wI}}\pi_t \tag{B26}$$

2.B.7 Banks

Wholesale unit

$$\begin{aligned} R_t^{bH} =& R_t-\kappa_{car}\left(\frac{K_t^b}{\omega_t^E B_t^E+\omega_t^H B_t^H}-\upsilon_t\right)\left(\frac{K_t^b}{\omega_t^E B_t^E+\omega_t^H B_t^H}\right)^2\omega_t^H \\ &-\kappa_{lev}\left(\frac{K_t^b}{B_t^E+B_t^H}-lev\right)\left(\frac{K_t^b}{B_t^E+B_t^H}\right)^2 \end{aligned} \tag{B27}$$

$$\begin{aligned} R_t^{bE} =& R_t-\kappa_{car}\left(\frac{K_t^b}{\omega_t^E B_t^E+\omega_t^H B_t^H}-\upsilon_t\right)\left(\frac{K_t^b}{\omega_t^E B_t^E+\omega_t^H B_t^H}\right)^2\omega_t^E \\ &-\kappa_{lev}\left(\frac{K_t^b}{B_t^E+B_t^H}-lev\right)\left(\frac{K_t^b}{B_t^E+B_t^H}\right)^2 \end{aligned} \tag{B28}$$

$$K_t^b=\left(1-\delta^b\right)\frac{K_{t-1}^b}{\varepsilon_t^{Kb}}+\mathcal{P}_{t-1}^b \tag{B29}$$

$$B_t^H+B_t^E=D_t+K_t^b \tag{B30}$$

$$\omega_t^H=\left(1-\rho_H\right)\bar{w}^H+\left(1-\rho_H\right)\chi_H\left(Y_t-Y_{t-4}\right)+\rho_H\omega_{t-1}^H \tag{B31}$$

$$\omega_t^E=\left(1-\rho_E\right)\bar{w}^E+\left(1-\rho_E\right)\chi_E\left(Y_t-Y_{t-4}\right)+\rho_E\omega_{t-1}^E \tag{B32}$$

$$\mathcal{P}_t^b = r_t^{bH} b_t^H + r_t^{bE} b_t^E - r_t^d d_t - \mathcal{D}_t^{\upsilon}(K_t^b) - \mathcal{D}_t^{lev}(K_t^b) - \sum_{s=H,E} \mathcal{A}_{bs}(r_t^{bs}) - \mathcal{A}_d(r_t^d) \tag{B33}$$

$$\mathcal{D}_t^{\upsilon}(K_t^b) = \frac{\kappa_{car}}{2}\left(\frac{K_t^b}{\omega_t^E B_t^E + \omega_t^H B_t^H} - \upsilon_t\right)^2 K_t^b \tag{B34}$$

$$\mathcal{D}_t^{lev}(K_t^b) = \frac{\kappa_{lev}}{2}\left(\frac{K_t^b}{B_t^E + B_t^H} - lev\right)^2 K_t^b \tag{B35}$$

$$\mathcal{A}_{bs}(r_t^{bs}) \equiv \frac{\kappa_{bs}}{2}\left(\frac{r_t^{bs}}{r_{t-1}^{bs}} - 1\right)^2 r_t^{bs} b_t^s, \quad \text{with } s = \{H, E\} \tag{B36}$$

$$\mathcal{A}_d(r_t^d) \equiv \frac{\kappa_d}{2}\left(\frac{r_t^d}{r_{t-1}^d} - 1\right)^2 r_t^d d_t \tag{B37}$$

Retail units

$$\begin{aligned}\left(\frac{\varepsilon^d}{\varepsilon^d - 1}\right)\frac{R_t^d}{r_t^d} = &\left(\frac{\varepsilon^d}{\varepsilon^d - 1}\right) - 1 - \kappa_d\left(\frac{r_t^d}{r_{t-1}^d} - 1\right)\frac{r_t^d}{r_{t-1}^d} \\ &+ \beta_P E_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_d\left(\frac{r_{t+1}^d}{r_t^d} - 1\right)\left(\frac{r_{t+1}^d}{r_t^d}\right)^2 \frac{d_{t+1}^P}{d_t^P}\right]\end{aligned} \tag{B38}$$

$$\begin{aligned}\left(\frac{\varepsilon^{bs}}{\varepsilon^{bs} - 1}\right)\frac{R_t^{bs}}{r_t^{bs}} = &\left(\frac{\varepsilon^{bs}}{\varepsilon^{bs} - 1}\right) - 1 + \kappa_{bs}\left(\frac{r_t^{bs}}{r_{t-1}^{bs}} - 1\right)\frac{r_t^{bs}}{r_{t-1}^{bs}} \\ &- \beta_P E_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_{bs}\left(\frac{r_{t+1}^{bs}}{r_t^{bs}} - 1\right)\left(\frac{r_{t+1}^{bs}}{r_t^{bs}}\right)^2 \frac{b_{t+1}^s}{b_t^s}\right],\end{aligned} \tag{B39}$$

with $s = \{H, E\}$

2.B.8 Monetary policy and macroprudential policy

$$\frac{1 + r_t}{1 + r} = \left(\frac{1 + r_{t-1}}{1 + r}\right)^{\rho_r}\left(\frac{\pi_t}{\pi}\right)^{\chi_\pi(1-\rho_r)}\left(\widetilde{Y}_t\right)^{\chi_y(1-\rho_r)}\varepsilon_t^r \tag{B40}$$

$$\upsilon_t = (\upsilon_{t-1})^{\rho_\upsilon}\left[\upsilon\left(\frac{\widetilde{B_t}}{Y_t}\right)^{\chi_{ccyb}}\right]^{(1-\rho_\upsilon)} \tag{B41}$$

$$LTV_t^s = \left(LTV_{t-1}^s\right)^{\rho_{ltv}^s}\left(LTV^s\left(\frac{\widetilde{B_t^s}}{Y_t}\right)^{\chi_{ltv}^s}\right)^{\left(1-\rho_{ltv}^s\right)}, \text{ with } s \in \{H, E\} \tag{B42}$$

$$\widetilde{Y}_t + \lambda_{HP}(1 - L)^2(1 - F)^2\widetilde{Y}_t = \lambda_{HP}(1 - L)^2(1 - F)^2 Y_t \tag{B43}$$

$$\left(\frac{\widetilde{B_t}}{Y_t}\right) + \lambda_{HP}(1 - L)^2(1 - F)^2\left(\frac{\widetilde{B_t}}{Y_t}\right) = \lambda_{HP}(1 - L)^2(1 - F)^2\left(\frac{B_t}{Y_t}\right) \tag{B44}$$

$$\left(\frac{\widetilde{B_t^i}}{Y_t}\right) + \lambda_{HP}\left(1-L\right)^2\left(1-F\right)^2\left(\frac{\widetilde{B_t^i}}{Y_t}\right) = \lambda_{HP}\left(1-L\right)^2\left(1-F\right)^2\left(\frac{B_t^i}{Y_t}\right) \tag{B45}$$

2.B.9 Market clearing conditions

$$Y_t = c_t^P + c_t^I + c_t^E + k_t - (1-\delta)k_{t-1}, \quad y_t^E = y_t, \quad l_t^{E,P} = l_t^P, \quad l_t^{E,I} = l_t^I, \quad 1 = h_t^P + h_t^I, \quad b_t^E = B_t^E,$$
$$b_t^H = B_t^H, \quad B_t = B_t^E + B_t^H, \quad d_t^P = D_t, \quad k_t^E = K_t. \tag{B46}$$

2.B.10 Shocks

$$\begin{aligned} &log(\varepsilon_t^x) = (1-\rho_x)log(\varepsilon^x) + \rho^x log(\varepsilon_{t-1}^x) + \xi_t^x, \ \text{ with } \ x = \{h, a, Kb, m\} \\ &and\ \xi_t^x \sim i.i.d.\ \mathcal{N}(0, \sigma_x^2). \end{aligned} \tag{B47}$$

2.B.11 Crisis probability

$$\mathcal{P}_t^c = \frac{\exp\left(\mathcal{C} + h_1\left(\frac{\widetilde{B_t}}{Y_t}\right) + h_2\left(\frac{K_t^b}{B_t} - lev\right)\right)}{1 + \exp\left(\mathcal{C} + h_1\left(\frac{\widetilde{B_t}}{Y_t}\right) + h_2\left(\frac{K_t^b}{B_t} - lev\right)\right)} \times 100 \tag{B48}$$

2.C The leverage ratio and its link with the capital adequacy ratio

In line with Basel III, we assume that banks have to meet a regulatory leverage ratio. In practice, this measure is intended to restrict the buildup of leverage in the banking sector to avoid fast deleveraging processes that can damage the broader financial system and the real economy. In addition, it reinforces and backstops the risk-based capital requirements with a simple, non-risk-based measure.[26] In the model, any deviation from the regulatory level, denoted lev, implies a quadratic cost parameterized by κ_{lev}, proportional to outstanding bank capital, such that:

$$\mathcal{D}_t^{lev}(K_t^b(j)) \equiv \frac{\kappa_{lev}}{2}\left(\frac{K_t^b(j)}{B_t^E(j)+B_t^H(j)} - lev\right)^2 K_t^b(j) \tag{C1}$$

A 3% minimum leverage ratio, as required by the Basel III framework, is incompatible with the capital adequacy ratio in the steady state of our model due to the relative simplicity of the financial sector. For example, exposure related to interbank loans, government bonds, derivatives, securities financing transactions and off-balance sheet items are not considered here. Hence, we follow Fender and Lewrick (2015), who propose a convenient method to calibrate a leverage ratio in a manner consistent with the capital adequacy ratio. By expanding the definition of the leverage ratio, we obtain:

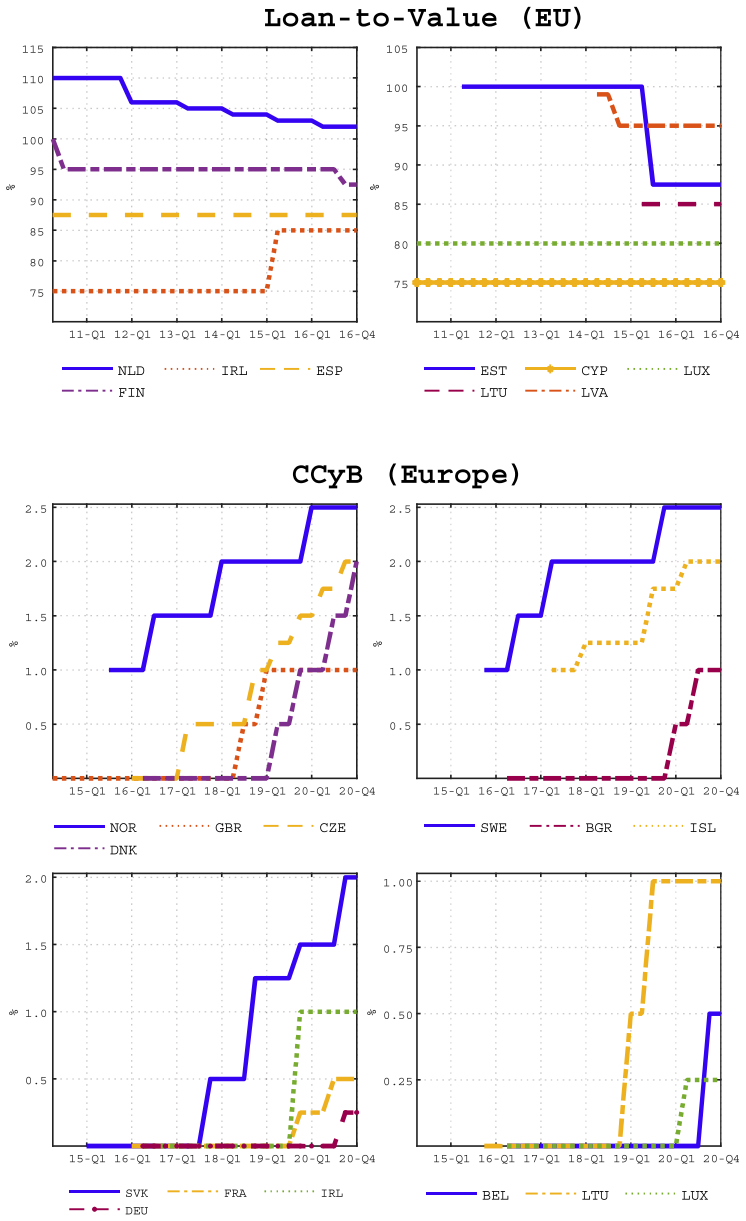
$$\begin{aligned} lev &= \frac{K_t^b(j)}{B_t^H(j)+B_t^E(j)} \\ &= \frac{K_t^b(j)}{\omega_t^H B_t^H(j)+\omega_t^E B_t^E(j)} \times \frac{\omega_t^H B_t^H(j)+\omega_t^E B_t^E(j)}{B_t^H(j)+B_t^E(j)} \\ &\equiv CAR \times DR \end{aligned} \tag{C2}$$

where DR is the so-called density ratio, defined as the ratio of risk-weighted assets to the leverage ratio exposure measure. Thus, we calibrate lev so that Eq. C2 is satisfied, ensuring a steady-state consistent calibration.

[26] See Basel Committee on Banking Supervision (2019) for an extended explanation of the definition, measurement and composition of the leverage ratio.

2.D Loan-to-value and countercyclical capital buffer in practice

Figure D1: Loan-to-value restriction and countercyclical capital buffer requirements in Europe



Note: The first two plots represent the regulated level of loan-to-value in EU countries where LTV restrictions have been implemented or announced. The four subsequent plots represent the level of CCyBs in European countries that have implemented or announced the implementation of this instrument.
The countries are Belgium (BEL), Bulgaria (BGR), Cyprus (CYP), Czech Republic (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), United Kingdom (GBR), Ireland (IRL), Iceland (ISL), Lithuania (LTU), Luxembourg (LUX), Latvia (LVA), Netherlands (NLD), Norway (NOR), Slovakia (SVK) and Sweden (SWE).
Values correspond to announcements as of 6 November 2019.
Source: Alam et al. (2019).

2.E Model-consistent output gap and credit-to-GDP gap

The aim of this appendix is to demonstrate how the output gap and the Basel gap can be derived from the model by applying a Hodrick-Prescott (HP) filter.

Let us start by considering any variable y_t, which is decomposed into a cyclical component (noted $\widetilde{y}_t$) and a growth component (noted x_t), such that

$$y_t = \widetilde{y}_t + x_t$$

To obtain this decomposition, it is necessary to apply the HP filter programme given by:

$$\min_{\{x_t\}_{t=1}^{T}} \mathcal{L}_t = \sum_{t=1}^{T} \left\{ (y_t - x_t)^2 + \lambda_{HP} \left[(x_{t+1} - x_t) - (x_t - x_{t-1}) \right]^2 \right\}, \tag{E1}$$

where λ_{HP} penalizes the acceleration of the growth component. The solution of this programme, given by the first-order condition, links the cyclical component to changes in the growth component in adjacent periods as follows:

$$\frac{\partial \mathcal{L}_t}{\partial x_t} = 0 \quad \Leftrightarrow \quad y_t \lambda_{HP} x_{t+2} - 4\lambda_{HP} x_{t+1} + (1 + 6\lambda_{HP}) x_t - 4\lambda_{HP} x_{t-1} + \lambda_{HP} x_{t-2} \tag{E2}$$

By denoting the lag operator as L, such that $L^i(y_t) = y_{t-i}$, and the forward operator as F, such that $F^i(y_t) = L^{-i}(y_t) = \mathrm{E}_t(y_{t+i})$, Eq. (E2) can be written as:

$$\begin{aligned} & y_t &=& \left[\lambda_{HP} F^2 - 4\lambda_{HP} F + (1 + 6\lambda_{HP}) - 4\lambda_{HP} L + \lambda_{HP} L^2 \right] x_t \\ \Leftrightarrow \quad & y_t &=& \left[1 + \lambda_{HP} (1 - L)^2 (1 - F)^2 \right] x_t \end{aligned}$$

By defining $A(L) \equiv 1 + \lambda_{HP} (1 - L)^2 (1 - F)^2$, one can define $y_t = A(L) x_t$, as well as $x_t = [A(L)]^{-1} y_t$. Moreover, given that the cyclical component is defined as $\widetilde{y}_t = y_t - x_t = y \left[1 - A(L)^{-1} \right]$, the final filtering equation follows:

$$\widetilde{y}_t = \left[\frac{\lambda_{HP} (1 - L)^2 (1 - F)^2}{1 + \lambda_{HP} (1 - L)^2 (1 - F)^2} \right] y_t$$

which may be written as follows for convenient state-space representation:

$$\widetilde{y}_t + \lambda_{HP} (1 - L)^2 (1 - F)^2 \widetilde{y}_t = \lambda_{HP} (1 - L)^2 (1 - F)^2 y_t \tag{E3}$$

Interestingly, not only is the resulting gap variable $\widetilde{y}_t$ model-consistent, but it also relies on a parsimonious expression (with only 2 leads and 2 lags), which implies a modest expansion of the model's state space.

This approach is used to define the DSGE-HP output gap, the total Basel gap and the HP-specific household and firm credit-to-GDP gaps, with $y_t = \left\{ Y_t, \left(\frac{B_t}{Y_t} \right), \left(\frac{B_t^i}{Y_t} \right) \right\}$ and $\widetilde{y}_t = \left\{ \widetilde{Y}_t, \left(\frac{\widetilde{B_t}}{Y_t} \right), \left(\frac{\widetilde{B_t^i}}{Y_t} \right) \right\}$, respectively, with $i \in \{I, E\}$. See Eq. (B43) to (B45) in Appendix 2.B for the full expressions.

2.F Calibration

Table F1: Calibration of the structural parameters and shocks

Parameter	Description	Value
β_P	Patient households' discount factor	0.9943
β_I	Impatient households' discount factor	0.975
β_E	Entrepreneurs' discount factor	0.975
ϕ	Inverse of the Frisch elasticity	0.5
ε^h	Steady state of housing in households' utility function	0.2
a^P, a^I, a^E	Degree of habit formation in consumption	0.856
α	Capital share in the production function	0.25
μ	Labour income share of patient households	0.8
ι_p	Indexation of prices to past inflation	0.16
ι_w	Indexation of nominal wages to past inflation	0.276
δ	Depreciation rate of physical capital	0.025
δ^b	Cost of managing the bank's capital position	0.084
κ_w	Cost of adjusting nominal wages	99.89
κ_i	Cost of adjusting investment	10.18
κ_P	Cost of adjusting good prices	28.65
κ_{car}	Cost of adjusting capital-asset ratio	50.0
κ_{lev}	Cost of adjusting leverage ratio	7.63
κ_{bE}	Cost of adjusting BLR to entrepreneurs	9.36
κ_{bH}	Cost of adjusting BLR to households	10.09
κ_d	Cost of adjusting deposit rate	3.50
$\varepsilon^l/(\varepsilon^l-1)$	Steady-state markup in the labour market	5.0
$\varepsilon^y/(\varepsilon^y-1)$	Steady-state markup in the goods market	6.0
$\varepsilon^{bE}/(\varepsilon^{bE}-1)$	Steady-state markup on BLR to entrepreneurs	1.154
$\varepsilon^{bH}/(\varepsilon^{bH}-1)$	Steady-state markup on BLR to households	1.154
$\varepsilon^d/(\varepsilon^d-1)$	Steady-state markdown on deposit rate	0.593
λ_{HP}	Smoothing parameter of HP filter	1600
ρ_h	Persistence of housing preference shock	0.92
σ_h	Standard deviation of housing preference shock	0.066
ρ_a	Persistence of technology shock	0.94
σ_a	Standard deviation of technology shock	0.006
ρ_{Kb}	Persistence of bank capital shock	0.81
σ_{Kb}	Standard deviation of bank capital shock	0.050
ρ_m	Persistence of collateral shock	0.93
σ_m	Standard deviation of collateral shock	0.002

Table F2: Baseline calibration of the policy framework

Parameter	Description	Value
ω^H	Steady-state risk weight on household credit	0.37
ρ_H	Persistence of the risk weight on household credit	0.94
χ_H	Sensitivity of ω^H to the business cycle	-15
ω^E	Steady-state risk weight on entrepreneur credit	1.0
ρ_E	Persistence of the risk weight on entrepreneur credit	0.92
χ_E	Sensitivity of ω^E to the business cycle	-10
υ	Steady state of capital adequacy ratio	0.08
lev	Steady state of leverage ratio	0.069
ρ_υ	Smoothing parameter in the capital adequacy ratio rule	0.99
χ_υ	Reaction parameter in capital adequacy ratio rule	$[0, 20]$
LTV^H	Steady-state LTV ratio for impatient households	0.7
ρ^H_{ltv}	Smoothing parameter in LTV rule for households	0.99
χ^H_{ltv}	Reaction parameter in LTV rule for households	$[-20, 0]$
LTV^E	Steady-state LTV ratio for entrepreneurs	0.8
ρ^E_{ltv}	Smoothing parameter in LTV rule for entrepreneurs	0.99
χ^E_{ltv}	Reaction parameter in LTV rule for entrepreneurs	$[-20, 0]$
ρ_r	Smoothing parameter in monetary policy rule	0.768
χ_π	Reaction parameter to inflation in monetary policy rule	$[1.7, 5]$
χ_y	Reaction parameter to output gap in monetary policy rule	$[0, 5]$

2.G Impulse response functions (w/ and w/o macroprudential rules)

Note: In the following plots, "H" and "E" refer to households and entrepreneurs, respectively. For instance, "H. Basel gap" and "E. Basel gap" refer to the mortgage and the corporate credit-to-GDP gaps, respectively.

Figure G1: Negative housing preference shock

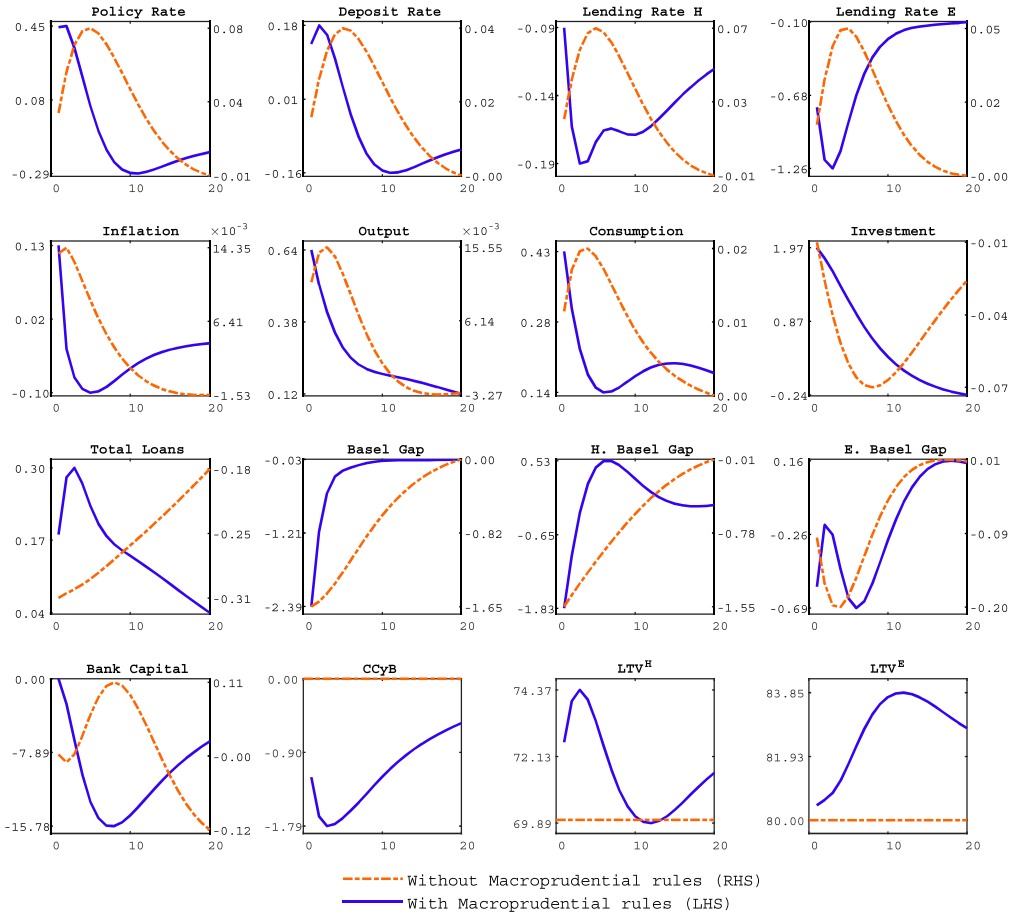


Figure G2: Positive productivity shock

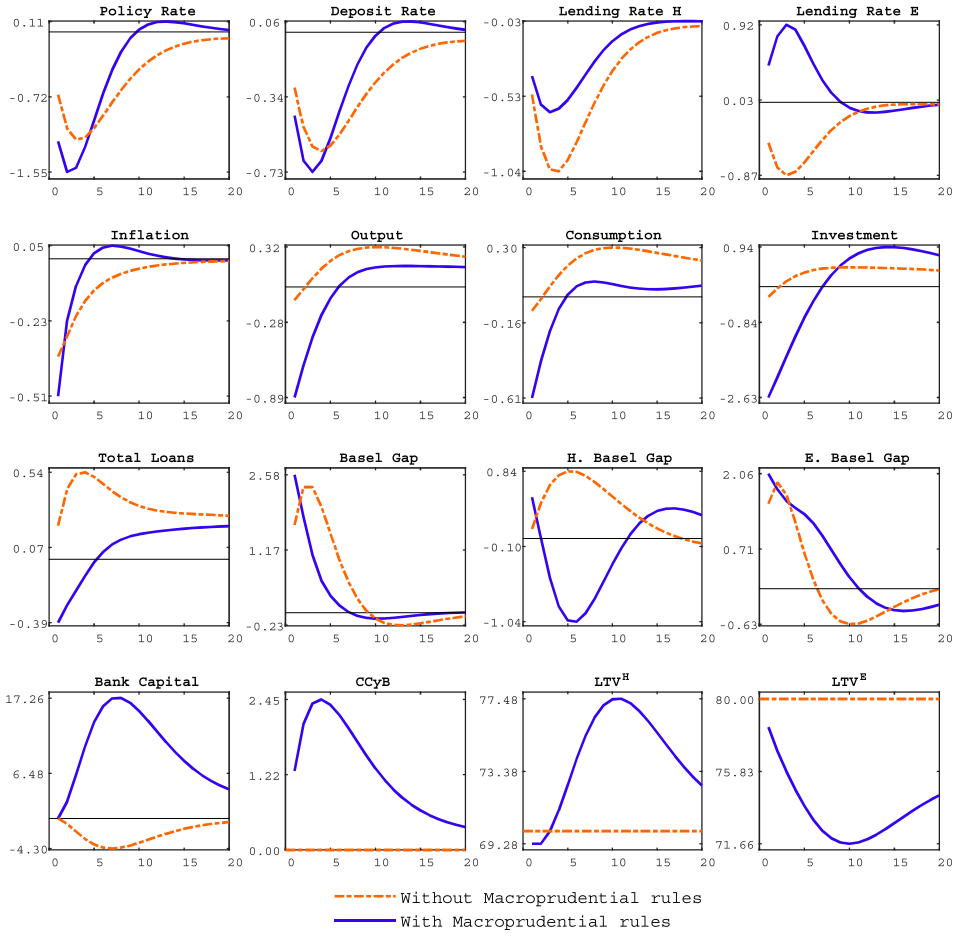


Figure G3: Negative bank capital shock

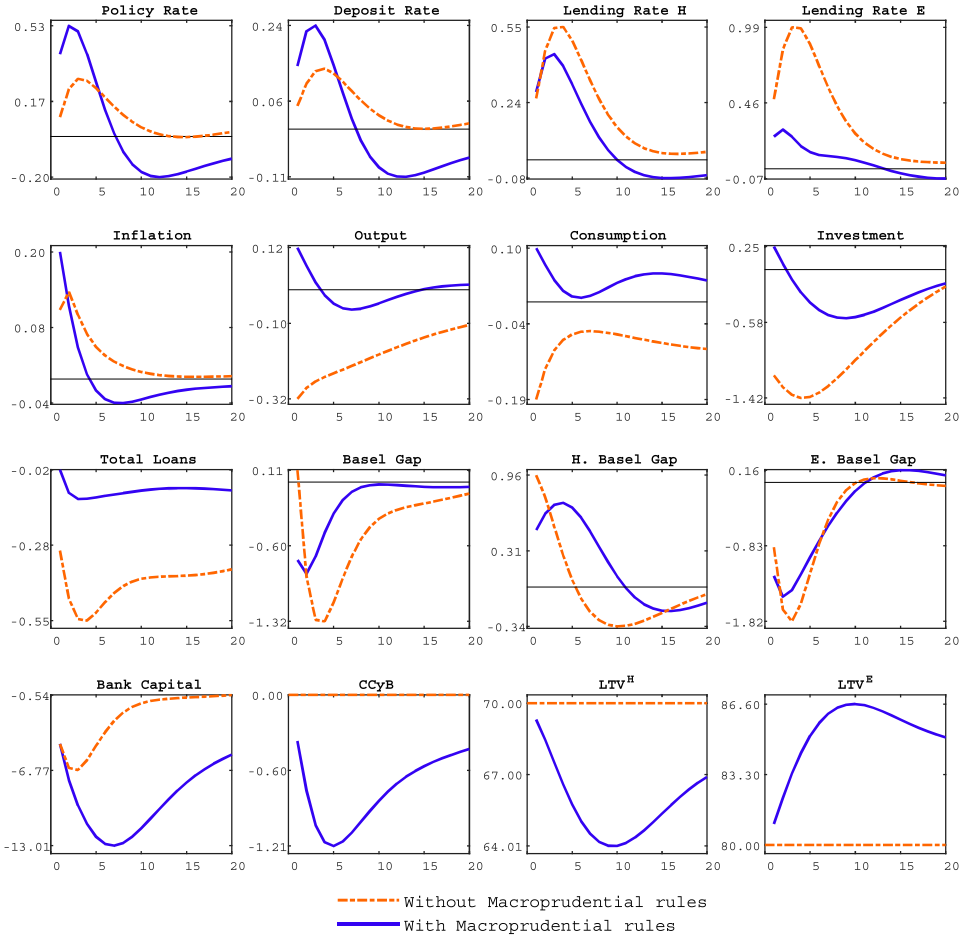
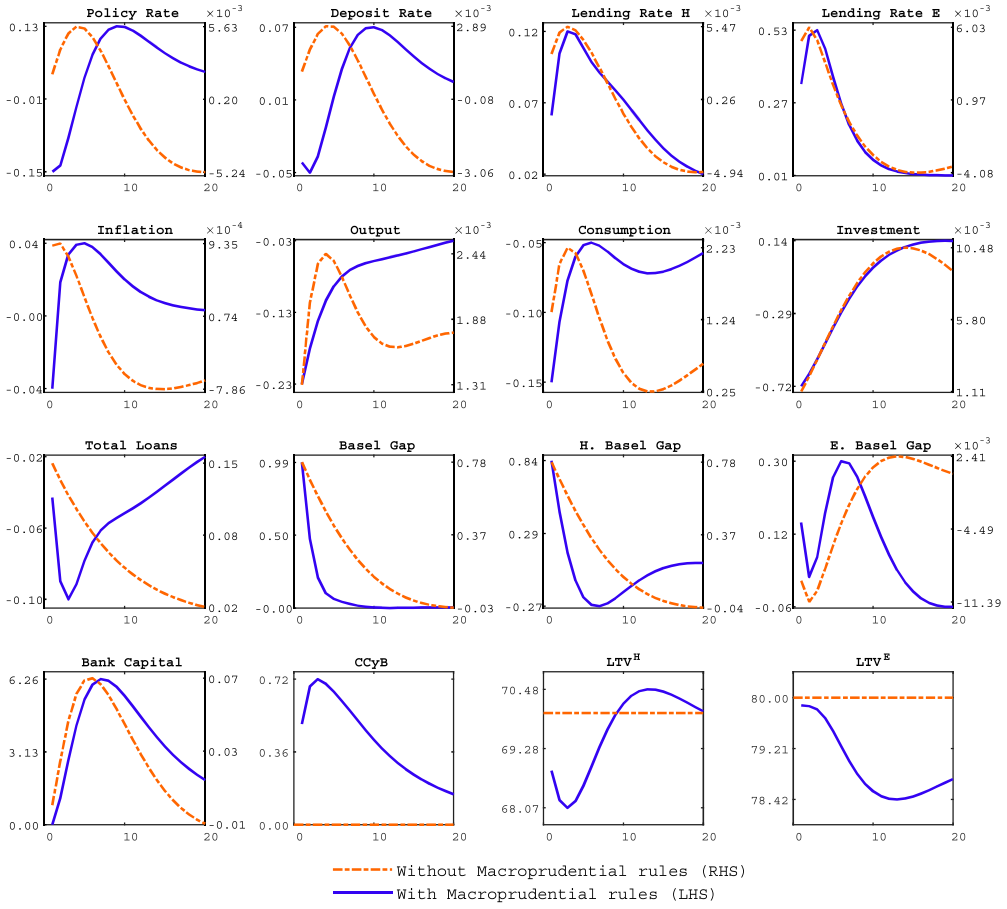
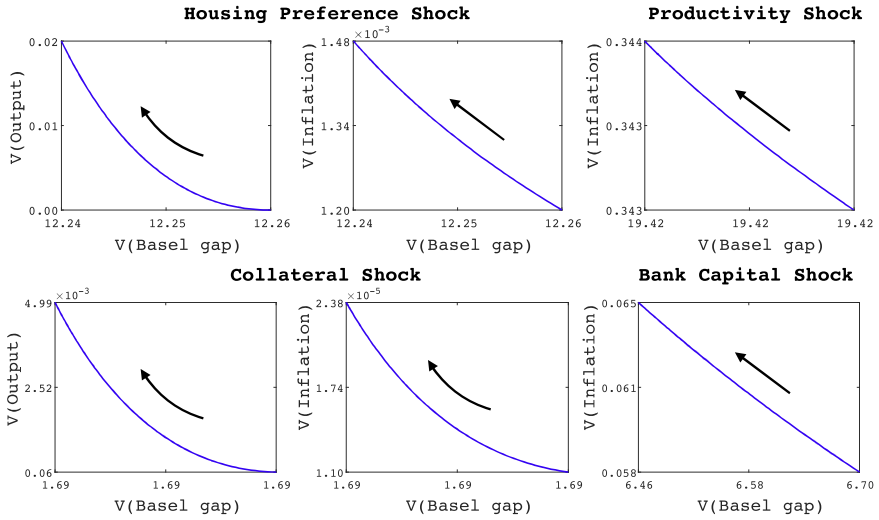


Figure G4: Positive collateral shock



2.H Policy frontiers

Figure H1: Real side effects of the CCyB: Illustration with policy frontiers



Note: Each plot represents the evolution of the variances of the Basel gap, output and inflation as the loss function of the policymaker, given by

$$\mathcal{L} = \lambda_{\pi}\sigma_{\pi}^2 + \lambda_{Y}\sigma_{Y}^2 + \lambda_{B.gap}\sigma_{B.gap}^2 + \lambda_{CAR}\sigma_{\Delta CAR}^2 + \lambda_{r}\sigma_{\Delta r}^2 + \lambda_{H}\sigma_{\Delta LTV^H}^2 + \lambda_{E}\sigma_{\Delta LTV^E}^2,$$

is minimized with respect to the optimized value of χ_{ccyb} in Eq. (2.17), the capital asset requirement (CAR) rule, subject to the structural model, and conditional on a given shock (housing preference, productivity, collateral or bank capital shock).

σ_x^2, for $x = \{\pi, Y, Bgap, \Delta CAR, \Delta r, \Delta LTV^H, \Delta LTV^E\}$ represents the theoretical variances of inflation, output, and the Basel gap, and the theoretical variances of the change in instruments, namely, state-contingent capital asset requirements, the policy rate, and LTV caps for households and entrepreneurs, respectively.

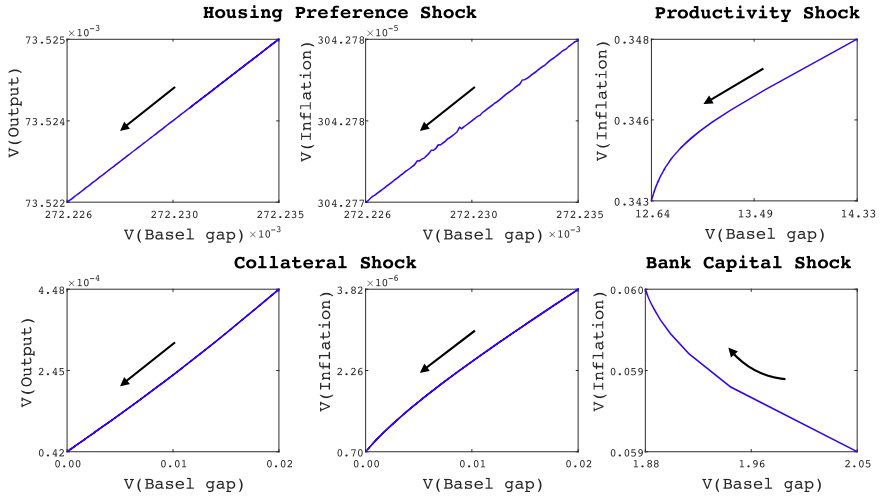
$\lambda_{\pi} = 1.$ and $\lambda_Y = 0.5$ are the relative weights assigned to the objectives of inflation and output stabilization. $\lambda_r = 0.1$ and $\lambda_{CAR} = \lambda_H = \lambda_E = 1.0$ are the weights assigned to the volatility of the policy instruments, i.e., the monetary policy rate, CAR, mortgage LTV and corporate LTV, respectively.

$\lambda_{B.gap}$ is the relative weight assigned to the stabilization of the Basel gap, lying between 0.01 and 1. The arrow in each plot designates the direction in which $\lambda_{B.gap}$ increases.

The corresponding optimal values of χ_{ccyb} are consistent with the range of variation considered in Figure 2.1, while the other parameters in all the policy rules, including the auto-regressive parameters, are set to their baseline values to neutralize the effects of the other policy instruments and to reduce the calculation time.

On the plots, we denote V(Inflation) $\equiv \sigma_{\pi}^2$, V(Output) $\equiv \sigma_Y^2$, and V(Basel gap) $\equiv \sigma_{B.gap}^2$.

Figure H2: Real side effects of LTV for households: Illustration with policy frontiers



Note: Each plot represents the evolution of the variances of the Basel gap, output and inflation as the loss function of the policymaker, given by

$$\mathcal{L} = \lambda_{\pi}\sigma_{\pi}^2 + \lambda_{Y}\sigma_{Y}^2 + \lambda_{B.gap}\sigma_{B.gap}^2 + \lambda_{CAR}\sigma_{\Delta CAR}^2 + \lambda_{r}\sigma_{\Delta r}^2 + \lambda_{H}\sigma_{\Delta LTV^H}^2 + \lambda_{E}\sigma_{\Delta LTV^E}^2,$$

is minimized with respect to the optimized value of χ_{LTV}^H in Eq. (2.18), the LTV rule for households, subject to the structural model, and conditional on a given shock (housing preference, productivity, collateral or bank capital shock).

σ_x^2, $\forall x = \{\pi, Y, Bgap, \Delta CAR, \Delta r, \Delta LTV^H, \Delta LTV^E\}$ represents the theoretical variances of inflation, output, and the Basel gap, and the theoretical variances of the change in instruments, namely, state-contingent capital asset requirements, the policy rate, and LTV caps for households and entrepreneurs, respectively.

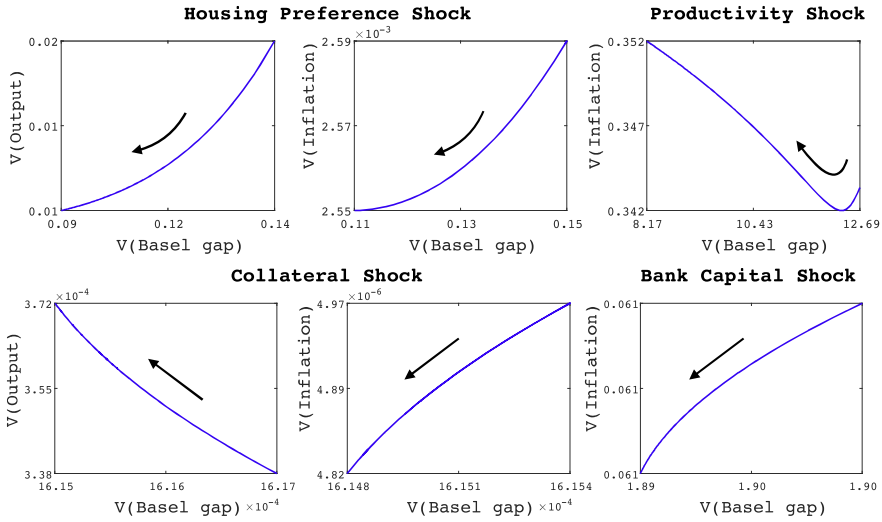
$\lambda_{\pi} = 1.0$ and $\lambda_{Y} = 0.05$ are the relative weights assigned to the objectives of inflation and output stabilization, respectively. $\lambda_{r} = 0.1$ and $\lambda_{CAR} = \lambda_{H} = \lambda_{E} = 1.0$ are the weights assigned to the volatility of the policy instruments, i.e., the monetary policy rate, CAR, mortgage LTV and corporate LTV, respectively. $\lambda_{B.gap}$ is the relative weight assigned to the stabilization of the Basel gap. It lies between 0.01 and 1. The arrow in each plot designates the direction in which $\lambda_{B.gap}$ increases.

The corresponding optimal values of χ_{LTV}^H are consistent with the range of variation considered in Figure 2.2, while the other parameters in all the policy rules, including the autoregressive parameters, are set to their baseline values to neutralize the effects of the other policy instruments and to reduce the calculation time.

On the plots, we denote V(Inflation) $\equiv \sigma_{\pi}^2$, V(Output) $\equiv \sigma_{Y}^2$, and V(Basel gap) $\equiv \sigma_{B.gap}^2$.

Note that the last plot in the second row represents the only clear-cut trade-off occurring while the LTV for households is implemented.

Figure H3: Real side effects of LTV for firms: Illustration with policy frontiers



Note: Each plot represents the evolution of the variances of the Basel gap, output and inflation as the loss function of the policymaker, given by

$$\mathcal{L} = \lambda_{\pi}\sigma_{\pi}^2 + \lambda_{Y}\sigma_{Y}^2 + \lambda_{B.gap}\sigma_{B.gap}^2 + \lambda_{CAR}\sigma_{\Delta CAR}^2 + \lambda_{r}\sigma_{\Delta r}^2 + \lambda_{H}\sigma_{\Delta LTV^H}^2 + \lambda_{E}\sigma_{\Delta LTV^E}^2,$$

is minimized with respect to the optimized value of χ_{LTV}^{E} in Eq. (2.18), the LTV rule for entrepreneurs, subject to the structural model, and conditional on a given shock (housing preference, productivity, collateral or bank capital shock).

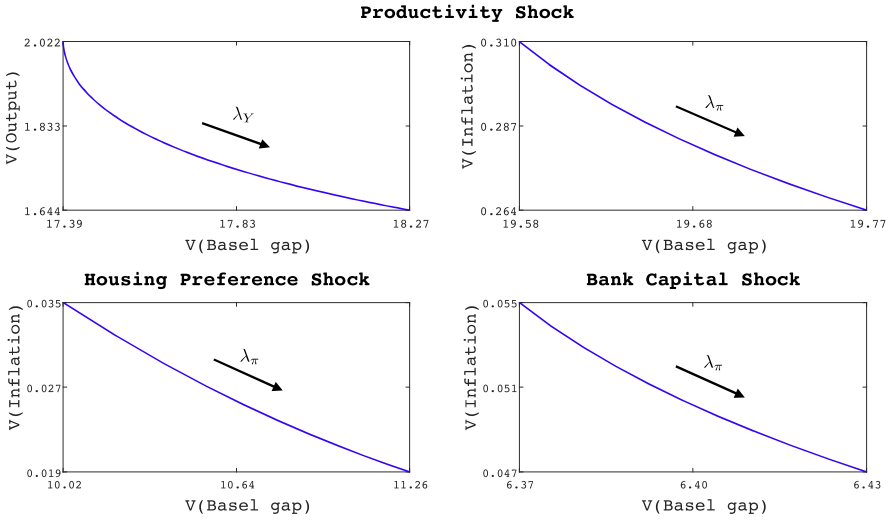
σ_x^2, $\forall x = \{\pi, Y, Bgap, \Delta CAR, \Delta r, \Delta LTV^H, \Delta LTV^E\}$ represents the theoretical variances of inflation, output, and the Basel gap, and the theoretical variances of the change in instruments, namely, state-contingent capital asset requirements, the policy rate, and LTV caps for households and entrepreneurs, respectively.

$\lambda_{\pi} = 1.0$ and $\lambda_{Y} = 0.04$ are the relative weights assigned to the objectives of inflation and output stabilization, respectively. $\lambda_{r} = 0.1$ and $\lambda_{CAR} = \lambda_{H} = \lambda_{E} = 1.0$ are the weights assigned to the volatility of the policy instruments, i.e., the monetary policy rate, CAR, mortgage LTV and corporate LTV, respectively. $\lambda_{B.gap}$ is the relative weight assigned to the stabilization of the Basel gap. It lies between 0.01 and 1. The arrow in each plot designates the direction in which $\lambda_{B.gap}$ increases.

The corresponding optimal values of χ_{LTV}^{E} are consistent with the range of variation considered in Figure 2.3, while the other parameters in all the policy rules, including the auto-regressive parameters, are set to their baseline values to neutralize the effects of the other policy instruments and to reduce the calculation time.

On the plots, we denote V(Inflation) $\equiv \sigma_{\pi}^2$, V(Output) $\equiv \sigma_{Y}^2$, and V(Basel gap) $\equiv \sigma_{B.gap}^2$.

Figure H4: Financial side effects of monetary policy: Illustration with policy frontiers



Note: Each plot represents the evolution of the variances of the Basel gap, output and inflation as the loss function of the policymaker, given by

$$\mathcal{L} = \lambda_{\pi}\sigma_{\pi}^2 + \lambda_{Y}\sigma_{Y}^2 + \lambda_{B.gap}\sigma_{B.gap}^2 + \lambda_{CAR}\sigma_{\Delta CAR}^2 + \lambda_{r}\sigma_{\Delta r}^2 + \lambda_{H}\sigma_{\Delta LTV^H}^2 + \lambda_{E}\sigma_{\Delta LTV^E}^2,$$

is minimized with respect to the optimized value of χ_π or χ_y in Eq. (2.19), the monetary policy rule, subject to the structural model, and conditional on a given shock The arrow in each plot designates the direction in which $\lambda_{B.gap}$ increases.

σ_x^2, $\forall x = \{\pi, Y, Bgap, \Delta CAR, \Delta r, \Delta LTV^H, \Delta LTV^E\}$ represents the theoretical variances of inflation, output, and the Basel gap, and the theoretical variances of the change in instruments, namely, state-contingent capital asset requirements, the policy rate, and LTV caps for households and entrepreneurs, respectively. $\lambda_{B.gap} = 0.1$ is the relative weight assigned to the stabilization of the Basel gap. $\lambda_{r} = 0.1$ and $\lambda_{CAR} = \lambda_{H} = \lambda_{E} = 1.0$ are the weights assigned to the volatility of the policy instruments, i.e., the monetary policy rate, CAR, mortgage LTV and corporate LTV, respectively.

λ_Y is the relative weight assigned to the objective of output stabilization. It is equal to 0.5 but varies between $[0.2, 1]$ in the first plot. λ_π is the relative weight assigned to the objective of inflation stabilization. It is equal to 1.0 as λ_Y varies in the case of a productivity shock (first plot), while it lies between 1.0 and 2.0 in the second plot.

The arrow in each plot designates the direction in which λ_π or λ_Y increases.

The corresponding optimal values of χ_π and χ_Y are consistent with the ranges of variation considered in Figure 2.4, while the other parameters in all the policy rules, including the auto-regressive parameters, are set to their baseline values to neutralize the effects of the other policy instruments and to reduce the calculation time.

On the plots, we denote V(Inflation) $\equiv \sigma_\pi^2$, V(Output) $\equiv \sigma_Y^2$, and V(Basel gap) $\equiv \sigma_{B.gap}^2$.

Chapter 3

Chapter 3

Macroprudential and Monetary Policies: The Need to Dance the Tango in Harmony

3.1 Introduction

In the wake of the 2007-2008 global financial crisis, macroprudential policy has attracted considerable attention from policymakers and researchers. A number of emerging countries were using macroprudential policy tools well before the crisis, but substantial progress has subsequently been made in both emerging and industrialised economies in putting in place dedicated institutional arrangements for macroprudential policy. The main objective of macroprudential policy is to safeguard the stability of the financial system as a whole by strengthening its resilience and preventing the build-up of systemic risk. To ensure the achievement of this primary objective, the European Systemic Risk Board (ESRB/2013/1) defines five intermediate objectives that macroprudential policy should aim to achieve: (i) mitigating and preventing excessive credit growth and leverage; (ii) mitigating and preventing excessive maturity mismatch and market illiquidity; (iii) limiting direct and indirect exposure concentrations; (iv) limiting the systemic impact of misaligned incentives with a view to reducing moral hazard; and (v) strengthening the resilience of financial infrastructures. These intermediate objectives are seen as transitional steps towards achieving robust financial stability.

Mitigating and preventing excessive growth in credit and leverage is particularly important for safeguarding financial stability. One important lesson of the global financial crisis is that financial imbalances largely developed because of the procyclical behaviour of the banking industry. Such behaviour tends to put upward pressure on asset prices and is often viewed as a key driver of banking crises and how severe they are. This is why several macroprudential tools have been designed to curb excessive credit growth and mitigate the procyclicality of domestic credit. Such instruments include for instance the countercyclical capital buffer and the loan-to-value ratio.

However, the implementation of macroprudential policies raises a number of challenges. The first of these is to evaluate how effective the policies are. The empirical literature on this is still in infancy, but there is a growing body of it (see, e.g., Galati and Moessner, 2018). The findings seem especially

to confirm that macroprudential tools are effective at containing credit growth and housing prices. The second challenge more importantly concerns how macroprudential policy interacts with other policies that also have an impact on financial stability, such as fiscal and monetary policies.

Most notably, macroprudential and monetary policies pursue different primary objectives that could be in conflict with one another. As already noted, macroprudential policy primarily aims to promote financial stability, while the primary objective of monetary policy is to maintain price stability. Consequently, each policy can have "side effects" on the objective of the other and make it more effective or less so. Side effects from monetary policy pose significant challenges for the conduct of macroprudential policy if they are detrimental to financial stability.

Monetary policy can have detrimental side effects on financial stability through various channels (IMF, 2013). If the policy interest rate is cut, monetary policy can worsen financial stability through two channels, the risk-taking channel and the asset prices channel. The risk-taking channel means that a low interest rate environment may encourage banks to expand their balance sheets and take on more risk, which in turn may contribute to an excessive expansion of credit and may in this way amplify boom-bust cycles (Adrian and Shin, 2010; Borio and Zhu, 2012). It is often argued that these effects are worse if the policy interest rate is held "too low for too long". A low interest rate environment can also lead to sharp rises in asset prices through the "financial accelerator" mechanism (Bernanke and Gertler, 1989; Bernanke and Gertler, 1995). Such a rise in asset prices tends to intensify the financial cycle, which may lead to a bubble.

When the policy interest rate rises, monetary policy can affect financial stability negatively through three different channels: the balance sheet channel, the risk-shifting channel, and for small open economies, the exchange rate channel. The balance sheet channel means that a tightening of the monetary policy stance can hurt the capacity of borrowers to repay their loans, which can lead to higher default rates and financial instability (see, e.g., Allen and Gale, 2001; Illing, 2007). The risk-shifting effect operates through the balance sheets of banks. As banks typically take in short-term deposits and make long-term loans, changes in the policy rate affect the interest rate applied to short-term deposits more than that for loans. A rise in the policy rate then reduces intermediation margins, and leads financial intermediaries to seek more risk in order to maintain their profits (Bhattacharya, 1982). As a result, monetary tightening is expected to increase financial instability. Finally, monetary policy can impact financial stability though the exchange rate channel, as the policy rate is an important determinant of capital inflows. These inflows can in turn drive credit growth and, owing to the presence of exchange rate externalities, contribute to excessive increases in leverage. The consequence is that, contrary to expectations, raising the policy rate may induce excessive growth in credit, especially in emerging markets and small open economies. Of course the strength of these side effects can vary with the financial cycle. As financial imbalances build up, monetary easing tends to reduce default rates, but can induce banks to make riskier loans and increase their leverage. When the policy rate is raised close to the peak of the financial cycle, this can induce risk-shifting and borrower defaults.

More importantly, these side effects highlight the potential tradeoffs and complementarities between monetary policy and macroprudential measures. Interactions between the two policies have been extensively studied by the recent theoretical literature. Most work in this area uses New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models with financial frictions (see, e.g., Loisel, 2014). These models usually consider two authorities that conduct their policies separately and independently, focusing on the objective of each. Their results suggest that macroprudential and monetary policies are comple-

ments rather than substitutes, although the results vary for different types of shock. In the wake of a financial shock, both policies should work in the same direction, even if the reaction in terms of macroprudential policy should be larger. In the presence of productivity and demand shocks, results suggest that policy responses could differ depending on the size and nature of the shocks. More recently, DSGE models have gone a step further by explicitly assessing the benefits of coordination between macroprudential policy and monetary policy. To this end, they differentiate between two cases: the perfect coordination of policy and the non-coordination of policy. They find that coordinating the two policies stabilises the effect of real and financial shocks to the macro-environment and maximises social welfare.

Despite the apparent consensus emerging in the theoretical literature about the benefits of synchronisation between macroprudential and monetary policies, little is known from an empirical perspective. Very few empirical studies have addressed this issue and their results are far from conclusive (Bruno et al., 2017; Gambacorta and Murcia, 2020; Zhang and Tressel, 2017). Moreover they only focus on a small sample of economies. Against this background, our paper aims to fill this gap in the existing literature by investigating from a sample of 37 emerging and advanced countries whether the effectiveness of macroprudential policy is conditional on monetary policy conditions.[1]

Our findings suggest macroprudential policy is more effective at curbing credit growth when macroprudential and monetary policies are both working in the same direction in harmony. Considering different measures of the macroprudential stance and using the Taylor gap as a measure of the monetary policy stance, we obtain two important results. First, we find that a restrictive monetary policy enhances the impact of macroprudential tightening on domestic credit growth. Second, we find evidence that monetary policy helps to reduce the transmission delay of macroprudential policy actions. To the best of our knowledge, it is the first empirical paper in the literature that formally confirms the benefits of synchronisation between macroprudential and monetary policies.

The remainder of the paper is organised as follows. Section 3.2 reviews the existing empirical literature on the effectiveness of macroprudential policies and the potential role of monetary policy. Section 3.3 presents the measures of macroprudential policy stance and monetary policy stance that we consider. Section 3.4 presents some descriptive statistics, describes our econometric approach and discusses our results. A battery of robustness checks is conducted in section 3.5, while section 3.6 concludes and gives some policy recommendations.

3.2 Literature review

In this section, we review the existing empirical literature that has analysed how macroprudential policies affect various measures of financial vulnerability and stability by discussing whether these studies deal with the challenges discussed above.[2] Nabar and Ahuja (2011) and Lim et al. (2011) were the first to use a cross-country analysis to assess the effectiveness of macroprudential policies. Considering a sample of 49 emerging and advanced economies, Nabar and Ahuja (2011) find that loan-to-value caps have a negative effect on the growth in housing prices and mortgage lending, while debt-service-to-income caps only reduce the growth in property lending. Considering a larger set of macroprudential instruments, Lim et al. (2011) find that macroprudential policies are effective at reducing credit procyclicality. In the same

[1] Our selection of sample countries is driven by data availability. Our sample contains countries listed in Table 3..3 in the Appendix, and twelve euro area countries, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

[2] For a comprehensive literature review on the effects of macroprudential policy, see Galati and Moessner (2018).

vein, Cerutti et al. (2017a) investigate whether a more developed macroprudential framework is associated with lower growth in credit and house prices. To this end, they construct an aggregate macroprudential index designed to measure the number of instruments in place in a given country. Their results confirm that macroprudential policies are effective at curbing credit growth, especially in developing and emerging countries, but they do not appear to have a statistically significant effect on the growth in real housing prices.

One important drawback of studies cited above is the way of measuring macroprudential policy. As they focus only on the existence of macroprudential instruments, these studies do not capture the direction of macroprudential policy actions and the cross-country heterogeneity in macroprudential activism (Boar et al., 2017). To overcome this shortcoming, some recent studies go a step further by considering how macroprudential policy evolves over time by being tightened of loosened (Vandenbussche et al., 2015; Kuttner and Shim, 2016; Zhang and Zoli, 2016; Cerutti et al., 2017b; Akinci and Olmstead-Rumsey, 2018; Altunbas et al., 2018; Carreras et al., 2018). Force instance, using a cumulative macroprudential policy stance indicator, Akinci and Olmstead-Rumsey (2018) find that macroprudential policy tightening is associated with lower growth in bank credit, housing credit, and house prices. Their findings also suggest that borrower-targeted macroprudential instruments tend to be more effective at curbing credit growth. Similar results are obtained by Zhang and Zoli (2016) for a sample of Asian economies, and by Carreras et al. (2018) for the OECD countries.

Other studies focus specifically on how the stance of macroprudential policy affects the real estate market (see for instance McDonald, 2015; Vandenbussche et al., 2015; Kuttner and Shim, 2016). Kuttner and Shim (2016) assess the relative effectiveness of macroprudential and housing-related tax policies in curbing housing credit and house prices. They find that both policies have a negative impact on the growth rate in housing credit. The results are more mixed when they consider housing price growth as an endogenous variable. Changes in taxes still have a statistically significant impact on house prices, but this is not the case for some of the macroprudential tools considered, such as the debt service ratio. As argued by Kuttner and Shim (2016), this result can easily be explained because the cost of buying a house, and consequently demand and prices in the real estate market, is directly affected by tax policies such as the deductibility of mortgage interest and property taxes, but not so much by macroprudential tools. More importantly, the results of Kuttner and Shim (2016) confirm that one major challenge for macroprudential policy is to interact with other policies in a way that fosters the effective conduct of this policy in pursuit of its objective of financial stability.

A key issue in both the academic literature and the policy debate is the interaction between macroprudential policy and monetary policy. As discussed in the introduction, each policy can have “side effects" on the objectives of the other. It is particularly widely recognised that monetary policy can have side effects on financial stability, for instance when policy rates are held “too low for too long". When monetary policy is very accommodative, there are greater incentives to borrow at low interest rates that are difficult for macroprudential policy to contain fully. Consequently, an important empirical issue is to assess how far the monetary policy stance affects how effective macroprudential policy is.

However, there is still very little empirical literature on this issue. To the best of our knowledge, only few studies try to address this question (Bruno et al., 2017; Gambacorta and Murcia, 2020; Zhang and Tressel, 2017). A sample of 12 Asia-Pacific economies over the period 2004-2013 is used by Bruno et al. (2017) to investigate two supplementary issues. First they distinguish between the pre and post-2007 periods and investigate whether macroprudential policies are synchronised with changes in monetary policy

rates.[3] They find that before 2007 monetary policy usually changed in tandem with macroprudential measures, but the opposite result is found after 2007. After 2007, there was a slight downward trend in the average monetary policy rate in the region, while macroprudential measures were tightening slightly. Second, they assess how effective macroprudential policy measures are in curbing growth in cross-border banking flows. They find that macroprudential policies effectively reduced banking inflows over the period 2004-2007, but they were not effective after 2007. These findings indirectly suggest that monetary and macroprudential policies tend to be more successful when they are pulling in the same direction rather than when they act in opposite directions.

Gambacorta and Murcia (2020) and Zhang and Tressel (2017) investigate this issue more specifically by assessing whether the impact of macroprudential policies on credit growth depends on monetary policy conditions. Using meta-analysis techniques and credit registry data for a sample of five Latin American countries, Gambacorta and Murcia (2020) find macroprudential tools to be made more effective at dampening credit cycles when monetary policies are pushing in the same direction. Indeed, considering the change in the real money rate as a monetary policy indicator, they find that a macroprudential policy tightening affects credit growth more when it is accompanied by a countercyclical monetary policy. Zhang and Tressel (2017) adopt a similar approach to gauge this issue for euro area countries. More precisely, they focus on the loan-to-value (LTV) ratio and assess whether macroprudential policy is more effective in containing credit growth and housing prices when monetary policy is tightened. They do this by interacting the LTV ratio with an interest rate gap computed using a Taylor rule. However, their results are relatively mixed especially since the sign and the significance of estimated coefficients associated with the interaction term are unstable depending on the lag order.

As we can see, empirical studies that assess the impact of monetary policy conditions on the effectiveness of macroprudential policies only focus on a small sample of economies, and their findings are relatively mixed. Against this background, our paper contributes to the existing literature by explicitly investigating for a large sample of emerging and industrialised countries whether synchronising macroprudential and monetary policies is a good way to strengthen the impact of macroprudential tools on domestic credit growth. Furthermore, in contrast to the existing literature, our empirical analysis considers an extensive set of prudential tools to capture the overall stance of macroprudential policy. In this way, our paper fills a gap in the literature and provides the first formal answer to an extensive academic and policy debate.

3.3 Measuring the stance of macroprudential and monetary policies

3.3.1 Measuring the stance of macroprudential policy.

To analyse how effective macroprudential instruments are at curbing the credit cycle, we first need to assess the overall macroprudential policy stance. Efforts have been made recently in the academic literature to develop datasets that capture the use of macroprudential policies in a large sample of emerging and industrialised economies.

Two types of dataset can be distinguished. First, some studies consider a large set of macropruden-

[3] Akinci and Olmstead-Rumsey (2018) investigate a similar issue for a sample of emerging and industrialised economies. They find a relatively high correlation between macroprudential measures and other policy actions.

tial tools to provide information on the number of instruments adopted by countries. This lets them give a picture of the evolution of the macroprudential policy framework. For instance, the IMF's 2017 Macroprudential Policy Survey (IMF, 2018) and national sources are used by Cerutti et al. (2017a) to construct an aggregate macroprudential index in which each instrument considered is coded as a simple binary variable, equal to 1 if the instrument is in place, and zero otherwise. Their results indicate the increasing use of macroprudential measures across countries.

Other studies go a step further by providing data on the quarterly changes in macroprudential tools (Vandenbussche et al., 2015; Kuttner and Shim, 2016; Cerutti et al., 2017b; Akinci and Olmstead-Rumsey, 2018; Alam et al., 2019). The main objective of these datasets is to use information on easing and tightening of different macroprudential policy instruments to reflect the policy direction.

In this paper, we use the database provided by Cerutti et al. (2017b), which is one of the most comprehensive datasets on macroprudential policy actions. Using the same survey as Cerutti et al. (2017a), Cerutti et al. (2017b) consider five types of prudential instrument across a sample of 64 countries over the period 2000Q1-2014Q4. The five types of instrument are capital buffers, interbank exposure limits, concentration limits, loan-to-value ratio limits, and reserve requirements. More precisely, capital buffers are divided into four sub-indexes: general capital requirements, specific capital buffers related to real estate credit, specific capital buffers related to consumer credit, and other specific capital buffers. Reserve requirements are also divided into two sub-indexes of reserve requirements on foreign currency-denominated accounts and reserve requirements on local currency-denominated accounts.

Cerutti et al. (2017b) then record the number of easing and tightening measures for each type of macroprudential instrument implemented by each country in each quarter. For a given instrument, a tightening action is coded +1 and a loosening action is coded -1, while 0 means that no change occurs during the quarter. If multiple actions are taken within a given quarter, the reported values correspond to the sum of all the changes recorded, so tightening and loosening actions taken within the same quarter cancel each other out. An instrument that is not adopted by a given country is coded as missing until it is applied by policymakers. Table 3.3.1 details the number of events for each macroprudential policy instrument, distinguishing between net tightening and net loosening events. As can be seen, reserve requirements on local and foreign currency-denominated accounts and capital requirements are the most frequently used instruments.

Given these characteristics of the dataset provided by Cerutti et al. (2017b), we consider six different measures for assessing the stance of macroprudential policies. Two of them, $PruC$ and $PruC2$, were originally developed by Cerutti et al. (2017b), and we also propose four alternative measures. These measures aim to give a better view of cross-country differences in terms of macroprudential policy conduct.

$PruC$ is a country index based on the sum of the quarterly changes of the nine instruments. It can take three different values: -1, 0, +1. Formally, $PruC$ is defined as follows:

$$PruC_{i,t} = \begin{cases} +1 & \text{if} \quad \sum_a x_{a,i,t} > 0 \\ 0 & \text{if} \quad \sum_a x_{a,i,t} = 0 \\ -1 & \text{if} \quad \sum_a x_{a,i,t} < 0 \end{cases} \tag{3.1}$$

where subscripts i and t refer respectively to country and time period, while the subscript a represents a given macroprudential instrument from among the nine recorded in the database. It is important though to note that the number of instruments considered can vary across countries depending on which

Table 3.3.1: Macroprudential policy instruments: number of events

Instruments	Target	No. of events	No. of net tightening events	No. of net loosening events
CB REC	Lender	33	28	5
CB CC	Lender	9	7	2
CB OS	Lender	11	7	4
CAP REQ	Lender	65	65	0
CONC	Lender	15	14	1
IBEX	Lender	16	16	0
LTV	Borrower	47	33	14
RR FC	Lender	56	33	23
RR LC	Lender	108	47	61
Total events		360	250	110
[share]		[17.86%]	[12.41%]	[5.46%]

Source: Cerutti et al. (2017b).
Note: CB REC: real estate credit related specific capital buffers; CB CC: consumer credit related specific capital buffers; CB OS: other specific capital buffers; CAP REQ: capital requirements; CONC: concentration limits; IBEX: limits on interbank exposures; LTV: loan-to-value ratio; RR LC: reserve requirements for deposit accounts denominated in local currency; RR FC: reserve requirements for deposit accounts denominated in foreign currency. The number of events is based on our sample of 37 countries from 2000Q1 to 2014Q4.

instruments have or have not been adopted. As mentioned above, the absence of legislation authorising the use of a particular macroprudential instrument by policymakers is coded in the database as missing. $x_{a,i,t}$ reflects the orientation of instrument a in country i at time t. More precisely, for each instrument, it corresponds to the difference between the number of tightening actions and the number of easing actions. Positive values of $x_{a,i,t}$ indicate a net tightening of the macroprudential policy instrument a, while negative values indicate a net easing. So if $PruC$ is equal to +1, the overall macroprudential policy framework has been tightened during the quarter, but if $PruC$ is equal to -1, then the framework has been loosened. $PruC$ being equal to 0 can correspond to two cases: no change in any instruments, or the same number of tightening and loosening actions during the quarter.

$PruC2$ is computed in a similar fashion to $PruC$. The only difference between these two country indexes is the way in which the orientation of individual macroprudential instruments is recorded. The orientation is now bounded between -1 and +1. For a given quarter, an instrument takes the value +1 if the difference between tightening and loosening actions is positive, -1 if this difference is negative, and 0 otherwise. $PruC2$ is computed as follows:

$$PruC2_{i,t} = \begin{cases} +1 & \text{if} \quad \sum_a y_{a,i,t} > 0 \\ 0 & \text{if} \quad \sum_a y_{a,i,t} = 0 \\ -1 & \text{if} \quad \sum_a y_{a,i,t} < 0 \end{cases} \tag{3.2}$$

where $y_{a,i,t} = \{-1, 0, +1\}$ summarises the orientation of the instrument a, in country i at time t. Unlike $PruC$, $PruC2$ gives the same weight to each instrument adopted, whatever the number of tightening or loosening actions taken during a quarter for any given instrument. $PruC2$ then corresponds to the difference between the number of tightened instruments and the number of eased instruments. $PruC2$ is equal to +1 if the number of tightened instruments during the quarter is higher than the number of loosened instruments, -1 if the difference between tightened and loosened instruments is negative, and 0

otherwise.

In addition to the measures proposed by Cerutti et al. (2017b), we compute four alternative country indexes. First, to have a more granular view of the macroprudential policy stance, we compute an overall index, called $PruC3$, which corresponds for a given quarter to the difference between the sum of tightening actions and the sum of loosening actions. Formally, $PruC3$ is defined as follows:

$$PruC3_{i,t} = \sum_{a} x_{a,i,t} \tag{3.3}$$

where, as in Equation (3.1), $x_{a,i,t}$ corresponds for each instrument a in country i at time t, to the difference between tightening and loosening actions. A larger positive value of this index indicates a more restrictive macroprudential policy, while a larger negative value reflects a more accommodative policy.

As with $PruC$ and $PruC2$ proposed by Cerutti et al. (2017b), one shortcoming of the $PruC3$ index is that it does not take into account that the number of instruments adopted can differ across countries. Indeed it would be expected that the number of actions be partly driven by the number of instruments adopted, especially if all the instruments move in the same direction. To address this issue, we compute an additional index, called $PruC4$, which is defined as follows:

$$PruC4_{i,t} = \frac{PruC3_{i,t}}{n_{i,t}} \tag{3.4}$$

where $n_{i,t}$ corresponds to the number of instruments adopted in country i at time t. Like this, $PruC4$ captures the overall direction of the macroprudential policy conditional on the number of tools implemented.

However, one potential drawback of the $PruC4$ index is that we do not distinguish between instruments that have actually been changed and those for which no action has been taken. To handle this we go a step further by computing an index that reflects the macroprudential policy stance conditional on the number of instruments actually changed during a given quarter. This index, called $PruC5$, is defined as follows:

$$PruC5_{i,t} = \frac{PruC3_{i,t}}{e_{i,t}} \tag{3.5}$$

where $e_{i,t}$ corresponds to the number of instruments in country i at time t that have effectively been changed.

The last measure that we consider aims to distinguish between tightening and loosening actions. This measure, called $PruC6$, is computed as follows:

$$PruC6_{i,t} = \frac{\sum_{T} x_{T,i,t}}{Tight_{i,t}} + \frac{\sum_{L} x_{L,i,t}}{Loose_{i,t}} \tag{3.6}$$

where $x_{T,i,t}$ corresponds to the recorded value of the macroprudential instrument T that is characterised by a net tightening during the quarter, while $x_{L,i,t}$ corresponds to the recorded value of the instrument L that is characterised by a net loosening. $Tight_{i,t}$ and $Loose_{i,t}$ stand for the number of net tightening instruments and the number of net easing instruments. $PruC6$ is then complementary to the previous indexes described above, as it reflects both the macroprudential policy stance and the more or less balanced path of the policy. In comparison to $PruC5$, the $PruC6$ index is notably better able to evaluate the stance of macroprudential policy when some macroprudential tools move in opposite ways.

A higher value of this index indicates a more restrictive macroprudential policy.

To illustrate the pattern of our macroprudential indexes following policy changes, we consider four countries, Argentina, Colombia, Poland and the Russian Federation, where different macroprudential policy actions have been taken during a given quarter (see Table 3.3.2). As expected, the other macroprudential measures that we propose in this article tend to discriminate the macroprudential policy stance across countries better than $PruC$ and $PruC2$ do. Looking at Colombia, we can see that $PruC6$ is higher in absolute terms than $PruC5$. This confirms the relevance of this index when the number of tightening actions per instrument is lower than the number of loosening actions per instrument.

Table 3.3.2: Changes in the macroprudential indexes: country case studies

	Argentina 2002Q1	Colombia 2008Q3	Poland 2012Q2	Russian Fed. 2008Q4
Macroprudential policy actions (+): tightening actions (-): loosening actions	RR LC: +5 RR FC: +5	RR LC: +1 RR FC: -2	CB REC: +1 CB CC: +1 CB OS: +1	RR LC: -3 RR FC: -3
No. of adopted inst.	8	9	7	7
No. of tightened inst.	2	1	3	0
No. of loosened inst.	0	1	0	2
$PruC$	1	-1	1	-1
$PruC2$	1	0	1	-1
$PruC3$	10	-1	3	-6
$PruC4$	1.25	-0.11	0.43	-0.86
$PruC5$	5	-0.5	1	-3
$PruC6$	5	-1	1	-3

Source: Cerutti et al. (2017b) and authors' calculations.
Note: RR LC: reserve requirements for deposit accounts denominated in local currency; RR FC: reserve requirements for deposit accounts denominated in foreign currency; CB REC: real estate credit related specific capital buffers; CB CC: consumer credit related specific capital buffers; CB OS: other specific capital buffers.

3.3.2 Measuring the stance of monetary policy.

To assess the monetary policy stance, we need to differentiate between "rule-based" monetary policy and "discretionary" monetary policy. We do this by following the existing literature (see, e.g., Bogdanova and Hofmann, 2012; Bruno et al., 2017) and using the well-known Taylor rule (Taylor, 1993). The Taylor rule constitutes an approximation of the behaviour of a central bank and has become popular in the academic literature for describing the monetary policy stance. The Taylor rule is a reaction function that defines the central bank interest rate as a function of inflation and a measure of economic activity, typically the output gap. Comparing the policy rate with the empirically estimated Taylor rate then gives an understanding of how far policy rate setting has deviated from the Taylor rule.

In line with Bogdanova and Hofmann (2012) and using historical time series for each country in our sample, we estimate the following reaction function:

$$i_t = \rho\, i_{t-1} + (1-\rho)[\alpha + \beta_\pi(\pi_t) + \beta_y(y_t - \bar{y_t})] + \varepsilon_t \tag{3.7}$$

where i_t is the actual short-term policy rate of a given country, which is lagged one period on the right side of Equation (3.7) to capture interest rate smoothing. As in the original Taylor rule, this assumes a gradual adjustment of policy rates to their benchmark level. π_t is the contemporaneous inflation rate, $y_t - \bar{y}$ is the output gap, and ε_t is the error term.[4] A positive relationship could be expected between the inflation rate, the output gap, and the policy rate, meaning $\beta_\pi > 0$ and $\beta_y > 0$.

The central bank policy rates are taken from the database provided by the Bank for International Settlements (BIS). As these data are collected on a monthly basis, we consider the end-of-quarter rates. The annual inflation rate comes from the International Monetary Fund's International Financial Statistics (IFS) database. Real GDP is taken from the OECD Statistics for the OECD countries, and from the IFS for the others. The inflation and GDP data series are seasonally adjusted using the US Census Bureau X-11-ARIMA method. Finally, the output gap corresponds to the difference between actual real GDP and its trend, computed using the traditional Hodrick-Prescott filter.

Following Clarida et al. (2000) and the related literature, we estimate Equation (3.7) using the Generalised Method of Moments (GMM) estimator to overcome the issue of potential endogeneity. Furthermore, the time period for estimating Equation (3.7) covers the longest available data time span so as to give consistent estimates, and then differs across the countries in our sample. An important consideration with such an approach is the selection of valid instruments. This selection is based on the overidentification test developed by Hansen (1982). This implies that the set of instruments considered can be different for each country. The Taylor rule estimates are reported in Table 3..3 in the Appendix.

The Taylor gap then corresponds to the difference between the actual policy rate and the estimated Taylor rate ($i_t - \hat{i}_t$). This gap reflects the monetary policy stance. A positive difference can be interpreted as a restrictive monetary policy, while a negative difference can be understood as an accommodative monetary policy.

However, the use of the policy rate as the main monetary policy instrument can be challenged, and some industrialised economies actually adopted unconventional monetary policies in the aftermath of the 2007-08 financial crisis. This means that assessing the impact of the unconventional measures implemented and understanding the overall monetary policy stance using the Taylor gap can be inappropriate. To address this issue, as is usual in the literature, we do not consider the gap between the actual policy rate and the Taylor rate, but the difference between the shadow rate and the Taylor rate.

The shadow rate, first introduced by Black (1995), has recently been used by a number of papers to quantify the stance of monetary policy in a "zero lower bound" environment (see, e.g., Krippner, 2013; Wu and Xia, 2016; Wu and Xia, 2017; Lombardi and Zhu, 2018). Indeed, when the zero lower bound is binding, the policy interest rate does not display meaningful variation and so no longer conveys information about the monetary policy stance. The shadow rate meanwhile is not bounded and can freely take on negative values to reflect unconventional monetary policy actions. Krippner (2015) and Wu and Xia (2016) argue that the shadow rate can be used in place of the policy rate to describe the stance and effects of the monetary policy in a "zero lower bound" environment. In this paper, we use the shadow rates provided by Krippner (2015) for the Euro area, Japan, the United Kingdom and, the United States. These data are available on the website of the Reserve Bank of New Zealand.

[4] Because our sample includes inflation targeting and non-inflation targeting countries, we do not consider the inflation gap in Equation (3.7). In most non-inflation targeting countries, the central bank does not publicly announce a numerical inflation target or the horizon of this target. However, under the assumption that the target is constant over time, it is captured in the constant term α.

3.4 Empirical analysis

Using the insights from the existing literature and the arguments presented above, our empirical analysis aims to gauge the effectiveness of macroprudential policies in curbing credit growth and whether the monetary policy stance drives this effectiveness. Given data availability, we do this by considering a sample of 37 advanced and emerging economies over the period 2000Q1-2014Q4. However, before turning to the econometric analysis, this section presents some descriptive statistics and preliminary findings.

3.4.1 Preliminary findings

We start our empirical investigation by analysing in Figure 3.4.1 the evolution of the macroprudential policy stance in our sample of countries. Panels (A) and (B) focus on the $PruC3$ index, which is the most explicit indicator for giving a clear picture of the overall evolution of macroprudential policies. Panel (A) represents the cross-sectional average value of the $PruC3$ index for each quarter. The blue bars indicate positive values, while the red bars indicate negative values. As would be expected, it appears that a broad range of macroprudential instruments have been significantly tightened in the aftermath of the global financial crisis. However, this does not mean that all the economies in our sample conducted their macroprudential policy in the same direction. To illustrate this we split our sample of countries into two categories in panel (B) of countries with a net tightened macroprudential policy stance during a given quarter, and those with a net loosened macroprudential policy stance. The blue bars correspond to the average value of the $PruC3$ index for the first category of countries, while the red bars indicate the average value of the $PruC3$ index for the second category of countries. A loose macroprudential policy can be observed in some countries since mid-2009. Panel (C) goes a step further by providing a picture of macroprudential activism. It represents the number of countries in which the macroprudential policy stance changed over a given quarter, and it also distinguishes the orientation of this change. The red bars correspond to the number of countries with a net loosened macroprudential policy stance, while the blue bars correspond to the number of countries with a net tightened macroprudential policy stance. It shows that macroprudential activism tended to increase over the period considered. Finally, panel (D) presents the frequency of quarterly observations with a net tightened or a net loosened macroprudential policy stance. It shows that net tightening actions are more than twice as common as net loosening actions in our sample.

In Figure 3.4.2 we represent the country-by-country cross-correlation coefficient between different lags of the $PruC3$ index and the residuals of the annual growth rate of total credit to the private non-financial sector from banks. The residuals are obtained by regressing credit growth on the annual GDP growth lagged by one period. They capture the part of credit that is not driven by real economic activity and so can be viewed as a proxy for excess credit growth. Panels (A), (B), (C) and (D) consider 1, 2, 3 and 4 lags for the $PruC3$ index respectively. As expected, the cross-correlation coefficient is negative for most countries, suggesting that a net tightened macroprudential stance is associated with lower credit growth. Furthermore, we can observe that the number of countries characterised by a negative correlation increases with the lag order and that a tightening in macroprudential policy is associated with a larger reduction in annual credit growth after one year.

In Figure 3.4.3, we give an overview of the synchronisation of macroprudential and monetary policies by comparing changes in macroprudential policy with the monetary policy stance. In panels (A), (B) and (C), grey bars represent the number of countries in each period where both policies exhibit the

Figure 3.4.1: Descriptive statistics on macroprudential policy stance

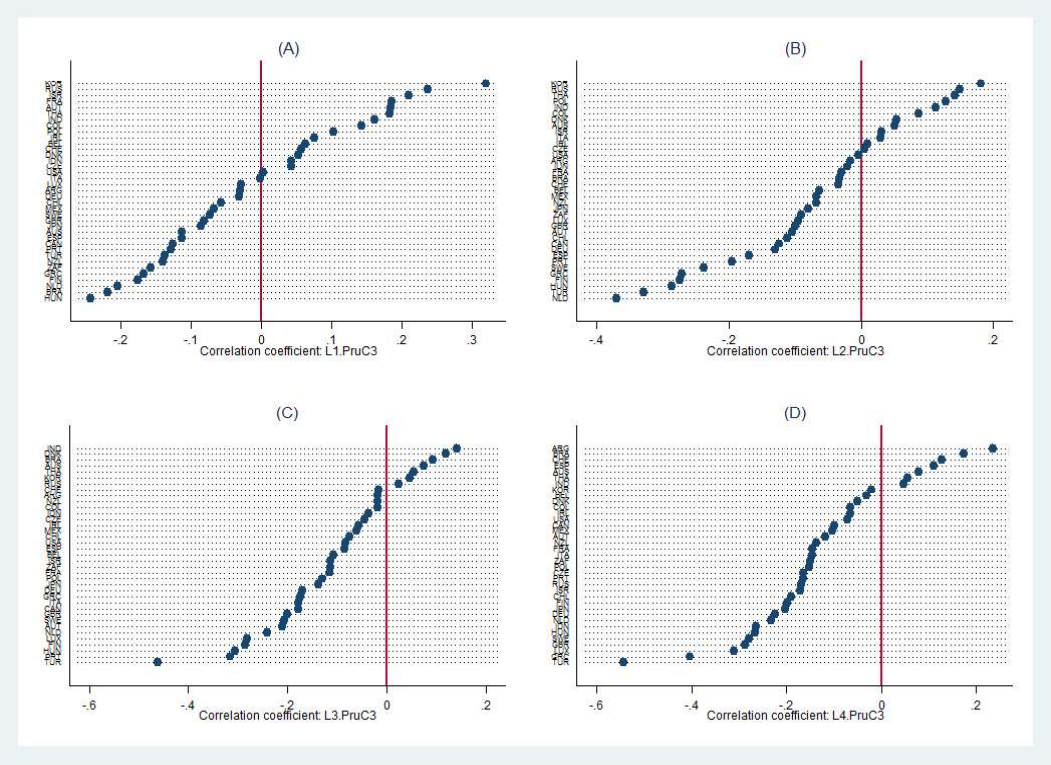
Source: Cerutti et al. (2017b) and authors' calculations.
Note: All panels are based on our sample of 37 countries. Panel (A) presents the cross-sectional average value of the $PruC3$ index for each quarter. In panel (B), the blue bars correspond to the average value of the $PruC3$ index of countries with a net tightened macroprudential policy stance, and the red bars correspond to the average value of the $PruC3$ index of countries with a net loosened macroprudential policy stance. Panel (C) presents the number of countries in which the macroprudential policy stance changed over a given quarter by distinguishing between tightened and loosened stances. Panel (D) presents the share of quarterly observations with a net tightened or a net loosened macroprudential policy stance. No action corresponds to no change in all instruments or to the same number of tightening and loosening actions during a given quarter.

same stance. Not surprisingly, panel (C) shows that monetary policy tended to desynchronise from macroprudential policy in the aftermath of the global financial crisis. During this period, most central banks around the world conducted accommodative monetary policies, and many countries strengthened their macroprudential framework at the same time [see panel (A)]. This picture is confirmed in panel (D), which represents the trend of the cross-sectional correlation between the $PruC3$ index and the Taylor gap for each quarter.[5]

Finally, in Figure 3.4.4 we analyse whether the monetary policy stance drives the country-by-country cross-correlation between the $PruC3$ index and credit growth. To this end, we compute the partial correlation by controlling for the Taylor gap. The partial correlation coefficients are illustrated by the red points, while the blue points indicate the correlation coefficients reported in Figure 3.4.2. Overall, the partial correlation coefficients are higher than the pairwise correlation coefficients regardless of the lag order considered. When the coefficient is negative, this means that taking account of the monetary policy stance reduces the correlation between the macroprudential policy stance and credit growth. These preliminary findings then confirm the importance of monetary policy for the effectiveness of macroprudential policy in curbing credit growth. This issue is investigated in more detail in the next sub-section.

[5]See, for instance, Borio and Shim (2007) and Bruno et al. (2017) for further evidence.

Figure 3.4.2: Correlation between the macroprudential stance and credit growth



Source: Cerutti et al. (2017b), Bank for International Settlements and authors' calculations.
Note: All panels are based on our sample of 37 countries. They represent the country-by-country cross-correlation coefficient between the $PruC3$ index and the residuals of the growth rate of total credit to the private non-financial sector from banks. The residuals are obtained by regressing credit growth on GDP growth lagged by one period. Panels (A), (B), (C) and (D) consider 1, 2, 3 and 4 lags for the $PruC3$ index respectively.

3.4.2 Econometric approach

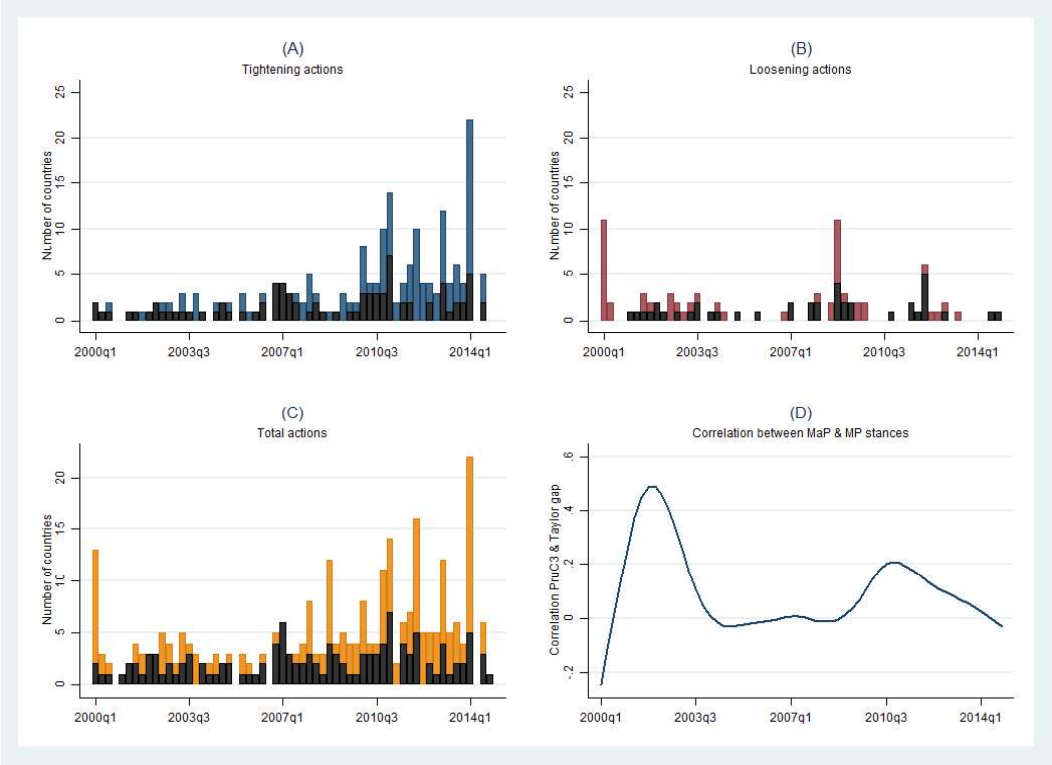
Our empirical analysis proceeds in two steps. First we follow the existing literature by reinvestigating how our different measures of the macroprudential policy stance affect credit growth. To this end we consider two alternative measures of domestic credit, which are total credit to the private non-financial sector from banks and total credit to households and non-profit institutions serving households. These data are taken from the BIS.

The baseline model that we estimate is the following:

$$\Delta Credit_{i,t} = \alpha + \sum_{k=1}^{4} \beta_k \, MaP_{i,t-k} + \eta \, X_{i,t-1} + \theta \, Crisis_t + \mu_i + \epsilon_{i,t} \tag{3.8}$$

where $\Delta Credit_{i,t}$ is the yearly growth of our different measures of credit, and $MaP_{i,t-k}$ corresponds to our alternative macroprudential policy stance indexes, for which we include four lags (see, e.g., Kuttner and Shim, 2016; Zhang and Tressel, 2017), as some macroprudential actions may be delayed in their effect. $X_{i,t-1}$ represents the vector of control variables. Following the existing literature, we consider two control variables, which are the annual GDP growth rate and the change in the nominal monetary policy rate. These two variables are lagged one period and are taken from the IFS database and the

Figure 3.4.3: Synchronisation of the stances of macroprudential and monetary policies



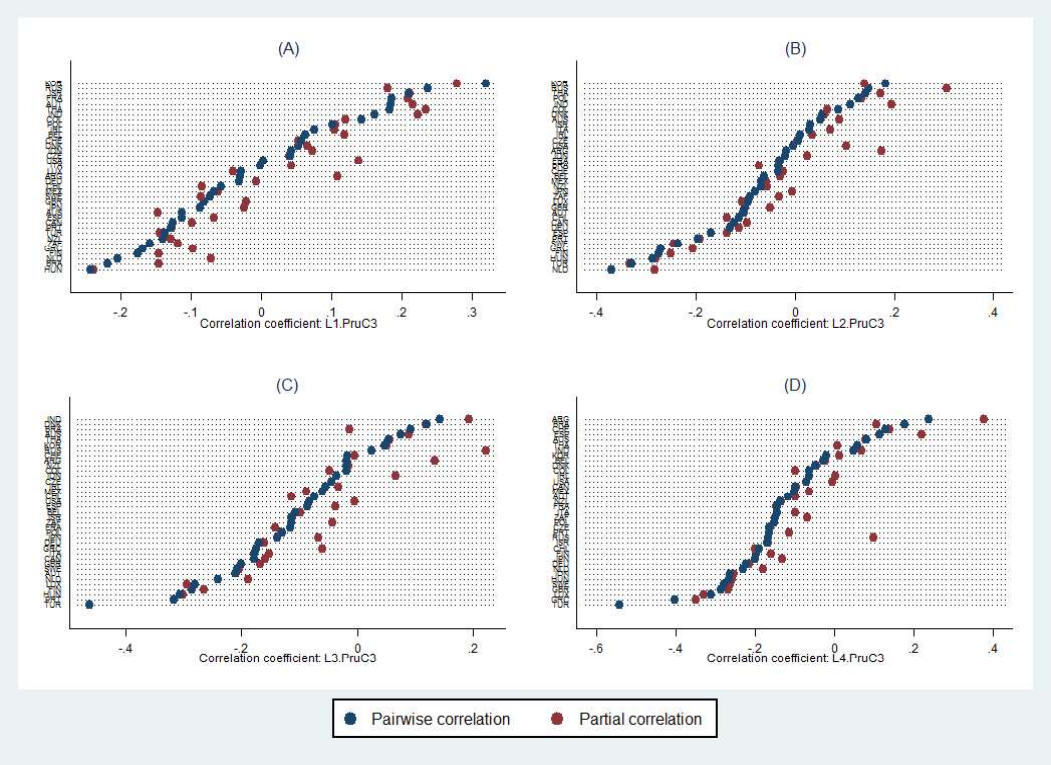
Source: Cerutti et al. (2017b) and authors' calculations.
Note: All panels are based on our sample of 37 countries. Panels (A) and (B) represent the number of countries with a net tightened and a net loosened macroprudential policy stance respectively for each quarter. Panel (C) represents the number of countries in which the macroprudential policy stance changed over the given quarter, whatever the direction of the macroprudential policy. For each of these panels, the grey bars correspond to the number of cases where macroprudential and monetary policies move in the same direction. Panel (D) represents the trend of the cross-sectional correlation between the $PruC3$ index and the Taylor gap for each quarter. The trend is obtained using the Hodrick-Prescott filter.

BIS respectively. A negative relationship should be expected between the change in policy rate and the growth of credit, while higher GDP growth should be associated with higher credit growth. The GDP growth rate is included to control for the procyclicality of credit (Athanasoglou et al., 2014), and this then allows us to capture the part of credit that is not driven by real economic activity, which is excess credit growth. $Crisis_t$ is a dummy variable capturing a potential drop in credit growth during the recent crisis period. It is equal to 1 from 2008Q3 to 2012Q4, and 0 otherwise. Country-fixed effects μ_i allow for cross-country differences in average credit growth, and $\epsilon_{i,t}$ is the error term. We could expect $\beta_k < 0$, meaning that a more restrictive macroprudential policy helps to curb domestic credit growth. In the second step, we extend our previous baseline model to assess whether a tighter macroprudential policy is more likely to curb domestic credit growth when it is accompanied by a restrictive monetary policy, giving a positive Taylor gap. More precisely, the equation that we estimate is the following:

$$\begin{aligned}\Delta Credit_{i,t} = \alpha + \sum_{k=1}^{4} \beta_k \, MaP_{i,t-k} + \sum_{k=1}^{4} \gamma_k \, (\, MaP_{i,t-k} \times TG_{i,t-k} \times D_{i,t-k}) \\ + \eta \, X_{i,t-1} + \theta \, Crisis_t + \mu_i + \epsilon_{i,t}\end{aligned} \tag{3.9}$$

where $TG_{i,t-k}$ corresponds to the Taylor gap described in the previous section and $D_{i,t-k}$ is a dummy

Figure 3.4.4: Partial correlation between the macroprudential stance and credit growth



Source: Cerutti et al. (2017b), Bank for International Settlements and authors' calculations.
Note: All panels are based on our sample of 37 countries. Red points represent the country-by-country partial cross-correlation coefficient between the $PruC3$ index and the residuals of the growth rate of total credit to the private non-financial sector from banks. The residuals are obtained by regressing credit growth on the one period lagged GDP growth. The partial correlation corresponds to the correlation between the $PruC3$ index and credit growth when controlling for the Taylor gap. Blue points are the cross-correlation coefficients reported in Figure 3.4.2. Panels (A), (B), (C) and (D) consider 1, 2, 3 and 4 lags for the $PruC3$ index, respectively.

variable equal to 1 when macroprudential and monetary policies are both restrictive in a given quarter, and 0 otherwise. Consequently, the interaction term $(MaP_{i,t-k} \times TG_{i,t-k} \times D_{i,t-k})$ captures the additional effect of macroprudential policies on credit growth conditional on the stance of monetary policy.[6]

As we are primarily interested in assessing whether the monetary policy stance is an important determinant of the effectiveness of macroprudential policies, we focus particularly on the marginal effect of our alternative macroprudential stance indexes on credit growth. Formally, this marginal effect can be derived from Equation (3.9) as follows:

$$\frac{\delta \Delta Credit_{i,t}}{\delta MaP_{i,t-k}} = \beta_k + \gamma_k \left(TG_{i,t-k} \times D_{i,t-k}\right) \tag{3.10}$$

If we find that $\beta_k < 0$ and $\gamma_k < 0$, this means that a more restrictive monetary policy reinforces the effect of macroprudential policies on credit growth. We can also expect the case where β_k is not statistically

[6]It is justified to consider the dummy variable $D_{i,t-k}$ because the macroprudential indexes and the Taylor gap can take positive and negative values. In this case, the estimated coefficient associated with the interaction term $(MaP_{i,t-k} \times TG_{i,t-k})$ cannot be interpreted properly. Indeed if both variables are positive, a negative coefficient would be expected, but if both variables are negative, a positive coefficient would be expected. This then justifies the use of a three-way interaction term to assess whether a tighter macroprudential policy is more likely to curb domestic credit growth when it is accompanied by a restrictive monetary policy.

significant at the conventional levels ($\beta_k = 0$) and $\gamma_k < 0$. Such a result indicates that credit growth cannot be contained through macroprudential policy alone, but that this needs the support of monetary policy. In other words, macroprudential tightening actions are more likely to reduce credit growth if they are implemented in tandem with a restrictive monetary policy.

Finally, we re-estimate Equation (3.9) by considering the first difference of the Taylor gap as an alternative measure of the monetary policy stance. The Taylor gap reflects whether a monetary policy is accommodative or restrictive, while its first difference captures the monetary policy orientation, meaning whether monetary policy has been tightened or loosened. Formally, the equation that we estimate is the following:

$$\begin{aligned}\Delta Credit_{i,t} = \alpha + \sum_{k=1}^{4} \beta_k \, MaP_{i,t-k} + \sum_{k=1}^{4} \gamma_k \, (MaP_{i,t-k} \times \Delta TG_{i,t-k} \times I_{i,t-k}) \\ + \eta \, X_{i,t-1} + \theta \, Crisis_t + \mu_i + \epsilon_{i,t}\end{aligned} \tag{3.11}$$

where $\Delta TG_{i,t-k}$ is the first difference of the Taylor gap, and $I_{i,t-k}$ is a dummy variable equal to 1 if the macroprudential index considered and the first difference of the Taylor gap are both positive in a given quarter, and 0 otherwise. As above, if monetary policy is an important driver of macroprudential policy effectiveness, we would expect $\gamma_k < 0$.[7]

3.4.3 Results

Our results are reported in Tables 3.4.1 to 3.4.3. In Table 3.4.1, we report the results when we consider $PruC$ and $PruC2$ as alternative measures of the macroprudential policy stance, Table 3.4.2 displays the results obtained with $PruC3$ and $PruC4$, while Table 3.4.3 displays the results obtained with $PruC5$ and $PruC6$. To give a better view of how important the monetary policy stance is for the conduct of macroprudential policy, we present the results of the baseline and extended models side by side. For each macroprudential index considered, the first column displays the results obtained when we consider only the effects of macroprudential policy stance on credit growth. The next two columns report the results when we take the monetary policy stance into account, which is proxied using two alternative measures, the Taylor gap and its first difference.

We find three important results. First, in line with the recent literature on macroprudential policy, our empirical findings suggest that an overall tightening in macroprudential policies is associated with a reduction in credit growth. Other than for two specifications (columns [2.1] and [2.7]), we find a negative and statistically significant relationship between our macroprudential indexes and domestic credit growth. Furthermore, and as might be expected, macroprudential policy actions take time to curb domestic credit growth effectively. For most specifications, we can see that the coefficients associated with macroprudential indexes are only significant at the third and fourth order lags.

Second, the results when we add the interaction term in the baseline model show that the monetary policy stance matters for the effectiveness of macroprudential policy. The coefficients associated with the interaction term are negative and statistically significant. When we consider the Taylor gap in the interaction term, this negative sign means that a restrictive monetary policy actually enhances the impact of macroprudential tightening actions on credit growth. Equally, the results from considering the first

[7] Please note that we also estimate Equation (3.11) by considering the policy interest rate variation as an additional measure of the monetary policy orientation. A summary of the results is reported in Tables 3..1 and 3..2 in the Appendix.

difference of the Taylor gap show that the marginal effect on credit growth of tightening macroprudential instruments is affected by whether the prevailing monetary policy stance is tight or loose. The benefits of synchronisation between macroprudential and monetary policies are also confirmed in columns [2.2], [2.3], [2.8] and [2.9]. While $PruC3$ and $PruC4$ did not appear statistically significant in the baseline specification (columns [2.1] and [2.7]), we can now observe a significant marginal effect of both indexes on credit growth when macroprudential and monetary policies complement each other.

Finally, we find evidence that monetary policy helps to reduce the transmission delay of macroprudential policy actions on private sector credit growth, as the coefficients associated with the interaction term are negative and significant at the first, second and third order lags. The results are more mixed when we consider the growth of credit to households as a dependent variable.

In sum, even though monetary and macroprudential policies pursue different primary objectives, our empirical analysis confirms that the two policies are complementary. Our results particularly emphasise the importance of implementing a monetary policy that supports the macroprudential policy by moving in the same direction, and then attenuating its potential side effects on financial stability.

Table 3.4.1: Results obtained with $PruC$ and $PruC2$

	$PruC$						$PruC2$					
	Credit to private sector			Credit to households			Credit to private sector			Credit to households		
	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(1.10)	(1.11)	(1.12)
L.MaP	0.972	0.931	0.743	-0.377	-0.557	-0.697	0.980	0.948	0.758	-0.416	-0.583	-0.724
	(1.184)	(0.959)	(1.032)	(1.638)	(1.403)	(1.437)	(1.199)	(0.973)	(1.044)	(1.651)	(1.418)	(1.449)
L2.MaP	-0.658	-0.861	-1.007	-2.377	-2.556*	-2.645*	-0.721	-0.914	-1.060	-2.450	-2.616*	-2.704*
	(1.132)	(0.937)	(0.958)	(1.679)	(1.471)	(1.467)	(1.162)	(0.966)	(0.987)	(1.705)	(1.497)	(1.489)
L3.MaP	-2.029	-2.285*	-2.475*	-4.030**	-4.207**	-4.356**	-2.082	-2.324*	-2.513**	-4.073**	-4.234**	-4.382**
	(1.388)	(1.256)	(1.227)	(1.914)	(1.703)	(1.657)	(1.382)	(1.258)	(1.229)	(1.911)	(1.708)	(1.662)
L4.MaP	-3.073*	-3.670**	-3.675**	-5.769**	-5.987***	-6.058***	-3.053*	-3.632**	-3.637**	-5.727**	-5.927***	-5.998***
	(1.775)	(1.473)	(1.425)	(2.472)	(1.993)	(1.968)	(1.768)	(1.468)	(1.420)	(2.481)	(2.003)	(1.977)
L.(MaP × TG × D)		-1.156***			-0.896			-1.154***			-0.891	
		(0.231)			(0.604)			(0.231)			(0.606)	
L2.(MaP × TG × D)		-0.914***			-0.816*			-0.911***			-0.811*	
		(0.188)			(0.433)			(0.189)			(0.435)	
L3.(MaP × TG × D)		-0.824***			-0.771*			-0.821***			-0.767*	
		(0.198)			(0.387)			(0.198)			(0.388)	
L4.(MaP × TG × D)		0.215			-0.336			0.214			-0.337	
		(0.175)			(0.515)			(0.175)			(0.514)	
L.(MaP × Δ TG × I)			-1.078***			-0.822			-1.077***			-0.818
			(0.209)			(0.545)			(0.209)			(0.547)
L2.(MaP × Δ TG × I)			-0.931***			-0.833**			-0.928***			-0.829**
			(0.136)			(0.328)			(0.136)			(0.330)
L3.(MaP × Δ TG × I)			-0.856***			-0.806***			-0.854***			-0.802***
			(0.111)			(0.271)			(0.111)			(0.271)
L4.(MaP × Δ TG × I)			0.135			-0.382			0.134			-0.382
			(0.169)			(0.497)			(0.169)			(0.496)
L.Δ GDP	2.460***	2.155***	2.142***	2.725***	2.442***	2.429***	2.458***	2.153***	2.140***	2.719***	2.437***	2.423***
	(0.256)	(0.241)	(0.234)	(0.296)	(0.363)	(0.347)	(0.256)	(0.242)	(0.234)	(0.294)	(0.365)	(0.348)
L.Δ Policy rate	-0.793	2.415	2.452	-2.406	-0.340	-0.306	-0.790	2.408	2.446	-2.403	-0.355	-0.318
	(0.722)	(1.628)	(1.539)	(2.173)	(4.511)	(4.315)	(0.725)	(1.631)	(1.541)	(2.177)	(4.516)	(4.318)
Crisis dummy	-4.246***	-4.707***	-4.692***	-5.568***	-6.119***	-6.075***	-4.237***	-4.698***	-4.682***	-5.548***	-6.098***	-6.054***
	(1.442)	(1.291)	(1.293)	(1.802)	(1.620)	(1.612)	(1.442)	(1.293)	(1.295)	(1.801)	(1.622)	(1.614)
Constant	5.974***	7.356***	7.333***	8.480***	9.737***	9.671***	5.981***	7.360***	7.338***	8.493***	9.743***	9.679***
	(1.173)	(0.957)	(0.942)	(1.210)	(1.171)	(1.124)	(1.172)	(0.957)	(0.942)	(1.208)	(1.175)	(1.128)
Observations	2,015	2,015	2,011	1,950	1,950	1,946	2,015	2,015	2,011	1,950	1,950	1,946
Number of countries	37	37	37	37	37	37	37	37	37	37	37	37
Adjusted R-squared	0.248	0.267	0.270	0.249	0.262	0.263	0.248	0.267	0.270	0.249	0.262	0.263

Note: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively. MaP is the different macroprudential policy indexes considered, TG corresponds to the Taylor gap, Δ TG corresponds to the first difference of the Taylor gap, and D and I correspond to the alternative dummy variables capturing the stance of macroprudential and monetary policies.

Table 3.4.2: Results obtained with $PruC3$ and $PruC4$

	$PruC3$						$PruC4$					
	Credit to private sector			Credit to households			Credit to private sector			Credit to households		
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)	(2.9)	(2.10)	(2.11)	(2.12)
L.MaP	-0.025	0.343	0.345	-0.985	-0.879	-0.855	0.017	2.462	2.459	-7.708	-7.098	-6.932
	(0.719)	(0.718)	(0.736)	(0.993)	(1.082)	(1.092)	(5.470)	(5.471)	(5.625)	(7.828)	(8.364)	(8.455)
L2.MaP	-0.682	-0.502	-0.480	-1.795	-1.596	-1.555	-4.499	-3.103	-2.962	-13.076	-11.516	-11.221
	(0.662)	(0.685)	(0.682)	(1.130)	(1.201)	(1.200)	(4.889)	(4.981)	(4.970)	(8.719)	(9.122)	(9.128)
L3.MaP	-1.387	-1.083	-1.075	-2.430*	-2.108	-2.080	-10.072	-7.906	-7.870	-18.254*	-15.966	-15.774
	(0.825)	(0.973)	(0.969)	(1.247)	(1.430)	(1.427)	(6.189)	(7.130)	(7.099)	(9.717)	(10.848)	(10.839)
L4.MaP	-1.526	-2.020*	-1.983*	-3.441*	-3.332*	-3.285*	-11.690	-14.994*	-14.726*	-26.257*	-25.305*	-24.966*
	(1.269)	(1.148)	(1.135)	(1.941)	(1.679)	(1.670)	(9.217)	(8.449)	(8.348)	(14.269)	(12.639)	(12.572)
L.(MaP × TG × D)		-0.099***			-0.059			-0.779***			-0.457	
		(0.024)			(0.062)			(0.192)			(0.504)	
L2.(MaP × TG × D)		-0.079***			-0.060			-0.634***			-0.490	
		(0.015)			(0.038)			(0.120)			(0.306)	
L3.(MaP × TG × D)		-0.075***			-0.065*			-0.602***			-0.515*	
		(0.014)			(0.033)			(0.107)			(0.263)	
L4.(MaP × TG × D)		0.023			-0.025			0.175			-0.211	
		(0.017)			(0.045)			(0.137)			(0.369)	
L.(MaP × Δ TG × I)			-0.092***			-0.055			-0.726***			-0.429
			(0.022)			(0.057)			(0.179)			(0.460)
L2.(MaP × Δ TG × I)			-0.074***			-0.058*			-0.601***			-0.468*
			(0.013)			(0.034)			(0.105)			(0.271)
L3.(MaP × Δ TG × I)			-0.071***			-0.062**			-0.570***			-0.492**
			(0.012)			(0.029)			(0.090)			(0.231)
L4.(MaP × Δ TG × I)			0.021			-0.023			0.160			-0.196
			(0.016)			(0.041)			(0.128)			(0.338)
L.Δ GDP	2.466***	2.209***	2.204***	2.706***	2.504***	2.493***	2.466***	2.209***	2.204***	2.710***	2.509***	2.498***
	(0.267)	(0.237)	(0.234)	(0.297)	(0.343)	(0.336)	(0.267)	(0.236)	(0.233)	(0.298)	(0.343)	(0.336)
L.Δ Policy rate	-0.733	1.574	1.633	-2.362	-1.199	-1.114	-0.766	1.544	1.602	-2.384	-1.241	-1.157
	(0.834)	(1.508)	(1.454)	(2.471)	(4.191)	(4.082)	(0.827)	(1.524)	(1.469)	(2.473)	(4.242)	(4.132)
Crisis dummy	-4.294***	-4.735***	-4.684***	-5.738***	-6.173***	-6.101***	-4.303***	-4.744***	-4.692***	-5.742***	-6.178***	-6.106***
	(1.507)	(1.309)	(1.304)	(1.836)	(1.601)	(1.582)	(1.508)	(1.311)	(1.306)	(1.835)	(1.601)	(1.582)
Constant	5.969***	6.975***	6.931***	8.479***	9.227***	9.166***	5.959***	6.966***	6.922***	8.465***	9.214***	9.152***
	(1.138)	(0.955)	(0.951)	(1.179)	(1.125)	(1.109)	(1.135)	(0.953)	(0.949)	(1.178)	(1.134)	(1.118)
Observations	2,015	2,015	2,011	1,950	1,950	1,946	2,015	2,015	2,011	1,950	1,950	1,946
Number of countries	37	37	37	37	37	37	37	37	37	37	37	37
Adjusted R-squared	0.246	0.261	0.261	0.245	0.252	0.252	0.246	0.261	0.261	0.246	0.253	0.252

Note: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively. MaP is the different macroprudential policy indexes considered, TG corresponds to the Taylor gap, Δ TG corresponds to the first difference of the Taylor gap, and D and I correspond to the alternative dummy variables capturing the stance of macroprudential and monetary policies.

Table 3.4.3: Results obtained with $PruC5$ and $PruC6$

	$PruC5$						$PruC6$					
	Credit to private sector			Credit to households			Credit to private sector			Credit to households		
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)	(3.8)	(3.9)	(3.10)	(3.11)	(3.12)
L.MaP	-0.014	0.384	0.372	-1.318	-1.175	-1.156	-0.015	0.399	0.386	-1.323	-1.175	-1.156
	(1.008)	(0.998)	(1.023)	(1.347)	(1.371)	(1.388)	(1.009)	(0.995)	(1.020)	(1.347)	(1.368)	(1.385)
L2.MaP	-1.409*	-1.255	-1.240	-3.003**	-2.822*	-2.776*	-1.416*	-1.255	-1.240	-3.029**	-2.845*	-2.799*
	(0.830)	(0.851)	(0.858)	(1.379)	(1.424)	(1.431)	(0.829)	(0.844)	(0.851)	(1.388)	(1.426)	(1.434)
L3.MaP	-2.526**	-2.270*	-2.288*	-4.237***	-3.952**	-3.940**	-2.552**	-2.302**	-2.319**	-4.287***	-4.008**	-3.996**
	(1.032)	(1.145)	(1.143)	(1.521)	(1.642)	(1.643)	(1.031)	(1.135)	(1.133)	(1.523)	(1.631)	(1.634)
L4.MaP	-2.733*	-3.226**	-3.182**	-5.518**	-5.343**	-5.297**	-2.791*	-3.292**	-3.247**	-5.587**	-5.418**	-5.371**
	(1.611)	(1.485)	(1.467)	(2.300)	(2.017)	(2.006)	(1.594)	(1.478)	(1.460)	(2.278)	(2.003)	(1.992)
L.(MaP × TG × D)		-0.199***			-0.124			-0.200***			-0.125	
		(0.048)			(0.126)			(0.048)			(0.126)	
L2.(MaP × TG × D)		-0.157***			-0.121			-0.157***			-0.121	
		(0.031)			(0.078)			(0.031)			(0.078)	
L3.(MaP × TG × D)		-0.150***			-0.127*			-0.150***			-0.127**	
		(0.025)			(0.063)			(0.025)			(0.062)	
L4.(MaP × TG × D)		0.041			-0.059			0.042			-0.058	
		(0.035)			(0.099)			(0.035)			(0.099)	
L.(MaP × Δ TG × I)			-0.186***			-0.117			-0.186***			-0.117
			(0.044)			(0.114)			(0.044)			(0.115)
L2.(MaP × Δ TG × I)			-0.149***			-0.117*			-0.150***			-0.117*
			(0.026)			(0.068)			(0.026)			(0.068)
L3.(MaP × Δ TG × I)			-0.143***			-0.122**			-0.143***			-0.122**
			(0.020)			(0.054)			(0.020)			(0.053)
L4.(MaP × Δ TG × I)			0.036			-0.055			0.037			-0.055
			(0.033)			(0.091)			(0.033)			(0.091)
L.Δ GDP	2.485***	2.225***	2.218***	2.732***	2.525***	2.514***	2.488***	2.228***	2.222***	2.740***	2.532***	2.521***
	(0.269)	(0.238)	(0.234)	(0.300)	(0.343)	(0.335)	(0.271)	(0.238)	(0.235)	(0.303)	(0.342)	(0.334)
L.Δ Policy rate	-0.657	1.763	1.820	-2.295	-1.086	-0.997	-0.661	1.767	1.824	-2.304	-1.090	-1.001
	(0.794)	(1.570)	(1.503)	(2.418)	(4.339)	(4.212)	(0.789)	(1.569)	(1.502)	(2.418)	(4.338)	(4.211)
Crisis dummy	-4.194***	-4.631***	-4.583***	-5.623***	-6.069***	-6.001***	-4.198***	-4.634***	-4.587***	-5.634***	-6.079***	-6.011***
	(1.514)	(1.326)	(1.319)	(1.870)	(1.648)	(1.626)	(1.517)	(1.327)	(1.321)	(1.873)	(1.650)	(1.628)
Constant	6.025***	7.060***	7.018***	8.604***	9.386***	9.326***	6.021***	7.058***	7.016***	8.597***	9.381***	9.321***
	(1.131)	(0.950)	(0.946)	(1.163)	(1.127)	(1.110)	(1.131)	(0.950)	(0.946)	(1.163)	(1.126)	(1.108)
Observations	2,015	2,015	2,011	1,950	1,950	1,946	2,015	2,015	2,011	1,950	1,950	1,946
Number of countries	37	37	37	37	37	37	37	37	37	37	37	37
Adjusted R-squared	0.250	0.265	0.265	0.252	0.259	0.259	0.250	0.265	0.265	0.253	0.260	0.260

Note: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively. MaP is the different macroprudential policy indexes considered, TG corresponds to the Taylor gap, Δ TG corresponds to the first difference of the Taylor gap, and D and I correspond to the alternative dummy variables capturing the stance of macroprudential and monetary policies.

3.5 Robustness checks

We check the robustness of our previous findings in three ways. First, we replace the change in the nominal policy rate as a control variable by the change in the bank lending rate. Indeed, the transmission of monetary policy to credit markets takes time and transmission delays can differ considerably across countries. A number of empirical studies show that the pass-through of monetary policy shocks to bank lending rates is usually sluggish and incomplete, and depends on a number of determinants (see, e.g., Gigineishvili, 2011; Leroy and Lucotte, 2016; Horváth, 2018). As Illes et al. (2019) argue, there are two main reasons why bank lending rates diverge from policy rates. First, the policy rate is a very short-term rate, while the lending rates to firms and households normally reflect longer-term loans. The spread between the lending and policy rates therefore reflects the maturity risk premium alongside other factors that determine the transmission of monetary policy shocks to bank lending rates. Second, the policy rate does not represent the marginal cost of funds for banks. Banks obtain funds from a variety of sources including retail deposits, senior unsecured or covered bond markets and the interbank market, and these differ in nature from policy rates since they comprise a range of liabilities of different maturities and risk characteristics.

All these reasons certainly explain why our initial findings did not indicate a statistically significant relationship between the change in the policy rate, lagged one period, and the domestic credit growth. Consequently, it is important to check whether our initial findings are robust when we replace the nominal policy rate by the bank lending rate as a control variable. The main issue with the use of bank lending rates is the lack of harmonised data for a large sample of advanced and emerging economies. Then, as it is usual in the bank interest rate pass-through literature (see, e.g., Gigineishvili, 2011), we use data on bank lending rates from different sources. For the euro area countries, we use the average of the composite cost-of-borrowing indicators computed by the European Central Bank (ECB). Four basic categories of lending rates are considered by the ECB: short-term and long-term lending rates both to non-financial corporations and to households for house purchase. For the non-euro area countries, we use the IFS database and, depending on data availability, we complete the database using data provided by national central banks.

To save space, we do not report the results, but detailed results are available upon request. We find that our main results are not impacted by the use of this alternative control variable. We still find a negative and significant relationship between the interaction terms and our measures of domestic credit growth, confirming that a restrictive monetary policy enhances the impact of macroprudential tightening actions on domestic credit growth. Concerning the bank lending rate, similarly to the nominal policy rate, we find that the estimated coefficients associated with the change in the bank lending rate are not statistically significant at the conventional levels.

Second, we take into account the potential sensitivity of the interest rate gap to the Taylor rule specification. To this end, following Colletaz et al. (2018), we consider six alternative Taylor rules (see Table 3.5.1) and compute the median of the resulting Taylor gaps.

Figure 3.5.1 and Figure 3.5.2 summarise the results that we obtain by considering this alternative measure of the Taylor gap when we estimate Equation (3.9) and Equation (3.11).[8] Like with the results discussed in the previous section, we find that the tightening of macroprudential policy tools leads to a reduction in domestic credit growth, even if macroprudential policy actions seem to take time to curb

[8] Detailed results are available upon request.

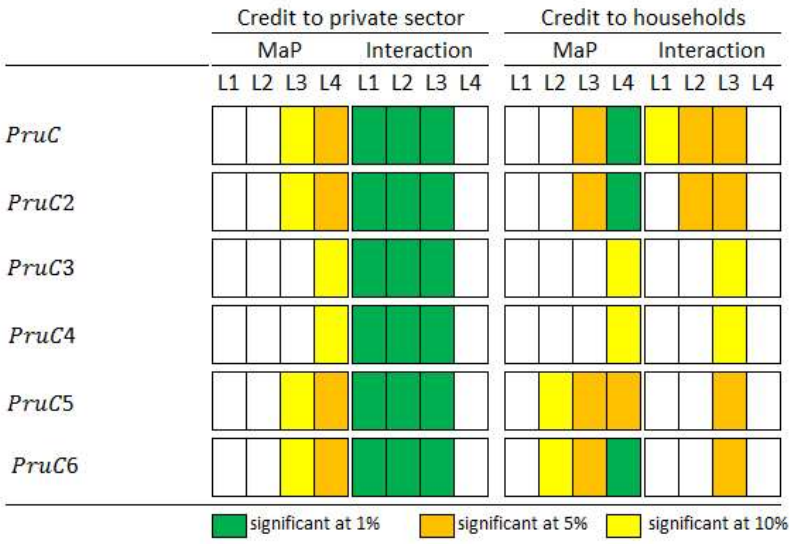
Table 3.5.1: Alternative measures of the monetary policy stance

Benchmark	Definition of the benchmark
Taylor (1)	$i_t^* = 0.9i_{t-1}^* + 0.1\{rr_t^* + \bar{\pi} + 1.5(\pi_t - \bar{\pi}) + 0.5\tilde{y}_t\}$
Taylor (2)	$i_t^* = rr_t^* + \bar{\pi} + 1.5(\pi_t - \bar{\pi}) + 0.5\tilde{y}_t$
Taylor (3)	$i_t^* = 1.5\pi_{t+12} + 0.5\tilde{y}_t$
Taylor (4)	$i_t^* = 0.9i_{t-1}^* + 0.1\{rr_t^* + \bar{\pi} + 1.5(\pi_{t+12} - \bar{\pi}) + 0.5\tilde{y}_t\}$
Taylor (5)	$i_t^* = i_{t-1} + \Delta i_t^*$, with $\Delta i_t^* = 0.5(\pi_{t+12} - \bar{\pi}) + 0.5\Delta\tilde{y}_t$
Interest trend (6)	$i_t^* = HP(i_t)$
Equilibrium real rate	$rr_t^* = \Delta y_t^*$, *with* $y_t^* = HP(y_t)$

Source: Colletaz et al. (2018).
Note: $\tilde{y}_t = (y_t - y_t^*)$, with $y_t^* = HP(y_t)$. $HP(x)$ means Hodrick-Prescott Filter applied to variable x. All measures of the monetary policy stance are computed as the difference between the actual interest rate i_t and the corresponding benchmark i_t^*. $\bar{\pi}$ corresponds to mean inflation over the sample period.

credit growth effectively. As before, the estimated coefficients associated with macroprudential indexes are only significant at the third and fourth order lags for most specifications. More importantly, our results confirm the importance of the monetary policy stance for the effectiveness of macroprudential policy. Regardless the measure of monetary policy stance considered, we find that the interaction term is negative and statistically significant at the conventional levels.

Figure 3.5.1: Robustness checks: results obtained with the median of the alternative Taylor gaps

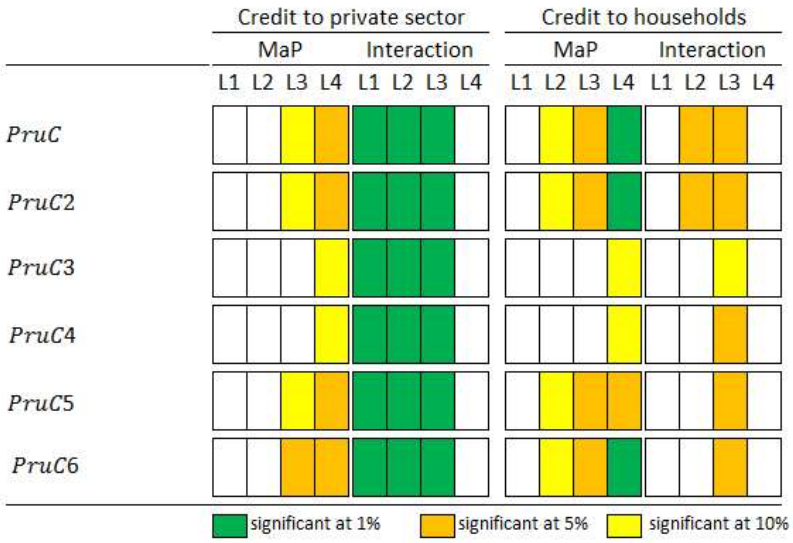


Note: The results reported are obtained by estimating Equation (3.9) and correspond to the coefficient estimates associated with the alternative macroprudential indexes and interaction terms. All significant coefficients have the expected negative sign.

Finally, we check whether our initial results are robust when we consider alternative shadow rate measures. Different empirical approaches have been developed to estimate the shadow rate and gauge the overall monetary policy stance in a zero lower bound environment.[9] Most papers in this literature use a shadow rate term structure model à la Black (1995) to assess the effective stance of monetary policy in the context of unconventional measures (see, e.g., Christensen and Rudebusch, 2014; Krippner, 2015;

[9]See Comunale and Striaukas (2017) for an extensive discussion of the different shadow short rate measures developed in the literature.

Figure 3.5.2: Robustness checks: results obtained with the first difference of the median of the alternative Taylor gaps



Note: The results reported are obtained by estimating Equation (3.11) and correspond to the coefficient estimates associated with the alternative macroprudential indexes and interaction terms. All significant coefficients have the expected negative sign.

Bauer and Rudebusch, 2016; Kortela, 2016; Wu and Xia, 2016; Lemke and Vladu, 2017). However, while all these papers build on the same theoretical approach, they often provide very different results in practice (Lombardi and Zhu, 2018). As shown by Christensen and Rudebusch (2014) and Krippner (2020), this is explained by the fact that shadow short rate estimates are very sensitive to model specification, like the number of factors used for modeling the term structure, the type of approximations chosen, or the way to count for the lower bound.

Given those sensitivities, we consider different shadow rate measures to capture the stance of monetary policy in countries where non-standard monetary policy measures have been implemented. As there is no consensus in the literature on the best shadow rate to be used, we employ an agnostic approach and consider all shadow rates for which we obtained data from the author(s). In total, we have eight different shadow rate measures. However, as the shadow rates are usually estimated for one specific central bank, the number of shadow rate series considered is different for each central bank. Table 3..4 in the Appendix details the shadow short rate measures that we consider, while Figure 4..2 in the Appendix plots the different shadow rate series.

We then compute the median of the different shadow rate series considered, and use this median to calculate the Taylor gap.[10] More precisely, we consider two different Taylor gap series, depending on whether we consider the estimated Taylor rate to compute the Taylor gap ($i_t - \hat{i}_t$), or the median of the six alternative Taylor rates described above.

Figures 3.5.3 to 3.5.6 summarise the results that we obtain by considering alternative shadow rate series to compute the Taylor gap.[11] Figures 3.5.3 and 3.5.4 correspond to the results obtained when we consider the estimated Taylor rate to compute the Taylor gap, while Figures 3.5.5 and 3.5.6 refer to the

[10] Please note that, for the Japan, only the shadow rate estimates provided by Krippner (2015) are available.
[11] Detailed results are available upon request.

results obtained when we consider the median of the six alternative Taylor rules to compute the Taylor gap. As we can see, results are very similar to our initial findings with the Krippner (2015) shadow rate series. In most specifications, we find that the interaction term is negative and statistically significant at the conventional levels. Overall, the different robustness checks conducted in this section confirm that monetary policy stance matters for the effectiveness of macroprudential policy, and reinforce the idea that macroprudential and monetary policies complement each other.

Figure 3.5.3: Robustness checks: Taylor gap computed as the difference between the alternative shadow rate series and the estimated Taylor rate

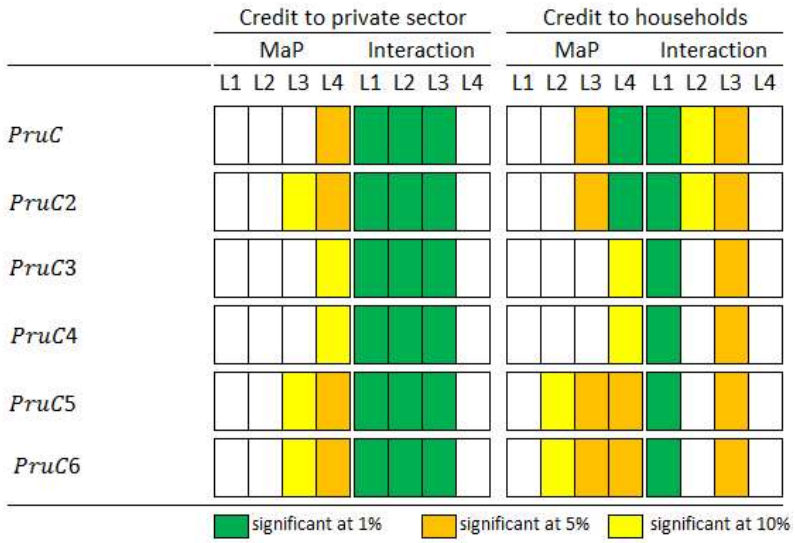


Figure 3.5.4: Robustness checks: first difference of the Taylor gap computed as the difference between the alternative shadow rate series and the estimated Taylor rate

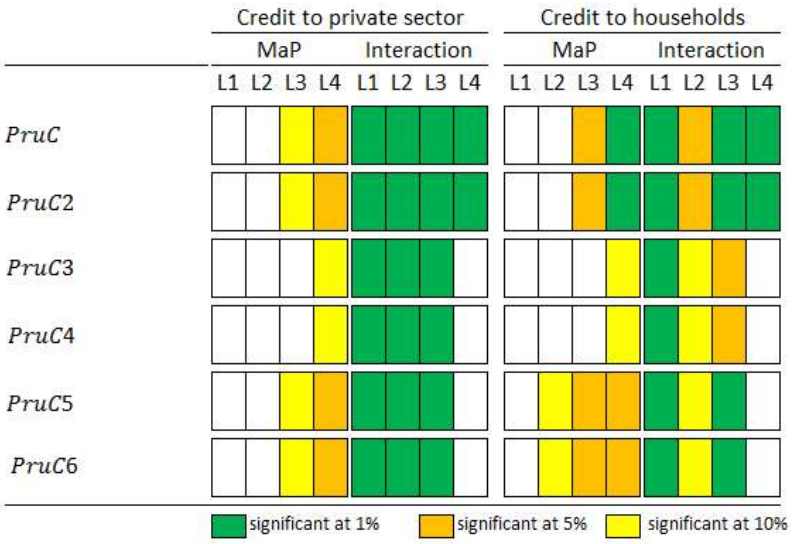


Figure 3.5.5: Robustness checks: Taylor gap computed as the difference between the alternative shadow rate series and the median of Taylor rates

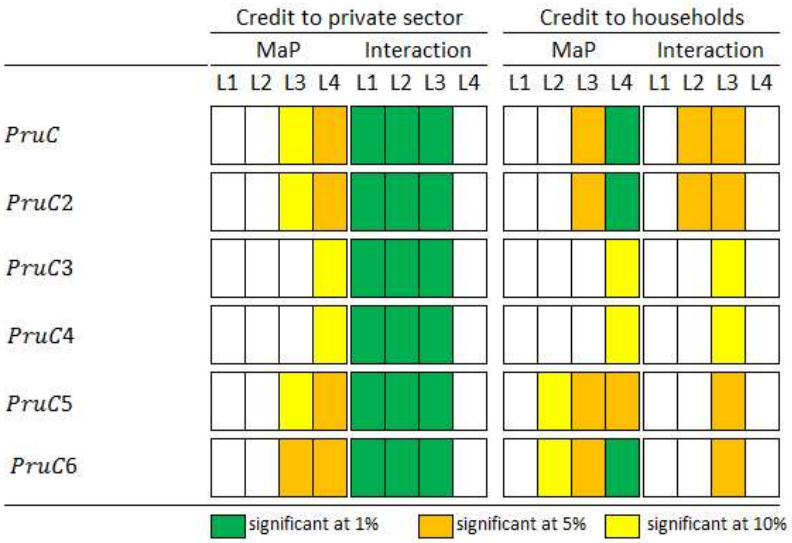
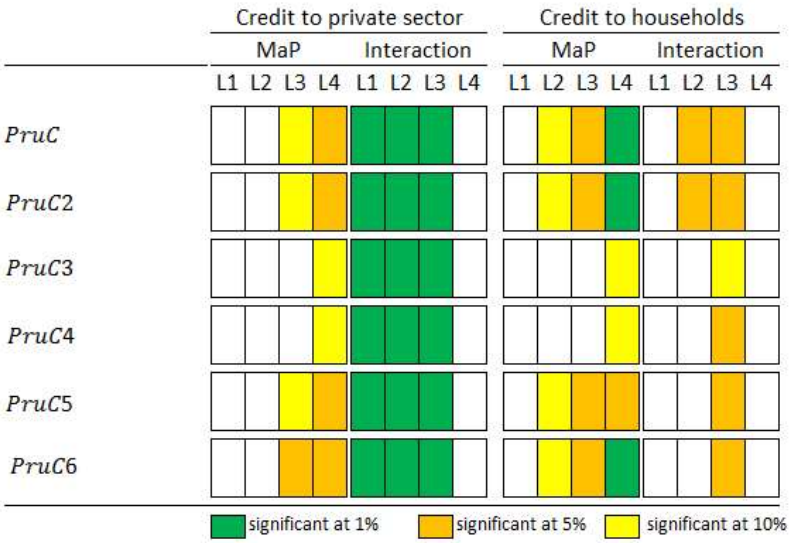


Figure 3.5.6: Robustness checks: first difference of the Taylor gap computed as the difference between the alternative shadow rate series and the median of Taylor rates



3.6 Concluding remarks

Since the 2007-2008 global financial crisis, the conduct of macroprudential policy has raised several important issues. One of them is the interaction of macroprudential and monetary policies, and this issue is currently at the heart of the academic and policy debate. It is well-known that monetary policy can have detrimental side effects on financial stability, while financial stability is the primary objective of macroprudential policy. This means that monetary policy can make macroprudential policy less effective at achieving its objective, and this suggests the need for synchronisation.

A growing number of theoretical studies address this issue and confirm the benefits of coordination between the two policies, but little is known from an empirical standpoint. Our paper fills this gap in the existing literature by providing the first empirical evidence for a large sample of economies on how monetary policy conditions impact the effectiveness of macroprudential policy.

More specifically, we obtain two important results. First, we find that a restrictive monetary policy enhances the impact of macroprudential tightening actions on domestic credit growth. Second, we find evidence that monetary policy helps to reduce the transmission delay of macroprudential policy actions. Our findings then confirm the complementarities between the two policies and the potential benefits of coordination highlighted by the theoretical literature.

To translate this result into a policy recommendation, a crucial open question concerns what the appropriate institutional framework and governance structure for conducting macroprudential policy should be. There is no clear-cut consensus among economists about this issue and in practice countries have implemented different macroprudential policy frameworks. While some countries have assigned macroprudential mandates to an independent council, some other countries have delegated macroprudential regulation to the central bank (see, e.g., Masciandaro, 2018; Masciandaro and Romelli, 2018; Edge and Liang, 2019). This choice of assigning a leading role in macroprudential policy to the central bank is usually justified by the argument that it will facilitate policy coordination between the two policies. It can also ensure that macroprudential policy draws on the expertise of the monetary authority in financial and macroeconomic analysis, and is expected to facilitate analysis of the side effects of each policy. Finally, as most of the central banks around the world are independent of the government, it would be expected that such an institutional arrangement would help to protect the macroprudential policy function from political pressure. This suggests it would be interesting to investigate empirically whether the institutional framework and the governance structure of macroprudential policy are the key drivers of its effectiveness. We leave this issue for further research.

Appendix

Table 3..1: Results obtained with the policy interest rate variation

	$PruC$		$PruC2$		$PruC3$	
	Credit to Private sector	Credit to Households	Credit to Private sector	Credit to Households	Credit to Private sector	Credit to Households
L.MaP	1.246	-0.408	1.265	-0.435	0.483	-0.951
	(1.120)	(1.615)	(1.140)	(1.636)	(0.741)	(1.223)
L2.MaP	-0.388	-2.341	-0.443	-2.404	-0.309	-1.682
	(1.099)	(1.753)	(1.134)	(1.789)	(0.701)	(1.365)
L3.MaP	-1.752	-4.002*	-1.795	-4.033*	-0.873	-2.232
	(1.417)	(2.062)	(1.416)	(2.067)	(1.044)	(1.683)
L4.MaP	-3.227**	-5.704**	-3.198**	-5.645**	-1.849	-3.370*
	(1.580)	(2.249)	(1.573)	(2.250)	(1.200)	(1.869)
L.(MaP × Δ PR × I)	-4.963***	-6.216***	-4.954***	-6.184***	-0.544***	-0.546***
	(0.552)	(0.715)	(0.556)	(0.713)	(0.083)	(0.098)
L2.(MaP × Δ PR × I)	-4.263***	-5.517***	-4.231***	-5.471***	-0.471***	-0.508***
	(1.219)	(1.242)	(1.234)	(1.255)	(0.048)	(0.071)
L3.(MaP × Δ PR × I)	-4.146***	-5.102***	-4.130***	-5.072***	-0.478***	-0.513***
	(1.290)	(1.315)	(1.293)	(1.319)	(0.067)	(0.086)
L4.(MaP × Δ PR × I)	-0.606	-2.097***	-0.613	-2.090***	0.017	-0.077
	(0.390)	(0.522)	(0.381)	(0.510)	(0.076)	(0.100)
L.Δ GDP	2.257***	2.447***	2.255***	2.441***	2.255***	2.469***
	(0.224)	(0.298)	(0.224)	(0.299)	(0.222)	(0.298)
Crisis dummy	-4.733***	-6.053***	-4.725***	-6.032***	-4.786***	-6.083***
	(1.247)	(1.551)	(1.248)	(1.552)	(1.269)	(1.512)
Constant	6.858***	9.719***	6.862***	9.725***	6.706***	9.352***
	(0.910)	(1.107)	(0.911)	(1.108)	(0.901)	(1.083)
Observations	2,007	1,942	2,007	1,942	2,007	1,942
Number of countries	37	37	37	37	37	37
Adjusted R-squared	0.262	0.260	0.262	0.260	0.260	0.252

Note: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively. MaP is the different macroprudential policy indexes considered, Δ PR corresponds to the policy interest rate variation, and I corresponds to the dummy variable capturing the stance of macroprudential and monetary policies.

Table 3..2: Results obtained with the policy interest rate variation

	PruC4		*PruC5*		*PruC6*	
	Credit to Private sector	Credit to Households	Credit to Private sector	Credit to Households	Credit to Private sector	Credit to Households
L.MaP	3.400	-7.615	0.546	-1.230	0.548	-1.223
	(5.621)	(9.215)	(1.038)	(1.457)	(1.033)	(1.447)
L2.MaP	-1.799	-12.138	-0.995	-2.899*	-1.000	-2.918*
	(5.005)	(10.092)	(0.857)	(1.559)	(0.840)	(1.546)
L3.MaP	-6.471	-16.870	-1.984	-4.082**	-2.016*	-4.137**
	(7.521)	(12.432)	(1.203)	(1.878)	(1.187)	(1.857)
L4.MaP	-13.793	-25.559*	-3.006*	-5.348**	-3.069*	-5.423**
	(8.777)	(13.849)	(1.549)	(2.203)	(1.539)	(2.186)
L.(MaP × Δ PR × I)	-4.280***	-4.309***	-1.046***	-1.121***	-1.049***	-1.126***
	(0.639)	(0.756)	(0.144)	(0.172)	(0.144)	(0.173)
L2.(MaP × Δ PR × I)	-3.803***	-4.129***	-0.900***	-1.006***	-0.902***	-1.008***
	(0.371)	(0.554)	(0.100)	(0.128)	(0.098)	(0.127)
L3.(MaP × Δ PR × I)	-3.826***	-4.112***	-0.924***	-1.000***	-0.923***	-0.999***
	(0.499)	(0.646)	(0.100)	(0.124)	(0.098)	(0.121)
L4.(MaP × Δ PR × I)	0.068	-0.681	-0.042	-0.243*	-0.038	-0.241*
	(0.562)	(0.741)	(0.110)	(0.130)	(0.109)	(0.130)
L.Δ GDP	2.255***	2.472***	2.279***	2.492***	2.283***	2.499***
	(0.221)	(0.298)	(0.223)	(0.299)	(0.224)	(0.300)
Crisis dummy	-4.789***	-6.087***	-4.686***	-5.990***	-4.688***	-6.001***
	(1.272)	(1.513)	(1.279)	(1.552)	(1.281)	(1.554)
Constant	6.701***	9.344***	6.757***	9.504***	6.754***	9.499***
	(0.899)	(1.083)	(0.904)	(1.092)	(0.904)	(1.093)
Observations	2,007	1,942	2,007	1,942	2,007	1,942
Number of countries	37	37	37	37	37	37
Adjusted R-squared	0.260	0.253	0.263	0.260	0.264	0.260

Note: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels respectively. MaP is the different macroprudential policy indexes considered, Δ PR corresponds to the policy interest rate variation, and I corresponds to the dummy variable capturing the stance of macroprudential and monetary policies.

Table 3..3: Results of the Taylor rule estimates.

Country	ρ	α	β_π	β_y	Hansen test p-value	Observations	Period of estimation
Argentina	0.554***	9.155***	-0.171	0.392	0.844	85	1993Q2:2015Q3
Australia	0.667***	1.862***	1.247***	0.818	0.128	161	1976Q2:2017Q3
Brazil	0.841***	4.032	1.345**	2.634***	0.569	81	1996Q2:2017Q3
Canada	0.957***	-2.432	2.249***	4.054**	0.160	184	1970Q1:2017Q3
Chile	0.532***	3.016***	0.225	0.731***	0.162	54	2003Q1:2017Q3
Colombia	0.692***	1.702***	0.902***	1.047***	0.105	65	2000Q2:2017Q3
Czech Republic	0.924***	-0.482	0.903***	1.035**	0.140	82	1996Q1:2017Q3
Denmark	0.880***	-0.845	1.367***	0.880***	0.699	86	1995Q1:2017Q3
Euro Area	0.767***	0.450	0.831***	0.626***	0.169	71	1999Q1:2016Q4
Hungary	0.936***	-0.555	0.738***	2.647**	0.326	81	1995Q1:2017Q3
India	0.873***	6.768***	0.0381	1.179***	0.679	75	1996Q3:2017Q3
Indonesia	0.894***	7.538***	-0.0767	1.117***	0.303	80	2005Q3:2017Q3
Israel	0.880***	1.418***	0.723***	0.047	0.283	86	1995Q1:2017Q3
Japan	0.869***	0.178**	0.016	0.087	0.309	72	1994Q1:2013Q1
Korea, Rep.	0.928***	1.070	0.526	2.584***	0.144	69	1999Q2:2017Q3
Mexico	0.561***	2.593***	0.763***	0.521***	0.726	75	1998Q4:2017Q3
New Zealand	0.741***	3.960***	0.805*	1.529**	0.791	117	1988Q1:2017Q3
Poland	0.676***	1.681***	1.275***	0.104	0.228	86	1995Q1:2017Q3
Russian Federation	0.665***	7.356***	0.217***	0.164***	0.254	47	2003Q2:2017Q2
South Africa	0.696***	7.206***	0.464***	1.170	0.240	147	1980Q4:2017Q3
Sweden	0.929***	1.705*	0.914***	0.873	0.437	146	1980Q1:2017Q3
Switzerland	0.917***	0.437	0.763***	0.513**	0.164	186	1970Q1:2017Q3
Thailand	0.897***	0.513	0.847**	-0.280	0.360	66	2000Q2:2016Q4
Turkey	0.839***	0.771	0.877***	1.368***	0.198	61	2002Q1:2017Q3
United Kingdom	0.900***	2.086**	0.705	1.943**	0.290	113	1989Q1:2017Q3
United States	0.828***	-1.036	1.735***	0.920**	0.175	188	1970Q1:2017Q3

Note: *, **, and *** denote statistical significance at the 10%, 5% and 1% level respectively.

Table 3..4: Summary of shadow rate estimates

Paper	Methodology	Central bank	Period
Bauer and Rudebusch (2016)	Mutlifactor shadow rate term structure model, considering both "yields-only" and macro-finance shadow-rate models	ECB	2004Q4-2014Q4
Ichiue and Ueno (2018)	Vector autoregressive (VAR) model based on survey forecasts of macroeconomic variables.	FED	2000Q1-2014Q4
Kortela (2016)	Multifactor shadow rate term structure model with a time-varying lower bound.	ECB	2000Q1-2014Q4
Krippner (2015)	Two-factor term structure model estimated using yield curve data.	ECB, FED, BoE, BoJ	2000Q1-2014Q4
Lemke and Vladu (2017)	Multifactor shadow rate term structure model including the possibility of an occasionally changing and possibly negative effective lower bound.	ECB	2000Q1-2014Q4
Lombardi and Zhu (2018)	Dynamic factor model based on a large set of variables reflecting unconventional monetary policy actions: interest rates, monetary aggregates, Federal Reserve balance sheet.	FED	2000Q1-2014Q4
Pattipeilohy et al. (2017)	Factor model based on yield curve data.	ECB	2004Q4-2014Q4
Wu and Xia (2016)	Multifactor shadow rate term structure model based on a simple analytical representation for bond prices.	ECB, FED, BoE	FED, BoE: 2000Q1-2014Q4 ECB: 2004Q4-2014Q4

Note: ECB: European Central Bank; FED: Federal Reserve; BoE: Bank of England; BoJ: Bank of Japan. The Bauer and Rudebusch (2016) shadow rate series are obtained from Comunale and Striaukas (2017).

Chapter 4

Chapter 4

Macroprudential Policies and Bank Risk-taking under a Persistently Low interest rate Environment

4.1 Introduction

For more than a decade, monetary policy rates in advanced economies have remained at, or near, their effective floor. In the Euro Area, Denmark, Japan, Sweden and Switzerland, have even adopted a negative interest policy rate strategy. In addition, the recent pandemic crisis has shown an even more challenging economic scenario, current low interest rates will continue for longer, and even lower rates will last for much longer. One of the most important concerns of persistent low interest rates environments is related with the banks risk-taking behaviour. Since the global economic turmoil caused by the Global Financial Crisis (GFC), the linkage between interest rates and banks risk-taking behaviour have become one of the main fronts of the economic policy and academic debates.

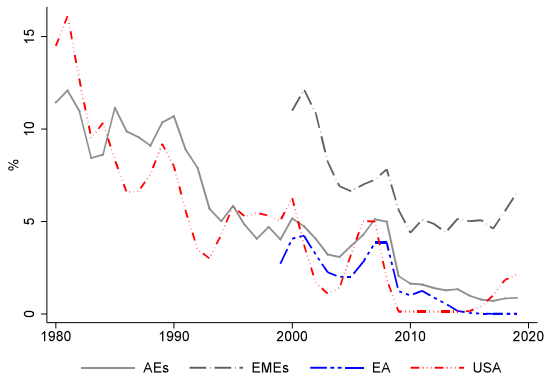
This paper investigate whether macroprudential policies could effectively mitigate the banks risk-taking behaviour under scenarios of extended periods of accommodative monetary policy. And to some extent, it also attempts to determine what kind of macroprudential tools are better suited to offset the negative externalities of monetary policy in such an environment.

The relevance of this study is related to the fact that the adoption of unconventional monetary policies providing additional monetary accommodation continues to push downward a 40-year trend in global nominal interest rates (See Figure 4.1.1a and Figure 4.1.1b), which may exacerbate banks' risk-taking behaviour. Some of the reasons explaining this downward pressure might be the demographic changes, higher propensity to save accompanied with lower propensity to invest, increasing income inequalities, lower total factor productivity and fast transition to a digital economy, where physical capital is no needed (Bean et al., 2015; Villeroy de Galhau, 2020).

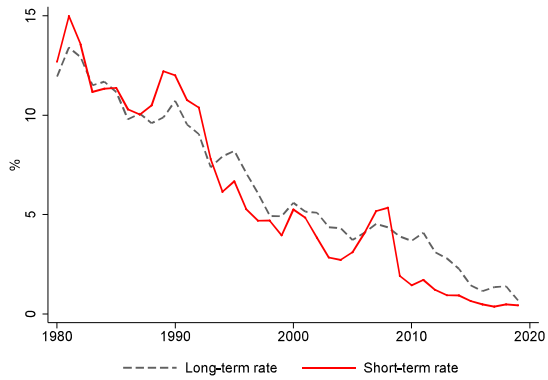
Borio and Zhu (2012) identified the linkage between interest rates and banks' risk-taking behaviour as the risk-taking channel of monetary policy (RTC). According to this channel, one mechanism of transmission is that accommodative monetary policy lowers the yield on the short-term assets relative to that

Figure 4.1.1: Interest Rates

(a) Policy interest rates



(b) Short and Long-term interest rates



Note: Advanced Economies (AEs): Australia, Canada, Denmark, Euro Area, Iceland, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States. Emerging Market Economies (EMEs): Brazil, Chile, China, Colombia, Croatia, Czech Republic, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russian Federation, Saudi Arabia, Serbia, South Africa, Thailand, Turkey. Long and short-term rate are composed of: Australia, Austria, Belgium, Canada, Germany, Denmark, Finland, France, United Kingdom, Irland, Iceland, Italy, Norway, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, United States.

one on the long-term liabilities. Hence, financial institutions may be induced to switch to riskier assets in order to be able to match their obligations. Furthermore, as the monetary policy approaches to the zero lower bound (or reaches the negative zone), interest margins are squeezed even more, pushing financial institutions to search for yield (Rajan, 2006). Therefore, persistent low-interest rates environments might exacerbate further the negative externalities of accommodative monetary policies, more precisely the banks risk-taking behaviour.

In order to counteract these negative externalities, policymakers and academics designated macroprudential policies as the best suited to the task. According to different international institutions, macroprudential policies are designed to identify and mitigate risks to systemic stability, in turn reduce the cost to the economy from a disruption in financial services that underpin the working of financial markets (FSB/IMF/BIS, 2009). Nevertheless, the implementation of macroprudential tools raises several questions regarding their effectiveness due to the difficulty of determining the ultimate objectives; and how the optimal interaction with other economic policies should be, especially with the monetary policy itself. In fact, the interaction with the monetary policy is a major concern that has gained prominence in the academic and policy debate in recent years. Both policies are capable to be complements, reinforcing each other; or to be substitutes, with offsetting effects or mitigating each other.

In the last decade, there have been significant contributions studying the effectiveness of macroprudential tools, though the literature investigating the banks risk-taking behaviour and macroprudential policies is still in its infancy. For instance, previous contributions focus on specific instruments such as the capital-based instruments (Aikman et al., 2015; Acosta-Smith et al., 2020; Anginer et al., 2020), borrower-side measures (Claessens et al., 2013; Acharya et al., 2020), or an aggregate index capturing the overall macroprudential policy (Cecchetti et al., 2017; Altunbas et al., 2018; Meuleman and Vander Vennet, 2020). More recently, the literature went a step further by accounting as well for interactions with the monetary policy. For instance, Gambacorta and Murcia (2020) showed that macroprudential policies are more effective at achieving its objectives when monetary policy goes in the same direction; Maddaloni and Peydró (2013) present evidence that a more stringent borrower-side and capital-targeting

instruments effectively reduce the effects of low monetary policy conditions on softening lending standards; and Altavilla et al. (2020) found that softer monetary policy, combined with softer macroprudential policy, boosts lending for riskier borrowers.

Against this background, this paper contributes to the previous literature by investigating whether macroprudential policies could effectively mitigate the banks risk-taking behaviour under scenarios of extended periods of accommodative monetary policy. And to some extent, it also attempts to determine what kind of macroprudential tools are better suited to offset the negative externalities of monetary policy in such an environment. To do so, this study exploits an unbalanced panel data set covering 1074 commercial banks from 38 countries over the period of 2010 to 2018. Moreover, compared to previous literature that uses the Z-score or the expected default frequency as measures of banks risk-taking (Altunbas et al., 2018; Delis et al., 2017; Segev, 2020), this research considers better-suited variables directly related to risk materialization and the past excessive banks risk-taking behaviour, such as non-performing loans, loans-loss reserves and loan-loss provisions. In addition, in line with Alessandri and Nelson (2015), this paper accounts for monetary conditions with changes in the slope of the yield curve. Under environments where unconventional monetary policies and policy rates bounded at the zero lower bound characterizing the monetary policy, changes in the slope of the yield curve measures monetary conditions more accurately than some measures used in previous researches.

With regard to the main results, this paper complements previous literature by presenting evidence that there has been an increase in the banks risk-taking behaviour during the post-crisis period for a large number of countries. With respect macroprudential policies, this paper extend previous studies threefold. First, it shows that more stringent instruments targeting the borrowers, bank capital and banks' credit management might reduce, and even offset, the effects of accommodative monetary policy conditions on the banks risk-taking behaviour. Second, this research identifies the borrower-based instruments and measures targeting banks' credit management as the most effective instruments to counteract the effects of accommodative monetary policy environments. In addition, accounting for bank specific characteristics, it appears that capital-based and borrower-side instruments are more effective on banks weakly capitalized and with limited liquidity, while instruments targeting banks' credit management are more effective on banks heavily capitalized with abundant liquidity. Finally, it comes out that the tree groups of macroprudential instruments are more effective in markets with strong competition and that the borrower side and credit-management measures are more effective under extreme scenarios of monetary accommodation. The article as a whole provides meaningful insights for policymakers on how, when and on which instrument take policy actions or implement.

The remaining of the paper is structured as follows. Section 4.2 reports the related literature. Sections 4.3 and 4.4 describe the measures of monetary policy and macroprudential policy. Section 4.5 describes the data and the empirical framework. Section 4.6 presents the main results. Section 4.7 presents the heterogeneous effects and robustness checks of the main analysis. Section 4.8 concludes.

4.2 Literature review

The risk-taking channel of the monetary policy, suggests that accommodative monetary policy ease lending conditions and change banks risk-taking behaviour (Borio and Zhu, 2012). With the introduction of unconventional monetary policies and persistently low interest rate, this channel became even more crucial. By exacerbating the risk-taking channel, persistently low-interest-rate environments may drive

central banks with price stability mandate to face a possible inter-temporal trade-off between improving current economic and financial conditions at the cost of increasing future financial vulnerabilities, threatening the overall stability of the financial system (Adrian and Liang, 2018).

There is significant empirical evidence proving that low (persistent) interest rates soften banks' lending standards, distort risk perception, increase leverage and reduce bank monitoring. Given the fast growth of this literature during the last decade, the available evidence applies different methodologies, data sets (e.g., loan-level, bank-level, and bank lending survey), risk measures (e.g., expected default frequency, distance-to-default, Z-score, loan pricing and rating policies, non-performing loans, risk assets ratio), and monetary conditions assessment (Taylor rule residuals, policy interest rate, shadow rates, overnight rates, short- and long-term interest rates, term spreads, shocks based on narrative approaches, real funds rates).[1]

According to this evidence, the potential for "low for too long" policy rates to result in a build-up of financial imbalances and excessive risk-taking seems undeniable. For this reason, more than a decade ago, policymakers saw in macroprudential policies the potential to safeguard the economies against these negative externalities. Since then, the literature has present significant progress regarding the effectiveness of macroprudential policies in persuading financial institutions to incur less risk-taking (see for instance, Aikman et al., 2015; Altunbas et al., 2018; Gropp et al., 2018; Juelsrud and Wold, 2020; Meuleman and Vander Vennet, 2020; Acosta-Smith et al., 2020; Garcia Revelo et al., 2020).[2]

Nevertheless, a major concern that has gained even more prominence in the academic and policy debate in recent years is the interaction between MP and MaP. Given their abilities to be complements, reinforcing each other; or to be substitutes, with offsetting effects or mitigating each other, these interactions have been subject of recent studies (for a comprehensive assessment of the interactions, see for instance Garcia Revelo and Levieuge, 2021).

As complements, previous literature using aggregate cross-country data assessed how the monetary policy could complement the macroprudential policy. Particularly, Garcia Revelo et al. (2020) showed that macroprudential policy is more effective in dampening excessive credit growth when the monetary policy reinforce their actions by going in the same direction. More recently, one could observe these kinds of complementarities at the onset of the Covid-19 pandemic crisis. Central banks and supervisors across the globe simultaneously announced accommodative MP policy actions and less tight macroprudential environments to mitigate the economic consequences of the pandemic.

As substitutes, one could consider a monetary policy following the view of Stein (2013), "leaning against the wind"; the use of looser macroprudential policies to substitute the MP when the zero lower bound constrain lower policy rates (Chadha et al., 2021); the use of strengthening macroprudential policy to stabilize inflation (Peydró et al., 2020); or both policies mitigating each other. As it might be the case of a tighter financial regulation reducing the effects of accommodative monetary policy on lending (Everett et al., 2021) and banks risk-taking, the main driver of this research.

The existing literature studying the latter issue remains scarce. Nonetheless, some exponents have emerged exploiting new macroprudential databases and studying banks' credit policies, the banks risk-taking behaviour. For instance, Maddaloni and Peydró (2013) analyse the impact on lending standards

[1] See for instance, Delis and Kouretas (2011); Maddaloni and Peydró (2011); Altunbas et al. (2014); Ioannidou et al. (2014); Jiménez et al. (2014); Alessandri and Nelson (2015); Angeloni et al. (2015); Paligorova and Santos (2017); Delis et al. (2017); Dell'ariccia et al. (2017); Neuenkirch and Nöckel (2018); Bonfim and Soares (2018); Colletaz et al. (2018); Segev (2020).

[2] Galati and Moessner (2018) present an extensive literature review regarding the effectiveness of macroprudential policies.

of monetary policy rates and macroprudential policy before the GFC. By exploiting the Bank Lending Survey from the E.U. and banks' balance sheet data, the authors present robust evidence that a more stringent macroprudential policy (i.e. Loan-to-Value limits or bank capital regulation) reduce the effects of low monetary policy conditions on softening lending standards. With a different approach, Cecchetti et al. (2017) study the effect of prolonged easing monetary policy on the bank leverage of different publicly listed financial institutions in 22 countries between 1998 and 2014. As an extension of their results, they control for the regulatory environment by introducing in their baseline regression the aggregate macroprudential policy index of Cerutti et al. (2017a), and found that a stringent regulatory environment might reduce the increase of leverage due to prolonged monetary policy accommodation. Whit a more granular assessment, Gambacorta and Murcia (2020) use credit registry data for commercial loans of five Latin American countries and consider the interaction between macroprudential tools and real money rate in their specifications. They find that macroprudential tools are more effective at dampening credit cycles when monetary policies are pushing in the same direction, which supports the view that macroprudential policies and monetary policy reinforce each other. In a more recent empirical work, Altavilla et al. (2020) exploit a biannual loan-level dataset from 2012 to 2017 of several European countries to study how the interaction between monetary policy and macroprudential policy influences bank lending behaviour. Among their results, they find that softer monetary policy, combined with softer macroprudential policy, boosts lending and that this effect is more pronounced for riskier borrowers.

Against this background, this paper contributes to the aforementioned empirical literature in several ways. First, since one of the ultimate objectives of macroprudential policies is to decrease the build-up of systemic risk (FSB/IMF/BIS, 2009), and one of the intermediate objectives is to mitigate and prevent excessive credit growth (ESRB/2013/1), this research goes one step further considering different measures of risk-taking contrary to bank-level risk measures used in the previous literature of the risk-taking channel, the Z-score or the EDF (Altunbas et al., 2014, 2018; Delis et al., 2017; Segev, 2020). In this paper, I consider first a measure of the build-up of systemic risks, such as the banks' excessive credit supply, and then three measures of the risk materialization, non-performing loans, loan-loss provisions, and loan-loss reserves. Using these measures, I found that there has been indeed an increase in the banks risk-taking behaviour during the periods of low interest rates and that macroprudential policies are capable to offset this effect. The latter complements and extends the previous finding of the literature, providing new evidence of the risk-taking channel under periods characterised by persistently low interest rates.

Contrary to previous studies assessing the eased monetary conditions with Taylor residuals or a dummy variable, in line with Alessandri and Nelson (2015), I account for changes in the slope of the yield curve. The main advantage of using the term structure of the yield curve as a proxy of the monetary conditions is that it measures monetary stance accurately during periods where unconventional policies and policy rates bounded at the zero lower bound define the monetary conditions. Furthermore, this variable has a direct impact on banks' decisions and also contains information on short- and long-term interest rates. Therefore, information about the conventional and unconventional monetary policies. Further explanation about this choice is given in Section 4.3.

Finally, this paper contributes to expand the understanding of the banks risk-taking behaviour and the interactions between the monetary policy and macroprudential policies under accommodative monetary conditions. This paper reinforce and complements previous finding from Maddaloni and Peydró (2013) given that the specific variables used in the analysis (non-performing loans, loan-loss reserves, and loan loss provisions) are linked directly with the consequences of softening lending standards due to accommodative

monetary environments. I present new evidence that more stringent capital related measures, borrower-based instruments, and instruments targeting the credit management might reduce and even offset the effects of low monetary policy conditions on the banks risk-taking behaviour. Results show that when the macroprudential policy becomes tighter during an episode of accommodative monetary conditions, it might significantly offset and mitigate the risk-taking channel. To the best of my knowledge, this paper is the first in presenting these results for several countries under the period post-crisis. Moreover, compared to Altavilla et al. (2020) which use a more granular database, this paper complement and extend their results. While Altavilla et al. (2020) focus on the impact of eased conditions from both policies on the risk-taking channel, I focus on the impact of eased monetary conditions and how tighter financial conditions might mitigate that excessive risk-taking from banks. In addition, the authors focus on banks' credit supply and capture banks risk-taking behaviour by looking at the granted loans and the borrowers' past non-performing loan status. Conversely, this paper confirms their findings by looking at the ex-post risk realisation on the banks' non-performing loans.

4.3 Assessing the accommodative monetary policy

The period that I analyse in this study is considered as a period where the policy rate as itself does not provide much information about the stance of the monetary policy. Current monetary policy rates in advanced economies have remained at, or near, their effective floor for more than a decade. In the Euro Area, Denmark, Japan, Sweden, and Switzerland, have even adopted a negative interest policy rate strategy. Moreover, the adoption of unconventional monetary policies providing additional monetary stimulus, continues to push downward global nominal interest rates. In addition, the recent pandemic crisis has shown us an even more challenging economic scenario. Current low interest rates will continue for longer, and even lower rates will last for much longer. Therefore, the way to measure the monetary conditions will be crucial to accurately determine its impact on the banks risk-taking decisions in the subsequent estimations.

The literature has been innovative in the way to assess the monetary policy stance. For instance, Claessens et al. (2018) using a sample of banks in 47 countries between 2005 and 2013, classify each country as under a low rate environment when the 3-month rate of a specific country is below 1.25%. Using similar criteria in the current data would have classified a large part of the countries under "low rate environment" during most of the periods, as the median 3-month rate of the sample is 0.53%. Moreover, even though the short-term interest rate is one of the most widely used indicators of MP stance, it becomes less informative once it reaches the ZLB. During episodes of UMP, the longer-term sovereign rate becomes a better measure of the stance of policy.[3] Another common approach used in the literature is the estimation of a Taylor rule (Taylor, 1993) and subsequently compute the Taylor gap (Maddaloni and Peydró, 2013; Bruno et al., 2017; Dell'ariccia et al., 2017; Garcia Revelo et al., 2020). This methodology effectively approximate the stance of monetary policy in previous studies. However, the time frame of this investigation is characterised by the rise of UMP and interest rates being stuck into lower levels with not much variation, making the policy rate itself not very suited. To address this issue, I could use the shadow rates as a proxy of the stance to the MP (Faia and Karau, 2019).[4] However, the data on shadow rates are not available for all the countries in the sample, and particularly in the Euro Area, the global

[3]For a discussion of how UMP affect long-term rates see, for instance, Gagnon et al. (2011), Wright (2012), Swanson and Williams (2014), and Chen et al. (2018).

[4]Shadow rates can track monetary policy rates in normal times but also in times of unconventional policy (Krippner, 2013; Wu and Xia, 2016; Lombardi and Zhu, 2018).

monetary policy stance does not imply that it would be tighten/loosen for each member of the whole zone due to heterogeneous transmissions (Altavilla et al., 2020). The latter would make differ risk-taking decisions among country members that would not be captured by the single monetary policy stance. A suitable alternative to tackle these issues is by using the term structure of the yield curve (Alessandri and Nelson, 2015; Borio et al., 2017; Cecchetti et al., 2017; Claessens et al., 2018). Monetary policy indeed shapes the yield curve in different ways (Evans and Marshall, 1998; Cochrane and Piazzesi, 2002; Altavilla et al., 2019; Bats et al., 2020).

According to Tillmann (2020), there are two reasons why the term structure of interest rates is closely tracked by central bankers and market participants. First, long-term interest rates should contain information about the public's expectations about future monetary policy, which gives central bankers an idea about the stance of the monetary policy perceived by markets. Second, the term structure itself can be a policy target. Which it is the case for UMP that were designed to reduce long-term interest rates in order to flatten the yield curve at the zero lower bound (likewise in the case of NIRP, see for instance, Boucinha and Burlon, 2020). Moreover, according to his findings, movements in the terms structure of the yield curve due to monetary policy shocks may account for the level of market uncertainty around the MP.

Following the arguments given above, I assess the monetary policy conditions by using the first difference of the slope of the yield curve. Doing so, I account for the fact that risk-taking decisions are forward-looking and can also be shaped by short-term interest rates. Banks' performance, an important factor for the search for yield, depends as well on short-term interest rates. Indeed, the banks' principal source of financing is retail deposits which are their lowest-earning liabilities. Under low-interest rates, and even more so, when we approach the Zero Lower Bound, deposits rates become less sensitive to accommodative monetary policy shocks, which squeezes banks' margins (retail deposits endowment effect, Borio and Gambacorta, 2017) and increase search-for-yield (Alessandri and Nelson, 2015; Bats et al., 2020). Hence, by using this variable, I account in a certain extent the effects the monetary policy (conventional and unconventional) and the future economic expectations over both sides of the banks' balance sheet. Moreover, this identification strategy allows me to exploit the heterogeneity of monetary conditions inherent to each country, even if countries face a similar monetary policy, as is the case of the Euro Area (see Figure 4.3.1).

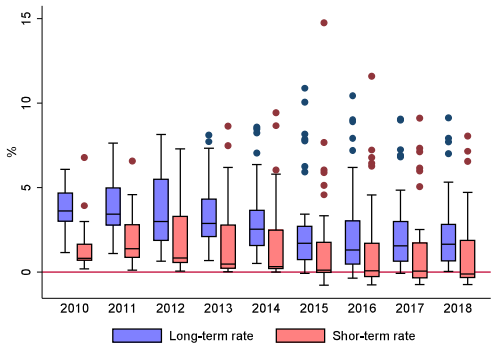
It is important to bear that when estimating the effect of the monetary policy on banks' willingness to increase their risk-taking, in the literature, there is no consensus about the pertinence of using the stance or the innovations of the monetary policy (Segev, 2020). As this paper attempts to assess the banks' willingness to increase their risk-taking during periods of persistent accommodative monetary conditions, variations of the slope of the yield curve may better account for changes in expectations about future economic conditions and monetary policy uncertainty.

4.4 Macroprudential measures

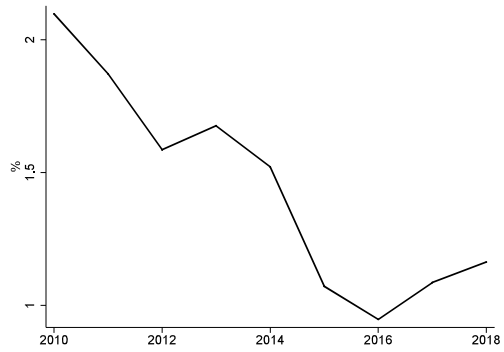
Since the aftermath of the GFC any countries in the developed word have adopted several macroprudential tools, and even more have taken policy actions over these instruments. For this reason, several academics and institutions have put together efforts to collect data and try to track the adoption and policy actions of the wide range of the macroprudential policy toolkit. During the last decade, the quality of databases has improved significantly. For example, the IMF has made significant contributions to international

Figure 4.3.1: Monetary Conditions

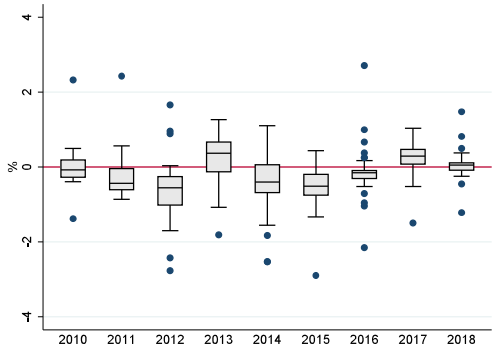
(a) Short and Long-term interest rates



(b) Slope of the yield curve



(c) Changes in the slope of the yield curve



Source: Author's computations.
Note: The box plot in Figure 4.3.1a represents the long-term and short-term rates in the whole sample from 2010 to 2018. The line plot in Figure 4.3.1b represents the mean of the slope of the yield curve of sample from 2010 to 2018. The box plot in Figure 4.3.1c represents the first difference in the slope of the yield curve in the whole sample from 2010 to 2018

databases with their Macroprudential Policy Survey (IMF, 2018). For instance, Cerutti et al. (2017b) and Cerutti et al. (2017a) use the IMF's Macroprudential Policy Survey to construct a macroprudential index. The former, centre on the adoption, construct an aggregate index in which each instrument considered is coded as a simple binary variable, equal to 1 from the time when the element was adopted. The latter, centre on the policy actions, records the number of easing and tightening actions for each macroprudential instrument.

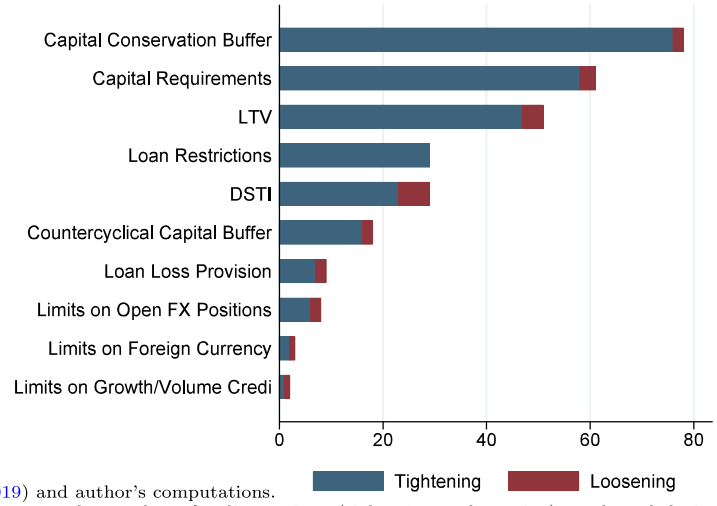
There has been as well contributions from different studies attempting to capture the main changes and direction of macroprudential policy instruments (Vandenbussche et al., 2015; Kuttner and Shim, 2016; Akinci and Olmstead-Rumsey, 2018; Alam et al., 2019), and to differentiate the announcements and the adoption dates (Budnik and Kleibl, 2018).

With regard to this research, I use the more recent IMF's integrated Macroprudential Policy (iMaPP) Database on macroprudential policies, originally constructed by Alam et al. (2019). They integrated databases from Lim et al. (2011, 2013), the Global Macroprudential Policy Instrument (GMPI) survey conducted by the IMF in 2013, Shim et al. (2013), the database by European Systemic Risk Board (ESRB), and the IMF's Annual Macroprudential Policy Survey (IMF survey). They also obtain information from national sources; the Bank for International Settlements (BIS), the Financial Stability Board

(FSB), and the IMF official documents. The final database covers 135 countries from January 1990 to December 2018 in monthly frequency and 17 macroprudential instruments.

The iMaPP database provides dummy-type tightening and loosening indices for each macroprudential instrument. The dummy-type policy action indices take the value of 1 for tightening actions, -1 for loosening actions and zero for no change. It would be preferable to calculate measures of policy intensity for all instruments. However, this presents some difficulties. Many policy instruments are implemented differently across countries, with different definitions of regulated variables, so that the numerical information provided in regulations is often not comparable across countries. For this reason, simple dummy-type variables are more useful to extract information across countries and to characterize the use of macroprudential policy instruments, therefore, making it meaningful to estimate the effects of these instruments per policy action accounting for their direction.

Figure 4.4.1: Total Policy Actions by Macroprudential Policy Tool



Source: Alam et al. (2019) and author's computations.
Note: Figure 4.4.1 represents the number of policy actions (tightening or loosening) conducted during the hole sample period (2010-2018) by macroprudential policy tool used for the analysis.

Against this background, the iMaPP database seems to be the most complete in terms of coverage, frequency, number of instruments and the ability to distinguish the direction of the policies. I proceed then to compute the indexes that I use for the empirical analysis with macroprudential policies as follow:

First, I choose the instruments that are more likely to influence banks risk-taking behaviour, a total of 11 instruments are used in this analysis, and I pool them into three different categories: capital targetting, credit management, and borrower-side measures.

Capital targetting measures (MaP_Capital). It includes requirements for banks to maintain a countercyclical capital buffer, implementations at 0% are not considered as a tightening in dummy-type indicators provided in the iMaPP database. Requirements for banks to maintain a capital conservation buffer. Other capital requirements for banks related to risk weights, systemic risk buffers, and minimum capital requirements.

Credit management measures (MaP_CMg). This category is the one that includes the largest number of instruments of the three categories. It includes loan-loss provision requirements for macroprudential purposes (i.e., dynamic provisioning and sectoral provisions). Limits and penalties on (high) credit growth

or the volume of credit (i.e., aggregate credit, credit to households, or credit to the non-financial sector). Loan limits and prohibitions conditioned to loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans) and bank characteristics. Restrictions on foreign currency lending. Limits on net or gross open foreign exchange positions, limits on foreign exchange exposures and funding, and currency mismatch regulations.

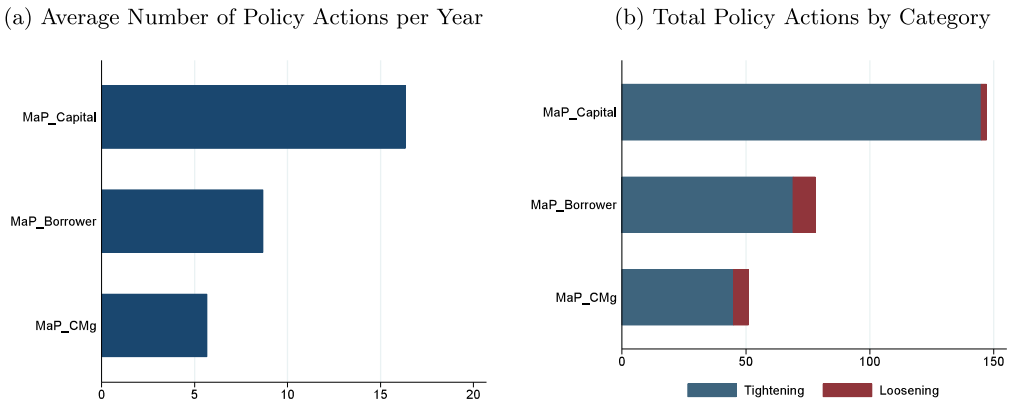
Instruments targeting the borrower side (MaP_Borrower). This category includes limits on the size of debt services or debt related to income (i.e., debt-service-to-income and loan-to-income ratios), and limits to the loan-to-value ratios.

Formally, an index for each category for a given year corresponds sum of the monthly difference between the total of tightening policy actions and the total of loosening actions for all the instruments in the category adopted in an specific country, as follow:

$$MaP_Category_{c,t} = \sum_{i}(x_{i,c,1} + x_{i,c,2} + \cdots + x_{i,c,12}),$$

where $x_{i,c,m}$ corresponds to the monthly policy action taken on the instrument i belonging to the category $MaP_Category_{c,t}$ in the country c. The macroprudential policy actions in the sample are presented in Figure 4.4.2 and Figure 4.4.3.

Figure 4.4.2: Policy Actions by Macroprudential Category



Source: Alam et al. (2019) and author's computations.

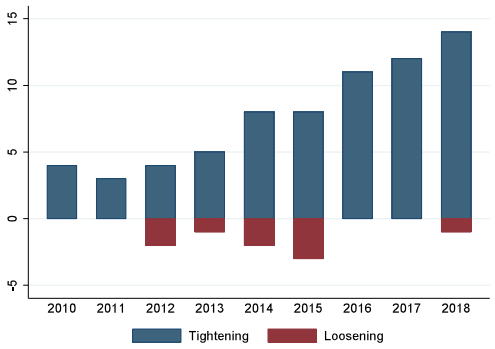
4.5 Empirical strategy

In order to assess the effect of persistent accommodative monetary policy and how macroprudential policies could mitigate the negative externalities of such an environment, I combine different data sources. In this analysis I will focus on commercial banks. Given their business model, commercial banks are impacted by the short-term rates in their deposits side and by the long-term rates in their assets side, which makes commercial banks a better-suited candidate in order to capture the risk-taking channel.[5]

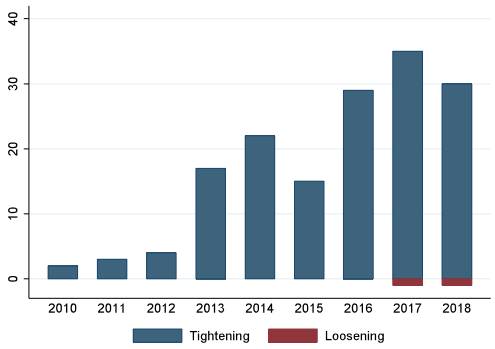
[5]Saving banks for instance will be much more impacted by changes of short-term interest rates due to their higher share of short-term funding. Meanwhile, co-operative banks have a smaller area of operation (region/local/industrial sector) and their risk-taking decisions could be influenced in a certain degree by their shareholders and where they are exerting their business activities.

Figure 4.4.3: Policy Actions per Year by Category

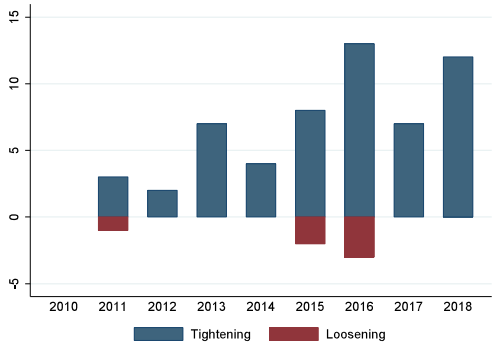
(a) MaP_Borrower



(b) MaP_Capital



(c) MaP_CMg



Source: Alam et al. (2019) and author's computations.

To do so, I use the Bureau van Dijk's BankFocus commercial database which is the primary source of banks' balance sheet variables.

Since Moody's Analytics BankFocus comprises cross-country banks operating in more than one country, banks' balance sheet data can be either consolidated or unconsolidated. Hence, to isolate the effect of a country's interest rates and macroprudential policy actions on only the bank's operations in that country, I keep only unconsolidated banks data. More precisely, I keep unconsolidated banks data with more than three observations during the period 2010-2018. In cases where there is no unconsolidated information available, I keep the consolidated bank. To avoid banks restructuring, merges, possible data omissions, and outliers, I also drop banks with changes on capital or loans superior to 50% over a year, and variables with unusual values. Then, I winsorize all the variables at the top and bottom 1% of the distribution. At the same time I drop unusual values on regulatory capital ratio (above 50% or below 0%), liquid asset over total asset ratios (above 100% or below 0%), risk-weighted assets (RWA) over to total assets (TA) ratio (above 100%), negative shareholders' equity. Applying these filters, I ensure that changes in banks' balance-sheet variables are the result of changes in MP and MaPs. The final bank-country unbalanced panel data set covers 1074 commercial banks, from 38 countries over the period of 2010 to 2018, giving a total of 6883 annual observations.

Regarding the macroeconomic variables, I use data form the OECD (real GDP growth, short- and long-term rates). Descriptive statistics for the bank balance-sheet variables, the macroeconomic series

and the macroprudential policy actions are shown in the appendix section.

4.5.1 Methodology

As it was presented above in the section of the related literature, most of the papers supporting the presence of the risk-taking channel carried their analysis with data form one country and focus on the period before crisis.[6] In this paper, I cover a different timespan (2010 - 2018), and I have a more international approach by including more countries in the same sample. Therefore, I proceed in two steps. First of all, I reinvestigate the presence of the risk-taking channel in a period characterized by persistently low-interest-rate environments. In a second step, I attempt to uncover the befits of macroprudential policies in mitigating the RTC, and to some extent, determine which instruments are better suited to do so.

4.5.2 Identifying the risk-taking channel

In order to identify the effects of low-for-long interest rates environments on banks risk-taking, I proceed to follow the trace of its transmission channel by 3 different sets of variables. (i) I look at the effects of excessively accommodative monetary policy on bank interest related profitability. (ii) I focus therefore on profitability related to loans. (iii) Then, I proceed to delve on how banks' adjust their risk-taking decisions regarding the quantity and quality of granted loans. A key question in this identification is to determine whether the induced risk-taking is actually excessive. Monetary policy has also effects on the aggregate risk aversion and the risk premia, hence, this risk-taking might not be necessarily excessive (Brunnermeier and Sannikov, 2016; Altavilla et al., 2020). However, the increases of the risk-taking can become excessive when monetary policy is persistently accommodative, which is the main characteristic of the sample (Dell'Ariccia et al., 2014). As persistently low policy interest rates squeeze interest margins, and controlling for demand factors, one would expect that banks both increase the quantity and decrease the quality of granted loans. The latter justifies that in the final estimations, I focus on ex-post risk measures that might evidence the effects of the past increase of risk-tanking conditional to the monetary policy environment.

In order to account for a potential delayed effect and for a persistent accommodative monetary policy, this empirical analysis is based on the following general specifications:

$$\begin{aligned} Y_{ic,t} = \alpha + \beta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j}\right) \\ + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}, \text{ where } j = \{0,1\} \end{aligned} \tag{4.1a}$$

$$\begin{aligned} Y_{ic,t} = \alpha + \sum_{j=0}^{1} \beta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j}\right) \\ + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t} \end{aligned} \tag{4.1b}$$

$Y_{ic,t}$ is the vector of dependent variables for each above mentioned stage regarding the bank i in the country c at time t. For the estimation of profitability related to interest income, I consider as

[6] The literature of the RTC in general focus mainly on the period before crisis of an specific country or region. For instance, recent studies like Dell'ariccia et al. (2017), Delis et al. (2017) and Segev (2020) present evidence for the U.S. using bank-level or credit registry data until 2011Q4, 2014Q4 and 2008Q4, respectively.

the dependent variables the interest income over average interest earning assets ($II/Av.IEA$), interest income over average gross loans ($II/Av.GL$), and the net interest margin (NIM). Regarding the profitability related to loan activity, I consider the logarithm of total interest income on loans (ln_TIIL), and the total interest income on loans over gross loans ($TIIL/GL$). To observe the reaction of the quantity of loans, I use the gross loans to total assets ratio (GL/TA). In order to assess the ex-ante risk-taking and the ex-post risk materialization, I gather different measures related to loan-loss reserves, for instance, the loan-loss reserves to gross loans ratio (LLR/GL), and loan-loss reserves to risk-weighted assets ratio (LLR/RWA); non-performing loans, for instance, the non-performing loans to gross loans ratio (NPL/GL), non-performing loans to total assets ratio (NPL/TA); and the loan-loss provisions to average gross loans ratio ($LLP/Av.GL$).

The variable $\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j}$ capture the effect of changes in the term structure of the yield curve accounting for an accommodative monetary environment at time $t-j$ in the country c. The slope of the yield curve is computed for every country by the difference between the ten-year government bond yields and the three-month treasury bill rate, or the money market rate where available. $Fall_Slope_{c,t-j}$ is a dummy equal to 1 when there is a negative change on the term structure of the yield curve (decrease of the slope), and 0 otherwise. One would expect that the coefficient related to this variable may be positive for the profitability analysis, and negative for the risk-taking assessment (the entire term has a negative sign).

According to Tillmann (2020), there are two reasons why the term structure of interest rates is closely tracked by central bankers and market participants. First, long-term interest rates should contain information about the public's expectations about future monetary policy, which gives central bankers an idea about the stance of the monetary policy perceived by markets. Second, the term structure itself can be a policy target. Which it is the case for UMP that were designed to reduce long-term interest rates in order to flatten the yield curve at the zero lower bound (Likewise in the case of NIRP, see for instance, Boucinha and Burlon, 2020). Moreover, according to his findings, movements in the terms structure of the yield curve due to monetary policy shocks may account for the level of market uncertainty around the MP.

Following the arguments given above, I assess the monetary policy conditions by using the first difference of the slope of the yield curve. Doing so, I account for the fact that risk-taking decisions are forward-looking and can also be shaped by short-term interest rates. Banks' performance, an important-factor for the search for yield, depends as well on short-term interest rates. Indeed, the banks' principal source of financing is retail deposits which are their lowest-earning liabilities. Under low-interest rates, and even more so, when we approach the Zero Lower Bound, deposits rates become less sensitive to accommodative monetary policy shocks, which squeezes banks' margins (retail deposits endowment effect, Borio and Gambacorta, 2017) and increase search-for-yield (Alessandri and Nelson, 2015; Bats et al., 2020). Hence, by using this variable, I account in a certain extent the effects the monetary policy (conventional and unconventional) and the future economic expectations over both sides of the banks' balance sheet. Moreover, this identification strategy allows me to exploit the heterogeneity of monetary conditions inherent to each country, even if countries face a similar monetary policy, as is the case of the Euro Area.

$BankC_{ic,t}$ is the vector including variables representing the bank-specific characteristics that are prone to affect profitability and risk-taking and capture the cross-bank heterogeneity over time. So, I account for the bank size by the relative size concerning the market where the bank operates, banks' total assets over

country's total assets ($Share_TA$). I lag this variable by one period. Bank size positively affects profits through economies of scale. Hence, larger banks may apply lower margins thanks to increasing returns to scale, affecting their performance and market-power. However, as the sample includes different kind of markets for the analysis, a rough measure of size proxied by total assets could mislead the interpretation of this variable. Therefore, the banks' share in the total assets of the county is useful for accounting the higher market heterogeneity in the sample.[7] Another important bank-specific characteristic that may influence risk-taking decisions is the bank capitalization. In the literature there are two different effects about level of bank capital, and the predominant one will depend on which channel rules: search-for-yield of risk-shifting. (Dell'ariccia et al., 2017) find that poorly capitalized banks take less risk under low-rate environment that those highly capitalized (risk-shifting channel), while Jiménez et al. (2014) find that least capitalized banks take more risk under low-rate environment (search-for-yield channel). Finally, I control for the deposits over total liabilities ratio, accounting for the short-term funding and liquidity. As it was discussed above, under persistently low interest rates, deposit rates are sticky. Therefore, the share of short-term funding may increase the exposure to low rates and increase risk-taking. Regarding the liquidity, banks having excessive deposit liquidity are less likely to have funding shortfalls in the near future, bank managers will then take more risk (Khan et al., 2017).

$MacroC_{ct}$ is the vector including variables representing the country-specific characteristics that are prone to affect profitability and risk-taking and capture the cross-country heterogeneity over time. I account for the real GDP growth and short term rates, important factors determining banking activity. A higher real GDP growth rate may be associated with higher banking activity, lower credit default rates and better banks' performance, while changes in short-term rates may be associated with demand fluctuation. Finally, η_t and $\nu_i \times \nu_c$ are the time and bank-country fixed effects, respectively. Time fixed effects control for unobservable time-varying common shocks and potential trends on the dependent variables. Bank-country fixed effects eliminate the omitted variable bias through time-invariant factors. Moreover, they control for no-time-varying bank factors that depend on the specific country characteristics where they operate. For instance, these fixed effects account for small banks that behave as large banks in the market where they operate.

4.5.3 What can do macroprudential policies under persistently low-rate environments

As the debate on "Leaning Against the Wind" of the monetary policy remains open since the GFC, the macroprudential policy is the frontline defence against financial imbalances. Indeed, the main objective of macroprudential policies is to dampen excessive risk-taking and to increase agents' soundness and resilience against financial shocks. Consequently, one would expect that macroprudential instruments may be capable of reducing the potential negative externalities of persistently-low interest rates on the banks' willingness to increase risk-taking. In this second stage, I attempt to uncover the potential benefits of macroprudential policies in attenuating the exacerbated risk-taking channel due to "too-low-for-too-long" environments. To do so, I take the same specification as in the first step, and introduce an interaction term with the macroprudential policies and the low-rate environment as follow:

[7] Even though the banks' share in the total assets on the county does not account for all the institutions operating in the market, it accounts for the most representative ones. Hence, it might be considered as a good proxy for the relative banks' size.

$$
\begin{aligned}
Risk_{ic,t} = \alpha &+ \beta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j}\right) \\
&+ \theta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j} \times MaP_{c,t-j}\right) \\
&+ \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}, \text{ where } j = \{0, 1\}
\end{aligned} \tag{4.2a}
$$

$$
\begin{aligned}
Risk_{ic,t} = \alpha &+ \sum_{j=0}^{1} \beta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j}\right) \\
&+ \sum_{j=0}^{1} \theta_j \left(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j} \times MaP_{c,t-j}\right) \\
&+ \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}
\end{aligned} \tag{4.2b}
$$

$Risk_{ic,t}$ represents the ex-post risk measures ($\text{LLR}_{ic,t}/\text{GL}_{ic,t}$, $NPL_{ic,t}/GL_{ic,t}$, $NPL_{ic,t}/TA_{ic,t}$, $ln_Doubt_{ic,t}$, and $LLP_{ic,t}/Av.GL_{ic,t}$) of the bank i in the country c at time t. $MaP_{c,t-j}$ represents the set of macroprudential instruments related to bank capital (MaP_Capital), credit management (MaP_CMg) and borrowers (MaP_Borrower). $\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j} \times MaP_{c,t-j}$ is the interaction term between the macroprudential instruments and the monetary policy conditions, the principal interest variable. If MaPs may be able to mitigate the effects of low interest rates on banks risk-taking, their effect would be observable in the subsequent reduction of the ex-post risk measures. Therefore, one would expect that the coefficient associated with the interaction terms to be positive and significant. The set of macroeconomic- and bank-level controls are the same as in the first step.

Since I am interested in regarding how effective macroprudential policyes are in mitigating the risk-taking channel under low-rates environments, I interested in the marginal effect of the risk-taking channel of the monetary policy, that is:

$$
\frac{\delta\, \Delta Risk_{ic,t}}{\delta(\Delta Slope_{c,t-j} \times Fall_Slope_{c,t-j})} = \beta_j - \theta_j \times MaP_{c,t-j}, \text{ for } j = 0, 1
$$

Therefore, it imply three possibilities: (i) Macroprudential policy tightening completely offset the RTC ($\beta_j < \theta_j$), (ii) macroprudential policy tightening mitigate the RTC ($\beta_j > \theta_j$, with θ_j being significant), and (iii) macroprudential policy tightening does not affect the RTC (θ_j being not significant).

4.6 Results

The empirical analysis focuses on the risk-taking transmission channel of monetary and macroprudential policies. Given that the time frame of the sample is different from previous studies presenting evidence of the existence of the risk-taking channel, the empirical analysis is divided into two sections.

First, I present evidence of the risk-taking channel of persistent accommodative monetary conditions. To do so, I study how the low rates environments have affected banks' interest related profitability and afterwards contemporaneous willingness to supply credit. Then, I look at the banks' ex-post risk materialization measures, which give insights into the quality of previous risk-taking decisions. This procedure identifies a quantity effect on credit supply and a quality effect related to the excessive risk-taking induced by the monetary policy.

In the second part of this section, I present results when introducing the macroprudential instruments

into the regression in order to determine whether they are capable of mitigating the exacerbation of the risk-taking channel under low rates environment. These results would give insights about the effectiveness of macroprudential instruments and which of them is the more suited to address these negative side-effects.

4.6.1 Risk-taking channel and monetary policy

According to Borio and Zhu (2012) the monetary policy can influence bank' risk-taking through the search-for-yield. In fact, the search-for-yield mechanism is more present under low-for-long environments. As interest margin and profitability decrease (Claessens et al., 2018), banks are more prone to take risk. Therefore, results connecting interest related profitability and decreasing slope of the yield curve are presented in Table 4.6.1. Table 4.6.1 presents results estimating Eq. (4.1a) and Eq. (4.1b).[8]

Consistently with the literature on monetary policy and banks' profitability (Alessandri and Nelson, 2015; Claessens et al., 2018; Molyneux et al., 2019), the main findings presented in Table 4.6.1 are threefold. First I find evidence that a decrease in the slope of the yield curve can be associated with contemporaneous reduction in the profitability of interest-earning assets and net interest margins (all the columns (1)). Second, I find evidence that under the period of analysis characterized by persistently low interest rates, a reduction in the slope of the yield curve can be associated with a reduction of the average rate of interest that banks charge on its loans and other interest earning assets (columns (1) of Int. Income/Avg. Int. earning assets, Int. Income/Avg. Loans and T. Int. Income on Loans/Gross Loans). Moreover, this effect might be persistent in the case of Loans even after two years has passed (columns (2) of T. Int. Income on Loans and T.Int.Income on Loans/ Gross Loans). Finally, a reduction in the slope of the yield curve during two consecutively years might be associated with lower net interest margins and lower rates charged on interest earning assets (columns (3) of Int. Income/Avg. Int. earning assets and Net Interest Margin). The latter cannot be confirmed for loans profitability, there is in increase after the second year that might be explained by increasing volumes of loans (Table 4.6.2).

Given that persistently accommodative monetary policy environments reduce interest rates and banks' interest related profitability, in Table 4.6.2, I investigate who banks compensate this negative effect by estimating Eq. (4.1a) and Eq. (4.1b) on the Gross loans to total assets ratio.

I find that under persistent low rates environment, banks attempt to compensate decreasing interest margins through increasing loan portfolio, a quantity effect. Moreover, after 2-year strike of decreasing slope of the yield curve, the volume of loans related to banks' total assets increase even more, which is in line with Altavilla et al. (2020) and their analysis of the bank lending channel. However, this increase on loans does not mean that banks are actually increasing risk-taking or deteriorating the quality of their portfolio. In order to assess this issue, I investigate next the monetary policy effects on ex-post risk measures. If banks engaged in excessive risk-taking and indeed deteriorated the quality of their portfolios, one could observe future increases in loan-loss reserves, non-perming loans, and/or loan-loss provisions.

For instance, banks' loan-loss reserves are reserves against possible losses on impaired of non performing loans. This account will absorb losses from loans that the bank can currently identify as bad loans and from some apparently good loans that for other factors will later be uncollectible. Hence, it represents the banks' perception of risk on their own credit portfolio, which make a measure that could be interpreted as a conscious risk-taking. Increases on loan-loss reserves may be for three reasons: when

[8] I do not test the downward pressure on global profitability because banks may try to offset interest income losses under a low (or negative) interest rate environments by shifting towards more fee-related activities, as well as charging higher fees and increasing their trading income (Bats et al., 2020; Lopez et al., 2020).

Table 4.6.1: Profitability Related to Interest Income

	Int. Income / Avg. Int. earning assets			Int. Income / Avg. Loans			Net Interest Margin			T. Int. Income on Loans (ln)			T. Int. Income on Loans / Gross Loans		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	0.340***		0.379***	0.194***		0.211***	0.180***		0.205***	0.050***		0.048***	0.345***		0.350***
	(0.066)		(0.075)	(0.062)		(0.063)	(0.061)		(0.064)	(0.010)		(0.013)	(0.067)		(0.073)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.017	0.118**		-0.040	0.029		0.037	0.092*		-0.020***	-0.004		-0.110**	0.004
		(0.042)	(0.051)		(0.044)	(0.043)		(0.048)	(0.051)		(0.007)	(0.009)		(0.049)	(0.053)
Share_TA$_{t-1}$	0.002	0.001	0.000	-0.000	0.000	-0.000	0.002	0.001	0.000	0.003**	0.003**	0.003**	-0.001	-0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Equity over assets$_t$	-0.016	-0.014	-0.016	0.014	0.015	0.014	0.066**	0.067**	0.066**	-0.017***	-0.017***	-0.017***	0.067***	0.069***	0.067***
	(0.035)	(0.035)	(0.035)	(0.015)	(0.015)	(0.015)	(0.029)	(0.029)	(0.029)	(0.003)	(0.003)	(0.003)	(0.026)	(0.027)	(0.026)
Liquidity$_t$	-0.002	-0.001	-0.002	-0.004	-0.003	-0.003	0.005	0.006	0.006	0.001	0.001	0.001	0.001	0.002	0.002
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.007)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.006)
GDP growth$_t$	-0.024**	-0.014	-0.026**	-0.024*	-0.013	-0.027**	0.009	0.014	0.008	0.041***	0.045***	0.042***	-0.031**	-0.011	-0.034**
	(0.012)	(0.014)	(0.012)	(0.013)	(0.015)	(0.014)	(0.013)	(0.015)	(0.013)	(0.009)	(0.010)	(0.009)	(0.015)	(0.017)	(0.015)
Short-term rates$_t$	0.356***	0.261***	0.376***	0.383***	0.323***	0.386***	0.018	-0.031	0.031	0.087***	0.073***	0.087***	0.430***	0.325***	0.429***
	(0.027)	(0.028)	(0.027)	(0.024)	(0.025)	(0.025)	(0.032)	(0.030)	(0.032)	(0.007)	(0.006)	(0.008)	(0.030)	(0.028)	(0.030)
Constant	5.125***	5.176***	5.087***	6.042***	5.998***	5.971***	2.507***	2.527***	2.479***	11.291***	11.279***	11.273***	5.062***	5.043***	5.003***
	(0.507)	(0.526)	(0.510)	(0.386)	(0.401)	(0.390)	(0.452)	(0.463)	(0.455)	(0.116)	(0.120)	(0.118)	(0.501)	(0.521)	(0.506)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank $\times$ Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,969	5,912	5,912	5,144	5,094	5,094	6,012	5,955	5,955	5,205	5,155	5,155	5,185	5,135	5,135
Number of Banks	1,018	1,016	1,016	865	863	863	1,049	1,047	1,047	895	893	893	878	876	876
Adj.R^2	0.117	0.0983	0.114	0.237	0.225	0.230	0.0423	0.0378	0.0433	0.155	0.151	0.156	0.195	0.181	0.192

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results on banks' profitability related to interest income. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. Share_TA represents banks' total assets share on the total assets of the country.

Table 4.6.2: Gross Loans

	Gross Loans/Total Assets		
	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.712***		-0.870***
	(0.241)		(0.287)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.257*	-0.481**
		(0.155)	(0.197)
Share_TA$_{t-1}$	0.028	0.032	0.032
	(0.022)	(0.024)	(0.024)
Equity over assets$_t$	0.503***	0.500***	0.505***
	(0.105)	(0.106)	(0.105)
Liquidity$_t$	0.069**	0.068**	0.069**
	(0.030)	(0.031)	(0.031)
GDP growth$_t$	-0.060	-0.087	-0.066
	(0.088)	(0.088)	(0.088)
Short-term rates$_t$	0.208	0.375***	0.108
	(0.139)	(0.111)	(0.156)
Constant	50.628***	50.597***	50.763***
	(2.433)	(2.492)	(2.488)
Time FE	YES	YES	YES
Bank $\times$ Country FE	YES	YES	YES
Observations	6,108	6,051	6,051
Number of Banks	1,050	1,048	1,048
Adj.R^2	0.0723	0.0704	0.0736

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results on banks' Gross Loans. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. Share_TA represents banks' total assets share on the total assets of the country.

it has become apparent that a loan or group of loans is more likely to be in part or wholly uncollectible; an unanticipated charge-off has occurred for which the bank did not set aside reserves; or the amount of loans in the bank's portfolio has increased. The latter is more difficult to identify without knowing the ex-ante riskiness customers profile, as increasing on loans portfolio does not mean necessarily an increase of excessive risk-taking. Therefore I try to control for this factor by including in the regression the GDP growth and the short-term rates as demand factors, and also I use different measures that subtract the effects of the growing loan portfolio (i.e. Loan-loss reserve ratio: the higher the ratio is, the poorer the quality of the loan portfolio will be). In the case of loan-loss provisions, this account represents the need for banks to increase reserves given some unexpected increase of their loans risk profile. Results regarding these variables are presented in Table 4.6.3.

Following the increase of loan supply presented in Table 4.6.2, it seems that there is not only an increase in the amount of loan-loss reserves but also a deterioration of the quality of loan portfolio. One can observe that the loan-loss provisions to average gross loans ratio increases after a contemporaneous relaxation of the monetary conditions (columns (1) and (3)). Furthermore, as the loan-loss reserves with

Table 4.6.3: Loan-Loss Reserves and Loan-Loss Provisions

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$		
	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	0.126		0.023	-0.130*		-0.156**
	(0.103)		(0.121)	(0.067)		(0.062)
$\Delta Slope_t \times$ Fall_Slope$_{t-1}$		-0.242***	-0.237**		0.005	-0.037
		(0.075)	(0.093)		(0.062)	(0.059)
Share_TA$_{t-1}$	0.006	0.005	0.005	0.002	-0.001	-0.001
	(0.006)	(0.006)	(0.006)	(0.003)	(0.002)	(0.002)
Equity over assets$_t$	0.087**	0.085**	0.085**	-0.043**	-0.044**	-0.043**
	(0.035)	(0.035)	(0.035)	(0.019)	(0.019)	(0.019)
Liquidity$_t$	0.012	0.010	0.010	0.001	-0.001	-0.001
	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.004)
GDP growth$_t$	0.041	0.036	0.035	-0.092***	-0.101***	-0.096***
	(0.031)	(0.031)	(0.031)	(0.022)	(0.022)	(0.022)
Short-term rates$_t$	-0.026	-0.073**	-0.066	-0.000	0.044	-0.003
	(0.051)	(0.036)	(0.055)	(0.036)	(0.033)	(0.034)
Constant	1.955**	2.209***	2.205***	1.911***	2.021***	2.053***
	(0.771)	(0.753)	(0.755)	(0.417)	(0.414)	(0.412)
Time FE	YES	YES	YES	YES	YES	YES
Bank × Country FE FE	YES	YES	YES	YES	YES	YES
Observations	5,960	5,905	5,905	5,788	5,732	5,732
Number of Banks	1,041	1,039	1,039	993	991	991
Adj.R^2	0.0428	0.0464	0.0463	0.0341	0.0344	0.0370

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results on banks' Loan-loss Reserves and Loan-Loss Provisions. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. Share_TA represents banks' total assets share on the total assets of the country.

regard to the loan portfolio increase, banks' perception of risk associated with their loans significantly increase the following period after the fall in the slope of the yield curve (columns (2) and (3)).

In order to be sure that loan-loss provisions and loan-loss reserves increase due to higher risk and not due to a larger loan portfolio, in Table 4.6.4 I look at the effects of accommodative monetary policy on non-performing loan. A non-performing loan may be considered as a loan in which the borrower is not able to paid the monthly principal and interest repayments for a specified period. Usually banks classify loans as non-performing when these repayments are due for more than 90 days. It is important to note that banks might have different methodologies in designating a loan as non-performing, which may differ across-countries and within the same country. However, from an economic policy perspective, variations in the level of non-performing loans provide very valuable insights as it is a good indicator of the bank's condition.[9]

Result on the NPL ratio and the NPL to total assets ratio, presented in Table 4.6.4, confirm previous findings. Indeed, a more accommodative monetary condition worsens the bank loan portfolio. One can observe that the share of NPL, related to the total loan portfolio and the total assets, increase after a drop in the slope of the yield curve (columns (1) and (2)). This effect intensifies when there is a persistently falling of the term structure of the yield curve (columns (3)).

[9]In similar a study Cantú et al. (2020) consider the NPL ratio ($NPL/GrossLoans$) as measure of bank risk in order to assess the effect of macroprudential policies on bank risk.

Table 4.6.4: Non-Performing Loans

	$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.263		-0.432**	-0.257**		-0.367***
	(0.174)		(0.193)	(0.109)		(0.120)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.313***	-0.423***		-0.190**	-0.282***
		(0.121)	(0.138)		(0.074)	(0.083)
Share_TA$_{t-1}$	0.018*	0.015	0.015	0.006	0.005	0.005
	(0.010)	(0.010)	(0.010)	(0.006)	(0.005)	(0.006)
Equity over assets$_t$	0.210***	0.207***	0.210***	0.144***	0.141***	0.144***
	(0.062)	(0.061)	(0.062)	(0.032)	(0.032)	(0.032)
Liquidity$_t$	-0.003	-0.006	-0.005	0.005	0.003	0.004
	(0.016)	(0.016)	(0.016)	(0.008)	(0.008)	(0.008)
GDP growth$_t$	0.048	0.027	0.038	0.003	-0.013	-0.004
	(0.064)	(0.063)	(0.063)	(0.044)	(0.043)	(0.043)
Short-term rates$_t$	-0.231**	-0.162**	-0.294***	-0.125**	-0.054	-0.166***
	(0.094)	(0.067)	(0.094)	(0.061)	(0.044)	(0.062)
Constant	3.747***	3.935***	3.994***	1.730**	1.860**	1.907***
	(1.279)	(1.255)	(1.250)	(0.741)	(0.737)	(0.734)
Time FE	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES
Observations	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	982	980	980	959	957	957
Adj.R^2	0.0461	0.0492	0.0523	0.0527	0.0543	0.0604

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results on banks' Non-Performing Loans. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. Share_TA represents banks' total assets share on the total assets of the country.

In summary, I found evidence of a global exacerbation of the risk-taking channel of the monetary policy during the period 2010 to 2018. Past lower and persistent interest rate environments might induced banks search-for-yield by increasing the volume of granted loans in order to compensate interest related profitability losses. This response might be associated with excessive risk-taking because it induces indeed a worsen loan portfolio, which deteriorate the quality of banks assets, and therefore endangering the whole financial stability. This results are in line with previous studies on the risk-taking channel of the monetary policy (Altunbas et al., 2014; Dell'Ariccia et al., 2014; Jiménez et al., 2014; Segev, 2020) and more related studies about concerns on the persistent accommodative monetary conditions (Bean et al., 2015; Borio and Gambacorta, 2017; Cecchetti et al., 2017; Claessens et al., 2018).

4.6.2 What can do macroprudential policies?

Given the evidence presented in the last section, it is understandable that throughout the last decade regulators have been interested in avoiding excessive risk-taking of financial institutions. As was mentioned above, macroprudential policies and the wide variety of instruments are the most suitable to address these concerns. Therefore, in this second step, I study the effectiveness of macroprudential policies in

mitigating the excessive risk-taking presented under low-for-long environments. To do so, I use the same measures related to risk-taking used in previous section and test the effectiveness of the different set of macroprudential instruments. As it was presented in Section 4.3, I group together different instruments with similar targets, for instance, capital measures (MaP_Capital) targeting the resilience of financial institutions, credit-management instruments (MaP_CMg) targeting the credit cycle, and borrower side measures (MaP_Borrower) targeting the borrower resilience. Results are presented in Table 4.6.5 to Table 4.6.8.

Results related to the borrower-side macroprudential instruments are presented in Table 4.6.5. I found that borrower-side measures improve the quality of loans portfolio by reducing exposure to risky customers. One can see this effect in columns (2) related to LLR and LLP, and columns (1) and (2) of NPLs. In the case of the LLR and LLP borrower-side instruments significantly reduce the ex-post risk-taking with a delay, only the lagged interaction term is positive and significant. Given that LLR express banks risk perception of their loan portfolio, a tightening of Map_Borrower under low-rate environment improve credit standards and therefore the quality of new customers is enhanced which is translated in lower LLR and LLP (Maddaloni and Peydró, 2013). Similarly is the case for NPL. What is interesting about these results is that contemporaneous tightening DSTI or LTV does not necessarily entirely offset the current excessive risk-taking, but it does after one period of delay. This result is observable in the columns (3). The current coefficient associated to the triple interaction term is smaller to the effect of decreasing slope of the yield curve, which means that the marginal effect of the monetary policy risk-taking channel is positive ($\beta_t + \theta_t \times MaP_{c,t} > 0$). However, after one period delay the negative externality associated to the risk-taking channel is entirely offset. Expecting the LLR ratio, the marginal effect of the monetary policy risk-taking channel is negative ($\beta_t + \theta_t \times MaP_{c,t} < 0$) when accounting for contemporaneous tightening of the macroprudential borrower-side instruments. For instance,Maddaloni and Peydró (2013) and Acharya et al. (2020) find similar results using the EU bank lending survey and the Irish loan level data, respectively.

Table 4.6.6 presents the results regarding macroprudential instruments concerning bank capital. Even though these instruments aim to improve the resilience of the financial system, there are some beneficial side effects in term of bank risk-taking. Given that rising new capital in order to meet capital regulations is actually expensive, it is not a surprise that banks found a way to meet these requirements cost-efficiently. For instance, an increase in risk-weighted capital requirement make banks to shift their portfolio towards assets with a lower risk-weight to reduce their RWAs and increase their ratio, which is consistent with debt overhang (Acosta-Smith et al., 2019; Gropp et al., 2018). However, this effect might be misleading in some situations due to the degree of discretion that banks have when setting risk weights. The latter gives banks room for manoeuvre regarding the risky assets rebalancing. Therefore, there are two possible interpretations. For instance, Juelsrud and Wold (2020) document that Norwegian banks rise capital ratios by reducing risk-weighted assets, but most of this reductions is accounted for by a reduction in average risk weights. Meanwhile Gropp et al. (2018) present evidence for the Euro Area that banks increase capital ratios by reducing risk-weighted assets, and Imbierowicz et al. (2021) present evidence for German banks that increases in capital requirements are associated with an immediate decrease in total domestic and cross-border lending. Results presented in Table 4.6.7 are in line to some extent with the mentioned above. I find that tightening of capital restrictions contemporaneously to the falling slope of the yield curve might reduce excessive risk-taking through a rebalancing effect on the assets side. Which explains why the tightening in previous periods does not have effect on risk measures. Taking a closer look at the gross loans to total assets ratio, gross loans to risk-weighted assets ratio and the

Table 4.6.5: MaP Instruments Related to Borrowers

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	0.117		0.014	-0.134**		-0.156**	-0.278		-0.441**	-0.269**		-0.373***
	(0.106)		(0.123)	(0.067)		(0.063)	(0.177)		(0.194)	(0.112)		(0.122)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.163		0.203	0.083		0.005	0.275**		0.267**	0.195**		0.169*
	(0.138)		(0.135)	(0.064)		(0.064)	(0.138)		(0.115)	(0.092)		(0.087)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.252***	-0.250***		0.002	-0.040		-0.331***	-0.446***		-0.201***	-0.297***
		(0.076)	(0.096)		(0.063)	(0.060)		(0.122)	(0.140)		(0.075)	(0.085)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.279***	0.302***		0.114**	0.110**		0.538***	0.543***		0.333***	0.331***
		(0.091)	(0.092)		(0.049)	(0.048)		(0.148)	(0.143)		(0.101)	(0.100)
Share_TA$_{t-1}$	0.006	0.005	0.004	0.002	-0.002	-0.001	0.017*	0.014	0.014	0.006	0.004	0.004
	(0.006)	(0.006)	(0.006)	(0.003)	(0.002)	(0.002)	(0.010)	(0.010)	(0.010)	(0.006)	(0.005)	(0.006)
Equity over assets$_t$	0.087**	0.085**	0.085**	-0.043**	-0.045**	-0.043**	0.210***	0.206***	0.210***	0.144***	0.141***	0.144***
	(0.035)	(0.035)	(0.035)	(0.019)	(0.019)	(0.019)	(0.062)	(0.062)	(0.062)	(0.032)	(0.032)	(0.032)
Liquidity$_t$	0.012	0.010	0.010	0.000	-0.001	-0.001	-0.004	-0.006	-0.005	0.005	0.003	0.004
	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.004)	(0.016)	(0.016)	(0.016)	(0.008)	(0.008)	(0.008)
GDP growth$_t$	0.048	0.035	0.042	-0.090***	-0.100***	-0.094***	0.060	0.026	0.047	0.011	-0.014	0.002
	(0.032)	(0.031)	(0.031)	(0.022)	(0.022)	(0.022)	(0.065)	(0.062)	(0.064)	(0.046)	(0.042)	(0.045)
Short-term rates$_t$	-0.026	-0.073**	-0.066	-0.000	0.045	-0.002	-0.230**	-0.160**	-0.292***	-0.125**	-0.053	-0.165***
	(0.051)	(0.036)	(0.055)	(0.036)	(0.033)	(0.034)	(0.094)	(0.066)	(0.093)	(0.060)	(0.043)	(0.061)
Constant	1.951**	2.204***	2.193***	1.915***	2.022***	2.054***	3.744***	3.925***	3.978***	1.727**	1.853**	1.895***
	(0.769)	(0.752)	(0.751)	(0.417)	(0.414)	(0.412)	(1.277)	(1.253)	(1.247)	(0.741)	(0.736)	(0.733)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,960	5,905	5,905	5,788	5,732	5,732	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,041	1,039	1,039	993	991	991	982	980	980	959	957	957
Adj.R^2	0.0430	0.0473	0.0476	0.0342	0.0346	0.0369	0.0463	0.0504	0.0535	0.0530	0.0556	0.0617

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results related to the effectiveness of borrower-side macroprudential instruments on the banks risk-taking behaviour. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. $MaP \times \Delta Slope \times$ Fall_Slope represents the triple interaction of the previous variable with the borrower-side macroprudential instruments. Share_TA represents banks' total assets share on the total assets of the country.

Table 4.6.6: MaP Instruments Related to Bank Capital

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.334***		-0.357***	-0.061		-0.134***	-0.780***		-0.823***	-0.528***		-0.558***
	(0.129)		(0.124)	(0.054)		(0.050)	(0.205)		(0.200)	(0.132)		(0.129)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.322***		0.339***	-0.048		-0.072*	0.368***		0.380***	0.193***		0.192***
	(0.059)		(0.068)	(0.038)		(0.042)	(0.098)		(0.113)	(0.061)		(0.070)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.179	-0.108		0.041	0.039		-0.445**	-0.335*		-0.318***	-0.249**
		(0.135)	(0.127)		(0.047)	(0.047)		(0.178)	(0.172)		(0.107)	(0.105)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.037	0.039		-0.021	-0.077**		0.077	0.079		0.075	0.047
		(0.051)	(0.051)		(0.036)	(0.039)		(0.084)	(0.084)		(0.052)	(0.051)
Share_TA$_{t-1}$	0.004	0.005	0.003	0.002	-0.001	-0.001	0.015	0.015	0.012	0.005	0.005	0.003
	(0.006)	(0.006)	(0.006)	(0.003)	(0.002)	(0.002)	(0.010)	(0.010)	(0.010)	(0.006)	(0.005)	(0.005)
Equity over assets$_t$	0.083**	0.084**	0.081**	-0.042**	-0.045**	-0.043**	0.205***	0.208***	0.205***	0.141***	0.143***	0.142***
	(0.035)	(0.035)	(0.035)	(0.019)	(0.020)	(0.019)	(0.062)	(0.062)	(0.062)	(0.032)	(0.032)	(0.032)
Liquidity$_t$	0.014	0.010	0.012	0.000	-0.001	-0.001	-0.001	-0.006	-0.003	0.006	0.003	0.005
	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.004)	(0.016)	(0.016)	(0.016)	(0.008)	(0.008)	(0.008)
GDP growth$_t$	0.002	0.034	-0.001	-0.085***	-0.102***	-0.087***	0.003	0.031	-0.001	-0.021	-0.009	-0.023
	(0.032)	(0.031)	(0.032)	(0.021)	(0.022)	(0.021)	(0.065)	(0.064)	(0.065)	(0.046)	(0.043)	(0.046)
Short-term rates$_t$	0.094	-0.074**	0.116*	-0.017	0.044	-0.060*	-0.092	-0.160**	-0.078	-0.053	-0.052	-0.055
	(0.057)	(0.036)	(0.068)	(0.039)	(0.033)	(0.035)	(0.104)	(0.066)	(0.110)	(0.066)	(0.043)	(0.070)
Constant	1.822**	2.210***	2.001***	1.926***	2.020***	2.103***	3.585***	3.941***	3.769***	1.649**	1.865**	1.796**
	(0.752)	(0.754)	(0.738)	(0.416)	(0.415)	(0.410)	(1.258)	(1.255)	(1.232)	(0.736)	(0.737)	(0.728)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,960	5,905	5,905	5,788	5,732	5,732	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,041	1,039	1,039	993	991	991	982	980	980	959	957	957
Adj.R^2	0.0591	0.0465	0.0611	0.0348	0.0345	0.0397	0.0531	0.0495	0.0582	0.0578	0.0553	0.0644

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results related to the effectiveness of macroprudential instruments targeting banks' capital on the banks risk-taking behaviour. The top of the table lists the dependent variables. $\Delta Slope \times$Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. $MaP \times \Delta Slope \times$Fall_Slope represents the triple interaction of the previous variable with the macroprudential instruments targeting banks' capital. Share_TA represents banks' total assets share on the total assets of the country.

risk-weighted assets, capital instruments reduce the banks search-for-yield effect, implying less exposure to risky customers, which in turn explain the reduction on the loan-loss reserves and non-performing loans.

Table 4.6.7: Bank Capital instruments and Banks' Exposure to Risk

	Gross Loans/Total Assets			Gross Loans/Risk-weighted Assets			Risk-weighted Assets (ln)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Map Capital$_t$	-0.147		-0.093	-0.002		-0.001	-0.016**		-0.015**
	(0.130)		(0.120)	(0.004)		(0.004)	(0.007)		(0.007)
Map Capital$_{t-1}$		-0.376***	-0.361***		-0.014***	-0.014***		-0.008	-0.005
		(0.140)	(0.131)		(0.005)	(0.005)		(0.008)	(0.008)
Share_TA$_{t-1}$	0.027	0.027	0.027	0.000	0.000	0.000	-0.002	-0.002	-0.002
	(0.022)	(0.022)	(0.022)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Equity over assets$_t$	0.497***	0.496***	0.495***	-0.008*	-0.008*	-0.008*	-0.024***	-0.025***	-0.024***
	(0.106)	(0.106)	(0.106)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
Liquidity$_t$	0.068**	0.066**	0.066**	0.002*	0.002*	0.002*	-0.004**	-0.004**	-0.004**
	(0.030)	(0.030)	(0.030)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
GDP growth$_t$	-0.087	-0.070	-0.073	0.003	0.003	0.003	-0.017	-0.017	-0.017
	(0.087)	(0.088)	(0.088)	(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.011)
Short-term rates$_t$	0.409***	0.386***	0.391***	-0.007	-0.009	-0.009	0.010	0.011	0.009
	(0.112)	(0.111)	(0.112)	(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)
Constant	50.635***	50.815***	50.854***	1.045***	1.056***	1.056***	24.349***	24.349***	24.353***
	(2.437)	(2.441)	(2.440)	(0.122)	(0.122)	(0.122)	(0.170)	(0.166)	(0.166)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6,108	6,108	6,108	3,195	3,195	3,195	3,197	3,197	3,197
Number of Banks	1,050	1,050	1,050	750	750	750	750	750	750
Adj.R^2	0.0702	0.0716	0.0716	0.0290	0.0330	0.0328	0.103	0.101	0.103

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table present results explaining how instruments targeting bank capital might reduce the banks risk-taking behaviour. The top of the table lists the dependent variables. Map Capital represents the macroprudential instruments targeting banks' capital. Share_TA represents banks' total assets share on the total assets of the country.

Results on macroprudential instrument aiming credit management are presented in Table 4.6.8. Based on columns (1) to (3) for each variable, I find that credit management instruments effectively prevent the ex-ante excessive risk-taking. The coefficient associated to the triple interaction variable ($MaP_{t-j} \times \Delta Slope_{t-j} \times$ Fall_Slope$_{t-j}$) is positive and statistically significant, which means that under low-interest rate environments a tightening of credit management instruments mitigates the associated excessive risk-taking. Furthermore, the marginal effect of current and past excessive risk-taking under persistently low-rates environments is entirely offset by the tightening of MaP_CMg ($\beta_j + \theta_j \times MaP_{c,t-j} < 0$), making them the most efficient among the set of macroprudential instruments considered in this study.

Accounting for the limitations of the data, the evidence presented above give some insights about the effectiveness of macroprudential policies in mitigating banks risk-taking under persistently low rates environments. The fact that borrower-side and credit management measures might be considered as the most effective instruments is not trivial. Both type of measures end in limiting banks exposure to credit, either by improving the quality of their portfolio or avoiding excessive credit growth, which is translated in lower risk-taking. Regarding the bank capital restrictions, even though their aim is not precisely to reduce risk-taking, the side-effects of bypassing the law seem to contain the bank risk appetite, which at the end is also translated in to a more resilient system.

As it is usual in the literature related to the risk-taking channel, the results presented above might vary according to bank specific characteristics and market conditions. Banks do not react similarly to tightening of macroprudential policies. For instance, poorly capitalized banks might be more constrained by the tightening of capital measures. However, the effect would depend on the liquidity constraints and

Table 4.6.8: MaP Instruments Related to Credit Management

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.237**		-0.615***	-0.182***		-0.218***	-0.548***		-0.939***	-0.548***		-0.939***
	(0.092)		(0.106)	(0.067)		(0.055)	(0.163)		(0.183)	(0.163)		(0.183)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	2.249***		1.578***	0.332***		0.308***	1.836***		1.214***	1.836***		1.214***
	(0.197)		(0.173)	(0.120)		(0.105)	(0.381)		(0.273)	(0.381)		(0.273)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.114	-0.425***		0.012	-0.074		-0.224*	-0.560***		-0.224*	-0.560***
		(0.078)	(0.087)		(0.062)	(0.058)		(0.125)	(0.137)		(0.125)	(0.137)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		1.526***	0.961***		0.068	-0.004		1.080***	0.843***		1.080***	0.843***
		(0.153)	(0.139)		(0.097)	(0.086)		(0.302)	(0.249)		(0.302)	(0.249)
Share_TA$_{t-1}$	0.009	0.000	0.004	0.003	-0.002	-0.001	0.020*	0.012	0.014	0.020*	0.012	0.014
	(0.006)	(0.006)	(0.005)	(0.003)	(0.002)	(0.002)	(0.011)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
Equity over assets$_t$	0.079**	0.073**	0.075**	-0.045**	-0.045**	-0.045**	0.207***	0.201***	0.205***	0.207***	0.201***	0.205***
	(0.035)	(0.035)	(0.035)	(0.020)	(0.020)	(0.020)	(0.061)	(0.060)	(0.060)	(0.061)	(0.060)	(0.060)
Liquidity$_t$	0.006	0.006	0.004	-0.000	-0.001	-0.002	-0.007	-0.009	-0.010	-0.007	-0.009	-0.010
	(0.010)	(0.010)	(0.009)	(0.004)	(0.004)	(0.004)	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)	(0.015)
GDP growth$_t$	0.071**	-0.015	0.028	-0.087***	-0.105***	-0.091***	0.071	-0.007	0.030	0.071	-0.007	0.030
	(0.032)	(0.032)	(0.032)	(0.022)	(0.022)	(0.022)	(0.064)	(0.063)	(0.064)	(0.064)	(0.063)	(0.064)
Short-term rates$_t$	-0.344***	0.034	-0.368***	-0.046	0.048	-0.055*	-0.487***	-0.085	-0.523***	-0.487***	-0.085	-0.523***
	(0.052)	(0.038)	(0.055)	(0.038)	(0.032)	(0.031)	(0.098)	(0.072)	(0.089)	(0.098)	(0.072)	(0.089)
Constant	3.049***	2.849***	3.478***	2.070***	2.051***	2.213***	4.589***	4.365***	4.950***	4.589***	4.365***	4.950***
	(0.735)	(0.737)	(0.707)	(0.417)	(0.419)	(0.412)	(1.241)	(1.240)	(1.210)	(1.241)	(1.240)	(1.210)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,960	5,905	5,905	5,788	5,732	5,732	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,041	1,039	1,039	993	991	991	982	980	980	982	980	980
Adj.R^2	0.146	0.137	0.177	0.0392	0.0347	0.0408	0.0687	0.0644	0.0816	0.0687	0.0644	0.0816

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table presents results related to the effectiveness of macroprudential instruments targeting banks' credit-management policies on the banks risk-taking behaviour. The top of the table lists the dependent variables. $\Delta Slope \times$ Fall_Slope represents the interaction term between the variation of the slope of the yield curve and the dummy variable equal to one whether this variation is negative. $MaP \times \Delta Slope \times$ Fall_Slope represents the triple interaction of the previous variable with the macroprudential instruments targeting banks' credit-management policies. Share_TA represents banks' total assets share on the total assets of the country.

their ability of adjusting their balance sheet given their specific market conditions. Therefore, in the following section, I delve deeper in the heterogeneous effectiveness of macroprudential polices and stress previous results.

4.7 Extensions and robustness

In this section, I extend the previous analysis to delve into how banks risk-taking behaviour and the effects of macroprudential instruments differ depending on bank-specific characteristics and market characteristics. For instance, the level of capitalization might lower incentives for risk-taking as higher bank capital implies more "skin in the game" for the banks' shareholders, hence more losses in case of default (Repullo, 2004). Furthermore, banks having excessive deposits and abundant liquidity are less likely to have funding shortfalls soon, encouraging them to take riskier positions (Khan et al., 2017). Finally, market concentration and the level of monetary accommodation might have different effects on the banks risk-taking behaviour. Therefore, I test whether macroprudential policies reduce risk-taking incentives for banks heavily capitalised, with abundant liquid assets, strong reliance on deposits, high market power and under deeper monetary accommodation. To this end, I insert interaction terms that are the products of macroprudential indicators, monetary policy and bank-specific and market characteristics as follows:

$$\begin{aligned} Risk_{ic,t} = {} & \alpha + \beta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j}\right) + \theta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j} \times MaP_{c,t-j}\right) \\ & + \delta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j} \times MaP_{c,t-j} \times D^{q^{th}}_{ic,t-j}\right) \\ & + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}, \text{ where } j = \{0, 1\} \end{aligned} \tag{4.3a}$$

$$\begin{aligned} Risk_{ic,t} = {} & \alpha + \sum_{j=0}^{1} \beta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j}\right) \\ & + \sum_{j=0}^{1} \theta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j} \times MaP_{c,t-j}\right) \\ & + \sum_{j=0}^{1} \delta_j \left(\Delta Slope_{c,t-j} \times Fall_{c,t-j} \times MaP_{c,t-j} \times D^{q^{th}}_{ic,t-j}\right) \\ & + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t} \end{aligned} \tag{4.3b}$$

where $D^{q^{th}}_{ic,t-j}$ is a dummy variable equal to one whether the bank-specific or the market-specific characteristic of bank i is in the upper tail and lower tail of the distribution, the 25^{th} and 75^{th} percentiles, respectively. Result are presented in Table 4..1 to Table 4..5.

Contrary to Altunbas et al. (2018), Table 4..1 results indicate that bank-capital measures are more likely to constrain risk-taking from weakly capitalized banks, while credit-management instruments have a stronger effect on heavily capitalized banks, the upper tail of the distribution. In line with Gropp et al. (2018) and Juelsrud and Wold (2020), a possible explanation for this result might be that weakly capitalized banks are more constrained by capital targetting measures, which force banks to incur in more portfolio rebalancing in order to comply with the regulator. Meanwhile, instruments targeting banks' credit-management define specific limits to credit growth and exposures, which are harder to bypass and always binding for event heavily capitalized banks. Regarding the borrower-based measures, there is no

differential effect regarding the level of capitalization.

Table 4..2 and Table 4..3 present results related to liquidity and deposit intensity, respectively. In line with Altunbas et al. (2018), macroprudential instruments targeting bank capital have limited effect on banks with abundant liquidity and higher deposit. Nonetheless, macroprudential instruments targeting banks' credit-management are more likely to reduce risk-taking incentives of banks with abundant liquidity and deposits. With respect to borrower-based instruments, results are mixed. Table 4..2 presents evidence that these instruments have a stronger effect on banks with abundant liquidity, but in Table 4..3 shows that there is no stronger effect on banks with lower incidence of wholesale funding (high deposits).

According to Whited et al. (2021), low rates environments depress bank profits from the deposit market as competition from cash intensifies, consequently increasing banks risk-taking. Therefore, I examine next whether the effect of macroprudential policies might be affected by the market power of banks. To do so, the market power of banks is proxied by the Lerner index computed with the efficiency stochastic frontier analysis following Koetter et al. (2012) and with the alternative profit efficiency function from Berger and Mester (2003). In line Whited et al. (2021), results presented in Table 4..4 show that macroprudential policies might be effective on banks with weak market power (higher competition). More precisely, borrower-side, capital-based and credit-management measures mitigate the risk-taking of banks in highly competitive markets. However, there is no significant effect of tightening these measures when there is a high concentration in the financial system. It is even counterproductive in the case of borrower-side instruments.

Regarding the level of monetary accommodation, Table 4..5 present results with a dummy variable accounting for banks under the lower interest rate environment in the sample (the 25^{th} percentile of the level of the slope of the yield curve). As one would expect, macroprudential policies have stronger effect under environments of deeper monetary accommodation. More precisely, macroprudential policies targeting borrowers indebtedness and the banks' credit management seem to be more effective under such environments.

Finally, I extend previous results in two ways. First, I remove the dummy variable $Fall_{c,t-j}$ from the interaction term in Eq. (4.2a) and Eq. (4.2b) as follows (results are presented in Table 4..6 and are in line with previous results):

$$
\begin{aligned}
Risk_{ic,t} &= \alpha + \beta_j \left(\Delta Slope_{c,t-j}\right) + \theta_j \left(\Delta Slope_{c,t-j} \times MaP_{c,t-j}\right) \\
&\quad + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}, \text{ where } j = \{0, 1\} \\
Risk_{ic,t} &= \alpha + \sum_{j=0}^{1} \beta_j \left(\Delta Slope_{c,t-j}\right) + \sum_{j=0}^{1} \theta_j \left(\Delta Slope_{c,t-j} \times MaP_{c,t-j}\right) \\
&\quad + \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}
\end{aligned}
$$

Next, I consider the existence of asymmetric effects for a tightening and an easing of macroprudential policies with the following specifications (results are presented in Table 4..7):

$$
\begin{aligned}
Risk_{ic,t} = \alpha &+ \beta_j \Delta Slope_{c,t-j} \\
&+ \theta_{T,j} \left(\Delta Slope_{c,t-j} \times MaP_T_{c,t-j}\right) + \theta_{L,j} \left(\Delta Slope_{c,t-j} \times MaP_L_{c,t-j}\right) \\
&+ \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}, \text{ where } j = \{0, 1\}
\end{aligned} \tag{4.5a}
$$

$$
\begin{aligned}
Risk_{ic,t} = \alpha &+ \sum_{j=0}^{1} \beta_j \Delta Slope_{c,t-j} \\
&+ \sum_{j=0}^{1} \theta_{T,j} \left(\Delta Slope_{c,t-j} \times MaP_T_{c,t-j}\right) + \sum_{j=0}^{1} \theta_{L,j} \left(\Delta Slope_{c,t-j} \times MaP_L_{c,t-j}\right) \\
&+ \gamma' \cdot BankC_{ic,t} + \psi' \cdot MacroC_{ct} + \eta_t + \nu_i \times \nu_c + \varepsilon_{ic,t}
\end{aligned} \tag{4.5b}
$$

where $MaP_T_{c,t-j}$ and $MaP_L_{c,t-j}$ are dummy variables equal to 1 when the overall direction of the specific group of macroprudential measures (Borrower, Capital or Credit Management measures) is tightening or loosening, respectively.

In summary, in line with Altunbas et al. (2018), I found that the effects are not symmetric. Macroprudential policies are more effective while tightening than in loosening episodes. For instance, loosening borrower-based measures under accommodative monetary environments results in a exacerbation of the risk-taking channel ($MaP_L_t \times \Delta Slope_t > 0$ when $\Delta Slope_t < 0$), while a tightening presents a delay of transmission but counteracts the negative effects of such an environment effectively. In the case of Capital measures, relaxing these instrument does not increase ex-post risk-taking measures as one would expect (coefficients related to $MaP_L_t \times \Delta Slope_t$ are not statistically significant), while tightening these measures reduce banks risk-taking effectively in the short- and mid-term. Finally, it appears that measures targeting banks' credit management are effective in both directions, coefficients related to $MaP_L_t \times \Delta Slope_t$ and $MaP_T_t \times \Delta Slope_t$ are statistically significant in most of the specifications.

As robustness test, in Table 4..8, I consider the Z-score which has been very often used in the literature as a measure of bank risk. Indeed, the Z-score measures the number of standard deviations a return realisation has to fall in order to deplete equity, under the assumption of normality of bank returns. A higher Z-score implies a lower probability of insolvency risk. Therefore, increasing risk-taking might decrease future bank returns under the hypothesis of ex-ante risky borrowers defaulting. Hence, one would expect that under low-interest rate environments an increase of current banks risk-taking might reduce future values of the Z-score, and a restricted macroprudential policy might counteract this effect. In line with Altunbas et al. (2018) and Altavilla et al. (2020), results in Table 4..8 suggest that macroprudential policies might reduce bank risk, which comforts previous results.

4.8 Concluding remarks

The economic aftermath of the global financial crisis left the world with monetary policy rates at their lowest level in history. For more than a decade, interest rates have steadily declined until reaching their effective floor and even becoming negative in some regions. In addition, the recent pandemic crisis has shown us that current low interest rates will continue for longer, and even lower rates will last for much longer. This challenging economic scenario brought "low-for-long" interest rates, banks risk-taking behaviour, and macroprudential policies to become one of the main fronts of policy and academic debates.

This paper focuses on the effectiveness of macroprudential policies to offset the exacerbation of the risk-taking channel due to persistently low-interest-rate environments. While the previous literature concentrates on variables related to overall bank risk (Z-score, or EDF), this paper goes one step further by looking at the ex-post realisation of the excessive banks risk-taking, which manifests in the non-performing loans and the loan-loss reserves and provisioning. To do so, this paper use bank-level data for 38 countries over the period of 2010 and 2018, characterised particularly for persistently low interest rates.

The evidence presented above give important policy insights about the effectiveness of macroprudential policies and its ability to mitigate banks risk-taking under persistently low rates environments. More stringent borrower-based measures, capital-based instruments, and instruments targeting the credit management might reduce, and even offset, the effects of accommodative monetary policy conditions on the banks risk-taking behaviour. Being the more effective instruments the borrower-based (if tightened a year ahead) and the credit-management measures. The latter provides evidence of the potential complementarities of macroprudential policies with the monetary policy.

Concerning bank specific characteristics, it appears that capital-based and borrower-side instruments are more effective on banks weakly capitalized and with limited liquidity, while instruments targeting banks' credit-management are more effective on banks heavily capitalized and with abundant liquidity. Moreover, it comes out that the tree groups of macroprudential instruments are more effective in markets with strong competition. Regarding the monetary environment, the more accommodative become the monetary policy, the borrower-side, and credit-management measures are more suitable for limiting the excessive banks risk-taking.

A key policy implication of previous results is that the negative externalities regarding the excessive risk-taking of persistent accommodative monetary policy characterizing the last decade, and very likely to persist for even longer, could be significantly mitigated by macroprudential policies. Particularly when the regulator tighten borrower-based and credit-management measures. However, given the current economic scenario of post-pandemic crisis, it may be required further investigation regarding the potential real effects that a tightening macroprudential policies might have on the global economy recovery, which represent an important concern for future research.

Appendix

Appendix Chapter 4

This appendix presents all the tables of results of Section 4.7. Table 4..1 presents results related to bank capitalization. Table 4..2 and Table 4..3 present results related to bank liquidity and deposit intensity, respectively. Table 4..4 presents results related to market concentration. Table 4..5 presents results related to extreme scenarios of monetary accommodation. Table 4..6 presents results without the dummy variable $Fall_{c,t-j}$. Table 4..7 presents results on the asymmetric effect of macroprudential policies. Table 4..8 presents results using the Z-score as an alternative measure.

Table 4..1: Level of Capitalization (TE/TA)

(a) MaP Instruments Related to Borrowers

	GL/Total Assets			$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.728***		-0.872***	0.116		0.015	-0.133**		-0.155**	-0.279		-0.442**	-0.267**		-0.371***
	(0.245)		(0.293)	(0.106)		(0.122)	(0.067)		(0.063)	(0.177)		(0.194)	(0.112)		(0.122)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.213		0.216	0.147		0.146*	0.156***		0.060	0.243*		0.221**	0.246**		0.210**
	(0.314)		(0.340)	(0.090)		(0.082)	(0.057)		(0.053)	(0.142)		(0.108)	(0.096)		(0.083)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.246	-0.471**		-0.251***	-0.247***		0.003	-0.041		-0.330***	-0.444***		-0.200***	-0.298***
		(0.155)	(0.199)		(0.075)	(0.093)		(0.063)	(0.060)		(0.122)	(0.139)		(0.074)	(0.084)
$MaP_{t-1} \times \Delta Slope_t \times \text{Fall_Slope}_{t-1}$		-0.294	-0.292		0.256***	0.272***		0.095**	0.099**		0.532***	0.542***		0.310***	0.321***
		(0.344)	(0.360)		(0.072)	(0.074)		(0.048)	(0.048)		(0.132)	(0.129)		(0.088)	(0.088)
$D_t^{p(75^{th})}$															
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.420		0.433	0.126		0.433	-0.523*		-0.399	0.239		0.348	-0.388		-0.311
	(1.124)		(1.234)	(0.784)		(0.713)	(0.280)		(0.281)	(0.436)		(0.397)	(0.262)		(0.256)
$D_{t-1}^{p(75^{th})}$															
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		3.022***	2.789**		0.305	0.371		0.297	0.192		0.095	0.007		0.325	0.126
		(1.088)	(1.139)		(0.688)	(0.665)		(0.203)	(0.202)		(1.025)	(1.035)		(0.699)	(0.702)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6,108	6,050	6,050	5,960	5,904	5,904	5,787	5,732	5,731	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,050	1,048	1,048	1,041	1,039	1,039	993	991	991	982	980	980	959	957	957
Adj.R^2	0.0721	0.0709	0.0737	0.0429	0.0472	0.0477	0.0349	0.0345	0.0372	0.0461	0.0503	0.0532	0.0530	0.0555	0.0615

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	GL/Total Assets			$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.803***		-0.645**	-0.330**		-0.360***	-0.059		-0.144***	-0.810***		-0.844***	-0.548***		-0.572***
	(0.275)		(0.267)	(0.130)		(0.125)	(0.054)		(0.053)	(0.206)		(0.203)	(0.133)		(0.130)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.031		0.007	0.324***		0.343***	-0.047		-0.072*	0.355***		0.368***	0.184***		0.183***
	(0.132)		(0.174)	(0.059)		(0.068)	(0.038)		(0.042)	(0.097)		(0.113)	(0.061)		(0.070)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-1.032***	-1.014***		-0.192	-0.113		0.028	0.027		-0.441**	-0.352**		-0.314***	-0.260**
		(0.273)	(0.267)		(0.136)	(0.129)		(0.048)	(0.049)		(0.176)	(0.173)		(0.106)	(0.105)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.453***	0.345***		-0.041	0.032		-0.024	-0.083**		0.079	0.081		0.076	0.049
		(0.113)	(0.124)		(0.051)	(0.052)		(0.036)	(0.038)		(0.085)	(0.086)		(0.052)	(0.052)
$D_t^{p(25^{th})}$															
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.693***		0.901***	-0.097		-0.167**	-0.038		-0.038	0.679*		0.503	0.453**		0.342*
	(0.192)		(0.238)	(0.084)		(0.084)	(0.083)		(0.085)	(0.361)		(0.353)	(0.181)		(0.207)
$D_{t-1}^{p(25^{th})}$															
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.044	0.269		0.299***	0.247**		0.299	0.316		-0.094	0.088		-0.090	0.042
		(0.238)	(0.266)		(0.097)	(0.107)		(0.312)	(0.331)		(0.249)	(0.209)		(0.128)	(0.140)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6,108	6,050	6,050	5,960	5,904	5,904	5,787	5,732	5,731	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,050	1,048	1,048	1,041	1,039	1,039	993	991	991	982	980	980	959	957	957
Adj.R^2	0.0726	0.0740	0.0756	0.0590	0.0476	0.0623	0.0347	0.0370	0.0425	0.0551	0.0493	0.0591	0.0603	0.0552	0.0655

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	GL/Total Assets			$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	0.087		0.375	-0.236**		-0.624***	-0.182***		-0.188***	-0.547***		-0.940***	-0.371***		-0.557***
	(0.234)		(0.280)	(0.092)		(0.106)	(0.067)		(0.055)	(0.163)		(0.188)	(0.106)		(0.126)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-3.757***		-3.450***	1.658***		1.236***	0.299**		0.164	1.249***		0.810**	0.512**		0.269
	(0.627)		(0.598)	(0.230)		(0.182)	(0.124)		(0.104)	(0.417)		(0.328)	(0.236)		(0.202)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.585***	0.003		-0.090	-0.414***		0.006	-0.093		-0.203	-0.551***		-0.158**	-0.339***
		(0.167)	(0.208)		(0.079)	(0.089)		(0.063)	(0.059)		(0.129)	(0.141)		(0.078)	(0.088)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-2.010***	-0.594		1.086***	0.722***		0.175	0.133		0.722**	0.619**		0.285*	0.312**
		(0.526)	(0.459)		(0.199)	(0.170)		(0.130)	(0.117)		(0.306)	(0.251)		(0.155)	(0.133)
$D_t^{p(75^{th})}$															
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-2.386***		-1.401*	1.061***		0.575*	0.058		0.462*	1.069		0.748	0.387		0.440
	(0.837)		(0.777)	(0.340)		(0.296)	(0.213)		(0.259)	(0.695)		(0.603)	(0.413)		(0.408)
$D_{t-1}^{p(75^{th})}$															
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-2.153***	-0.872		0.784***	0.392		-0.188	-0.417*		0.645	0.317		0.115	-0.037
		(0.710)	(0.713)		(0.284)	(0.279)		(0.200)	(0.247)		(0.554)	(0.515)		(0.305)	(0.298)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	6,108	6,050	6,050	5,960	5,904	5,904	5,787	5,732	5,731	5,630	5,579	5,579	5,630	5,579	5,579
Number of Banks	1,050	1,048	1,048	1,041	1,039	1,039	993	991	991	982	980	980	959	957	957
Adj.R^2	0.122	0.110	0.125	0.153	0.144	0.183	0.0390	0.0354	0.0436	0.0712	0.0659	0.0837	0.0629	0.0584	0.0733

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..2: Level of Liquidity (Liquid Assets/TA)

(a) MaP Instruments Related to Borrowers

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	0.121		0.012	-0.141**		-0.156**	-0.288		-0.441**	-0.272**		-0.373***
	(0.106)		(0.123)	(0.067)		(0.063)	(0.176)		(0.194)	(0.111)		(0.122)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.144		0.164*	0.187***		0.059	0.466***		0.310**	0.289**		0.239**
	(0.116)		(0.098)	(0.063)		(0.052)	(0.174)		(0.142)	(0.126)		(0.108)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.253***	-0.251***		0.002	-0.041		-0.332***	-0.448***		-0.202***	-0.298***
		(0.076)	(0.095)		(0.063)	(0.060)		(0.122)	(0.140)		(0.075)	(0.085)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.345***	0.367***		0.188***	0.188***		0.686***	0.703***		0.419***	0.431***
		(0.121)	(0.121)		(0.065)	(0.065)		(0.192)	(0.191)		(0.134)	(0.136)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.051		0.162	-0.259*		-0.122	-0.564*		-0.098	-0.378**		-0.188
	(0.317)		(0.290)	(0.150)		(0.143)	(0.299)		(0.208)	(0.170)		(0.136)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.276*	-0.281*		-0.237**	-0.240**		-0.553**	-0.587**		-0.325**	-0.359**
		(0.143)	(0.145)		(0.102)	(0.100)		(0.265)	(0.263)		(0.156)	(0.157)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,992	5,904	5,903	5,811	5,731	5,728	5,658	5,579	5,578	5,661	5,579	5,579
Number of Banks	1,043	1,039	1,038	993	991	990	984	980	979	959	957	957
Adj.R^2	0.0422	0.0477	0.0480	0.0344	0.0347	0.0369	0.0460	0.0506	0.0535	0.0527	0.0558	0.0618

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.335***		-0.370***	-0.071		-0.141***	-0.780***		-0.841***	-0.525***		-0.563***
	(0.129)		(0.124)	(0.055)		(0.051)	(0.204)		(0.201)	(0.132)		(0.129)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.328***		0.371***	0.024		0.004	0.274**		0.344**	0.161**		0.179**
	(0.077)		(0.100)	(0.071)		(0.074)	(0.117)		(0.141)	(0.073)		(0.080)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.186	-0.115		0.041	0.037		-0.452**	-0.341**		-0.320***	-0.251**
		(0.135)	(0.127)		(0.047)	(0.047)		(0.177)	(0.172)		(0.107)	(0.105)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.065	0.161*		-0.017	-0.043		0.229*	0.246*		0.111	0.098
		(0.067)	(0.083)		(0.050)	(0.049)		(0.121)	(0.141)		(0.075)	(0.079)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	-0.002		-0.035	-0.086		-0.090	0.106		0.048	0.030		0.016
	(0.066)		(0.084)	(0.076)		(0.078)	(0.106)		(0.128)	(0.062)		(0.069)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.119*	-0.146*		-0.004	-0.040		-0.178	-0.197		-0.042	-0.060
		(0.061)	(0.079)		(0.060)	(0.062)		(0.130)	(0.155)		(0.081)	(0.089)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,992	5,904	5,903	5,811	5,731	5,728	5,658	5,579	5,578	5,661	5,579	5,579
Number of Banks	1,043	1,039	1,038	993	991	990	984	980	979	959	957	957
Adj.R^2	0.0585	0.0478	0.0625	0.0360	0.0343	0.0407	0.0525	0.0502	0.0592	0.0570	0.0553	0.0645

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.236**		-0.635***	-0.190***		-0.192***	-0.562***		-0.983***	-0.377***		-0.584***
	(0.092)		(0.105)	(0.067)		(0.055)	(0.162)		(0.185)	(0.105)		(0.125)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	1.567***		1.222***	0.477***		0.207	0.884*		0.483	0.351		0.130
	(0.227)		(0.176)	(0.181)		(0.153)	(0.518)		(0.490)	(0.351)		(0.330)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		-0.092	-0.408***		0.003	-0.090		-0.184	-0.522***		-0.147*	-0.321***
		(0.078)	(0.088)		(0.063)	(0.059)		(0.127)	(0.139)		(0.078)	(0.087)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.954***	0.633***		0.310*	0.261		0.168	0.150		0.021	0.067
		(0.212)	(0.194)		(0.174)	(0.160)		(0.238)	(0.188)		(0.171)	(0.124)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	0.930***		0.403	-0.184		0.255	1.292*		0.813	0.497		0.401
	(0.312)		(0.246)	(0.225)		(0.236)	(0.699)		(0.665)	(0.448)		(0.452)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.777***	0.470*		-0.322	-0.449*		1.248***	1.009***		0.449*	0.389
		(0.281)	(0.274)		(0.216)	(0.240)		(0.449)	(0.390)		(0.272)	(0.238)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,992	5,904	5,903	5,811	5,731	5,728	5,658	5,579	5,578	5,661	5,579	5,579
Number of Banks	1,043	1,039	1,038	993	991	990	984	980	979	959	957	957
Adj.R^2	0.149	0.142	0.181	0.0394	0.0364	0.0431	0.0706	0.0689	0.0870	0.0625	0.0600	0.0751

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..3: Share of Deposits (Deposits/Liabilities)

(a) MaP Instruments Related to Borrowers

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	0.121		0.013	-0.141**		-0.155**	-0.288		-0.440**	-0.272**		-0.373***
	(0.105)		(0.123)	(0.067)		(0.063)	(0.176)		(0.194)	(0.111)		(0.122)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.189		0.243	0.127*		0.039	0.306**		0.282**	0.159		0.157
	(0.156)		(0.151)	(0.069)		(0.067)	(0.152)		(0.122)	(0.107)		(0.096)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.252***	-0.251***		0.002	-0.040		-0.331***	-0.446***		-0.202***	-0.297***
		(0.076)	(0.096)		(0.063)	(0.060)		(0.122)	(0.140)		(0.075)	(0.085)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.274***	0.302***		0.153***	0.151***		0.568***	0.569***		0.350***	0.342***
		(0.100)	(0.101)		(0.055)	(0.053)		(0.162)	(0.157)		(0.112)	(0.110)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-0.201		-0.183	-0.375*		-0.288	-0.245		-0.106	0.016		0.075
	(0.163)		(0.151)	(0.207)		(0.200)	(0.257)		(0.231)	(0.133)		(0.130)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.030	-0.049		-0.370**	-0.380**		-0.273	-0.235		-0.161	-0.115
		(0.141)	(0.141)		(0.152)	(0.170)		(0.326)	(0.327)		(0.185)	(0.188)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,902	5,902	5,815	5,730	5,730	5,659	5,578	5,578	5,661	5,577	5,577
Number of Banks	1,043	1,038	1,038	993	990	990	984	979	979	959	956	956
Adj.R^2	0.0422	0.0473	0.0476	0.0344	0.0347	0.0372	0.0457	0.0503	0.0532	0.0523	0.0556	0.0615

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.333***		-0.353***	-0.068		-0.135***	-0.783***		-0.827***	-0.525***		-0.561***
	(0.129)		(0.124)	(0.054)		(0.050)	(0.203)		(0.200)	(0.132)		(0.129)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.291***		0.294***	-0.047		-0.070	0.361***		0.397***	0.179**		0.195**
	(0.063)		(0.075)	(0.054)		(0.057)	(0.110)		(0.125)	(0.070)		(0.077)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.180	-0.105		0.041	0.039		-0.450**	-0.342**		-0.322***	-0.253**
		(0.136)	(0.128)		(0.047)	(0.047)		(0.178)	(0.174)		(0.108)	(0.106)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.051	0.010		-0.016	-0.071		0.154	0.165		0.121*	0.096
		(0.059)	(0.065)		(0.049)	(0.049)		(0.105)	(0.108)		(0.065)	(0.063)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.065		0.083	-0.003		-0.003	0.004		-0.026	0.015		-0.004
	(0.052)		(0.059)	(0.062)		(0.065)	(0.102)		(0.117)	(0.061)		(0.070)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.027	0.052		-0.010	-0.011		-0.142	-0.158		-0.085	-0.090
		(0.054)	(0.062)		(0.065)	(0.069)		(0.116)	(0.131)		(0.072)	(0.081)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,902	5,902	5,815	5,730	5,730	5,659	5,578	5,578	5,661	5,577	5,577
Number of Banks	1,043	1,038	1,038	993	990	990	984	979	979	959	956	956
Adj.R^2	0.0590	0.0467	0.0620	0.0347	0.0343	0.0394	0.0522	0.0503	0.0590	0.0570	0.0561	0.0652

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.234**		-0.631***	-0.190***		-0.212***	-0.562***		-0.964***	-0.379***		-0.586***
	(0.092)		(0.106)	(0.067)		(0.057)	(0.163)		(0.183)	(0.106)		(0.120)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	2.002***		1.492***	0.410***		0.324***	1.219**		0.813**	0.346		0.219
	(0.239)		(0.209)	(0.130)		(0.116)	(0.544)		(0.413)	(0.332)		(0.278)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.105	-0.418***		0.009	-0.078		-0.202	-0.547***		-0.147*	-0.326***
		(0.078)	(0.087)		(0.062)	(0.059)		(0.125)	(0.139)		(0.076)	(0.087)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		1.291***	0.802***		0.128	0.046		0.599	0.505		0.050	0.120
		(0.176)	(0.155)		(0.134)	(0.126)		(0.418)	(0.321)		(0.243)	(0.194)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.570		0.112	-0.164		0.000	1.396**		0.829	0.837*		0.505
	(0.354)		(0.291)	(0.231)		(0.285)	(0.709)		(0.614)	(0.427)		(0.408)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.506*	0.385		-0.128	-0.131		1.056*	0.726		0.653**	0.488*
		(0.289)	(0.261)		(0.203)	(0.253)		(0.572)	(0.519)		(0.318)	(0.292)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,902	5,902	5,815	5,730	5,730	5,659	5,578	5,578	5,661	5,577	5,577
Number of Banks	1,043	1,038	1,038	993	990	990	984	979	979	959	956	956
Adj.R^2	0.147	0.140	0.179	0.0395	0.0349	0.0409	0.0724	0.0688	0.0873	0.0658	0.0630	0.0790

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..4: Market Concentration (Lerner)

(a) MaP Instruments Related to Borrowers

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	0.206*		0.143	-0.142**		-0.160**	-0.114		-0.198	-0.167		-0.231*
	(0.112)		(0.134)	(0.072)		(0.068)	(0.181)		(0.205)	(0.118)		(0.133)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.368*		0.295	0.140**		0.038	0.467***		0.313***	0.326***		0.216**
	(0.199)		(0.205)	(0.056)		(0.051)	(0.167)		(0.116)	(0.113)		(0.092)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.155**	-0.118		0.023	-0.023		-0.134	-0.193		-0.088	-0.156*
		(0.077)	(0.101)		(0.068)	(0.066)		(0.125)	(0.146)		(0.077)	(0.090)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.354***	0.391***		0.164***	0.163***		0.660***	0.689***		0.403***	0.420***
		(0.096)	(0.107)		(0.055)	(0.053)		(0.172)	(0.176)		(0.115)	(0.117)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-0.542**		-0.292	-0.116		-0.020	-0.510**		-0.272	-0.302**		-0.144
	(0.259)		(0.224)	(0.177)		(0.181)	(0.236)		(0.189)	(0.150)		(0.130)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.423***	-0.459***		-0.318**	-0.307*		-0.878***	-0.902***		-0.469***	-0.478***
		(0.163)	(0.169)		(0.160)	(0.159)		(0.273)	(0.275)		(0.156)	(0.155)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,485	5,430	5,430	5,434	5,379	5,378	5,194	5,144	5,144	5,196	5,146	5,146
Number of Banks	940	938	938	920	918	918	890	888	888	868	866	866
Adj.R^2	0.0473	0.0474	0.0488	0.0368	0.0376	0.0397	0.0409	0.0439	0.0442	0.0516	0.0545	0.0565

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.409***		-0.446***	-0.079		-0.150***	-0.720***		-0.812***	-0.477***		-0.550***
	(0.144)		(0.142)	(0.056)		(0.054)	(0.231)		(0.232)	(0.158)		(0.154)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.406***		0.491***	-0.036		-0.041	0.400***		0.509***	0.213***		0.267***
	(0.068)		(0.079)	(0.040)		(0.044)	(0.111)		(0.131)	(0.072)		(0.084)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.005	0.051		0.027	0.042		-0.080	-0.000		-0.104	-0.049
		(0.150)	(0.135)		(0.054)	(0.053)		(0.187)	(0.180)		(0.112)	(0.110)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.087	0.053		-0.012	-0.061		-0.012	0.061		0.031	0.043
		(0.055)	(0.058)		(0.037)	(0.040)		(0.081)	(0.089)		(0.047)	(0.052)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-0.083		-0.016	-0.053		0.070	0.159		0.131	0.029		-0.044
	(0.132)		(0.188)	(0.179)		(0.170)	(0.270)		(0.309)	(0.178)		(0.181)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.179	0.183		0.384*	0.403*		-0.138	-0.081		-0.241	-0.241
		(0.139)	(0.195)		(0.220)	(0.230)		(0.443)	(0.476)		(0.348)	(0.369)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,485	5,430	5,430	5,434	5,379	5,379	5,194	5,144	5,144	5,196	5,146	5,146
Number of Banks	940	938	938	920	918	918	890	888	888	868	866	866
Adj.R^2	0.0693	0.0480	0.0761	0.0369	0.0423	0.0455	0.0481	0.0431	0.0541	0.0564	0.0546	0.0637

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.182*		-0.567***	-0.189***		-0.223***	-0.427**		-0.779***	-0.290**		-0.471***
	(0.096)		(0.111)	(0.073)		(0.061)	(0.168)		(0.190)	(0.114)		(0.130)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	2.365***		1.439***	0.314**		0.236*	2.007***		1.052***	0.773***		0.268
	(0.219)		(0.203)	(0.129)		(0.121)	(0.391)		(0.322)	(0.227)		(0.217)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.003	-0.299***		0.031	-0.050		-0.008	-0.312**		-0.038	-0.185**
		(0.079)	(0.087)		(0.067)	(0.063)		(0.129)	(0.141)		(0.080)	(0.092)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		1.646***	1.109***		0.072	0.038		1.251***	1.020***		0.454***	0.512***
		(0.167)	(0.165)		(0.098)	(0.092)		(0.296)	(0.272)		(0.163)	(0.166)
$D_t^{p(75^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	-1.380***		-0.552**	-0.106		0.046	-1.041		-0.223	-0.070		0.411
	(0.358)		(0.263)	(0.297)		(0.232)	(1.842)		(1.567)	(1.286)		(1.169)
$D_{t-1}^{p(75^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.940**	-0.573		-0.332	-0.322		-0.561	-0.411		-0.252	-0.370
		(0.388)	(0.365)		(0.504)	(0.499)		(1.720)	(1.459)		(1.045)	(0.889)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,485	5,430	5,430	5,434	5,379	5,378	5,194	5,144	5,144	5,196	5,146	5,146
Number of Banks	940	938	938	920	918	918	890	888	888	868	866	866
Adj.R^2	0.156	0.152	0.183	0.0408	0.0378	0.0428	0.0665	0.0630	0.0741	0.0618	0.0601	0.0686

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..5: Level of the Slope of the Yield Curve

(a) MaP Instruments Related to Borrowers

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	0.124		0.024	-0.140**		-0.150**	-0.283		-0.422**	-0.269**		-0.357***
	(0.105)		(0.122)	(0.067)		(0.061)	(0.175)		(0.192)	(0.111)		(0.121)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.036		0.190	-0.019		-0.011	0.059		0.236**	0.024		0.116
	(0.146)		(0.140)	(0.066)		(0.067)	(0.123)		(0.119)	(0.092)		(0.097)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.271***	-0.263***		-0.004	-0.041		-0.347***	-0.447***		-0.206***	-0.291***
		(0.076)	(0.096)		(0.063)	(0.060)		(0.122)	(0.140)		(0.075)	(0.085)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.168*	0.177*		-0.018	-0.022		0.252*	0.243*		0.150	0.138
		(0.091)	(0.091)		(0.044)	(0.043)		(0.133)	(0.131)		(0.097)	(0.096)
$D_t^{p(25^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	2.229***		2.213**	1.725***		2.308***	3.537**		5.451***	2.293**		3.193***
	(0.775)		(0.884)	(0.579)		(0.700)	(1.664)		(1.966)	(1.002)		(1.188)
$D_{t-1}^{p(25^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$		0.880**	1.779***		1.006**	1.838***		2.328**	4.524***		1.496**	2.757***
		(0.432)	(0.683)		(0.406)	(0.551)		(1.003)	(1.547)		(0.626)	(0.943)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0454	0.0479	0.0495	0.0381	0.0367	0.0416	0.0486	0.0522	0.0579	0.0557	0.0576	0.0659

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.313**		-0.371***	-0.069		-0.149***	-0.776***		-0.807***	-0.525***		-0.532***
	(0.130)		(0.134)	(0.054)		(0.055)	(0.204)		(0.215)	(0.132)		(0.139)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.015		0.062	-0.033		-0.040	0.259		0.254	0.179		0.139
	(0.168)		(0.195)	(0.063)		(0.073)	(0.220)		(0.250)	(0.137)		(0.162)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.206	-0.115		0.031	0.024		-0.460***	-0.360**		-0.300***	-0.244**
		(0.134)	(0.132)		(0.047)	(0.049)		(0.173)	(0.175)		(0.104)	(0.106)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		0.177*	0.254*		-0.043	-0.025		-0.140	0.085		-0.215*	-0.073
		(0.102)	(0.145)		(0.046)	(0.061)		(0.168)	(0.212)		(0.119)	(0.150)
$D_t^{p(25^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.316*		0.292	-0.016		-0.032	0.105		0.127	0.008		0.045
	(0.162)		(0.190)	(0.073)		(0.084)	(0.229)		(0.266)	(0.138)		(0.167)
$D_t^{p(25^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$		-0.214**	-0.218		0.027	-0.049		0.232	0.012		0.292**	0.124
		(0.093)	(0.133)		(0.055)	(0.070)		(0.178)	(0.227)		(0.125)	(0.161)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0598	0.0467	0.0626	0.0347	0.0338	0.0392	0.0522	0.0491	0.0573	0.0569	0.0555	0.0633

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	$\frac{\text{LLR}}{\text{Gross Loans}}$			$\frac{\text{LLP}}{\text{Avg. Gross Loans}}$			$\frac{\text{NPL}}{\text{Gross Loans}}$			$\frac{\text{NPL}}{\text{Total Assets}}$		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times \text{Fall_Slope}_t$	-0.214**		-0.632***	-0.188***		-0.201***	-0.543***		-0.997***	-0.369***		-0.596***
	(0.092)		(0.112)	(0.067)		(0.054)	(0.163)		(0.191)	(0.106)		(0.129)
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	0.389		0.643**	0.083		0.095	0.488*		0.810***	0.160		0.316*
	(0.288)		(0.294)	(0.101)		(0.099)	(0.253)		(0.264)	(0.176)		(0.192)
$\Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.071	-0.403***		0.006	-0.097*		-0.184	-0.511***		-0.144*	-0.304***
		(0.080)	(0.088)		(0.063)	(0.058)		(0.128)	(0.139)		(0.078)	(0.086)
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		-0.121	-0.144		0.160*	0.146		-0.140	-0.227		-0.072	-0.132
		(0.113)	(0.116)		(0.090)	(0.091)		(0.180)	(0.201)		(0.109)	(0.121)
$D_t^{p(25^{th})}$												
$MaP_t \times \Delta Slope_t \times \text{Fall_Slope}_t$	2.244***		1.040***	0.300*		0.405**	1.617***		0.220	0.670**		0.024
	(0.352)		(0.353)	(0.173)		(0.177)	(0.509)		(0.435)	(0.309)		(0.323)
$D_{t-1}^{p(25^{th})}$												
$MaP_{t-1} \times \Delta Slope_{t-1} \times \text{Fall_Slope}_{t-1}$		1.869***	1.212***		-0.105	-0.291**		1.367***	1.337***		0.470**	0.622**
		(0.206)	(0.227)		(0.139)	(0.138)		(0.390)	(0.392)		(0.222)	(0.248)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.159	0.149	0.185	0.0397	0.0342	0.0416	0.0704	0.0654	0.0824	0.0626	0.0581	0.0724

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..6: First Difference of the Slope of the Yield Curve

(a) MaP Instruments Related to Borrowers

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	0.288***		0.320***	-0.061		-0.134***	0.065		0.057	-0.030		-0.049
	(0.055)		(0.065)	(0.054)		(0.050)	(0.106)		(0.120)	(0.068)		(0.075)
$MaP_t \times \Delta Slope_t$	0.063		0.051	-0.048		-0.072*	0.099		0.041	0.058		0.018
	(0.115)		(0.119)	(0.038)		(0.042)	(0.130)		(0.127)	(0.090)		(0.092)
$\Delta Slope_{t-1}$		0.140***	0.200***		0.041	0.039		0.049	0.059		-0.020	-0.029
		(0.049)	(0.059)		(0.047)	(0.047)		(0.088)	(0.100)		(0.052)	(0.059)
$MaP_{t-1} \times \Delta Slope_{t-1}$		0.167**	0.184**		-0.021	-0.077**		0.244*	0.251*		0.171*	0.171
		(0.084)	(0.087)		(0.036)	(0.039)		(0.141)	(0.147)		(0.101)	(0.105)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,788	5,732	5,732	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0571	0.0458	0.0649	0.0348	0.0345	0.0397	0.0445	0.0463	0.0462	0.0489	0.0515	0.0516

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	-0.130		-0.073	0.008		-0.055	-0.370***		-0.373***	-0.235**		-0.264***
	(0.081)		(0.082)	(0.041)		(0.041)	(0.141)		(0.142)	(0.097)		(0.099)
$MaP_t \times \Delta Slope_t$	0.252***		0.349***	-0.022		-0.010	0.266***		0.364***	0.126***		0.170***
	(0.041)		(0.046)	(0.027)		(0.029)	(0.071)		(0.079)	(0.045)		(0.048)
$\Delta Slope_{t-1}$		0.127	-0.047		0.049	0.077**		-0.082	-0.150		-0.104	-0.102
		(0.085)	(0.070)		(0.036)	(0.030)		(0.126)	(0.105)		(0.076)	(0.064)
$MaP_{t-1} \times \Delta Slope_{t-1}$		0.011	0.229***		-0.020	-0.048*		0.089	0.207***		0.057	0.079*
		(0.036)	(0.041)		(0.027)	(0.029)		(0.060)	(0.070)		(0.036)	(0.041)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,788	5,732	5,732	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0741	0.0453	0.105	0.0348	0.0345	0.0397	0.0508	0.0470	0.0597	0.0528	0.0522	0.0587

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	-0.374***		-0.480***	-0.159***		-0.182***	-0.604***		-0.689***	-0.350***		-0.384***
	(0.079)		(0.081)	(0.043)		(0.043)	(0.153)		(0.157)	(0.108)		(0.110)
$MaP_t \times \Delta Slope_t$	0.478***		0.437***	0.094***		0.114***	0.489***		0.415***	0.234***		0.189***
	(0.051)		(0.049)	(0.036)		(0.035)	(0.100)		(0.101)	(0.064)		(0.063)
$\Delta Slope_{t-1}$		-0.427***	-0.205***		0.022	0.053*		-0.414***	-0.314***		-0.198***	-0.185***
		(0.055)	(0.060)		(0.041)	(0.030)		(0.090)	(0.094)		(0.056)	(0.060)
$MaP_{t-1} \times \Delta Slope_{t-1}$		0.561***	0.460***		-0.005	-0.015		0.465***	0.436***		0.181***	0.187***
		(0.052)	(0.047)		(0.034)	(0.033)		(0.099)	(0.087)		(0.057)	(0.051)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0968	0.140	0.171	0.0356	0.0340	0.0390	0.0586	0.0680	0.0788	0.0577	0.0600	0.0682

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..7: Asymmetric Effects of Macroprudential Policies

(a) MaP Instruments Related to Borrowers

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	0.290***		0.329***	-0.030		-0.031	0.065		0.067	-0.030		-0.043
	(0.055)		(0.065)	(0.044)		(0.044)	(0.107)		(0.121)	(0.069)		(0.076)
$MaP_L_t \times \Delta Slope_t$	-1.398***		-2.246***	-0.431*		-0.941***	-1.165**		-2.304***	-0.826*		-1.567***
	(0.367)		(0.595)	(0.235)		(0.360)	(0.515)		(0.839)	(0.426)		(0.569)
$MaP_T_t \times \Delta Slope_t$	0.128		-0.159	0.130		-0.108	0.228		-0.211	0.135		-0.140
	(0.207)		(0.220)	(0.118)		(0.114)	(0.323)		(0.286)	(0.202)		(0.186)
$\Delta Slope_{t-1}$		0.137***	0.203***		0.016	0.012		0.039	0.056		-0.026	-0.031
		(0.049)	(0.060)		(0.041)	(0.040)		(0.089)	(0.102)		(0.052)	(0.060)
$MaP_L_{t-1} \times \Delta Slope_{t-1}$		0.354	0.082		-0.165	-0.220**		0.908	0.698		0.526	0.420
		(0.480)	(0.487)		(0.106)	(0.107)		(0.927)	(0.936)		(0.770)	(0.780)
$MaP_T_{t-1} \times \Delta Slope_{t-1}$		0.337**	0.420**		0.149	0.193**		0.656**	0.764***		0.447***	0.527***
		(0.151)	(0.167)		(0.091)	(0.097)		(0.270)	(0.293)		(0.173)	(0.182)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0578	0.0459	0.0666	0.0321	0.0342	0.0350	0.0445	0.0469	0.0474	0.0491	0.0522	0.0531

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) MaP Instruments Related to Bank Capital

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	-0.350***		-0.350***	-0.042		-0.066*	-0.576***		-0.611***	-0.321***		-0.351***
	(0.085)		(0.085)	(0.038)		(0.039)	(0.152)		(0.153)	(0.107)		(0.108)
$MaP_L_t \times \Delta Slope_t$	1.012		1.126	0.208		0.103	1.836**		1.691	0.878		0.733
	(0.677)		(0.699)	(0.415)		(0.421)	(0.906)		(1.058)	(0.652)		(0.752)
$MaP_T_t \times \Delta Slope_t$	0.835***		1.036***	0.018		0.032	0.844***		1.027***	0.383***		0.456***
	(0.102)		(0.110)	(0.058)		(0.062)	(0.179)		(0.198)	(0.115)		(0.125)
$\Delta Slope_t$		-0.139*	-0.225***		0.056*	0.061**		-0.231**	-0.289***		-0.134**	-0.150**
		(0.075)	(0.070)		(0.031)	(0.031)		(0.099)	(0.097)		(0.060)	(0.058)
$MaP_L_{t-1} \times \Delta Slope_{t-1}$		-0.883	-1.011		-0.803***	-0.766***		-2.561	-2.429		-1.613	-1.523
		(0.883)	(0.907)		(0.157)	(0.160)		(1.565)	(1.690)		(1.035)	(1.117)
$MaP_I_{t-1} \times \Delta Slope_{t-1}$		0.429***	0.760***		-0.054	-0.070		0.444***	0.653***		0.187**	0.242***
		(0.085)	(0.094)		(0.060)	(0.062)		(0.128)	(0.153)		(0.075)	(0.087)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.0860	0.0568	0.131	0.0319	0.0356	0.0359	0.0547	0.0524	0.0682	0.0546	0.0555	0.0631

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(c) MaP Instruments Related to Credit Management

	LLR / Gross Loans			LLP / Avg. Gross Loans			NPL / Gross Loans			NPL / Total Assets		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t$	-0.573***		-0.425***	-0.149***		-0.147***	-0.720***		-0.616***	-0.370***		-0.342***
	(0.076)		(0.070)	(0.045)		(0.038)	(0.148)		(0.122)	(0.102)		(0.082)
$MaP_L_t \times \Delta Slope_t$	-0.690		-1.428	-0.877**		-1.177**	-1.928		-1.963	-1.201*		-0.833
	(1.406)		(1.600)	(0.405)		(0.471)	(1.228)		(1.592)	(0.691)		(0.977)
$MaP_I_t \times \Delta Slope_t$	1.743***		1.079***	0.248***		0.234***	1.617***		0.912***	0.703***		0.371***
	(0.152)		(0.117)	(0.088)		(0.084)	(0.300)		(0.232)	(0.184)		(0.140)
$\Delta Slope_t$		-0.385***	-0.247***		0.007	0.009		-0.411***	-0.417***		-0.212***	-0.256***
		(0.051)	(0.056)		(0.042)	(0.031)		(0.085)	(0.090)		(0.053)	(0.057)
$MaP_L_{t-1} \times \Delta Slope_{t-1}$		2.081**	2.010		0.805***	0.719*		8.435***	8.474***		6.873***	6.944***
		(0.851)	(1.275)		(0.228)	(0.371)		(2.189)	(2.718)		(2.199)	(2.475)
$MaP_T_{t-1} \times \Delta Slope_{t-1}$		1.462***	1.022***		0.027	-0.022		1.273***	1.111***		0.523***	0.529***
		(0.130)	(0.109)		(0.084)	(0.082)		(0.246)	(0.200)		(0.140)	(0.115)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,993	5,937	5,937	5,815	5,758	5,758	5,659	5,608	5,608	5,661	5,610	5,610
Number of Banks	1,043	1,041	1,041	993	991	991	984	982	982	959	957	957
Adj.R^2	0.136	0.146	0.170	0.0358	0.0345	0.0380	0.0674	0.0802	0.0889	0.0607	0.0785	0.0859

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..8: Alternative Measure of Risk: Z-score

	MaP_Borrower			MaP_Capital			MaP_CMg		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
$\Delta Slope_t \times$ Fall_Slope$_t$	-0.081**		-0.068	0.010		-0.011	-0.056		-0.017
	(0.040)		(0.053)	(0.064)		(0.067)	(0.040)		(0.056)
$MaP_t \times \Delta Slope_t \times$ Fall_Slope$_t$	-0.151**		-0.153**	-0.057**		-0.083***	-0.386***		-0.366***
	(0.074)		(0.075)	(0.026)		(0.029)	(0.115)		(0.118)
$\Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.038	0.019		0.080	0.058		0.018	0.029
		(0.025)	(0.035)		(0.052)	(0.052)		(0.030)	(0.036)
$MaP_{t-1} \times \Delta Slope_{t-1} \times$ Fall_Slope$_{t-1}$		0.086	0.070		-0.021	-0.053**		-0.147*	-0.097
		(0.059)	(0.061)		(0.018)	(0.021)		(0.076)	(0.081)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank × Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	4,854	4,801	4,801	4,854	4,801	4,801	4,854	4,801	4,801
Number of Banks	914	912	912	914	912	912	914	912	912
Adj.R^2	0.0337	0.0324	0.0337	0.0346	0.0323	0.0367	0.0365	0.0331	0.0361

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4..9 presents the number of banks per country included in the sample.

Table 4..9: Number of Banks per Country

Country	Number of Banks	Country	Number of Banks
Australia	21	Austria	15
Belgium	1	Canada	26
Chile	10	Colombia	10
Costa Rica	12	Czech Republic	12
Denmark	21	Finland	15
France	71	Germany	27
Hungary	9	Iceland	1
India	32	Ireland	6
Israel	10	Italy	42
Japan	105	Latvia	10
Lithuania	4	Luxembourg	13
Mexico	26	Netherlands	13
New Zealand	8	Norway	13
Poland	14	Portugal	9
Republic of Korea	8	Russian Federation	166
Slovakia	7	Slovenia	9
South Africa	12	Spain	20
Sweden	18	Switzerland	70
United Kingdom	45	United States	163

Figure 4..1 presents the number of observations per country.

Figure 4..1: Number of Observations per Country

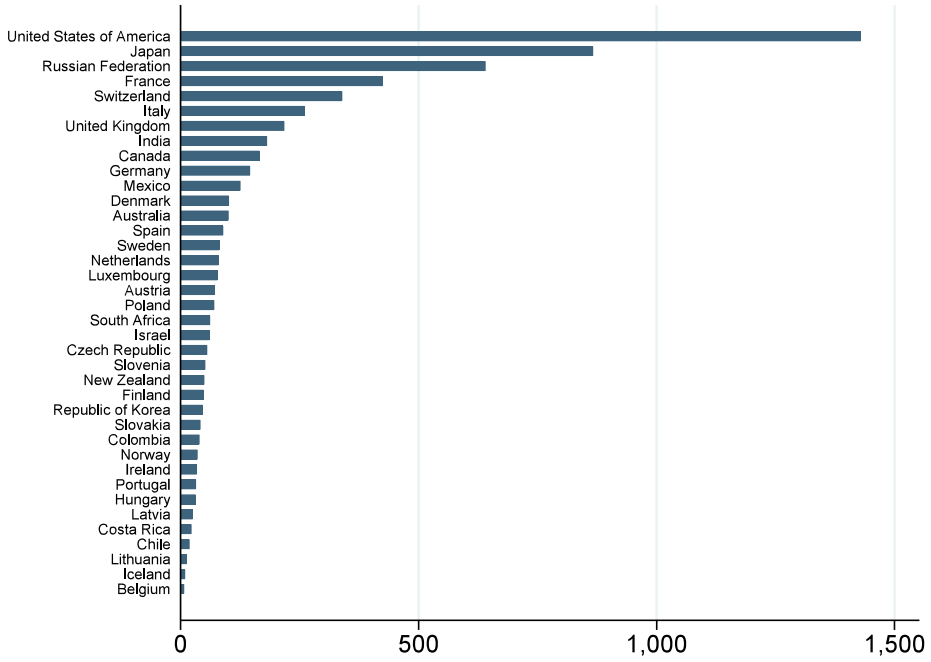


Table 4..10: Summary Statistics of the Variables Used in the Regressions

Variables	Observations	Mean	Median	Std. Dev.	p(25)	p(75)	Max	Min
Interest Income / Average Interest Earning Assets	6010	4.73	3.32	4.66	1.93	4.84	42.91	0.87
Interest Income / Avg. Loans	5195	5.82	4.38	4.92	2.77	6.33	40.18	1.09
Net Interest Margin	6013	3.27	2.40	3.42	1.39	3.73	34.75	0.42
Total Interest Income on Loans*	5088	663167	91322	1657773	32461	363977	8781052	798
Total Interest Income on Loans / Gross Loans	5066	9.48	4.33	229.92	2.80	6.40	16361.74	-3.82
Gross Loans / Total Assets	6132	62.64	65.31	18.89	53.01	76.14	95.29	7.47
Loan-Loss Reserves / Gross Loans	5983	3.35	1.46	4.81	0.79	3.38	23.38	0.02
Loan-Loss Provisions / Loans	5849	0.75	0.21	1.64	0.04	0.75	10.03	-1.99
Non-Performing Loans / Gross Loans	5651	4.22	2.15	6.07	0.75	4.75	36.10	0.00
Non-Performing Loans / Total Assets	5682	2.60	1.24	3.76	0.47	2.93	23.13	0.00
Share of Total Assets	6131	3.20	0.17	9.91	0.05	1.05	100.00	0.00
Leverage	6133	10.38	8.99	7.20	6.30	11.95	92.94	0.00
Deposits / Total Liabilities	6133	79.19	87.20	22.04	71.57	94.45	99.90	0.00
Total Equity / Total Assets	6131	10.37	8.99	7.20	6.30	11.95	92.94	0.00
Liquid Asset / Total Assets	6129	18.91	12.05	17.85	5.58	27.99	96.20	0.07
Lerner Index	4889	0.98	0.98	0.02	0.97	0.99	1.00	0.92
Z-score	5032	4.42	4.44	1.31	3.59	5.21	8.78	1.36
Slope of the Yield Curve	6133	0.97	0.86	1.31	0.45	1.75	5.59	-3.87
GDP Growth	6133	1.99	1.92	1.79	1.11	2.56	25.16	-3.44
Short-term Rates	6133	1.91	0.30	3.68	0.07	1.70	14.76	-0.78

* In the econometric analysis, the variable is used in logarithm.

Figure 4..2: Comparison of shadow rate series

Note: For Japan, for the periods when no target interest rate was adopted, the policy rate corresponds to the interest rate applied on excess reserves.

General Conclusion

The Global Financial crisis of 2008 completely reshaped the macroeconomic policy framework. As a result of rethinking the conduct of economic policy during this period, we now have at our disposal new instruments in the monetary policy toolkit and a large variety of macroprudential tools. As the financial stability integrated the main pillars of macroeconomic stability, this new policy arrangement has raised several concerns regarding the interactions and the potential side-effects between these policies. In particular, the interactions between macroprudential and monetary policy have attracted considerable interest among economists and policymakers during the last decade.

Throughout this doctoral thesis, we have addressed some on-going important issues in the academic and policy debate regarding the interactions between macroprudential and monetary policies. We propose a comprehensive analysis of the conditions under which the objectives of the macroprudential policy and the monetary policy may conflict. We present empirical evidence indicating that monetary policy can support macroprudential policy in containing domestic credit procyclicality. Furthermore, we show that macroprudential tools can help to limit the negative externalities of the "too-low for too-long" interest rate environment induced by unconventional monetary policies.

After having identified in Chapter 1 the interactions between macroprudential and monetary policies as the focus of the liveliest policy debates, in Chapter 2, we identify the conditions under which macroprudential and monetary policies may be conflicting. We find that conflicts are fairly frequent, particularly in the case of technological and bank capital shocks. Among the policy instruments, we identify that the CCyB and monetary policy conflict in many cases. The reason is that both of them "get in all the cracks" by broadly impacting the economy through the adjustment of retail rates, albeit with targets often moving in opposite directions. However, the stronger the reaction of monetary policy to the output gap, the weaker the adverse side effects of the monetary policy are. Moreover, LTV caps, which are targeted measures, tend to cause few conflicts. Even when they are found to increase real-side volatility, they eventually reduce downside risks to GDP. These results suggest that LTV limits can be easily implemented without worrying about potential spillovers. In contrast, the implementation of CCyBs and of monetary policy requires a smooth coordination.

Although in this chapter we attempt to account for non-linearities of macroprudential policy by stressing conflicts of both policies on the probability of crisis and the Growth-at-Risk; it is important to highlight that the DSGE model developed by Gerali et al. (2010) is a linear model. Therefore, a possible extension would be to address the non-linearities of macroprudential policy by introducing non-binding borrowing constraints. This approach would also allow us to address the effects of low-for-long policy interest rates and, to some extent, the effects of excess liquidity in the economy. However, we could run the risk of identifying conflicts only when the borrowing constraints are binding. Finally, even though we cover shocks with different characteristics and different ways of impacting the economy, it could be interesting to examine which shocks have been predominant in recent years. For instance, we could estimate a structural VAR model in order to identify these shocks. Therefore, we could provide policy insights in line with the current environments.

Further research related to this specific chapter could be the extension of the analytical framework by inserting an endogenous risk-taking channel as Adrian et al. (2020), which is an additional source of financial vulnerability caused by the monetary policy, which is highlighted in Chapter 4. In the same vein, another extension may be to use a DSGE model with regime-switching including endogenous financial crisis as in Benigno et al. (2020). It would allow a better assessment of the real-side benefits of having macroprudential instruments in attenuating the detrimental feedback loop between the financial and real

sectors and the cost of crises. In addition, given that in our approach we consider only two sources of conflicts, steaming from the monetary and macroprudential policy rules, it would be interesting to investigate whether the simultaneous implementation of two macroprudential tools, namely the CCyB and the LTV, might lead to conflicts. Indeed, during the elaboration of this chapter, we notice that the transmission channels and objectives may differ among macroprudential instruments (i.e., excess of sectoral or total credit), which raises the issue of potential "internal" conflicts inside the macroprudential toolkit.

In Chapter 3, we contribute to the existing empirical literature by providing evidence on how monetary policy conditions impact the effectiveness of the macroprudential policy. We find evidence that a restrictive monetary policy enhances the impact of macroprudential tightening on domestic credit growth and reduces the transmission delay of macroprudential policy actions. Hence, our findings confirm the complementarities between the two policies and the potential benefits of coordination highlighted by the theoretical literature.

Even though in this chapter we address endogeneity concerns with the GMM approach, a potential issue remains. Macroprudential policy shocks are not necessarily exogenous; financial institutions can anticipate them. Therefore, a way to account for exogenous shocks of policy actions could be to use recent macroprudential databases, which include announcement dates, and a narrative approach (De Schryder and Opitz, 2021). In fact, there may be a significant difference in the effect of the macroprudential policy on excessive credit growth when accounting for announcement dates rather than the implementation dates. Another way to improve the robustness of our results would be to use the methodology of local projections proposed by Jordà (2005). There are several advantages of using this methodology. Among them, we could study shocks of a synchronised tightening of macroprudential and monetary policies, account for non-linearities and better understand credit dynamics. However, the pertinence of both approaches may depend on the time frame available in the databases, as this may imply working with a smaller sample size.

Moreover, we argue that the institutional architecture is a factor that needs to be taken into account. Regarding the institutional framework in charge of the macroprudential policy, there is high heterogeneity around the world (Masciandaro, 2018; Masciandaro and Romelli, 2018; Edge and Liang, 2019). The ideal institutional architecture must guarantee the independence of the macroprudential regulator, the access to information allowing the identification of systemic risks, the power to act promptly, and avoid inaction bias. For instance, assigning a leading role in macroprudential policy to the central bank is usually justified by the argument that it will facilitate coordination between the two policies, avoid side effects and political pressure on macroprudential policy actions. However, this requires a reflection on the objectives and mandates of the monetary policy as well. Therefore, an interesting extension of this chapter may be to investigate empirically which institutional framework and governance structure of macroprudential policy is the most conducive to good coordination.

In Chapter 4, we consider an alternative perspective and analyse how macroprudential policy complements the monetary policy. In this chapter, we focus on the effectiveness of the macroprudential policy and its ability to mitigate banks' risk-taking behaviour under a persistently low interest rates environment. We find that more stringent borrower-based measures, capital-based measures, and instruments targeting the credit management might reduce, and even offset, the effects of accommodative monetary policy on banks' risk-taking behaviour. We find that borrower-based (if tightened a year ahead) and credit-management measures are the most effective macroprudential tools. Moreover, accounting for bank

characteristics, capital-based and borrower-side measures are, in particular, more effective in influencing the risk-taking behaviour of weakly capitalized banks and banks with limited liquidity. Meanwhile, instruments targeting banks' credit management are more effective on heavily capitalized banks and banks with abundant liquidity. Finally, it appears that borrower-side and credit-management measures are more suitable in counteracting the side-effects of extremely accommodative monetary policy environments.

Even if working with bank-level data significantly increases sample size, our analysis is still limited to commercial banks due to their business model and data availability. An important fact to take into account is that worldwide shadow banking is increasing together with tighter regulations, therefore the results of this chapter may have a downward bias because non-bank financing may be limiting the effectiveness of the macroprudential policy. Another potential shortcoming of our analysis is that we are not able to distinguish between ex-ante risk-borrowers, so we cannot determine whether ex-post risk-materialization is due to the fact that in the past banks granted loans to risky borrowers. Using confidential credit registry data, in the same vein as in Bonfim and Soares (2018) and Altavilla et al. (2020), would better address this issue.

The last chapter opens an interesting debate on the real effects that a tightening of macroprudential policy could have on the global economic recovery. Moreover, regarding the actual post-crisis scenarios, which left the monetary policy and fiscal policy with limited room for manoeuvre, several concerns have been raised. Indeed, these concerns have led academics and policymakers to question the role of the central bank regarding financial stability. In addition, the recovery from the pandemic may precede the tapering of asset purchases and likely anticipates rising interest rates. The latter is a potential reason to start to worry about potential banks' profit losses due to credit defaults and non-performing loans. However, whether macroprudential policy can increase the room for manoeuvre of other macroeconomic policies requires further research. Finally, in line with Chapter 2, another measure that could enrich our analysis is the Growth-at-Risk approach. The Growth-at-Risk may account for excessive current risk-taking behaviours that have the potential to materialize in the future as lower economic growth. There is a growing literature explaining the benefits of macroprudential policy on the realisations of future economic growth (Franta and Gambacorta, 2020; Galán, 2020). However, to the best of our knowledge, there is no literature exploring the coordination between monetary and macroprudential policies on the Growth-at-Risk, which is an interesting field to further research.

Throughout this document, we study the interactions between macroprudential and monetary policies. However, other relevant debates related to the macroprudential policy were left aside and require further research. Such debates include, the role of policy announcements, the implications of policy actions for wealth distribution, the interactions with the fiscal and microprudential policies, the climate risk, and one of the most relevant concerns, how macroprudential policy will evolve in the wake of the Covid-19 pandemic crisis. In other words, research has been started but still needs to be expanded.

First, as well as the monetary policy communication and its forward guidance, the role of the macroprudential policy communication may play an important role in terms of its effectiveness and its potential interactions with other economic policies. Announcements related to future instrument implementations, future policy actions, or even financial stability reports may modify agents' decisions. Indeed, the recent literature has started to distinguish between announcement dates and the de facto implementation of macroprudential policy actions in order to capture more accurately its effectiveness. Regarding the interaction with the monetary policy, it would be interesting to analyse the implications of communication of both policies on financial stability.

Second, as mentioned before, the implementation of macroprudential policy also has raised concerns related to the interactions and coordination with other economic policies, notably the fiscal and microprudential policies. For instance, taxes and subsidies to the housing sector may conflict with macroprudential tools such as LTV and DSTI ratios. Also, by affecting agents' credit affordability, macroprudential policy may have negative effects on resource allocations, investment decisions and wealth inequality concerns. Moreover, conflicts may arise with microprudential policies, especially during downturns. Indeed, during stress periods there could be a risk of coordination failures in the credit market that could lead to a tightening in bank lending, thereby exacerbating any credit crunch and downturn in activity and employment (Restoy, 2020). Both interactions open up avenues of investigation that have not yet been completely explored.

Finally, two factors may encourage the reassessment of the conduct of macroprudential policy and the other economic policies; the climate risk and the post-pandemic crisis era. The last decade stressed the risk of climate change on financial stability and the real economy. That is the reason why central banks, international institutions and governments have pointed out the importance to closely follow climate risk and concentrate their efforts to support the green transition. The main research question here is what role macroprudential policy could play in tackling these issues.

Regarding the monetary policy, the current post-crisis environment has reopened the debate on whether central banks should include in their mandates the objective of financial stability. Indeed, central banks have started reviewing their monetary policy strategy (e.g., the ECB and the FED) in order to adapt themself to the new normal of the post-pandemic economy. This debate is not new. According to the BIS 2011 report on Central Bank Governance and Financial Stability, few banks have financial stability as one of their objectives when the debate started (BIS, 2011). The main argument against this is that an objective of financial stability would not always be aligned with the price stability objective, and therefore, leading to a socially suboptimal monetary policy (Svensson, 2017). However, it is clear that financial stability cannot be achieved without price stability and vice versa. Besides, in the post-Covid era, with the expected end of the unconventional monetary policies and the return to the " new normal", some questions arise: what place should have the financial stability in the conduct of monetary policy? If the introduction of financial stability in the central banks' mandate is the answer, how should it be included? And if the answer is to not include it, should the macroprudential policy be more aggressive and be used more frequently? These questions suggest that additional theoretical and empirical research are needed to uncover the optimal interactions between monetary policy and macroprudential policy in this new era.

In summary, by providing evidence of the potential complementarities and conflicts between macroprudential and monetary policies, this thesis stresses the importance their coordination. Moreover, as an outcome of this investigation, we identify three relevant issues that will require further research in the times to come: the role of macroprudential policy on climate change, how to be prepared for future tapering and increasing interest rates, and the institutional arrangement of the macroprudential policy, which is still an open issue.

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Résumé en Français

Cette thèse de doctorat se concentre sur le cadre de politique macroéconomique post-crise financière mondiale (GFC) dans le but d'étudier les interactions entre les politiques macroprudentielles et monétaires. *Comment ces interactions se produisent-elles ? Les deux politiques se complètent-elles ou entrent-elles en conflit ? Ces complémentarités ou conflits sont-ils toujours présents ? Si non, quand ont-ils lieu ? Les deux politiques sont-elles capables de compenser mutuellement leurs effets secondaires ? Ou entravent-elles toujours leur tâche ?* Ce sont là quelques questions de recherche auxquelles nous tentons de répondre tout au long de ce document. La principale contribution de cette investigation est triple. Premièrement, elle propose une analyse complète des interactions et des scénarios possibles lorsque les objectifs de la politique macroprudentielle et de la politique monétaire peuvent entrer en conflit. Ensuite, elle présente des preuves empiriques, au niveau macroéconomique, de la manière dont la politique monétaire peut soutenir la politique macroprudentielle pour contenir la procyclicité du crédit. Enfin, il présente des preuves empiriques, au niveau microéconomique, de la façon dont les outils de politique macroprudentielle peuvent aider à contenir les externalités négatives des environnements monétaires "trop bas pour trop longtemps", le scénario économique actuel et potentiel.

Cette introduction générale vise à décrire le contexte institutionnel, à mettre en évidence les résultats les plus pertinents obtenus jusqu'à présent dans la littérature, et à présenter les origines et le contexte dans lequel les principales questions de recherche sont posées. Dans cette perspective, la section Origines de la politique macroprudentielle décrit les origines, les objectifs, les fondements théoriques et l'efficacité de la politique macroprudentielle. Les deux sections suivantes, Politique macroprudentielle et cadre institutionel et Interactions entre la politique macroprudentielle et les autres politiques, décrivent les principales préoccupations au coeur des débats politiques et academiques actuels. La section Macroprudential policy and monetary policy interactions décrit les principaux canaux de transmission et les effets secondaires potentiels entre les deux politiques; elle présente une brève revue de la littérature sur le sujet principal de la thèse et les principales préoccupations motivant cette recherche. Enfin, la section des contributioins décrit les quatre essais présentés dans les chapitres réunis dans ce document.

Origines de la politique macroprudentielle

Tout au long de l'histoire de l'humanité, les événements extrêmes ont été les points de retournement de plusieurs aspects de notre société. Les crises politiques, sociales et économiques sont non seulement critiques mais aussi nécessaires au progrès de l'humanité. Elles ont façonné notre structure sociale et la manière dont nous comprenons et interagissons avec notre environnement. Il n'est donc pas surprenant que la Grande Dépression des années 30, la stagflation des années 70 et, plus récemment, la crise financière mondiale de 2008-2009 aient poussé les academiques et les décideurs politiques à repenser et à transformer la conduite et les interactions des politiques macroéconomiques.

La Grande Dépression des années 30 a appris aux économistes à mener une politique fiscale et monétaire et a posé les bases de la macroéconomie, dont la politique fiscale est le principal pilier. Quatre décennies plus tard, la stagflation des années 70 a bouleversé la conduite antérieure des politiques macroéconomiques. En premier lieu, la politique monétaire a gagné en importance pour la stabilité macroéconomique, limitant la politique budgétaire à un rôle secondaire politiquement contraint. Plus récemment, la crise financière mondiale a été une occasion exceptionnelle de repenser les politiques macroéconomiques. Elle a rappelé l'importance de la sphère financière en termes de stabilité économique globale et de bien-être, a étendu la mise en œuvre et l'utilisation de la politique macroprudentielle, a élargi

la boîte à outils de la politique monétaire et a encouragé la coordination et les interactions potentielles au sein du nouveau cadre de politique macroéconomique.

Le sillage et les conséquences de la crise financière mondiale ont permis aux décideurs politiques et aux academiques de tirer une leçon de la pire façon qui soit: sous un environnement macroéconomique apparemment calme et stable, des déséquilibres financiers insidieux peuvent s'accumuler. Le principal problème de ces accumulations est que les crises financières sont plus profondes et plus lentes à se rétablir que les récessions normales. En cas de crise financière, les chocs sont amplifiés plutôt qu'amortis lorsqu'ils se propagent au secteur réel et aux différents agents de l'économie. Cette dernière a en effet mis en évidence les limites de la politique monétaire pour empêcher ces scénarios. Par conséquent, cela a déclenché une remise en question globale de la manière de conduire les politiques macroéconomiques.

La crise financière mondiale a rappelé l'importance de la stabilité financière pour la stabilité macroéconomique, en soulignant le coût élevé en termes de bien-être. Elle a souligné que le taux d'intérêt de la politique monétaire n'était plus un instrument suffisant pour remédier à ces déséquilibres. En outre, l'environnement passé, actuel et futur potentiel de faibles taux d'intérêt nominaux et réels a suscité (et suscite toujours) des inquiétudes quant au comportement des intermédiaires financiers. Ces préoccupations concernent en particulier les comportements des agents en matière de prise de risque, leurs décisions en matière d'effet de levier et les capacités du cadre de politique économique à contrer les effets secondaires indésirables d'un tel environnement (Borio and Zhu, 2012). Pour résoudre ces problèmes, des politiques monétaires non conventionnelles, des mesures de relance budgétaire et une toute nouvelle approche macroéconomique de la réglementation financière (c'est-à-dire la politique macroprudentielle) ont été mises en place en première ligne de l'économie.

Avant la crise, la résilience et la solidité des institutions financières étaient confiées à la réglementation microprudentielle. Toutefois, cette période a prouvé que la réglementation des institutions individuelles ne garantit pas toujours la robustesse du système financier dans son ensemble en raison de sa procyclicité. Par conséquent, la nature anticyclique de la réglementation macroprudentielle et sa mise en œuvre avec l'accord de Bâle III ont constitué une amélioration importante pour garantir la stabilité financière.

La politique macroprudentielle vise à préserver la stabilité du système financier dans son ensemble en renforçant sa résilience et en empêchant l'accumulation du risque systémique. En particulier, selon le Comité européen du risque systémique (CERS), il s'agit d'atténuer et de prévenir la croissance excessive du crédit et de l'effet de levier; d'atténuer et de prévenir l'inadéquation excessive des échéances et l'illiquidité du marché; de limiter les concentrations d'exposition directes et indirectes; de limiter l'impact systémique des incitations divergentes (réduire l'aléa moral); et de renforcer la résilience des institutions financières.

Bien que la réglementation macroprudentielle ait été considérée comme une nouvelle approche visant à atténuer l'accumulation de vulnérabilités dans le système financier dans son ensemble, le terme "macroprudentiel" date des années 70. L'utilisation de ces instruments a commencé il y a plusieurs décennies dans les économies avancées, puis dans les économies de marché émergentes. Selon Kenç (2016), les États-Unis ont probablement été le premier pays à mettre en œuvre une politique macroprudentielle pour contrôler la croissance du crédit dans son ensemble ou dans un secteur économique majeur comme le logement. Les économies de marché émergentes ont également mis en œuvre de nombreuses mesures de politique macroprudentielle pour atténuer les effets des entrées excessives de capitaux dans leurs pays dans les années 2000.

Les fondements théoriques de la réglementation macroprudentielle découlent du fait que les agents ont tendance à propager les risques en augmentant leur propre effet de levier, en développant leurs bilans et en

dépendant principalement de la liquidité à court terme. En outre, étant donné l'interconnexion naturelle au sein du système financier et les complémentarités stratégiques entre les intermédiaires financiers, la propagation des risques au sein de l'ensemble du système s'intensifie. Par conséquent, le risque systémique augmente à la fois dans la dimension temporelle et transversale. La dimension temporelle fait référence à l'accumulation des déséquilibres financiers dans le temps et à la procyclicité du système financier. Quant à la dimension transversale, elle englobe les expositions communes, les concentrations de risques, les liens et les interdépendances entre les institutions financières à un moment donné. Les externalités qui expliquent ces comportements et donnent les raisons fondamentales de la politique macroprudentielle sont l'interconnexion, de nature transversale, et les complémentarités stratégiques et les externalités pécuniaires, de nature chronologique.

Les externalités d'interconnexion font référence à la nature interconnectée du système financier. En particulier dans le secteur bancaire compte tenu de leur modèle économique. En effet, les portefeuilles des banques sont corrélés et les bilans sont fortement interconnectés, comme nous avons pu le constater lors de la crise financière mondiale et de la crise postérieure de la dette souveraine en Europe. Le principal problème de cette interconnexion entre les banques est qu'elles peuvent mettre en danger la stabilité financière en exposant excessivement l'ensemble du système aux chocs et en augmentant la contagion. Un choc idiosyncratique affectant une seule banque peut être très susceptible d'avoir un impact sur l'ensemble du secteur bancaire.

Les externalités négatives liées aux complémentarités stratégiques résultent des interactions stratégiques entre les différents agents du système financier. Ces externalités induisent l'accumulation de vulnérabilités pendant les phases d'expansion du cycle financier et leur amplification lors des phases de ralentissement. En présence d'externalités d'interconnexion, une ruée sur une seule banque peut potentiellement conduire à un arrêt complet du système car les autres déposants s'attendent à ce que leur propre banque présente des difficultés similaires. La meilleure option est alors de se retirer également. Par exemple, à Chypre, toutes les banques sont restées fermées pendant trois jours pour éviter une ruée sur les dépôts lors de la panique de 2013, gelant ainsi l'ensemble du système bancaire chypriote. Une autre source de complémentarités stratégiques peut également être la concurrence accrue et les garanties gouvernementales, augmentant la prise de risque et l'exposition par la mise en commun des actifs. En étant exposés à des risques similaires, à une qualité de portefeuille similaire et à des co-mouvements d'actifs, les intermédiaires financiers accumulent des vulnérabilités, ce qui peut conduire à la chute d'un cycle financier.

Enfin, l'externalité pécuniaire est liée aux ventes à la sauvette pendant les périodes de ralentissement économique et peut être très importante pour les banques, étant donné leur modèle d'entreprise fondé sur la liquidité, la maturité et la transformation du crédit. En l'absence de frictions, les ventes au rabais d'un actif font baisser son prix en dessous de sa valeur fondamentale et peuvent également déprimer les prix d'actifs similaires. Cette dynamique entraîne des pertes pour le vendeur et pour les autres agents détenant ces actifs, ce qui affecte la répartition de la richesse entre les agents, mais sans incidence sur le bien-être. Cependant, en cas de marché imparfait, elle peut entraîner des pertes de bien-être. En effet, les inefficacités caractérisant le système financier (responsabilité limitée, information asymétrique et application limitée) sont à l'origine du risque endogène. Pour se protéger de l'information limitée sur le profil de risque de leurs clients, les banques exigent des garanties de la part des emprunteurs et limitent le montant de la dette en fonction de la valeur de leurs garanties. Par conséquent, un choc entraînant la vente par les banques de ces actifs particuliers peut entraîner une baisse de la valeur des garanties, ce qui fait que les emprunteurs réduisent leur capacité de crédit et deviennent limités par le crédit. En conséquence, les possibilités d'investissement diminuent et, par conséquent, une perte sur le bien-être et

l'économie réelle.

Le principal problème ici est que les agents n'internalisent pas ces externalités et ne tiennent pas compte des retombées potentielles sur les autres agents, le système financier et l'économie réelle dans son ensemble. La réglementation macroprudentielle existe donc pour prendre en compte le coût social des défaillances du marché dans le coût privé des défaillances des intermédiaires financiers et des agents économiques. Depuis la réapparition de la politique macroprudentielle, l'un des débats qui a émergé était de savoir si la politique macroprudentielle devait être le troisième pilier de la politique macroéconomique ou simplement une béquille pour soutenir la politique fiscale et monétaire. La crise financière mondiale a clairement montré que les politiques fiscales et monétaires n'étaient pas les mieux adaptées pour traiter les déséquilibres financiers, et le temps a fini par clore le débat.

À la lumière de ces changements dans le cadre de la politique macroéconomique mondiale, plusieurs questions se sont posées concernant l'efficacité et le calibrage des instruments macroprudentiels. La première question qui s'est posée dans le débat politique et académique était de savoir si ces politiques étaient efficaces pour atteindre leurs objectifs, et donc si les économies pouvaient s'appuyer sur elles. La littérature s'est considérablement développée au cours de la dernière décennie autour de cette question, et les academiques et les décideurs politiques ont acquis des connaissances et de l'expérience sur l'efficacité et le calibrage des instruments. L'évaluation de l'efficacité de la politique macroprudentielle a été rendue difficile par le fait qu'elle dispose d'un grand nombre d'outils pour atteindre ses objectifs. Ces outils peuvent affecter soit des vulnérabilités sectorielles spécifiques, soit l'ensemble du système financier. Ils peuvent être classés en deux grandes catégories. D'une part, les instruments destinés aux prêteurs, qui visent à influencer leur comportement (par exemple, les coussins contracycliques, les exigences de fonds propres, les limites à la croissance du crédit, les limites à des expositions spécifiques ou les exigences de liquidité). D'autre part, les instruments destinés aux emprunteurs, qui visent à influencer leur comportement (par exemple, les taxes sur le logement, les ratios prêt/valeur, les ratios service de la dette/revenu ou les ratios dette/revenu). Afin d'aborder cette question, la littérature se concentre sur des instruments individuels ou utilise un indice de politique globale pour étudier l'efficacité de la politique macroprudentielle à atteindre des objectifs intermédiaires spécifiques. Les conclusions tirées concernant l'efficacité globale sont plutôt mitigées.

D'une part, les résultats concernant les instruments ciblant les emprunteurs sont plutôt favorables. Il semble que ces instruments soient efficaces pour réduire les booms sur les marchés immobiliers, qui sont une source majeure d'instabilité financière et réelle. Par exemple, les ratios prêt-valeur (LTV) et service de la dette/revenu (DSTI) sont associés à une baisse de la croissance des prix des logements, de la croissance du crédit hypothécaire, du crédit aux ménages (Nabar and Ahuja, 2011; Kuttner and Shim, 2016; Zhang and Zoli, 2016; Cerutti et al., 2017a).

En revanche, les conclusions sur les instruments fondés sur les prêteurs sont plutôt mitigées. Par exemple, les résultats concernant les économies de marché émergentes semblent prouver que ces instruments sont associés à une croissance plus faible du crédit. En revanche, cela ne semble pas être le cas pour les économies avancées et les pays asiatiques (Zhang and Zoli, 2016; Cerutti et al., 2017a).

Lorsqu'on utilise un indice global comme mesure, il apparaît que le durcissement de la politique macroprudentielle est associé à une croissance plus faible des prêts, du crédit au logement et des prix des logements.

Toutefois, leur effet n'est pas symétrique : lorsque le cycle financier s'interrompt, elles sont moins efficaces (Lim et al., 2011; Claessens et al., 2013; Kuttner and Shim, 2016; Cerutti et al., 2017a,b; Akinci

and Olmstead-Rumsey, 2018). Ce dernier résultat est important en ce qui concerne la procyclicité du crédit et démontre la nature préventive de la politique macroprudentielle.

Si la nécessité d'une politique macroprudentielle est désormais largement acceptée, de nombreuses questions demeurent. L'absence de résultats concluants sur l'efficacité des outils macroprudentiels a conduit à des investigations beaucoup plus poussées. Certaines raisons peuvent être le cadre institutionnel et les interactions possibles avec d'autres politiques économiques. La littérature n'a pas apporté de réponses claires à ces deux questions et, avec cette thèse de doctorat, nous tentons de contribuer à combler cette lacune.

Politique macroprudentielle et cadre institutionnel

En ce qui concerne le cadre institutionnel, les principaux candidats pour être en charge de la politique macroprudentielle sont la banque centrale, une agence de supervision existante (régulateur microprudentiel), un nouveau régulateur macroprudentiel ou un comité composé de différentes institutions. L'idée derrière un cadre institutionnel adéquat est que cela peut éviter toute obstruction à la mise en œuvre des politiques, garantir l'indépendance et la rapidité de réaction, l'accès à l'information permettant d'identifier à l'avance les déséquilibres financiers, et éviter le biais d'inaction. En fait, il n'existe pas de cadre optimal particulier. Chaque pays a sa propre configuration, qui comprend les instruments, l'organisation institutionnelle et les règles de gouvernance les mieux adaptés à son économie et à la structure de son système financier. Par exemple, dans des pays comme la Nouvelle-Zélande, la Norvège et la Suisse, la banque centrale est chargée de la surveillance et de la réglementation prudentielle. Au Royaume-Uni, le comité de politique financière au sein de la Banque d'Angleterre remplit ce rôle, tandis que dans des pays comme la France et l'Allemagne, le comité est extérieur à la banque centrale. C'est également le cas dans l'Union européenne. Le ESRB est responsable de la surveillance macroprudentielle de l'ensemble du système financier et est présidé par le président de la BCE, les gouverneurs des banques centrales des États membres, un membre de la Commission européenne et des représentants des différentes autorités de régulation au niveau européen.

Même si toutes les configurations différentes ont leurs propres avantages, certaines sont susceptibles d'être exposées à des pressions extérieures, de compromettre la crédibilité de l'autorité macroprudentielle et de souffrir d'un biais d'inaction. En outre, une conception dans laquelle la banque centrale est l'institution hôte peut également soulever des questions pertinentes. En effet, la conduite de la politique macroprudentielle peut interférer avec l'objectif ultime de l'autorité monétaire (c'est-à-dire la stabilité des prix), ce qui entraîne des conflits entre les deux politiques. Avec cette thèse de doctorat, nous mettons en lumière les situations où des conflits peuvent survenir.

Interactions entre la politique macroprudentielle et les autres politiques

Parallèlement au débat sur la structure institutionnelle appropriée, les responsables politiques se sont interrogés sur la manière dont la politique macroprudentielle serait intégrée aux autres politiques économiques. Cette question a suscité le développement d'une littérature sur les interactions entre la politique macroprudentielle et les autres politiques économiques. Ainsi, les interactions avec la politique microprudentielle,

la politique fiscale et la politique monétaire sont les plus concernées dans ce débat.

Interaction avec la politique microprudentielle. En temps normal, les objectifs des deux politiques sont alignés, mais en période de crise, c'est une autre histoire. En période de récession, la réglementation microprudentielle cherche à protéger les déposants et les investisseurs en renforçant ou en maintenant inchangées les exigences réglementaires, ce qui accroît la procyclicité du système financier. Parallèlement, la vision globale du système financier de la politique macroprudentielle exige d'assouplir ces exigences pour éviter les ventes au rabais et l'arrêt du flux de crédit vers l'économie réelle. Par exemple, pendant le GFC, la réglementation microprudentielle a été critiquée pour cette nature procyclique.

Interaction avec la politique budgétaire. La politique budgétaire en général peut être favorable ou défavorable à l'efficacité de la politique macroprudentielle. La façon dont la politique fiscale est menée peut contrer ou être à l'origine de la procyclicité du système financier et peut augmenter le risque systémique (Caruana and Shim, 2016). En outre, les politiques fiscales peuvent encourager l'effet de levier ou la mauvaise allocation des ressources dans le système financier (c'est-à-dire les déductions fiscales ou les distorsions du prix des actifs). Par exemple, les taxes et les subventions réelles de l'État peuvent se répercuter sur les prix de l'immobilier, ce qui peut affecter l'accessibilité au crédit des ménages, mettant probablement en danger la stabilité financière (Van den Noord, 2005).

Interaction avec la politique monétaire. Par nature, les deux politiques sont anticycliques mais ont des objectifs finaux différents, ce qui soulève des questions sur les conflits et les complémentarités potentiels. L'interaction entre les deux politiques est complexe et peut modifier leurs objectifs finaux. La politique macroprudentielle peut affecter la demande globale, puis l'économie réelle et la stabilité des prix. A l'inverse, la politique monétaire affecte les comportements de prise de risque des agents et les décisions d'endettement, affectant la stabilité financière.

Ces dernières années, et de manière beaucoup plus complète, le cœur du débat politique s'est déplacé vers les interactions entre la politique macroprudentielle et la politique monétaire. Dans la figure 4.0.4, nous pouvons observer la pertinence que ce sujet a gagné parmi les academiques au cours de la dernière décennie. Le nombre de publications a augmenté de manière significative. Néanmoins, le nombre de publications relatives à l'interaction et à la coordination entre les deux politiques est encore rare, ce qui augmente la pertinence de cette thèse de doctorat. Comme ces interactions constituent le cœur de cette recherche, la section ci-dessous explique plus en détail leur pertinence et leurs implications pour la stabilité macroéconomique et les préoccupations politiques.

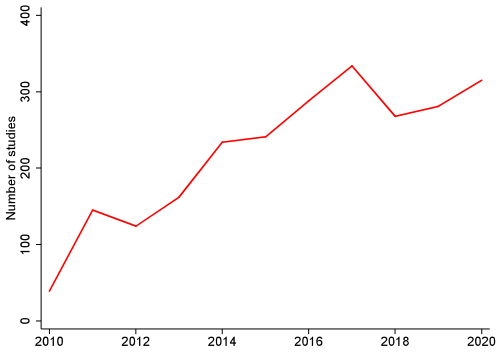
Interactions entre la politique macroprudentielle et la politique monétaire

Les interactions entre la politique macroprudentielle et la politique monétaire ont suscité beaucoup d'attention ces derniers temps, car elles peuvent toutes deux avoir des effets secondaires sur les objectifs de l'autre par des canaux similaires. Par exemple, le canal du prix des actifs, le canal du bilan des banques, le canal du taux de change, le canal du déplacement du risque et le canal de la prise de risque.

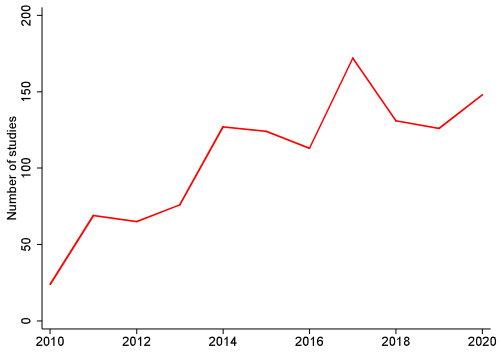
Par le biais du canal du prix des actifs, la politique monétaire peut affecter les prix des actifs, desserrer les contraintes de collatéral ou induire des ventes de feu, selon que les conditions monétaires sont respectivement assouplies ou resserrées. Par conséquent, elle peut affecter l'offre et la demande de crédit. Par exemple, lorsque les taux d'intérêt sont bas, cela peut conduire à une augmentation des prix des actifs et

Figure 4.0.3: Nombre de publications par terme

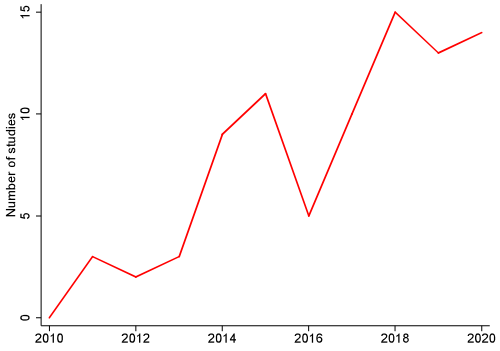
(a) Politique Macroprudentiel



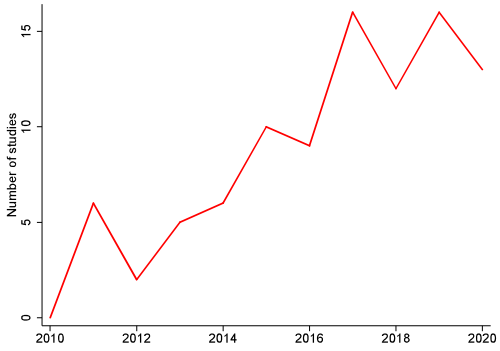
(b) Politique macroprudentielle + Politique monétaire



(c) Politique macroprudentielle + Politique monétaire + Interaction



(d) Politique macroprudentielle + Politique monétaire + Coordination



Chaque graphique représente le nombre de publications et de documents de travail par an comprenant les termes (a), (b), (c) ou (d) dans leur titre. Les données sont collectées à partir du site IDEAS.

exacerber le cycle financier par l'accélérateur financier et son mécanisme d'auto-renforcement (Bernanke and Gertler, 1989, 1995).

Lorsque les taux d'intérêt commencent à monter, les conditions monétaires restrictives passent par le canal du bilan, ce qui augmente les taux de défaut et les charges de remboursement de la dette dans le cas des prêts à taux variable. Par conséquent, un resserrement de la politique monétaire peut entraîner un taux de défaut plus élevé, une réduction des profits des banques, une augmentation des prêts non performants, et donc une déstabilisation du système financier. En outre, la hausse des taux d'intérêt augmente les entrées de capitaux, ce qui entraîne une appréciation de la monnaie locale. Le canal du taux de change augmente la croissance du crédit, l'effet de levier et les emprunts excessifs en devises étrangères, en particulier dans les marchés émergents et les petites économies ouvertes.

En outre, étant donné que le modèle économique des banques traditionnelles consiste à recevoir des dépôts à court terme et à accorder des prêts à long terme, le resserrement des conditions monétaires peut accroître la prise de risque par le biais du canal du déplacement du risque également. En raison des contrats à long terme, l'augmentation du taux directeur tend à affecter davantage les taux à court terme (dépôts) que les taux à long terme (prêts), ce qui réduit les marges d'intérêt des banques et conduit les intermédiaires financiers à rechercher davantage de risques afin de maintenir leurs bénéfices.

Contrairement au canal de déplacement du risque, le canal de prise de risque opère lorsque les conditions monétaires se relâchent, et il s'exacerbe lorsque ces conditions se maintiennent pendant une période relativement longue. Durant ces périodes, les intermédiaires financiers étendent leurs bilans, s'engagent dans des activités plus risquées et réduisent la rigueur avec laquelle les banques sélectionnent les emprunteurs. Selon Borio and Zhu (2012), ce comportement résulte de l'augmentation de la tolérance au risque, de la réduction de la perception du risque et de l'effort des banques pour compenser la compression des marges d'intérêt (recherche de rendement).

De même, la politique macroprudentielle est également susceptible d'avoir des effets secondaires sur l'inflation. Par exemple, les instruments basés sur les emprunteurs se sont avérés efficaces pour affaiblir l'accélérateur financier, et donc pour contenir les fluctuations de la demande globale, puis de l'inflation. Cependant, si ces instruments sont durcis très fortement et rapidement, les agents soumis à ces réglementations peuvent trouver compliqué de s'adapter puis de réviser leur demande ou leur offre de crédit. Dans ce cas, la demande agrégée peut être affectée en fonction des réponses précédentes, ce qui perturbe la conduite de la politique monétaire.

Au cours de la dernière décennie, la littérature a tenté de démêler les interactions complexes entre la politique macroprudentielle et la politique monétaire. Au début, la littérature s'est concentrée sur la manière dont les deux politiques interagissent (effets secondaires), sur l'articulation optimale et sur la nécessité d'une coordination. En raison de l'environnement macroéconomique actuel, qui pourrait persister dans les années à venir, la littérature a commencé à se demander ce que la politique macroprudentielle peut faire pour soutenir une politique monétaire liée à des taux bas sans marge de manœuvre.

En effet, l'orientation accommodante persistante de la politique monétaire dans les économies développées a suscité des inquiétudes quant à la santé et à la stabilité du système financier en raison de ses effets secondaires. En général, des taux directeurs bas assouplissent les conditions financières et influencent le comportement des marchés financiers, ce qui peut conduire à une mauvaise perception du risque et à une prise de risque excessive. En fait, l'interaction auto-renforcée entre la perception du risque et la tolérance au risque, d'une part, et les contraintes financières, d'autre part, peut exacerber le cycle financier et entraîner une détresse financière et des perturbations macroéconomiques. En outre, des conditions financières plus souples peuvent laisser présager une diminution du risque de baisse à court terme, réduisant ainsi la volatilité de la croissance économique. Cependant, à moyen terme, il peut signaler un risque de baisse plus important et une plus grande volatilité de la croissance économique.

En ce qui concerne les interactions entre les deux politiques en temps normal, la littérature a d'abord adopté une approche théorique afin de donner quelques indications sur l'optimalité et la coordination. Par exemple, Collard et al. (2017) suggère qu'il est optimal d'attribuer l'objectif de stabilité financière à la politique prudentielle et l'objectif de stabilisation macroéconomique à la politique de taux d'intérêt, conformément au principe de Tinbergen. Certaines études ont démontré que les outils macroprudentiels (c'est-à-dire les exigences de fonds propres, les coussins contracycliques et les ratios LTV) améliorent le bien-être social en traitant la procyclicité du crédit (Benes and Kumhof, 2015; Alpanda and Zubairy, 2017; Gersbach and Rochet, 2017; Mendicino et al., 2018). Cependant, si l'économie est soumise à un choc de capital bancaire ou à un choc technologique, ces améliorations ont également des effets secondaires sur la volatilité de l'inflation et de la production Angelini et al. (2014). D'autres études se sont concentrées sur la réduction de la probabilité de crise, comme objectif ultime de la politique macroprudentielle. Leurs principaux résultats montrent que les réponses optimales de la politique macroprudentielle réduisent la probabilité et l'ampleur de la crise. Néanmoins, elle est coûteuse en termes de production et d'inflation

à court terme (Bianchi and Mendoza, 2018; Aikman et al., 2019). En ce qui concerne la coordination optimale, les résultats restent non concluants. Certains soutiennent qu'une interaction non coopérative dans laquelle la politique macroprudentielle est le chef de file offre un bien-être plus élevé (Rubio and Carrasco-Gallego, 2014; De Paoli and Paustian, 2017). Cependant, la coopération peut être mieux adaptée lorsque le cadre institutionnel comporte deux autorités indépendantes pour chaque politique et lorsque la stabilisation de la production devient pertinente pour les deux mandats de politique (Gelain and Ilbas, 2017; Bodenstein et al., 2019; Lazopoulos and Gabriel, 2019).

Par la suite, les études empiriques ont tenté de valider ces conclusions antérieures, mais avec des résultats mitigés. Par exemple, certaines études constatent que les exigences en matière de fonds propres n'ont pas d'effets qui compensent les effets secondaires de la politique monétaire sur le crédit bancaire (Aiyara et al., 2016). En revanche, des études plus récentes ont trouvé des effets complémentaires de la politique monétaire. En d'autres termes, la politique macroprudentielle améliore son efficacité à freiner la croissance du crédit lorsque la politique monétaire la soutient (Bruno et al., 2017; Gambacorta and Murcia, 2020). Néanmoins, il est plus probable que ces complémentarités disparaissent lorsque l'environnement macroéconomique présente une faible inflation suivie d'une forte croissance du crédit (Kim and Mehrotra, 2018).

"Parmi les surprises de 2019, la prolongation des politiques monétaires très accommodantes, alors que beaucoup s'attendaient - espéraient ? - à une normalisation. Et donc, des taux bas qui vont durer : "low for longer"; un nombre croissant de personnes craignent les conséquences pour les banques, les compagnies d'assurance et les épargnants. Que la politique monétaire fasse l'objet de débats est légitime, mais qu'elle intéresse même le grand public est nouveau". François Villeroy de Galhau, Gouverneur de la Banque de France (2020).

Aujourd'hui, l'évaluation des interactions entre les deux politiques a évolué en fonction de l'environnement macroéconomique actuel. Depuis les suites de la crise financière mondiale, les taux d'intérêt sont restés bas tout au long de la décennie, et la récente crise de la pandémie de Covid-19 a également montré que ces taux d'intérêt bas dureront encore plus longtemps. L'extrait ci-dessus du discours de François Villeroy de Galhau en 2020 montre clairement les préoccupations des décideurs politiques, des academiques et de la société en général concernant les taux bas et leurs implications pour la stabilité financière. Un tel environnement a potentiellement incité les banques à étendre leur bilan, à réduire la rigueur dans la sélection des emprunteurs et à intensifier les comportements de prise de risque pour obtenir des rendements plus élevés. Dans l'hypothèse où la tendance à la baisse des taux d'intérêt s'inverserait un jour, cela pourrait avoir des conséquences indésirables sur la qualité des emprunteurs, les taux de défaut et, éventuellement, déclencher une crise. Par conséquent, les préoccupations des academiques et des décideurs politiques concernant le canal de la prise de risque ont augmenté de manière significative. En réponse, certains travaux récents ont tenté d'éclairer cette question, mais la littérature en est encore à ses débuts. Par exemple, certaines recherches recommandent la mise en œuvre d'outils macroprudentiels afin de compenser les limites et les effets secondaires de la politique monétaire à la limite inférieure zéro (Farhi and Werning, 2016; Korinek and Simsek, 2016; Rubio and Yao, 2020).

Avec cette thèse de doctorat, nous tentons d'éclairer et de répondre à certaines des principales questions du débat politique et académique actuel. Pour être plus précis, cette thèse de doctorat contribue à la littérature existante en étudiant les interactions entre la politique macroprudentielle et la politique monétaire selon trois approches différentes. Tout d'abord, elle contribue à la littérature existante en identifiant des scénarios ou des circonstances où potentiellement les deux politiques peuvent générer des conflits ou

se compléter. Ensuite, elle identifie comment la politique monétaire, lorsqu'elle fonctionne correctement et dispose d'une marge de manœuvre, peut soutenir ou entraver une politique macroprudentielle visant à freiner la croissance excessive du crédit. Enfin, cette thèse étudie l'environnement actuel où la politique monétaire est contrainte et n'a pas de marge de manœuvre. Ce dernier point met en lumière la façon dont la politique macroprudentielle peut compléter la politique monétaire en affaiblissant les effets négatifs du canal de la prise de risque. La thèse se compose de quatre articles présentés sous forme de chapitres, d'un chapitre introductif et de trois chapitres complémentaires.

Dans le chapitre introductif, publié dans le *Revue Française d'Économie*, nous discutons des avancées de la littérature au cours de la dernière décennie et des principaux débats depuis la mise en oeuvre à grande échelle de la politique macroprudentielle.[10] Parmi les conclusions, nous identifions les interactions avec la politique monétaire comme l'un des principaux défis de la politique macroprudentielle, ce qui justifiera le développement de cette thèse. Dans le second chapitre, nous développons un cadre théorique pour étudier ces interactions de plus près. Notre analyse nous permet d'identifier théoriquement les cas où une coordination entre les deux politiques serait préférable. Ainsi, ce chapitre établit la base théorique des deux chapitres suivants. Dans le troisième chapitre, publié dans le *Journal of International Money and Finance*, nous évaluons empiriquement au niveau macroéconomique l'efficacité de la politique macroprudentielle dans la réduction de la croissance excessive du crédit, et si leur efficacité est affectée par les conditions monétaires, c'est-à-dire lâches ou serrées.[11] Nous constatons que la synchronisation des deux politiques renforce la stabilité financière. Enfin, dans le quatrième chapitre, nous tenons compte de l'environnement monétaire actuel où une politique monétaire restrictive n'est pas à l'horizon proche. Nous étudions empiriquement, à l'aide de données bancaires, l'efficacité de la politique macroprudentielle en présence d'une politique monétaire accommodante persistante et à atténuer les effets secondaires négatifs sur le comportement des banques en matière de prise de risque. Nous constatons que les outils basés sur les emprunteurs et la gestion du crédit sont efficaces pour atténuer les effets secondaires des conditions monétaires accommodantes persistantes. Chacun des chapitres est décrit plus en détail ci-dessous.

Chapitre 1 : Politiques macroprudentielles : Enjeux et défis

Chapitre 1, intitulé "Politiques macroprudentielles : Issues and Challenges", est le chapitre d'introduction de cette thèse de doctorat et se concentre sur la première décennie qui a suivi le déclenchement de la crise financière mondiale. Par rapport aux précédentes revues de littérature centrées sur les instruments et l'efficacité de la politique macroprudentielle (Galati and Moessner, 2018; Lubis et al., 2019), nous présentons une vue d'ensemble de l'avancée des connaissances et de ce qui reste inconnu sur les principaux débats liés à la mise en œuvre de la politique macroprudentielle. Ce chapitre fournit également les définitions des principaux concepts et l'état de la littérature sur la politique macroprudentielle.

Comme indiqué précédemment, le concept de macroprudentiel n'était pas nouveau lorsque la crise a débuté en 2007. Toutefois, c'est à la suite de la crise que les academiques et les responsables politiques ont convenu qu'une politique prudentielle est macroprudentielle si elle combine deux caractéristiques : elle doit adopter une perspective macroéconomique du système financier en tenant compte des boucles de rétroaction entre le secteur réel et le secteur financier ; et elle est caractérisée par une nature préventive lorsqu'elle s'attaque au risque systémique. Sur la base de cette clarification, quatre aspects ont

[10] Garcia Revelo, J. D., Leroy, A., et Lucotte, Y. (2018). Les politiques macroprudentielles : enjeux et défis. *Revue française d'économie*, 33(4):127–174.

[11] Garcia Revelo, J.D., Lucotte, Y., et Pradines–Jobet, F. (2020). Politiques macroprudentielles et monétaires : La nécessité de danser le tango en harmonie. *Journal of International Money and Finance*, 108:102156.

suscité un grand intérêt parmi les academiques et les décideurs politiques et ont fait l'objet d'études complémentaires. Le premier aspect était la définition des objectifs et des instruments de sa boîte à outils, une étape cruciale avant la mise en œuvre à grande échelle des instruments macroprudentiels. Deuxièmement, l'efficacité de ces instruments. Troisièmement, la manière dont la politique macroprudentielle et les autres politiques économiques s'imbriquent, notamment avec la politique monétaire. Et quatrièmement, l'identification des problèmes de coordination internationale liés à d'éventuels effets de débordement transfrontaliers. Ce chapitre aborde ces quatre questions afin d'avoir une vision plus large des progrès de la littérature et de ce qu'il reste à approfondir.

L'une des principales conclusions de ce chapitre est que l'interaction entre la politique macroprudentielle et la politique monétaire implique en fait d'ouvrir deux fronts de questionnement. Premièrement, il s'agit de savoir si l'application d'outils macroprudentiels interfère avec les objectifs de la politique monétaire, et deuxièmement, si la politique macroprudentielle a des effets secondaires sur la politique monétaire. Ces interactions ont fait l'objet des débats et des contributions les plus animés ces dernières années. Toutefois, comme il est indiqué dans ce chapitre, la prolifération des recherches théoriques et empiriques n'a pas abouti à une conclusion définitive, ce qui explique que les chapitres suivants proposent une contribution importante à l'état actuel de la littérature sur la politique macroprudentielle. Dans le Chapitre 2, nous évaluons ces interactions bilatérales entre les politiques monétaires et macroprudentielles. Dans le Chapitre 3, nous montrons comment une coordination potentielle entre les autorités monétaires et macroprudentielles peut améliorer la stabilité financière. Et dans le Chapitre 4, nous montrons comment la politique macroprudentielle peut également venir compléter la politique monétaire en réduisant ses externalités négatives sur le système financier dans le cas d'environnements de taux d'intérêt bas.

Chapitre 2 : Quand les politiques macroprudentielles et monétaires peuvent-elles être en conflit ?

Chapitre 2, intitulé "Quand les politiques macroprudentielle et monétaire pourraient-elles être en conflit ?", fournit une analyse complète des conflits (complémentarités) potentiels entre la politique macroprudentielle et la politique monétaire. Comme indiqué au chapitre 1, il existe des interactions bilatérales entre les deux politiques, et des conflits peuvent survenir des deux côtés. Dans ce chapitre, nous utilisons un modèle DSGE pour découvrir les scénarios dans lesquels ces conflits peuvent survenir, et nous proposons une taxonomie des interactions entre les politiques macroprudentielle et monétaire. Par rapport à la littérature précédente (Angelini et al., 2014; Aikman et al., 2019; Silvo, 2019) nous identifions des scénarios spécifiques où les conflits peuvent survenir. Nous utilisons des chocs de nature différente, des objectifs de politique différents et des instruments différents. Cette évaluation globale peut éclairer les autorités monétaires et prudentielles sur les retombées potentielles de leurs politiques et sur les cas où une coordination serait nécessaire.

Le cadre théorique est basé sur le modèle DSGE développé par Gerali et al. (2010). Ce modèle a été largement utilisé dans la littérature pour plusieurs raisons. Premièrement, il s'agit d'un modèle réaliste, avec des rigidités nominales et réelles. Deuxièmement, le modèle intègre un secteur bancaire qui assure l'intermédiation entre les ménages patients, d'une part, et les entreprises et les ménages impatients, d'autre part. Troisièmement, il présente des frictions financières provenant de contraintes de collatéral.

Nous introduisons ensuite dans le modèle trois règles macroprudentielles visant à renforcer la résilience

des institutions financières et à maîtriser la procyclicité du système financier. Ainsi, nous introduisons un tampon de capital contracyclique (CCyB) et deux plafonds de LTV dépendants de l'état, un pour les ménages et un pour les entreprises. En ce qui concerne la politique monétaire, nous introduisons une règle de taux d'intérêt standard répondant aux déviations de l'inflation par rapport à son objectif et à l'écart de production.

Afin de découvrir les scénarios potentiels où des conflits peuvent survenir, nous suivons une approche descriptive qui est agnostique quant aux préférences des décideurs politiques. En outre, le but de notre analyse n'est pas de déterminer les politiques monétaires et macroprudentielles optimales en soi, nous cherchons à identifier les cas dans lesquels des conflits peuvent spontanément survenir. Par conséquent, nous considérons ce chapitre comme un prérequis à l'analyse de la coordination optimale. À cette fin, nous considérons différents types de scénarios de chocs, puis nous découvrons les circonstances où la politique monétaire a des effets secondaires sur l'objectif de la politique macroprudentielle, à savoir atténuer l'excès de crédit, et où la politique macroprudentielle a des effets secondaires sur les objectifs de la politique monétaire, à savoir stabiliser l'inflation et le cycle économique.

Parmi les principaux résultats, nous constatons que les conflits entre les politiques macroprudentielles et monétaires sont assez fréquents mais pas systématiques. Ils sont particulièrement susceptibles de survenir en cas de chocs technologiques et de chocs sur le capital des banques. Lorsque nous examinons instrument par instrument, il apparaît que le CCyB et le taux d'intérêt directeur génèrent des conflits dans plusieurs cas. En revanche, les ratios LTV provoquent peu de conflits. Ces résultats suggèrent que les limites de LTV peuvent être facilement mises en œuvre sans crainte de débordements potentiels. En revanche, la mise en œuvre de la CCyB et de la politique monétaire nécessite une coordination harmonieuse.

Le chapitre 2 prouve théoriquement qu'il existe effectivement des conflits et des complémentarités entre la politique macroprudentielle et la politique monétaire. Dans les deux chapitres suivants, nous proposons deux approches empiriques différentes pour analyser comment les deux politiques peuvent se compléter ou générer des conflits entre elles d'un point de vue macroéconomique et microéconomique.

Chapitre 3 : Politiques macroprudentielles et monétaires : La nécessité de danser le tango en harmonie

Chapitre 3, intitulé "Politiques macroprudentielles et monétaires : The need to dance the tango in harmony", examine de manière empirique l'efficacité de la politique macroprudentielle à freiner la croissance excessive du crédit domestique au niveau macroéconomique. En outre, par rapport à des recherches antérieures (Akinci and Olmstead-Rumsey, 2018; Gambacorta and Murcia, 2020), le cœur de notre analyse se concentre sur la façon dont l'orientation de la politique monétaire (c'est-à-dire, stricte ou souple) affecte cette efficacité. Cette dernière nous permet de comprendre comment les conditions de la politique monétaire peuvent entraver ou renforcer la poursuite de la politique macroprudentielle pour la stabilité financière. Au cours de la dernière décennie, un nombre croissant d'études théoriques ont abordé cette question et confirmé les avantages d'une coordination entre les deux politiques, mais peu de choses étaient connues d'un point de vue empirique. Les recherches menées dans ce chapitre comblent cette lacune dans la littérature existante en fournissant les premières preuves empiriques de l'impact des conditions de politique monétaire sur l'efficacité de la politique macroprudentielle pour un large échantillon

d'économies.

Nous considérons un échantillon de 37 économies émergentes et avancées du premier trimestre 2000 au quatrième trimestre 2004, pour lesquelles nous calculons des indices de l'orientation de la politique macroprudentielle et monétaire. Pour l'orientation de la politique macroprudentielle, nous utilisons la base de données fournie par Cerutti et al. (2017b) pour calculer six mesures différentes de l'orientation. Ces mesures visent à donner une meilleure vision des différences entre les pays en termes de cadre de politique macroprudentielle et de sa conduite. Pour l'orientation de la politique monétaire, nous suivons la littérature existante [voir, par exemple,] []BogdanovaHofmann12,BrunoShimShin2017 et estimons une règle de Taylor. Afin de tenir compte des pays mettant en œuvre des politiques monétaires non conventionnelles (PMC) après le GFC, nous ne considérons pas l'écart entre le taux directeur effectif et le taux de Taylor, mais la différence entre le taux fantôme fourni par Krippner (2015) et le taux de Taylor.

Ensuite, notre analyse empirique se déroule en deux étapes. Tout d'abord, nous suivons la littérature existante en réexaminant comment nos différentes mesures de l'orientation de la politique macroprudentielle affectent la croissance du crédit. À cette fin, nous considérons deux mesures alternatives du crédit domestique, qui sont le crédit total des banques au secteur privé non financier et le crédit total aux ménages et aux institutions sans but lucratif au service des ménages. Le taux de croissance du PIB est inclus pour contrôler la procyclicité du crédit (Athanasoglou et al., 2014) ce qui nous permet de capturer la croissance excessive du crédit, la partie du crédit qui n'est pas entraînée par l'activité économique réelle. Dans un deuxième temps, nous étendons le modèle de base précédent pour savoir si une politique macroprudentielle plus stricte accompagnée d'une politique monétaire restrictive est plus susceptible de freiner la croissance du crédit domestique.

Parmi les principaux résultats, nous constatons qu'un durcissement global de la politique macroprudentielle est associé à une réduction de la croissance du crédit. En outre, nous observons que les actions de politique macroprudentielle prennent environ deux à trois trimestres pour freiner efficacement la croissance du crédit domestique. Lorsque nous tenons compte de l'orientation de la politique monétaire, nous constatons que l'efficacité du resserrement de la politique macroprudentielle est renforcée lorsqu'il est mené parallèlement à une politique monétaire restrictive. Ce résultat confirme les avantages de la synchronisation des politiques macroprudentielle et monétaire. Enfin, nous trouvons des preuves que la politique monétaire peut aider à réduire le délai de transmission des actions de la politique macroprudentielle sur la croissance excessive du crédit du secteur privé.

Ce chapitre montre que les politiques monétaires et macroprudentielles sont complémentaires même si elles poursuivent des objectifs primaires différents. Nos résultats soulignent en particulier l'importance de la mise en œuvre d'une politique monétaire qui soutient et complète la politique macroprudentielle par un resserrement à l'unisson, puis par l'atténuation de ses effets secondaires potentiels sur la stabilité financière.

Même si les conclusions de ce chapitre donnent des indications utiles sur les avantages de la synchronisation des politiques monétaire et macroprudentielle, dans l'environnement macroéconomique actuel, un resserrement de la politique monétaire n'est pas concevable. Depuis plus d'une décennie, les taux d'intérêt n'ont cessé de baisser jusqu'à atteindre leur plancher effectif et même devenir négatifs dans certaines régions. En outre, la récente crise pandémique a montré que les taux d'intérêt actuellement bas le resteront encore longtemps. Ce scénario économique difficile a fait des taux d'intérêt "bas pour longtemps" et du comportement de prise de risque des institutions financières l'un des principaux fronts des débats politiques et academiques. C'est pourquoi, dans le dernier chapitre, nous tentons de découvrir

ce que la politique macroprudentielle peut faire pour soutenir une politique monétaire contrainte et éviter les comportements de prise de risque excessive.

Chapitre 4 : "Politiques macroprudentielles et prise de risque bancaire dans un environnement de taux d'intérêt durablement bas"

Chapitre 4, intitulé "Politiques macroprudentielles et prise de risque bancaire dans un environnement de taux d'intérêt durablement bas", étudie empiriquement si la politique macroprudentielle peut effectivement atténuer le comportement de prise de risque des banques dans des scénarios de périodes prolongées de politique monétaire accommodante au niveau des banques. En outre, ce chapitre présente des données sur les outils macroprudentiels les mieux adaptés à cette fin. En ce qui concerne la littérature la plus proche, ce chapitre renforce et complète les conclusions précédentes de Maddaloni and Peydró (2013) étant donné que les variables spécifiques de prise de risque utilisées dans l'analyse sont directement liées aux conséquences de l'assouplissement des normes de prêt en raison des environnements monétaires accommodants. Par rapport aux recherches de (Altavilla et al., 2020), ce chapitre se concentre sur l'impact de l'assouplissement des conditions monétaires et sur la manière dont le resserrement des conditions financières pourrait atténuer la prise de risque excessive des banques, alors que Altavilla et al. (2020) se concentre sur les effets de l'assouplissement des conditions financières et monétaires.

Pour ce faire, cette recherche exploite un ensemble de données de panel non cylindrées couvrant 1074 banques commerciales de 38 pays de 2010 à 2018. Par rapport à la littérature précédente qui utilise le Z-score ou la fréquence de défaut attendue comme mesures de la prise de risque des banques (Altunbas et al., 2018; Delis et al., 2017; Segev, 2020), cette recherche considère des variables mieux adaptées directement liées à l'accumulation du risque systémique et à la matérialisation du risque lié au comportement excessif des banques dans le passé. Par exemple, l'offre excessive de crédit des banques, les prêts non performants, les réserves pour pertes sur prêts et les provisions pour pertes sur prêts. En outre, cette enquête tient compte des conditions monétaires avec les changements de la pente de la courbe des taux. En effet, les changements de la pente de la courbe des taux mesurent plus précisément les conditions monétaires dans les environnements où les taux directeurs sont limités à la borne inférieure zéro. Pour la politique macroprudentielle, nous incluons le ciblage des capitaux, la gestion du crédit et les mesures basées sur les emprunteurs.

Ce chapitre met à jour et complète les résultats précédents de la littérature sur la prise de risque en présentant des preuves que le comportement des banques en matière de prise de risque a augmenté au cours de la période post-crise pour de nombreux pays. En ce qui concerne la littérature sur l'efficacité de la politique macroprudentielle et les interactions avec la politique monétaire, cette analyse élargit les études précédentes à trois niveaux. Premièrement, elle montre que des outils macroprudentiels plus stricts ciblant les emprunteurs, le capital des banques et la gestion du crédit des banques pourraient réduire, voire compenser, les effets des conditions accommodantes de la politique monétaire sur le comportement de prise de risque des banques. Deuxièmement, elle identifie les instruments axés sur les emprunteurs et les mesures ciblant la gestion du crédit des banques comme les instruments les plus efficaces pour contrecarrer les effets d'un environnement de politique monétaire durablement accommodant. En outre, lorsque l'on tient compte des caractéristiques spécifiques des banques, il apparaît que les instruments fondés sur les fonds propres et sur les emprunteurs sont plus efficaces pour les banques faiblement capitalisées et disposant de peu de liquidités. En revanche, les instruments ciblant la gestion du crédit des banques sont plus efficaces pour les banques fortement capitalisées et disposant de liquidités abondantes. Enfin, les trois

groupes d'outils macroprudentiels semblent être efficaces lorsque le système financier est très concentré (forte concurrence). Néanmoins, lorsque les conditions monétaires sont extrêmement accommodantes, les mesures basées sur les emprunteurs et la gestion du crédit sont plus efficaces.

Ce chapitre fournit des indications utiles aux décideurs politiques sur la manière, le moment et le type d'outil macroprudentiel à mettre en œuvre ou à utiliser pour atténuer le comportement de prise de risque des institutions financières. En outre, il confirme la capacité des outils macroprudentiels à atténuer la prise de risque des banques dans des environnements de taux bas persistants. Des environnements qui ont caractérisé la dernière décennie, et qui sont très susceptibles de persister plus longtemps. Ce dernier point met en évidence les complémentarités potentielles entre la politique macroprudentielle et la politique monétaire.

Jose David GARCIA REVELO

Essais sur les interactions entre les politiques monétaire et macro-prudentielle

Cette thèse de doctorat se concentre sur l'étude des interactions entre les politiques macro-prudentielles et les politiques monétaires. Par nature, les deux politiques sont contracycliques mais avec des objectifs finaux différents, ce qui soulève des questions sur les conflits potentiels et les complémentarités. Pour être plus précis, en quatre chapitres, cette thèse de doctorat alimente la littérature existante en étudiant ces interactions sous trois approches différentes. Tout d'abord, elle y contribue en identifiant des scénarios et des circonstances dans lesquels les deux politiques peuvent potentiellement entrer en conflit ou se compléter. Ensuite, elle identifie comment la politique monétaire peut soutenir ou entraver une politique macro-prudentielle visant à freiner la croissance excessive du crédit. Enfin, cette thèse étudie comment la politique macro-prudentielle peut compléter la politique monétaire en affaiblissant les effets négatifs du canal de la prise de risque dans un environnement de taux d'intérêt bas. La contribution de cet exercice de recherche est triple. Premièrement, il propose une analyse complète des interactions et des scénarios possibles lorsque les objectifs de la politique macro-prudentielle et de la politique monétaire sont en conflit. Ensuite, il présente des preuves empiriques, au niveau macroéconomique, de la manière dont la politique monétaire peut soutenir la politique macro-prudentielle pour contenir la procyclicité du crédit. Enfin, elle présente des preuves empiriques, au niveau microéconomique, de la façon dont les outils de politique macro-prudentielle peuvent aider à contenir les externalités négatives d'un environnement durable de taux bas.

Mots clés : politique macroprudentielle, politique monétaire, interaction, coordination, stabilité financière, efficacité des politiques macroprudentielles.

Interactions between monetary and macroprudential policy

This doctoral thesis focuses on the post Global Financial Crisis (GFC) macroeconomic policy framework to study the interactions between macroprudential and monetary policies. By nature, both policies are countercyclical but with different ultimate goals, which raises questions about potential conflicts and complementarities. To be more precise, this doctoral thesis contributes to the existing literature by studying these interactions under three different approaches. First, it contributes by identifying scenarios or circumstances where potentially both policies may generate conflicts or complement each other. Then, it identifies how the monetary policy, may support or hinder a macroprudential policy aiming to dampen the excessive credit growth. Finally, this thesis studies how macroprudential policy may complement the monetary policy by weakening the adverse effects of the risk-taking channel under a low-interest-rates environment. The main contribution of this research exercise is threefold. First, it proposes a comprehensive analysis of the interactions and the possible scenarios when the objectives of the macroprudential policy and the monetary policy may conflict. Second, it presents empirical evidence, at a macroeconomic level, of how monetary policy can support macroprudential policy in containing credit procyclicality. Finally, it presents empirical evidence, at a microeconomic level, of how macroprudential policy tools can help to contain the negative externalities "too-low for too-long" monetary environments. The thesis consists of four articles presented in a chapter format.

Keywords : macroprudential policy, monetary policy, interaction, coordination, financial stability, macroprudential policy effectiveness.

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