Essays on the Interaction of Monetary and Banking Regulation Policies

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À minha família.
Abstract

This thesis investigates the interaction of monetary policy and banking regulation and supervision and what it may imply for the design of their institutional setup. Reforms implemented all over the world in the aftermath of the financial crisis aimed not only at revising the institutional arrangements of banking supervision that were in place, but also at introducing a macroprudential oversight of the financial system, as a complement to the microprudential approach, mainly empowering central banks with new financial stability objectives and instruments.

Despite the research effort undertaken, it is still unclear whether central banks, which main role is to ensure the price stability, should engage in banking supervisory responsibilities and extend their mandates to embrace financial stability goals. This thesis contributes to this literature by:

- Surveying the empirical and theoretical literature concerning the implications of the interactions between these policies for the design of their institutional framework.
- Assessing the conflicting goals of price and banking stability. Acknowledging that central banks in charge of banking regulation may be less aggressive in their inflation mandate, in cases in which tight monetary policy conditions could have a negative effect on the stability of the banking system, it has been argued that banking supervisory powers should be assigned to an independent authority to avoid inflation bias.
- Revisiting the role of monetary policy in 'leaning against the financial imbalances' and its interaction with macroprudential regulation.
- Investigating the transmission mechanisms of different macroprudential policy instruments and their interactions with monetary policy-controlled interest rates, under a New Keynesian (NK) model with two types of financial frictions. For this topic, preliminary findings are shown.

We start by showing the lack of both analytical and empirical studies focused on the trade-offs between expected benefits (‘sharing of information’ and ‘expertise’) and expected costs (‘conflict of interests’, ‘reputation risks’, ‘organizational costs’ and ‘balance of powers’) of central bank involvement in banking supervision. The main conclusions from the remaining research work conducted in this thesis are:
Empirically, there is no evidence of an inflationary bias arising from institutional frameworks in which central banks have banking supervisory mandates.

Theoretically, based on a NK framework with a banking system and financial frictions, we find that 'leaning against the financial imbalances' monetary policy rules maximise welfare compared to a standard, conventional Taylor rule. Moreover, the deployment of macroprudential regulation together with standard monetary policy also improves welfare, regardless of the financial target used and the type of policy mandate under assessment (separate or unified). The welfare maximization is achieved under a partially unified mandate featuring a macroprudential rule reacting simultaneously to credit and credit spreads. Inflation stabilization is better accomplished in a separate mandate, with a standard Taylor rule and a macroprudential rule responding to credit and spreads.

When considering loan-to-value (LTV) ratios as a macroprudential tool, preliminary results show that less stricter regulatory requirements for the LTV ratio amplify the propagation mechanism of monetary policy shocks.
Declaration

This thesis and the work to which it refers are the results of my own efforts. Any ideas, data, images or text resulting from the work of others (whether published or unpublished) are fully identified as such within the work and attributed to their originator in the text, bibliography or in footnotes. This thesis has not been submitted in whole or in part for any other academic degree or professional qualification. I agree that the University has the right to submit my work to the plagiarism detection service TurnitinUK for originality checks. Whether or not drafts have been so-assessed, the University reserves the right to require an electronic version of the final document (as submitted) for assessment as above.

Chapter 3 draws on “The Effect of Financial Regulation Mandate on Inflation Bias: A Dynamic Panel Approach” and was written with Ioannis Lazopoulos and Vasco Gabriel and a preliminary version was already published in the CIMS working paper series. This working paper was presented in the 2014 Royal Economic Society (RES) Conference, on 9th April 2014 in Manchester, in the 12th INFINITI Conference on International Finance in Prato, and in the World Finance Conference, 2-4 July 2014. The version of this working paper as presented in Chapter 3 was done by the candidate alone.

Chapter 4 draws on “Policy Mandates for Macroprudential and Monetary Policies in a New Keynesian Framework” written with Paul Levine and published in the ECB Working Paper Series, 1784/April 2015. This working paper was presented in a CIMS workshop at the University of Surrey, on the 18 of March 2013, in the RES Easter School 2013, at the University of Birmingham and it will be presented as a poster in the ECB Forum on Central Banking, in June 2016. This work was equally conceived by the authors. Paul Levine was mostly responsible for developing the model. The candidate was entirely responsible for surveying the literature, incorporating augmented monetary policy and macroprudential policy simple rules in the model, by conducting the simulations and optimal policy exercises and finally for interpreting the results.

The remaining chapters of the thesis were done by the candidate alone.
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Contents

1 Introduction

2 Institutional setups of monetary policy and banking regulation and supervision - a survey

   2.1 Introduction .............................................................. 21
   2.2 The Interactions of Banking Regulation and Monetary Policy ............ 24
   2.3 Institutional arrangements of monetary policy and banking regulation 28
      2.3.1 Arguments against a separate mandate between monetary policy and banking regulation .................................................. 30
      2.3.2 Arguments for a Separate Mandate of Monetary Policy and Banking Regulation .............................................................. 36
   2.4 Banking Regulation and Monetary Policy - Theoretical Approach ....... 45
   2.5 The degree of financial supervision consolidation - a political-economy approach ................................................................. 52
   2.6 Macroprudential regulation and monetary policy ............................ 54
      2.6.1 Objectives and Instruments of Macroprudential Policy ............... 55
      2.6.2 Institutional arrangements of macroprudential and monetary policies 57
      2.6.3 The interactions of macroprudential and monetary policies ......... 62

3 The Effect of Financial Regulation Mandate on Inflation Bias: A Dynamic Panel Approach

   3.1 Introduction .................................................................. 67

8
3.2 Interactions of monetary policy and banking supervision - a review 71

3.3 Empirical Analysis 76
   3.3.1 Data 77
      3.3.1.1 Institutional Factors 77
      3.3.1.2 External and Economic Factors 81
      3.3.1.3 Banking Sector Factors 82
   3.3.2 Model Specification 83
   3.3.3 Estimation Results 86
      3.3.3.1 Static Panel Data Models 86
      3.3.3.2 Dynamic Panel Data Model 91
      3.3.3.3 Robustness checks 93
   3.4 Conclusions 95

3.5 Appendix 98
   3.5.1 Variables: definitions, expected impact on inflation and sources 98
   3.5.2 Descriptive Statistics 101
   3.5.3 Countries classification into separate and combined mandates of monetary policy and banking supervision 102
   3.5.4 Robustness Checks 103
   3.5.5 Test for strict exogeneity of the variable separate banking supervisor 112

4 Policy Mandates for Macroprudential and Monetary Policies in a New Keynesian Framework 115
   4.1 Introduction 115
   4.2 The Model 120
      4.2.1 Households 120
      4.2.2 Goods Producers 122
      4.2.3 Capital Producers 123
      4.2.4 Retail Producers 123
5.6 Appendix A - Equilibrium conditions

5.6.1 Households

5.6.2 Goods Producers

5.6.3 Capital Producers

5.6.4 Entrepreneurs

5.6.5 Banking Sector

5.6.6 Retail Sector

5.6.7 Closing the Model

5.6.8 Shocks

5.7 Appendix B - Steady State

5.7.1 Households

5.7.2 Goods Producers

5.7.3 Capital Producers

5.7.4 Entrepreneurs

5.7.5 Banking Sector

5.7.6 Retail Sector

5.7.7 Closing the Model

6 Concluding Remarks

Bibliography
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Main arguments for different institutional arrangements of monetary policy and banking regulation and supervision</td>
<td>30</td>
</tr>
<tr>
<td>4.1</td>
<td>Monetary Policy Rules only: Productivity Shock</td>
<td>158</td>
</tr>
<tr>
<td>4.2</td>
<td>Monetary Policy Rules only: Capital Shock</td>
<td>158</td>
</tr>
<tr>
<td>4.3</td>
<td>Monetary and Macroprudential Policies Rules: Productivity Shock</td>
<td>159</td>
</tr>
<tr>
<td>4.4</td>
<td>Monetary and Macroprudential Policies Rules: Capital Shock</td>
<td>159</td>
</tr>
<tr>
<td>5.1</td>
<td>New Keynesian Model with a banking sector with two financial frictions</td>
<td>164</td>
</tr>
<tr>
<td>5.2</td>
<td>Impulse response functions to a negative technology shock - a). Note: all variables expressed in % deviation from steady state</td>
<td>179</td>
</tr>
<tr>
<td>5.3</td>
<td>Impulse responses to a negative technology shock - b)</td>
<td>180</td>
</tr>
<tr>
<td>5.4</td>
<td>Impulse responses to a monetary policy tightening - a). Note: all variables expressed in % from steady state</td>
<td>181</td>
</tr>
<tr>
<td>5.5</td>
<td>Impulse responses to a monetary policy tightening - b)</td>
<td>181</td>
</tr>
<tr>
<td>5.6</td>
<td>Model Comparison - 2 FF Model vs NK Model (IRF to a negative monetary policy shock)</td>
<td>183</td>
</tr>
<tr>
<td>5.7</td>
<td>Model Comparison - 2 FF Model vs GK and KM Models (IRF to a monetary policy tightening shock)</td>
<td>185</td>
</tr>
<tr>
<td>5.8</td>
<td>Monetary Policy Shock under a low and a high LTV ratio.</td>
<td>186</td>
</tr>
</tbody>
</table>
## List of Tables

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Mandates of Banking Supervision Around the World</td>
<td>29</td>
</tr>
<tr>
<td>2.2</td>
<td>Organizational Features of Monetary and Competition Policies</td>
<td>41</td>
</tr>
<tr>
<td>2.4</td>
<td>Conflicting outcomes of monetary and macroprudential policies</td>
<td>60</td>
</tr>
<tr>
<td>3.1</td>
<td>Mandates of banking supervision and average inflation for 25 countries</td>
<td>78</td>
</tr>
<tr>
<td>3.2</td>
<td>Estimation Results (1975-2012)</td>
<td>87</td>
</tr>
<tr>
<td>3.3</td>
<td>Estimation Results (1975-2012)</td>
<td>92</td>
</tr>
<tr>
<td>3.4</td>
<td>Estimation Results (1975-2012) [cont. Table 3.3]</td>
<td>93</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Variables’ description and expected impact on inflation</td>
<td>98</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Variables - Sources and Definitions</td>
<td>99</td>
</tr>
<tr>
<td>3.5.3</td>
<td>Variables - sources and definitions (cont.)</td>
<td>100</td>
</tr>
<tr>
<td>3.5.4</td>
<td>Descriptive Statistics</td>
<td>101</td>
</tr>
<tr>
<td>3.5.5</td>
<td>Countries classification - separate and combined mandates</td>
<td>102</td>
</tr>
<tr>
<td>3.5.6</td>
<td>Fixed Effects Estimation Results (1975-2012)</td>
<td>104</td>
</tr>
<tr>
<td>3.5.7</td>
<td>Dynamic Panel Data Model - Estimation Results (1975-2012)</td>
<td>105</td>
</tr>
<tr>
<td>3.5.8</td>
<td>Dynamic Panel Data Model - Estimation Results (1975-2012) [cont. Table 3.5.7]</td>
<td>106</td>
</tr>
<tr>
<td>3.5.9</td>
<td>Fixed Effects Estimation Results (1975-2012)</td>
<td>107</td>
</tr>
<tr>
<td>3.5.10</td>
<td>Dynamic Panel Data Model - Estimation Results (1975-2012)</td>
<td>108</td>
</tr>
<tr>
<td>3.5.11</td>
<td>Dynamic Panel Data Model - Estimation Results (1975-2012) [cont. Table 3.5.10]</td>
<td>109</td>
</tr>
<tr>
<td>3.5.12</td>
<td>Fixed Effects Estimation Results (1975-2007)</td>
<td>110</td>
</tr>
</tbody>
</table>
3.5.13 Panel Data Model - Estimation Results (1975-2007) ......... 111
3.5.14 Dynamic Panel Data Model - Estimation Results (1975-2007) (cont. Table 3.5.13) ......................................................... 112
3.5.15 Fixed Effects Estimation Results ........................................... 113
3.5.16 Results for Strict Exogeneity Test on “separate banking supervisor” .... 114

4.2.1 Calibrated Parameters .......................................................... 138
4.3.1 Optimal Monetary Policy Rules - Optimised Coefficients .......... 141
4.3.2 Optimal Monetary Policy Rules - Welfare Losses / Gains and Std Deviations .... 142
4.3.3 Separate Mandate - Monetary Policy Optimised Coefficients .......... 144
4.3.4 Separate Mandate - Macroprudential Policy Optimised Coefficients .... 145
4.3.5 Separate Mandate - Welfare Losses / Gains and Std Deviations .......... 146
4.3.6 Partially Unified Mandate - Monetary Policy Optimised Coefficients ...... 148
4.3.7 Partially Unified Mandate - Macroprudential Policy Optimised Coefficients .... 148
4.3.8 Partially Unified Mandate - Welfare Losses/Gains and Std Deviations ... 149
4.3.9 Comparison of Macroprudential Tools ...................................... 150
4.4.1 Implementable Policy Rules .................................................. 156
4.4.2 Separate Mandate - Monetary Policy Coefficients ...................... 157
4.4.3 Separate Mandate - Macroprudential Policy Coefficients ............... 157

5.2.1 Calibrated Parameters ....................................................... 177
Chapter 1

Introduction

The consensus towards the separation of monetary policy and banking regulation and supervision was unsettled by the 2008 financial crisis, which revealed the need for implementing major reforms into the institutional mandates of monetary policy and banking regulation and supervision. These reforms aimed not only at revising the institutional arrangements of banking supervision that were in place, but also at introducing a macroprudential oversight of the financial system, as a complement to the microprudential approach, mainly empowering central banks with new financial stability objectives and instruments. Although these changes to the institutional designs of monetary policy and prudential regulation have occurred all over the world, there is still a lack of deep investigation on the interactions between these policies and, consequently, on their implications to the stability of prices, the financial system, the macroeconomy and, ultimately, to the social welfare.

The introduction of macroprudential policies can improve the trade-offs for monetary policy and be helpful in particular situations. For example, by ensuring that the financial system works smoothly, thereby contributing to an effective transmission process of monetary policy. Furthermore, by managing the financial cycle and increasing the resilience of the financial sector, macroprudential policies may reduce the probability of systemic crisis and therefore the probability of monetary policy becoming constrained by the zero lower bound. However, as explained by Smets (2014), there are side-effects that one policy has on the objectives of the other, originated by the sharing of transmission channels.

1As an example of reforms in Europe, the United Kingdom is a an example of a country in which reforms were made in the institutional setup of banking regulation and supervision after the 2008 financial crisis, by bringing the Financial Services Authority to the Bank of England.
For instance, changes in policy rates or non-conventional monetary policies may affect risk-taking behavior *ex ante* and the tightness of credit constraints *ex post*. In a crisis, liquidity policies by the central bank may avoid a collapse of the banking sector, but also reduce incentives for banks to recapitalize and restructure, while promoting the growth of non-performing loans and regulatory forbearance by supervisors. Changes in macro-prudential policy may pose challenges to monetary policy as well, by altering financing conditions and affecting the real economy and price stability. In the current juncture, macroprudential policies tend to reinforce the banking sector resilience to shocks, by imposing stricter bank capital ratios, such as capital buffers for systemically important institutions. These measures’ expected impact is to reduce credit availability, conflicting with the purpose of the actual monetary policy stance of very low interest rates and quantitative easing.

The need for coordination between monetary and macroprudential policies brings additional challenges for the design of institutional setups which aims at maximising the complementary aspects of these policies and minimising the potential conflicts that may arise in the short run. In the academic literature, despite the proliferation of research work on these fields, there is not a clear-cut answer to whether central banks shall engage in banking supervisory responsibilities and extend their mandates to comprise financial stability goals.

This thesis contributes to this literature in several ways. Chapter 2 surveys the literature concerning the implications of the interactions between these policies for the design of the institutional framework. To this extent, we compile both theoretical and empirical literature and identify the topics that need to be further explored. This review indicates that there is a trade-off between expected benefits (sharing of information and expertise) and expected costs (‘conflict of interests’, ‘reputation risks’, ‘organizational costs’ and ‘balance of powers’) of central bank involvement in banking regulation and supervision.

On the one hand, there is a lack of analytical frameworks studying the interplay between monetary policy and banking regulation. On the other hand, the empirical evidence is scarce and not fully conclusive. Empirical studies focus essentially in analysing the arguments related with the ‘information gains’, ‘staff and funding’ and ‘conflict of interests’. These studies tend to support the ‘conflict of interests argument’, pointing out for a separate institutional setup of monetary policy and banking regulation. In contrast, the “informational gains” argument does not gather the same consensus in the empirical literature. Nevertheless, only a few papers investigate these effects, as it will be discussed in Chapter 1.
Regarding the theoretical literature, microeconomic approaches on this topic shows that the analysis of the banking regulators / supervisors incentives should be carefully considered in the design of optimal supervisory institutional setups. This literature, mainly centered in the supervisory and regulatory functions of policymakers, would benefit from an extension to assess the implications for the institutional setups of incorporating its interplay with monetary policy. Macroeconomic models in which the interplay of monetary policy and banking regulation is investigated are also scant and focused on Basel I and Basel II capital regulation frameworks. These studies show that capital regulation has an impact on the level of output and increases business cycle fluctuations, highlighting the procyclical effects of Basel II capital requirements. Also, they suggest that capital regulation requires, in some cases, adjustments of monetary policy.

Chapter 3 focuses on the conflicting goals of price and financial stability. In this chapter, we examine the macroeconomic outcomes of economies characterised by different monetary and financial supervisory architectures. Acknowledging that central banks in charge of banking regulation may be less aggressive in their inflation mandate, it is argued that banking supervisory powers should be assigned to an independent authority to avoid inflation bias. The paper empirically assesses whether central banks’ combined mandates lead to an inflation bias problem using panel data for 25 industrialised countries from 1975 to 2012, adopting both static and dynamic panel data models. Findings suggest that, once we control for relevant policy and institutional factors, the separation of banking supervision and monetary policy does not have a significant negative effect on inflation outcomes, i.e., there is no evidence of an inflationary bias arising from institutional frameworks in which central banks have banking supervisory mandates. Results show that there are other institutional pillars of the monetary and financial supervisory architecture, such as deposit insurance schemes and inflation targeting mandates of central banks, that contribute in a significant manner to keeping inflation rates low. Deposit insurance schemes, in particular, are seen as incentives to the banking industry to undertake riskier activities, putting the stability of the banking system at stake. This study suggests that, on the contrary, deposit insurance schemes are important institutional cornerstones for the stability of prices, by promoting confidence in the well functioning of the banking system. As such, they contribute in a non-negligible manner to the stability of the overall economy.

Chapter 4 aims at investigating the role of monetary policy in promoting financial stability and its interaction with macroprudential regulation. Before the financial crisis, there was a broad consensus in the literature stating that monetary policymakers should
target price stability without taking pre-emptive measures to avoid the development of asset prices bubbles. In the aftermath of the crisis, it is clear that policymakers should do more than cleaning after the bubble burst. To this extent, some authors argue that monetary policy should also react to financial variables, such as credit and indebtedness, and help countervailing the development of financial imbalances. On the other hand, policymakers and researchers in general advocate the need for a macroprudential oversight of the financial system, to monitor and mitigate the building up of systemic risks across financial institutions and throughout time.

We address both sides of the debate by developing a model with price stickiness, financial imperfections and a macroprudential oversight of the banking system. Our focus is on standard monetary policy measures and we suggest as a macroprudential tool a non-neutral tax/subsidy scheme. Optimal policy exercises are conducted to assess the gains (or losses) in terms of social welfare of these alternative policy regimes.

First, we evaluate whether monetary policy should respond to financial variables, such as credit, credit spreads or asset prices, under the assumption of the existence of disruptions in the banking system. Second, we introduce a macroprudential instrument to examine the impact of having a macroprudential regulator reacting countercyclically to financial imbalances. This exercise is performed under two policy mandates. We assume that each policy targets its own policy goal, meaning that monetary policy pursues price stability and macroprudential policy focus on financial stability. Then, we extend the analysis by assuming that monetary policy also reacts to financial imbalances, in order to replicate a unified institutional mandate, in which both monetary and macroprudential policies target financial stability objectives.

We show that, in a model featuring financial frictions, a ‘leaning against the financial imbalances’ monetary policy rule would perform better in terms of maximizing welfare than a standard, conventional monetary policy rule. However, rules responding to credit spreads and asset prices would be related to higher inflation volatility, as claimed in the literature. As a matter of compromise between welfare maximization and macroeconomic stability, our results suggest that a monetary policy rule that could accomplish this balance would be one feeding back on credit only, given that it provides a smaller welfare loss compared to a standard Taylor rule, at the same time it delivers lower inflation, output and interest rate volatility.

In the case of scenarios encompassing a macroprudential policy approach, our findings from optimization exercises are interesting from a policy perspective. First, they con-
firm the countercyclical nature of macroprudential tools. More important, we show the
deployment of macroprudential regulation together with standard monetary policy
improves welfare, regardless of the target selected in the analysis and, to some extent, of the
type of policy mandate under assessment (separate or unified). The welfare maximiza-
tion is achieved, though, under a partially unified mandate featuring a macroprudential
rule that reacts simultaneously to credit and credit spreads. The welfare gains from
introducing macroprudential regulation are, in the best case scenario, around 0.07% in
consumption equivalent terms. This improvement is small, but aligned with previous
findings in the literature (see, for instance, De Paoli and Paustian (2012); Angelini et al.
(2011)). Inflation stabilization, on the other hand, is better accomplished in a separate
mandate, in which we have a standard Taylor rule feeding back on inflation and output
gaps, and a macroprudential rule responding to credit and spreads.

Despite showing macroprudential regulation improves welfare in every policy mandate
considered in the analysis, our findings do not provide a definite answer in terms of
the institutional mandates of monetary and macroprudential policies. A separate policy
regime seems to perform also well in what welfare improvement is concerned. This finding
is not fully aligned with the consensus among policy makers and academics towards the
joining of macroprudential regulation and monetary policy under a same authority.

Chapter 5 examines the transmission mechanisms of different macroprudential policy
instruments and their interactions with monetary policy-controlled interest rates. For
this purpose, we develop a New Keynesian model with two types of financial frictions.
Based on a New Keynesian model with a banking sector based on Gertler and Kiyotaki
(2010); Gertler and Karadi (2011), which incorporates an incentive constraint between
households and banks, we include a second friction along the lines of Kiyotaki and
Moore (1997) and Iacoviello (2005). This friction arises from a collateral constraint on
the entrepreneurs’ optimization problem. In this extended framework, the provision of
funds from banks to entrepreneurs is not only constrained by the amount of funds that
households are willing to deposit in the banking system, but also by the limits on the
borrowing capacity of entrepreneurs. The model features two macroprudential policy
instruments that differ in their effectiveness in addressing the different frictions.

This setup provides a first step to analyze how monetary policy would differ depending on
whether it has access to the full or only parts of the macroprudential toolkit – a question
that is particularly relevant in the emerging institutional landscape of the euro area
where the central bank lacks some important macroprudential instruments. The follow
preliminary findings stand out. First, when merging two sources of credit frictions in an
otherwise standard New Keynesian framework, the collateral constraint type of credit friction is dominant over the incentive constraint proposed by Gertler and Karadi (2011). Against this background, the net worth channel of the banking sector from the Gertler and Karadi (2011) model is not so relevant and, as a consequence, the model’s large effect on the economy also vanishes under a technology and monetary type of shocks. This is a robust property of our framework, since it holds for different calibration scenarios and alternative monetary policy rules. Second, the inclusion of a collateral constraint, that can be seen as a prudent bank behaviour, enhances banks’ resilience to shocks. This ability is improved when a more stringent loan-to-value (LTV) ratio is considered. These outcomes offer some insight on the benefits of introducing time-varying LTV ratios as a macroprudential tool.

Finally, less stricter regulatory requirements for the loan-to-value ratio amplify the propagation mechanism of monetary policy shocks. The incorporation in this two financial frictions model of macroprudential tools, such as countercyclical capital requirements and time-varying loan-to-value ratios, will be work for future research. Once this extension is completed, we will focus our analysis on the assessment of how effective macroprudential policy is in counteracting the effects of shocks in the business cycle, assuming a perfect control of both instruments and considering two alternative scenarios: one including an alternative monetary policy response and the other abstracting from monetary policy.
Chapter 2

Institutional setups of monetary policy and banking regulation and supervision - a survey

2.1 Introduction

The recent financial crisis raised the debate regarding the institutional arrangements of monetary policy and banking regulation and supervision.\(^1\)

Historically, as pointed out by Haubrich (1996), the institutional arrangements of monetary policy and banking regulation were mainly influenced by two distinct traditions: the English tradition and the German influence. For example, the United States, the United Kingdom, Australia and Hong Kong used to follow the English tradition, combining the monetary policy and supervision under the central bank premises. On the other hand, Germany, Austria, Denmark, and Switzerland used to follow the German tradition of separation of functions. According to Haubrich (1996), the origin of these different traditions is related to the evolution of the payment system. Countries that adopted the English tradition experienced a rapid expansion of credit through the introduction of alternative forms of money, where the central banks naturally became the guarantors of the smooth functioning of the payment system and the regulators in these market-based

\(^1\)The concepts of banking regulation and banking supervision are distinct. The former relates to the definition of legal rules which the banks have to comply with; the latter respects to the surveillance of the compliance of those rules by banks. These are two different tasks, but usually they are conducted by the same authority. In this survey, since these responsibilities are intertwined, they will be studied en bloc.
financial systems. In contrast, countries that experienced a slow expansion of credit developed a bank-based financial system of well-capitalised banks that were regulated by an independent authority following the German tradition.

In the late 90’s there was a tendency for the separation of both functions (Docherty (2008)), following the German approach. This has occurred in the European Monetary Union, when the European Central Bank was assigned the responsibility for the conduct of monetary policy and the national authorities became in charge of the banking regulation and supervision (Goodhart and Schoenmaker (1995)). Likewise, United Kingdom and Australia have opted for the separation of these functions. DiNoia and DiGiorgio (1999) states that only a few industrialised countries have assigned to a single agency (i.e. the central bank) both tasks. The degree of unification between financial regulators seemed to be inversely related to the central bank role in the banking regulation and supervision (also known as central bank fragmentation effect) (Masciandaro (2004)). Nonetheless, there are still differences among countries in what regards the institutional arrangements of banking regulation and supervision.

Notwithstanding the institutional mandates trends around the world in the period preceding the financial crisis, in academic literature it remained an open-ended question. The arguments for and against separation are strong and therefore it is not an easy task to find a theoretical solution to the issue of what would be the most efficient institutional mandate from a social welfare point of view. From an empirical standpoint, it seems to exist in the literature a relative consensus around the thesis of the ‘conflict of interests effect’, but not in what concerns the ‘information effect’, which are two of the inevitable arguments of this discussion, as it will be explained in the next sections.

Recently, the 2008 financial crisis questioned this apparent consensus towards the separation of functions, and many countries, as the United Kingdom, Germany, United States of America, Ireland and even the European Union, implemented major reforms regarding the role of the central bank in banking supervision mandates. In particular, these reforms encompassed the introduction of a macroprudential view of the financial system as a complement of the microprudential approach already in place. This was due to costs triggered by the financial crisis and the inability of banking supervisors to prevent it strongly emphasized the need for more policies and instruments targeting macro-financial stability. As defined by Borio (2003), “the objective of a macroprudential approach is to limit the risk of episodes of financial distress with significant losses in terms of the real output for the economy as a whole”, in which it differs from the objective of the microprudential approach, that aims “to limit the risk of episodes of financial
distress at individual institutions, regardless of their impact on the overall economy”.

The discussion concerning the role of macroprudential policy in financial stability regulatory frameworks introduced new questions into the governance debate. In fact, there is now a clearer distinction between microprudential and macroprudential policies, which may change the way governance issues regarding monetary policy and banking regulation and supervision have been addressed in the past. For instance, macroprudential policies might be more connected to monetary policy than microprudential policies, namely in what regards informational synergies, since macroprudential and monetary policies are more macro-oriented. As a consequence, the discussion at the current juncture has to include a new variable into the institutional framework equation, that is macroprudential policy.

This paper aims at surveying the arguments in favour and against the different options for institutional arrangements, taking also into account the new role of banking regulation and supervision and how it should interact with monetary policy. We identify key issues in the literature that need to be further explored. On the one hand, there is a need for analytical frameworks in order to study the interactions between monetary policy and banking regulation and supervision. In particular, the impacts of the implementation of macroprudential policy on the transmission mechanism of monetary policy in different macroeconomic models, in the form of cooperative and non-cooperative interactions. On the other hand, the empirical evidence is scarce and not fully conclusive in what the advantages and disadvantages of specific institutional designs are concerned. Empirical research should be expanded not only on the grounds of the work done so far, by including a larger number of countries, time horizon, explanatory variables and the use of different estimation techniques, but also by identifying the economic situations in which the interplay of monetary policy and prudential policies is likely to produce conflicting outcomes.

The survey is organised as follows. Acknowledging that the effectiveness of monetary policy decisions depends on the smooth operation of the banking system, but the soundness and stability of the banking sector also rely on price and macroeconomic stability, an overview of the interactions of monetary policy and banking regulation is thereby crucial to understand the issues related to the design of the institutional mandates of these policies. Section 2.2 of the survey explains how these interactions may occur. Section 2.3 analyses the most important arguments in favour and against the separation of policies,

\footnote{Nonetheless, as Galati and Moessner (2012) point out, “there is no clear consensus on the relationship and delineation between microprudential policy and macroprudential policy”.}
by surveying the relevant empirical literature. Theoretical approaches are covered in Section 2.4 and Section 2.5 provides a complementary perspective to the economic view on this topic, by surveying the political-economy approach.

The second part of the survey is focused on the post-2008 crisis period, in which reforms in banking regulatory mandates were implemented to introduce a macroprudential policy oversight of the financial systems. We discuss the implications of these reforms for the monetary policy mandate and how it reconciles with the debate pre-crisis in Section 2.6. Section 2.6.3 concludes.

2.2 The Interactions of Banking Regulation and Monetary Policy

Banking regulation and monetary policy are completely distinct functions, not only in terms of the objectives pursued, but also in terms of the nature and frequency of their decisions and qualification of staff. Nonetheless, both are intertwined in several ways. On the one hand, the effectiveness of monetary policy depends on the smooth functioning of the banking system, which is promoted by sound banking regulation and supervision practices. On the other hand, the monetary policy stance may also pose risks to financial stability, justifying that monetary policy decisions should be under the watchful eye of the banking supervisors.

Although there are several channels of monetary policy transmission, we focus our analysis on those that work through financial imperfections, and are more likely to impact on bank stability and ultimately on the stability of the financial system. From this perspective, there are three main channels of monetary policy propagation: i) the credit channel, which comprises the bank lending and the borrowers’ balance-sheet channels, ii) the bank capital channel and iii) the risk-taking channel.

Through the credit channel, monetary policy shocks have an impact not only on the level of interest rates, but also on the size of the external financial premium (i.e. the difference between the cost of funds raised externally and the opportunity cost of internal funds) (Bernanke and Gertler (1995)). The bank lending and the borrowers’ balance-sheet channels illustrate the link between monetary policy decisions and the external

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3 See European Central Bank (2011) for more on the transmission channels of monetary policy.
4 In this section we address only the transmission channels of conventional monetary policy.
finance premium. The borrowers’ balance-sheet channel is based on the assumption that the external finance premium is directly related to the borrower’s financial condition, which, in turn, is positively determined by the net worth the borrower owns (addressed as the sum of the liquid assets and the market value of collaterals). A stronger financial condition (or a greater net worth) of a borrower is thereby associated to a lower external finance premium. The lower external finance premium results from the borrower capacity to internally finance a higher share of his or her investments and / or to offer more collateral to the lender. Given that the borrowers’ financial situation affects the external finance premium, thus determining the general credit conditions available to them, variations in the quality of borrowers’ balance-sheets should likewise impact on credit terms they face and, consequently, on their investment and spending decisions.

The balance-sheet transmission mechanism of monetary policy arises from the impact of changes in interest rates on the borrowers’ net worth, at least in two ways. Directly, by increasing the cost of liabilities (such as outstanding short-term or floating-rate debt), in the case of rising interest rates, which reduces cash flows and deteriorates the borrower’s financial position. Or even by decreasing the price of assets that can be used as collateral, deteriorating in this way the borrower’s financial position. Indirectly, a rise in interest rates may also reduce demand for a certain product, also affecting firms’ net cash flows and collateral values. In both situations, a tightening in monetary policy interest rates increases the external finance premium, negatively impacting the borrowers’ ability to take loans out (i.e. it reduces credit demand in general).

The bank lending channel of monetary policy, on the other hand, operates through the banks’ balance-sheet. In particular, monetary policy may affect the external finance premium by changing the financial intermediaries’ supply of funds, which, in turn, affects credit supply. A reduction in the supply of funds can, in principle, be achieved by an increase in reserve requirements (directly reducing the share of liabilities used for granting credit), a policy measure that is not so common nowadays, or by a rise in interest rates (raising the relative cost of funds faced by banks). In the case of a decline in credit supply, the most bank-dependent borrowers, although they may not be completely excluded from credit, they may have to face costs associated with finding a new lender, for instance. The higher costs are likely to increase, by this manner, their external finance premium and reduce real activity (Bernanke and Gertler (1995)).

The bank capital channel thesis highlights the role of bank capital requirements, for market or regulatory reasons, in influencing the banks’ business choices. It is argued that the bank capital requirements are likely to amplify the effects of monetary policy shocks.
According to Borio and Zhu (2012), changes in interest rates can affect bank capital in diverse ways. They may have a direct impact, by affecting cash flows, net interest margins, profits and the valuation of assets. Changes in interest rates may also indirectly generate changes in bank capital, through its impact on non-bank balance-sheets and the macroeconomy, which can have an effect on asset quality and the adequacy of the bank capital cushion in turn. Overall, when the banks’ cost of funds increase, as a result of the decrease of the value of the bank capital or the increase of its issuance cost, it is likely to induce higher funding costs to firms when borrowing from banks. Higher lending costs may lead to lower borrowing and, thereby, a decrease in firms investment and output. This propagation effect typically comes from imperfections in the markets for bank capital, which dictate changes in the value of bank capital - see Drumond (2009) for a review on the theoretical reasons.

The risk-taking channel, as first argued by Borio and Zhu (2012), is also considered an important way through which monetary policy could impact on banking stability. It is argued that low interest rates boost assets and collateral prices and if the market believes that this is a sustainable rise, it prompts banks and borrowers to accept higher risks. Then, a softening of credit standards can follow, which may lead to an excessive increase in loan supply. At the same time, low interest rates make riskier assets more attractive given the demand for higher yields (‘search for yield’ effect) as an alternative to less profitable investments. By the means of the risk-taking monetary policy channel, low interest rates reduce risk perceptions and/or improve risk tolerance, thereby encouraging risk taking behaviour.

The close link between monetary policy and the banking system implied by these transmission channels makes the stability of the banking sector not only a concern but a crucial matter for monetary policy effectiveness. Otherwise, an unstable banking system can pose significant threats to the desired smooth functioning of these transmission mechanisms and to the expected and desirable effects of monetary policy decisions. Against this background, regulation and supervision of the banking system, as a necessary condition to promote banking and financial stability, is thereby a requirement to obtain stability of prices.

On the other hand, it is reasonable to argue that banking regulators should also be interested in the stability of prices (Tuya and Zamalloa 1994). Price stability is a source of macroeconomic stability and banks prefer to operate in an environment with low degree of uncertainty. As explained by the authors, “high and volatile inflation may provide wrong market signals, causing miss-allocation of resources and thus endangering
the credit decisions of bankers”, increasing the probability of bank failures.

The effects of banking regulation and supervision tools in monetary conditions should thereby be object of concern for monetary policymakers. The instruments used by banking regulators to minimize moral hazard problems and promote the safety, soundness and competition of the banking system (for instance, capital adequacy requirements, asset classification and liquidity requirements) can have undesirable effects in monetary aggregates and interest rates. Banking regulations, such as Basel I and Basel II systems of risk-based capital requirements, may change the monetary transmission mechanism, by affecting balance-sheet responses of the banking system and limiting credit and other assets growth. As Hanson et al. (2010) describe, when a troubled bank is asked to increase its capital to total assets ratio, for instance, “the regulator does not care whether the bank adjusts via the numerator or via the denominator - that is, by raising new capital or by shrinking assets”, because in both cases this ratio is strengthened to the level required by the banking authority. However, if the bank chooses to decrease its assets instead of raising capital, that might represent a reduction on lending and, as a result, it might affect the transmission mechanism of monetary policy.

In addition, it is argued that the introduction of capital requirements or its reinforcement can have a procyclical effect in the economy. In a crisis, a negative shock to the capital positions of banks, which are highly leveraged and regulated institutions, requires them to shrink assets to comply with the minimum regulatory capital requirements, amplifying the negative impact of economic shocks.

The implications of banking regulation on the monetary policy effectiveness are largely studied. VanHoose (2008) and Drumond (2009) provide surveys on theoretical predictions and empirical evidence, mainly focusing on the amplification effects of the Basel I and Basel II accords through the bank capital channel. The survey by VanHoose (2008) shows that the effects of monetary policy through the banking system are asymmetric, depending on the levels of capitalization of the banks. The survey shows that banks which are well capitalized are less constrained in their reactions to contractionary monetary policy shocks than banks with relatively lower levels of capitalization. When there is a monetary policy easing the capital unconstrained banks tend to be less reactive. Drumond (2009) concludes that the theoretical models focusing on the bank capital channel under the Basel II accord generally support the procyclicality hypothesis and that the magnitude of the procyclical effects depends on, among other determinants, the composition of banks’ asset portfolios, the approach adopted by banks to compute their minimum capital requirements, and the capital buffers over the regulatory minimum
held by the banking institutions.

The introduction of a macroprudential oversight of the financial system, as already established by the Basel III regulatory framework, brings new challenges for the interaction between monetary policy and banking regulation, which need to be thoroughly investigated. Among other aspects, the interactions may result from the fact that some of the instruments used by monetary policy and macroprudential regulation are similar. This is the case of changes in haircuts for central bank operations or changes in reserve requirements, which can be considered substitutes of macroprudential instruments such as liquidity requirements and regulation of margin requirements (Smets, 2014). The sharing of transmission channels and the use of similar instruments calls for the design of institutional arrangements in which strong coordination mechanisms are embedded. Section 2.6 presents preliminary findings in this regard.

Having in mind the ways through which monetary policy and banking regulation may be interlinked, the next section reviews the rationale behind the different designs of the institutional framework of monetary policy and banking regulation around the world, covering, in particular, the main arguments for and against a certain type of institutional arrangement.

### 2.3 Institutional arrangements of monetary policy and banking regulation

Worldwide, according to the World Bank database, there is still a preference for assigning banking supervision responsibilities to central banks, given that only 39 economies out of 98 favoured an institutional mandate in which banking supervision is assigned to an independent authority. Moreover, the allocation of banking supervision powers to central banks has not changed significantly after the beginning of the 2007 and 2008 financial crisis, as shown in Table 2.1. In 2007, the prudential supervision of the banking sector was conducted by the central bank in 60 countries, comparing to 59 economies in 2010.

Nonetheless, developed economies (40 countries in 2010) show a more balanced distribution of banking supervision responsibilities, since, based on the 2010 figures, 50%
assigned this regulatory and supervisory role to the central bank. On the other hand, upper-middle and lower-middle income countries still reveal a tendency to assign the banking supervision power to the central bank.

Table 2.1: Mandates of Banking Supervision Around the World

<table>
<thead>
<tr>
<th>Countries</th>
<th>Prudential Banking Supervision</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within the CB</td>
<td>Outside the CB</td>
<td>2007</td>
</tr>
<tr>
<td>High Income</td>
<td>21</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Upper-Middle Income</td>
<td>22</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Lower-Middle Income</td>
<td>17</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>59</td>
<td>38</td>
</tr>
</tbody>
</table>

Source: The World Bank, Organization of Financial Sector Supervision Database. Author’s own calculations.

With the purpose of clarifying the different political options for the design of the monetary policy and banking regulation and supervision institutional arrangements, in the next subsections we start by reviewing the arguments supporting the choice of a combined institutional mandate, in which the central bank is the banking supervisory authority, and then we survey the arguments for a separate institutional mandate, where banking regulation and supervision are assigned to an independent authority (Figure 2.1 provides a summary of the main arguments).
For this literature review, we limit the scope of our analysis to these two types of institutional mandates of banking regulation and supervision (i.e. we only assess whether the banking regulatory and supervisory powers are within the central bank or outside the central bank), deliberately omitting other types of financial supervisory architectures.

2.3.1 Arguments against a separate mandate between monetary policy and banking regulation

There is a large number of arguments in the literature regarding the defense of a unified mandate of monetary policy and banking regulation. As referred by Haubrich (1996), “the economics of combination is the economics of information and incentives”. The arguments are listed in two categories: ‘informational gains’ and ‘staff and funding’.

‘Information Gains’ arguments

There are informational advantages resulting from the participation of the monetary policy authority in bank regulation and supervision. The ‘information gains’ result from
having direct access to confidential information concerning banks' financial conditions. The literature points out three types of advantages from having access to confidential information regarding the safety and soundness of the banks: its usefulness to decide whether to provide the lender of last resort (LOLR) support by central banks, as a source of information about the state of the economy and it improves the accuracy of economic forecasting.\footnote{As highlighted in Fahr et al. (2011), in the limit the central bank could replace the interbank market entirely, working as a market maker of last resort, in contrast to a loan provider to a single bank. The 'information gains' argument is valid, regardless of the role of a central bank (as a lender or as a market maker of last resort).}

One important advantage is intimately closed to the LOLR role of central banks, that makes them concerned about the systemic stability of the banking and financial systems (Tuva and Zamalloa 1994 and Goodhart and Schoenmaker 1995). Given this role, the central bank needs to be aware of the economic and financial conditions of the bank institutions to distinguish between illiquid banks that can be solvent or insolvent, in order to provide the LOLR support (which should be put in action in situations where the bank is illiquid, but solvent) and reduce moral hazard. If the central bank participates in the supervisory process of the banking system, it will have direct access to the banking supervision data and, under these circumstances, it would be more straightforward to judge about the solvency of the troubled banks and decide whether to provide or not the LOLR assistance.\footnote{Nevertheless, Goodhart and Schoenmaker (1993, 1995) argue that the preferences of the central banks, regarding bank rescues, are focused on the risk of a contagion effect, instead of being concentrated in the banks' solvency.} More specifically, Repullo (2000) states that in order for the LOLR to provide liquidity to banks, it can require to lend on "good" collaterals, as banking securities. To distinguish between "good" and "bad" collaterals, Repullo (2000) argues that an obvious source of information is bank supervision, because it can have access to private information on the financial condition of the illiquid bank. Therefore, the decision to implement the lending of last resort assistance should rely on this supervisory information. Since the central bank can be seen as the "ultimate guarantor of financial stability", as argued by Eichengreen and Dincer (2011), the type of information it needs to be a competent guarantor can only be obtained when it has regulatory and supervisory responsibilities.

The combination of policies becomes even more relevant during periods of financial crises, when only direct supervision can provide timely and relevant information about banking conditions (Haubrich 1996). DeGrauwe (2007) expands this argument further, stating that if the balance sheets of central banks are affected by a bubble crash, they should be
also concerned about movements in the assets markets, in order to prevent the bubbles to form and eventually burst. Therefore, the author concludes that central banks should expand their responsibilities to the supervision of all institutions that generate credit and liquidity (and not only to banks).

Banking supervision data is important not only to guide decisions related with the role of the LOLR, but also to improve the accuracy of economic forecasting so as to conduct monetary policy in a more effective way, as argued by [Peek et al., 1999]. Accordingly, problems in the banking sector can be used as an early indicator of the deterioration of the macroeconomic conditions. Another aspect worth mentioning is that banking supervisory information is also relevant to understand how banks might respond to changes in interest rates ([Peek et al., 1999] and [Goodhart, 2000]). As already referred, monetary policy affects inflation through a transmission mechanism in which the intermediation by the banking system is essential. Therefore, in order to assure the effectiveness of monetary policy, it is necessary to understand how banks might react in their decisions on lending and credit creation to changes in the monetary policy instruments, i.e. interest rates.

There are also other arguments related to operational issues, but not as relevant as the ones described before. For instance, [Tuya and Zamalloa, 1994] argue that the design of monetary policy and bank supervision is heavily dependent on information collected from banks. Therefore, the two policies should be conducted by the same agency to guarantee the time availability of this type of information and avoid a unnecessary reporting burden on banks. Another argument by [Tuya and Zamalloa, 1994] is that central bankers have international contacts with their counterparts that are very useful for banking supervision. In their regular meetings, they discuss policy coordination and timely analyse economic developments that can affect international banks. Being a separate agency, banking supervision would not be able to have access to this information.

**Discussion**

Although this is a major argument to join both functions, there is not a general consensus regarding the view that monetary policy authorities should have access to banking information by undertaking supervisory responsibilities ([Peek et al., 1999] and [Goodhart, 2000]). First, LOLR facility is not an exclusive mission of central banks, as argued...
by Goodhart (2000): “(...) crisis management, at least in most countries, has already gone beyond the capacity of the Central Bank to handle on its own. (...) So crisis management already involves joint co-operation, assessment and agreement between Central Banks and Ministries of Finance”, and the use of taxpayers’ funds to resolve the banking system crisis. Khan and Santos (2005) also point out that the LOLR may be unable to distinguish between insolvent and illiquid banks, due to information asymmetry problems, even in the cases central banks have supervisory responsibilities.

In addition, in the absence of direct supervisory responsibilities, the central bank could simply request the supervisory information from the bank regulator. Peek et al. (1999) point out some hurdles that, in practice, could hamper these efforts. For example, the monetary authority should have ready access to all supervisory data in order to be able to ascertain which data are important for the conduct of monetary policy. Thus, central banks must have access to timely and reliable supervisory data. More important is that the assessment of a bank’s health and the information used to make that assessment might depend on the objective function of the banking supervisor, which would limit the ability of the central bank to interpret the supervisory information. For instance, the different objectives could originate the collection of and emphasis on different bank information or affect the way CAMEL ratings are assigned. In addition, Goodhart (2000) points out that, once the banking supervision has been removed from the central bank, it can lose the ability to interpret supervisory information properly. Ferguson (1999) agrees with this view, referring that “in the last analysis, there simply is no substitute for understanding the links among supervision, regulation, market behaviour, risk taking, prudential standards, and [...] macro stability”.

Finally, based on the adversarial legal system theory, Haubrich (1996) claims that the separation of functions would produce the most information. In other words, each separate authority with different objectives will obtain evidence that confirms their own view, whereas combined authorities may not be interested to find information that contradicts their preferred policy.

With regard to the argument that underlines the importance of banking supervision data to improve the accuracy of economic forecasting, the empirical evidence is weak. In the literature, there are two papers about this issue, but they show contradictory results. Peek et al. (1999) analyse whether the banking supervisory functions enhances

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9CAMEL rating is a United States supervisory rating, that is based on the banks’ overall conditions. The financial conditions of the banks are assessed by the following components: Capital Adequacy (C), Asset Quality (A), Management (M), Earnings (E) and Liquidity (L).
the conduct of monetary policy by the central banks, by investigating whether the supervisory information is used by the Federal Reserve in the conduct of monetary policy to improve macroeconomic forecasts. They conclude that supervisory confidential information about banks’ health is not used by the Federal Reserve staff to improve their forecasts of inflation and unemployment rates in way that is different from forecasters that do not have access to this information. However, they show that confidential supervisory information is useful to predict inflation and unemployment.

Using a different methodology, Feldman et al. (2003) contradicts this last result, by comparing the performance of two forecasting models, one including supervisory information and one without it, in order to understand whether adding these confidential data to the model improves forecasting accuracy for unemployment and inflation or not. Results show that the forecast errors are virtually the same as in both models specifications. Therefore, in out-of-sample exercises, this paper does not find evidence from any methodology applied that supervisory information would improve forecasts of inflation, contradicting the empirical results by Peek et al. (1999).

‘Qualified Staff’ argument

Another group of arguments is related with the expertise of human capital employed by central banks and banking supervisors. It is argued that both banking supervision and monetary policy could benefit from being allocated to the central bank. There are some advantages for banking regulators. First, the knowledge and skills originated by the management of systemic risk, which has traditionally been associated with the conduct of monetary policy, may improve the conduct of prudential supervision due to the closed relationship between this task and monetary policy (Docherty, 2008). In addition, the prestige and independence of central banks improve their ability to enforce actions, as well to recruit and retain the most skilled professional staff. Therefore, the banking regulator would naturally benefit from these abilities, being able to recruit the most skilled staff and take advantage of the credibility of the central bank when enforcing their actions to bank institutions (Garicano and Lastra, 2010). This argument is specially relevant in countries where the level of human capital with this expertise is scarce (Abrams and Taylor, 2000).

By the same token, the development of expertise about the way the financial system operates is of critical importance to monetary policy making, as argued by Ferguson (1999). In his view, “there is no substitute [...] for the understanding of the institutions
and the workings of the markets that comes with the hands-on experience derived from actual supervisory responsibility”. Ferguson (1999) claims central banks should have supervisory roles, in order to develop the knowledge and experience that would be crucial to manage a financial crisis.

The only empirical evidence related to the staff argument is given by Goodhart et al. (2002). Based on a sample of 91 banks across 57 countries, they conclude that the main determinant for the employment of experts with different skills (economists or lawyers) is whether the supervisory authority is the central bank or not. More precisely, central banks hire economists and finance experts, but few lawyers in their supervisory and financial stability department. By contrast, non-central bank agencies employ more lawyers than economists. Considering this empirical evidence together with economists ability to analyse the impact of macroeconomic trends on the banking system, the authors conclude that “an institutional setting with involvement of the central bank is more likely to produce such a macro-approach than a setting without central bank involvement”.

Therefore, they propose an institutional arrangement where the central bank and the banking regulator and supervisor are physically together, but with separate boards. This empirical result sheds some light into the argument that the expertise of central banking staff would contribute to the effectiveness of banking supervision. However, it would be necessary to explore whether these differences of expertise enhance the effectiveness of banking regulation and supervision.

‘Independence and Funding’ argument

In what regards to funding, a unified mandate ensures independence of banking supervision from fiscal budget pressure ((Tuya and Zamalloa 1994), (Abrams and Taylor 2000), among others). In the same way as monetary policy, banking regulation and supervision policy requires independence from political pressure to adequately perform its function. Central banks are generally self-funded and usually profitable and these features would provide banking regulation with independence from budget pressures and its supervisory actions would not be influenced by political decisions.

Currently, this argument is overpast in the sense that banking regulators and supervisors are now mainly funded by the central banks and by the supervised financial institutions, insulating them from political pressures. Based on information concerning funding of

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As stressed by the authors, the results should be interpreted carefully, because they are influenced by the different ways in which supervisory institutions answered the questionnaire.
supervisory agencies for 143 countries provided by the World Bank (Banking Regulation Survey, June 2008), we ascertain that in 28% of the countries, those agencies are funded by the Central Bank, in 21% they are funded by supervised financial institutions and in only 3% supervisory agencies rely on government funding.  

Garicano and Lastra (2010) argue that “the wider is the role of the central bank, the more subject it could become to political pressures, thus threatening its independence”. In particular, that may happen when a large failure requires government intervention and funding, letting the central bank politically subservient in a supervisory role (Goodhart 1996).

2.3.2 Arguments for a Separate Mandate of Monetary Policy and Banking Regulation

As Goodhart (1996) pointed out, “there is a growing list of arguments for separation”. These arguments can be grouped in three categories, namely ‘conflict of interests’, ‘reputation risk’, ‘organizational costs’ and ‘balance of powers’. The empirical evidence is also surveyed.

‘Conflict of Interests’ argument

An important argument for separation is that a conflict of objectives between the monetary authority and the regulatory and supervisory authority may arise, due to the impact of changes in interest rates (Goodhart and Schoenmaker 1993 1995) in banking stability. The argument goes as follows. Under certain circumstances, the monetary authority may be interested in raising interest rates to control inflation, but the banking regulator may try to avoid the adverse effect of high interest rates on the soundness and profitability of the banking sector. Therefore, when both functions are ruled by the same agency, i.e. the central bank, monetary policy stance might become more flexible if the central bank fears that tight monetary conditions may cause bank distress and ultimately bank failures. In cases like this, it is likely that the flexibility in guiding monetary policy will lead to an inflation bias, since, as Haubrich (1996) explains, “the central bank might view its primary function as protecting banks, not the public interest”.

Tuya and Zamalloa (1994) explore the effects of monetary policy in the banking sector. They conclude that, under certain circumstances, monetary policy conflicts with the

11 Note: This information was not available for 33% of the countries.
objective of preserving the soundness of the banking system. The contraction of the monetary policy instrument, i.e. a rise in interest rates, is likely to increase the risk of loan default and, consequently, deteriorate the soundness of the banking system.

On the other hand, Goodhart and Schoenmaker (1993, 1995) discuss what would be the negative impact of high short-term interest rates to the banking system. They argue that the impact depends not only on the period of time in which high interest rates are likely to last, but also on the structure of the banking system’s balance sheets. For instance, banking systems which are mainly financed by a retail deposit base, whose interest rates are unlikely to change following changes in money market wholesale rates, would have better conditions to deal with contractionary monetary policies. Or, another example, bank institutions that have bank loans and mortgages contracts defined in terms of a fixed interest rate are also less prone to temporary periods of high interest rates. Therefore, they conclude that the structure of the banking and financial systems influence the degree of the ‘conflict of interests effect’ and that these conflicts increase proportionally to the financial intermediation and competitiveness of the banking system.

So far, we have described the sources of the conflict of interest in the case of a tightening of monetary policy. Nonetheless, as Blinder (2010) explains, this problem can also arise when monetary policy is expansionary. Suppose the banks are in trouble and the macroeconomic environment is weak. The banking supervisor should enforce banking discipline and the monetary policymaker should decrease interest rates to stimulate the economy. However, if the central bank has supervisory powers the policies will conflict, because the increase of discipline in banks will have the effect of reducing bank lending, while the decrease of interest rates will have the opposite result. In a context of a financially distressed banking system, Blinder (2010) argues that the consequence may be regulatory and supervisory forbearance.

In sum, the discussion about conflict of interest implies that, in a unified institutional regime, when there are inflationary pressures and monetary policy should be tightened, there is the risk that a lax monetary policy policy may be implemented, to safeguard the banks, sacrificing the inflation target; when there are deflationary pressures and monetary policy should be expanded, there is the risk that a lax banking supervision will be pursued, to avoid the adverse impact in bank lending. Underpinned on this arguments, banking regulation policies should be assigned to separate and independent authorities.

In a critical perspective, Goodhart and Schoenmaker (1993, 1995) defend that, in an
environment characterized by open, competitive, and market-driven banking system, the conflict of interest should be incorporated into a single agency in order to achieve a more efficient resolution of bank distress. In face of a potential bank failure, the monetary policy authority, as it is also responsible for systemic stability, will prefer to rescue the bank, whereas the banking regulator will tend to close it in order to avoid moral hazard. In addition, Blinder (2010) considers that separation of policies may not maximise the society outcome, because the banking supervisor would be unlikely to take into account macroeconomic concerns when disciplining the banks. Thus, the supervisor might be strict with banks and, consequently, reduce bank lending, even when it is necessary to provide more credit to the economy.

The empirical evidence seems to support the argument that ‘conflicts of interests’ may arise, suggesting that the central banks should only focus on monetary policy. This conclusion is confirmed by the empirical results of DiNoia and DiGiorgio (1999), Copelovitch and Singer (2008) and Ioannidou (2005). DiNoia and DiGiorgio (1999) focus on 25 developed countries and classify them in two groups, monopolistic and non-monopolistic countries. Monopolistic countries includes the ones in which the central bank is in charge of the monetary policy and acts as a monopolist in banking supervision. The estimation results show that monopolist central banks are less effective in controlling inflation. Nevertheless, as the authors pointed out, the sample dimension is small, so the differences found in the average level of inflation could be due to other common features shared by the group of countries that composes the sample.

Based on the same set of countries, Copelovitch and Singer (2008) extend this study to test the following hypothesis: institutional mandates of central bankers have an important influence on inflation outcomes; the effect of a central bank’s mandate on inflation is conditional on the government’s choice of exchange rate regime, and the effect of the central bank’s regulatory mandate is conditional upon the size of the domestic banking sector. Though their econometric approach incorporates additional explanatory variables, their findings agree with those of DiNoia and DiGiorgio (1999). However, they

12 Using inflation rates data for the 1960-1996 period, they perform an econometric analysis where the dependent variable in the regression, average inflation rate, is explained by the country’s institutional mandate (dummy variable, that takes 1 when the central bank is monopolistic and 0 otherwise) and by the degree of independence of the central bank from the government, measured by the index of Grilli et al. (1991).

13 This study presents an additional empirical contribution to this literature, by analysing the bank’s pricing behaviour and performance in monopolistic and non-monopolistic countries. They suggest that the different institutional arrangements may influence the competition model of the banking system. In particular, they argue that “the banking sectors in ‘monopolistic’ countries are more protected and somehow less developed and efficient than those in ‘non-monopolistic’ countries”.

38
also show that the impact on inflation rates of having a separate banking regulator is conditional on the choice of exchange regime and the size of the domestic banking sector. In particular, the separation mandate has a significant negative effect on inflation under floating rates, but this effect is only observed at middle to high levels of banking sector size.

An additional empirical contribution by Ioannidou (2005) about the ‘conflict of interests effect’ uses data from one country only, the United States of America, avoiding the criticism of cross-sectional studies. The study focuses on the particular banking system regulatory architecture of United States, in which three authorities, the Federal Reserve System (Fed), the Office of the Comptroller of the Currency (OCC) and the Federal Deposit Insurance Corporation (FDIC), share the supervisory powers, but the Fed is the only authority with monetary policy responsibilities. In this study, the behaviour of the Fed as a bank supervisor is compared with the supervisory behaviour of the other two agencies. In particular, it is analysed the effect of the monetary policy on the probability of a bank getting a formal action (dependent variable). Data covers the period 1990-1998. Results suggest monetary policy influences the supervisory actions of the Fed, but does not affect the actions of the other supervisory agencies. When the Fed rises the funds rate, the probability of getting a formal action decreases, which means that the Fed turns out to be more flexible in its bank supervisory role when it tightens its monetary policy stance. Overall, the empirical results support for the “conflict of interest” effect.

‘Reputation Risk’ argument

An additional relevant argument is that the reputation of the central bank is more likely to suffer, than to benefit, from banking regulation and supervision, specially in periods of banking distress (Goodhart and Schoenmaker 1995 and Ferguson 1999). If bank failures occur, public perception of central bank credibility in conducting monetary policy can be negatively affected by its role as banking regulator and supervisor. In this situation, the reputation costs could be very high for the central banks in charge of both monetary policy and banking regulation. Hence, the monetary policy authority may not be interested in damaging its credibility by being responsible for both powers. As Goodhart (1996) clearly explains, “external regulation is only desirable to the point where the marginal benefits exceed the marginal costs”. Thus, it is reasonable to expect that “an optimal regulator will be a regulator who fails from time to time in the exercise of her duty, because the alternative is too expensive”. However, a failure of the banking regulator
is generally visible by the public and it weakens credibility of the banking regulator and supervisor, because it is not interpreted as a possible outcome of an optimal policy.

Haubrich (1996) offers a critical view about this argument. Allowing a bank failure might mean not only that the central bank is incompetent and, consequently, flexible on inflation, but also that it is strict in both functions. According to the author, each interpretation is valid, depending on the circumstances. Hawksey (2001), in turn, perceives the reputation risk as a consequence of the potential conflict of interest that may occur once the central bank is in charge of both policies. He argues that the central bank may have the motivation to be more lax in its monetary policy function to avoid the failure of a bank or group of banks, which would hurt its credibility as a prudential supervisor.

‘Organizational Costs’ argument

The existence of ‘organizational costs’ as an argument against a unified institutional arrangement is claimed by Vickers (2002) and Garicano and Lastra (2010) among others. Vickers (2002) analyses the operational differences between monetary policy (the ‘hedgehog’) and competition policy (the ‘foxes’) in the United Kingdom. Banking regulation is considered a competition policy, according to his definition. Vickers (2002) argues that monetary policymakers and competition authorities are very distinctive institutions, in what concerns four organizational aspects: simplicity of tasks, repetition of decisions, confidentiality and transparency, and interested parties.

Table 1 summarizes the main differences between the two kind of policymakers, based on the organizational categories suggested by Vickers (2002):

\footnote{Competition policy comprises a variety of industries and markets, such as “banks, beer, broadcasting and buses” and also different issues, for instance “mergers, collusion, vertical relationships, pricing behaviour, and so on” (Vickers 2002).}
Table 2.2: Organizational Features of Monetary and Competition Policies

<table>
<thead>
<tr>
<th></th>
<th>Monetary Policy</th>
<th>Competition Policy</th>
</tr>
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<tbody>
<tr>
<td>Simplicity of Tasks</td>
<td>Yes - Choose the official short-term interest rate to determine the infla...</td>
<td>No - variety of competition policy questions. Some competition questions have not-so-simple answers nor remedies.</td>
</tr>
<tr>
<td>Repetition of decisions</td>
<td>The key monetary policy question is repeated every month.</td>
<td>Competition cases are more one-off in nature - there are no repeated decisions.</td>
</tr>
<tr>
<td>Confidentiality / Transparency</td>
<td>Public information and public models.</td>
<td>Confidential information.</td>
</tr>
<tr>
<td>Interested Parties</td>
<td>Decisions affect everyone to some degree.</td>
<td>Mostly producers and their representatives.</td>
</tr>
</tbody>
</table>

Vickers (2002) argues that monetary policymakers tasks are simple, in the sense that they typically deal with one goal only (price stability) and use one instrument (interest rates) to achieve their objective. Therefore, the assessment of its success in controlling inflation rates should be straightforward. The simplicity of tasks by the central bank contrasts with the variety of competition policy issues, which sometimes are difficult to solve. Focusing on banking regulation and supervision, Garicano and Lastra (2010) defend that, as a rule, this activity is multitasking, because it deals with multiple goals (financial stability, investor/consumer protection, conduct of business, among others), and deploys a wide range of tools (licensing requirements, macro and micro prudential supervision, financial stability reviews, lender of last resort operations and crisis management and resolution).

Another attribute distinguishing both functions is related to the frequency of decisions. The decision monetary policy authorities have to make - to increase, maintain or decrease the interest rate, given economic conditions - is the same every month, whereas competition regulators usually do not repeat decisions, due to the singular nature of competition cases. Furthermore, competition cases deal with confidential information and, as a consequence, competition policymakers must be extremely cautious in what regards the public release of information. Conversely, monetary policy handles with
public information and public models. Transparency is also difficult to deal with in competition policy, even though it has become more transparent in recent years.

Lastly but rather important, generally the decisions about interest rates undertaken by monetary policy affects everyone to some degree, but the impact of decisions of competition regulators affects mostly producers and their representatives, making this functions more vulnerable to lobbying by interested parties. As argued by Haubrich (1996), “the banking industry, which is better organised and affected than the public, could “capture” the central bank and gain undue influence.”

‘The Balance of Power’ argument

Ferguson (2000), Haubrich (1996) and Goodhart (1996, 2000) introduce another argument for the separation of functions, that is the concentration of powers in a single institution. A central bank that is responsible for both monetary policy and banking regulation and supervision is a very powerful institution and it should be monitored closely by the citizens and their elected representatives. A related argument by Ferguson (1999) is that banking regulation and supervision, considering its importance for the economy, should be allocated to elected authorities, so as to be collectively evaluated in its performance.

The concerns about the concentration of powers in a single institution are raised when the central bank is independent from the government. In a democracy, this means that important powers are delegated to an authority that is not democratically elected. Goodhart and Schoenmaker (1993) and Goodhart (2000) state that the tendency towards the independence of the central bank from the government occurred simultaneously with the trend towards the removal of banking regulation and supervision from the central bank. Some explanations for this occurrence are addressed by Goodhart (2000). One explanation is that democratically elected governments are unlikely to delegate important powers to an independent agency. Alternatively, the separation of functions could have been the acceptance that there are ‘conflicts of interest’ between the two functions.

Another argument related to the ‘balance of powers’ is associated to the development of the financial system that calls for a unified regulator for the banks, insurance companies and securities markets, as stated by Goodhart (2000) and Ferguson (1999). According to

\footnote{This argument is associated to the ‘organizational costs’ argument, that states that competition regulators are more vulnerable to lobbying by interest parties, as banking industry, than monetary policymakers (Vickers 2002).}
Ferguson (1999), “[...] coupling it with the Central Bank would create too much power in one entity and place the Central Bank beyond its expertise”. However, a single supervisory authority for all financial institutions would pose some concerns, in the sense that it would be focused on its broad mission and neglect the consequences of its actions in the economy.

Conclusions on Section 2.3

The literature review referring to the advantages and disadvantages of a combined institutional mandate for monetary policy and banking supervision indicates that there is a trade-off between expected benefits (sharing of information and expertise) and expected costs (‘conflict of interests’, ‘reputation risks’, ‘organizational costs’ and ‘balance of powers’) of central bank involvement in banking regulation and supervision (Pellegrina et al., 2010).

Hence, as Tuya and Zamalloa (1994) point out, the decision of placing banking regulation and supervision in the central bank should be taken on a case-by-case basis. For example, banking regulation and supervision powers should be assigned to the central bank in economies in transition, characterised by institutions and legal systems under a development process, scarcity of human capital and a lack of coordination between institutions. Moreover, in countries where there is no statutory guarantee to ensure an independent banking supervision agency the central bank should also be in charge of banking supervision. On the other hand, countries with high developed financial systems operating internationally, the argument that a central bank should have regulatory and supervisory powers for all banking institutions loses strength, due to the complexity of supervising all the financial intermediaries that are affected by its decisions.

Another critique comes from Beck and Gros (2012), which advocate that most of this literature focuses on normal times rather than a crisis situation, although theory and practice may show that “the nature of the relationship between supervision and monetary policy might differ fundamentally between crisis and normal times”.

Goodhart and Schoenmaker (1995) also conclude that “the question of the appropriate design of regulatory system may need to be answered against the particular financial / banking structure of each country, rather than being capable of resolution as an abstract generality”. Furthermore, the reasoning concerning the advantages and disadvantages of separate institutional arrangements is conditioned by the type of institution - the central bank or the banking regulator - that is being under analysis. Haubrich (1996) argues
that “as technology, finance, and the global economy change, so too may the shape of the world’s central banks. [...] This should serve as a reminder that the regulatory structure keeps evolving and needs continuous reappraisal”. In sum, there is not a “one size fits all” solution, which means that the design of institutional mandates must undertake a careful and balanced analysis of the arguments, taking into account the specificities of each country, in terms of political system, financial sector development and current architecture of financial regulation and supervision.

There are important conclusions from the empirical review. First of all, there is little empirical analysis on the advantages and disadvantages of different institutional mandates of monetary policy and banking regulation and supervision. The empirical studies focus essentially in analysing the arguments related with the ‘information gains’, ‘staff and funding’ and ‘conflict of interests’. Furthermore, empirical evidence seems to support the option for an institutional framework where the central bank does not have regulatory and supervisory responsibilities. In particular, the empirical evidence seems to confirm that the conflict of interests effect may occur, suggesting that central banks should only focus in monetary policy. However, the samples in which the authors based their analysis are small in terms of time horizon considered (only 24 years). Moreover, the econometric methods employed are not the most appropriate to analyse panel data.

In contrast, the ‘informational gains’ advantage does not gather the same consensus in the empirical literature. Nevertheless, only a few papers investigate this effect. This effect is particularly relevant having in mind that, according to [Garicano and Lastra 2010], the apparent consensus towards a separate regime was affected by the recent financial crisis and, more precisely, by the Northern Rock failure, which “caught the Bank of England completely unprepared”.

Regarding the staff expertise argument, it was empirically found that the central banks with supervisory powers employ more economists than banking regulators and supervisors, which hire comparatively more lawyers. Although it sheds some light into the differences in expertise among supervisory institutions, it is not sufficient to confirm the argument that the unique expertise of central banking staff would improve the effectiveness of banking regulation and supervision. Lastly, it is not easy to assess the pertinence of ‘reputation and organizational costs’ arguments, which may explain the dearth of empirical papers approaching these issues.

In conclusion, it is necessary to undertake more empirical research, in order to understand the real relevance of the arguments discussed above. Otherwise, as pointed out by
Hawkseby [2001], political factors end up having a key role in the choice of supervisory structure, given the high degree of uncertainty about the economic costs and benefits of supervisory structures.

The recent financial crisis highlighted the importance of developing a macroprudential approach to regulatory policy, which may introduce a different perspective to the traditional debate about governance of banking regulation and supervision (microprudential policy focus) and monetary policy. Garicano and Lastra [2010] suggest an intermediate solution, that is that the function of macroprudential policy should be conducted by the central bank, whilst the microprudential policy should be allocated to a separate institution.

2.4 Banking Regulation and Monetary Policy - Theoretical Approach

The connections between monetary policy and banking regulation are poorly addressed in the theoretical literature. However, there is an interesting and fruitful strand studying the optimal institutional allocation of regulatory functions, such as lender of last resort (LOLR), deposit insurance and banking supervision, with microeconomic frameworks (Repullo [2000], Khan and Santos [2005] and Ponce [2010]). It is interesting in the sense that it focuses on one of the major arguments for allocating banking supervision powers at the central bank: its role as LOLR. This argument, as explained above, claims that the LOLR should have access to supervisory information in order to distinguish between insolvent and illiquid banks. By addressing the issue of which institution should play the lender of last resort role and of whether it should accumulate this function with supervisory powers, this literature provides useful insights to this debate.

While the abovementioned studies are based on microeconomic models, there are others approaching the interconnections between monetary policy and banking regulation and supervision from a macroeconomic point of view ((Seater 2000), (Cecchetti and Li 2008), (Wakue et al. 2010), (Angeloni and Faia 2013) and (Cecchetti and Kohler 2014)). In this section, we will first survey the microeconomic approaches, and then we will cover the macroeconomic models. Repullo [2000] is one of the first attempts to explore the interactions between central banks and regulators, by studying the optimal allocation of the lending of last resort
function. Based on an incomplete contract framework, Repullo (2000) develops a banking model with liquidity shocks, in order to analyse which agency, the central bank or the deposit insurer, should perform the lender of last resort function. The model assumes that the agency to which is given the lender of last resort role shall also be the supervisory authority, so as to have access to supervisory information. Supervisory information is key for a LOLR entity to correctly evaluate the true value of the assets that will be used as collateral in the liquidity loan. The central bank and the deposit insurer maximise their own objective functions. The central bank is concerned about the impact of a bank failure on the stability of the banking system, while the deposit insurer is worried about the risk of having to reimburse depositors after a bank failure. Results show that the central bank should provide the LOLR assistance for small liquidity shocks, whilst the deposit insurer should have this role for large liquidity shocks. Therefore, assuming that small liquidity shocks are more frequent than large ones, conclusions suggest that the LOLR function should be allocated to central banks, and consequently, the banking supervision too, in order to avoid duplication of monitoring costs. In face of large liquidity shocks, the central bank shall delegate this role to the deposit insurer.

Khan and Santos (2005) extend the Repullo (2000) framework to investigate whether the deposit insurer and the lender of last resort should be separate or unified agencies and whether one of these regulators should be responsible for banking supervision. However, they introduce new features. They explicitly model banking regulation and supervision, which corresponds to the power of closing a bank, and they also allow for a distinction between insolvent and illiquid banks. In addition, by assuming that information is asymmetric, they assess the impact of the institutional allocation of banking regulation and supervision on regulator’s incentive to obtain and share confidential information on banks’ financial conditions with the other regulators.

The study considers different types of institutional arrangements: i) a single-regulator arrangement without supervisory powers, where the LOLR and the DI functions are performed by a single regulator, but banking supervision (i.e. the closure authority) is allocated to a distinct agency; ii) a single-regulator arrangement, with banking supervisory powers; iii) a multi-regulator, characterised by three independent institutions, a central bank that is in charge of the LOLR function, a deposit insurer that cannot

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16Repullo (2000) follows a political economy approach, in the sense that the two agencies are not maximising social welfare. Otherwise, there would be no issue, since either of them would act optimally as LOLR.

17The authors consider the term “banking regulation” in a broad sense, since it includes not only formal rules, but also supervision, deposit insurance and lending of last resort.
withdraw DI coverage and a banking supervisor; and finally iv) a multi-regulator, where the deposit insurer has supervisory powers. The main conclusions are that the best institutional arrangement seems to be the one described in iv), where the central bank is only responsible for the LOLR assistance and the deposit insurer has the power to close banks. This institutional arrangement is not a common allocation of functions, since deposit insurers usually are not assigned supervisory responsibilities. However, it assures that banks invest efficiently in loans (as opposite to choosing an excessive level of reserves) and reduces excessive forbearance (i.e., regulators’ reluctance to close the banks), that arises in institutional frameworks such as i) and iii). These results were obtained by assuming no informational frictions in the model. When informational asymmetry is incorporated in the model by assuming that the profitability signal is observed costlessly only by banks, so that monitoring the banks is now a costly activity for regulators, it is shown that, first the regulator’s incentives to obtain information depend on their responsibilities. Second, it is shown that regulators may prefer not to share information that they obtain in an individual basis with other regulators.

Based on these studies, Ponce (2010) presents a formal model to derive the optimal LOLR policy to manage liquidity shortages in individual banks. This model extends the previous models in several aspects, but the most important innovation relates to a first attempt to model reputation risk and its implications for the optimal allocation of banking supervision, by assuming that all bank regulators (central bank, deposit insurer and bank supervisor) incur in political costs. These are of different magnitude regarding the type of regulator and are incorporated in the utility function of each regulator.

Under the assumption that information is symmetric (i.e. both the liquidity shortfall and the solvency signal are verifiable), the main finding is that, for small liquidity shortfalls, the central bank should be the lender of last resort (as in Repullo (2000)), whereas for large shortfalls the illiquid bank should always be supported. This leads to an optimal institutional arrangement of the regulatory system, in which the optimal lender of last resort policy can be implemented when a central bank that is responsible for the LOLR role, a deposit insurer that guarantees the central bank’s last resort loans that exceed a certain solvency threshold, and a supervisory agency that implements corrective actions

\footnote{Other innovations regarding the previous literature relates to i) the incentives of the bank supervisor, who prefer to financially assist illiquid banks in order to avert the political costs of bank failures; ii) the policy instruments of the bank supervisor, which are “a series of triggers to increase the efficiency of banking regulation”, instead of the authority to close the bank; or iii) the role also played by bankers in determining the magnitude of their banks’ liquidity problems, as opposite to the other papers, that assume that bankers are passive agents.}
that are triggered by the provision of the last resort loans.\textsuperscript{19} These results do not change even if the deposit insurance premium is positive or banks have capital different from zero.\textsuperscript{20}

Under information asymmetry, results are largely the same as in Khan and Santos (2005). Assuming that the central bank is the LOLR and the depositor insurer is the bank supervisor (i.e., it gathers information about the bank’s solvency), it is shown that for certain solvency levels the deposit insurer will prefer to omit such information to the central bank. In this situation, the central bank has to have supervisory powers in order to perform his role effectively.

In summary, the models present different conclusions regarding the optimal institutional regime. On one hand, Repullo (2000) and Ponce (2010) suggest that the central bank shall have supervisory powers, since it performs the LOLR role more effectively when the liquidity shocks are small. On the other hand, Khan and Santos (2005) argue that, in the hypothesis of information symmetry, the optimal institutional arrangement is one that assures deposit insurer should have supervisory responsibilities, whereas the central bank should perform the LOLR role. This type of institutional mandate would ensure, according to the model, an efficient allocation of bank resources and reduce excessive forbearance. By introducing information asymmetry in the model, Khan and Santos (2005) show as well that information sharing may depend on regulator’s objectives and incentives. In particular, Ponce (2010) shows that, for certain solvency levels, the deposit insurer will prefer to omit such information to the central bank, justifying the allocation of supervisory functions at the central bank to be able to perform his role effectively.

Overall, results underscore that when it is assumed that regulators have distinct objective functions, the analysis of the incentives underlying their actions has to be carefully considered when designing an optimal institutional arrangement of banking regulation and supervision. This literature could be further extended to assess the implications for the optimal institutional arrangements of banking supervision of considering its interplay with the monetary policymaker.

In what regards the macroeconomic approach of the interplay between monetary policy and banking regulation and supervision, the study by Seater (2000) is one of the first to model this relationship and, particularly, the optimal structure of the institutional

\textsuperscript{19}According to the author, there are two reasons that justify the use of deposit insurers as guarantors: the money of taxpayers is not used and it increases transparency, since deposit insurance schemes are mainly funded by the banking sector.

\textsuperscript{20}However, the results change slightly when it is assumed that corrective actions are costly. In this case, the results depend on the magnitude of the cost and liquidity shortages.
arrangement for both policies. Based on a IS-LM model with rational expectations, a financial service provided by the banking system is introduced, i.e. bank monitoring of its borrowers, and by affecting the productivity of the output sector of the economy, it provides a link between real economic activity and the financial sector. Another innovation is the introduction of a bank regulatory requirement, such as a reserve requirement or minimum bank capital ratio requirement, imposed by a banking regulator to the banking system. Results suggest that “optimal regulatory and monetary policy should be simultaneously chosen, implying that the institutions responsible for them must at least coordinate their activities and perhaps even should be combined into one agency”.

Cecchetti and Li (2008) provide an insightful contribution to this literature, by developing a model through which the conflicts that arise from diverse policy objectives of monetary policymakers and banking regulators are analysed. The model extends the Blum and Hellwig (1995) banking sector framework to include a central bank and derive an optimal monetary policy rule, in which the potential procyclicality of capital requirements is incorporated. The central bank and the banking regulator are separate authorities and the game between the two is modelled by assuming that the central bank moves first and it is followed by the banking regulator, since monetary policy is usually conducted on a daily basis, whereas banking regulation change slowly.

Results show that the central bank should respond to the banking system’s balance sheet in order to neutralize the procyclical effect of prudential capital regulation. Thus, in a situation of financial distress and economic downturn, the optimal monetary policy stance should decrease interest rates more aggressively when the banking system is capital constrained, counteracting the procyclicality of capital regulation and, simultaneously, stabilising the aggregate economic activity. In summary, the authors show that capital regulation requires adjustments by monetary authorities, but they are not an obstacle to the effective conduct of monetary policy. Hence, the conflict of interest between both policy’s objectives can be overcome in a game where the central bank reaction depends on whether the banking system is capital constrained.

Cecchetti and Kohler (2014) extend the Cecchetti and Li (2008) methodology to analyse the interaction of the monetary policy and banking regulation instruments - in particular, to investigate whether interest rates and capital requirements may be substitutes in stabilising the economy. They find that the instruments are full substitutes for achieving greater banking system distress under capital regulation.

\[^{21}\text{Cecchetti and Li (2008) show that, from 1989 to 2000, the Fed has optimally decreased the federal funds rate in response to a higher leverage ratio, that was embedded in its reaction function to capture greater banking system distress under capital regulation.}\]
a standard monetary policy goal of output and price stability, due to their similarities regarding the transmission mechanism. They also show that introducing a financial stability goal impacts on the substitutability between interest rates and capital requirements. Coordination is, in this case, suggested to achieve full substitutability, but the type of coordination also matters. The authors refer to the situation in which partial coordination is assumed (where the authority in charge of financial stability moves first). In this case, the worse outcomes may be attained, given that the policymakers do not take each other’s reactions into their optimisation problem.

Walque et al. (2010) develop a Real Business Cycle model with a heterogeneous banking sector (banks of two types: merchant and deposit banks) with endogenous default probabilities for both firms and banks and banking regulation and monetary policy. Given the Real Business Cycle nature of the model, monetary policy is expressed in terms of liquidity injections into the interbank market, which are represented by a supply of commodities. The aim is to understand the interconnections between the banking sector and the rest of the economy, together with the role of supervisory and monetary authorities in restoring financial stability. In the optimal monetary policy exercise, the central bank follows two separate objectives, output stability and financial stability (by minimising bank default fluctuations), and it takes capital regulation as given. The banking sector is constrained by both Basel I and Basel II capital requirements. Results show that, under capital regulation, monetary policy increases the volatility of the financial sector. As explained by Walque et al. (2010), this occurs because liquidity injections “imply an artificially low interbank rate and hence an artificially high bank repayment rate”.

Angeloni and Faia (2013) introduce banks in a standard DSGE model with nominal rigidities to “analyse the role of banks in transmitting shocks to the economy, the effect of monetary policy when banks are fragile and the way monetary policy and bank capital regulation can be conducted as a coherent whole”. In this model, the banking regulator aims at reducing banks’ risk, considered high under a unregulated regime, by setting minimum capital requirements, imposed by a penalty on non-compliance. The minimum capital requirement is represented by a time-contingent ratio between the required banking capital and the total bank loan exposure, that, depending on some assumptions, mimics i) the fixed capital ratio under Basel I, ii) the minimum capital requirement implied by the internal ratings (IRB) approach of Basel II, and iii) the anti-cyclical capital

22 The banking sector follows the model by Goodhart et al. (2006).
23 The banking sector is based on the Diamond and Rajan (2000; 2001) model.
requirements under Basel III. Monetary policy is incorporated in the model through a Taylor Rule’s objective function, that is extended by including two alternative terms representing a systematic reaction on financial market conditions, in the form of a response to asset prices or to changes in the deposit ratio. The interaction of monetary policy and banking regulation is performed under four capital regimes (the Basel I, Basel II and Basel III capital regimes, plus a free capital regime) and under six different combinations of monetary policy rules.

Results suggest that an expansion of monetary policy increase bank leverage and risk. Secondly, pro-cyclical capital requirements, similar to those under Basel II, enlarge the reaction of output and inflation to other shocks, increasing the volatility of inflation and output and reducing welfare. In turn, anti-cyclical bank capital ratios (Basel III) have the opposite effect. Findings are thus indicative of, while Basel II procyclicality may lead to potential conflicting outcomes with monetary policy, the adoption of Basel III capital regime (in which macroprudential instruments are envisaged) may provide a hand to monetary policy. Moreover, in what regards the measurement of performance of alternative policies, the authors conclude that the optimal combination includes a mildly anti-cyclical capital requirement (Basel III) and a monetary policy that reacts aggressively to inflation and reacts systematically to asset prices or to bank leverage.

Overall, these papers show that capital regulation has an impact on the level of output and increase business cycle fluctuations. In addition, the procyclical effects in the economy of capital requirements are supported by this literature, mainly when the focus is on Basel II capital adequacy requirements. Lastly, capital regulation requires adjustments of the monetary policy, but there are circumstances where they are not an obstacle to the effective conduct of monetary policy. For example, as suggested by Angeloni and Faia (2013), an optimal policy would be one that combines the anti-cyclical capital requirement and a monetary policy that responds to inflation and financial imbalances.

\footnote{In case of non-compliance, the model assumes that \textit{“the regulator adjusts the return to bank capitalists downward, to replicate the return to outside investors (depositors and capitalists) that, in an unregulated regime, would prevail under a bank run.”}}
2.5 The degree of financial supervision consolidation - a political-economy approach

In the preceding sections, we have covered the theory and the empirical evidence concerning the advantages and disadvantages of allocating the banking regulation and supervision functions to the central bank. However, as concluded above, a theoretical approach in which the benefits and costs of different institutional arrangements are balanced, does not offer an answer for what would be the optimal supervision architecture. A political economy approach of the institutional arrangements of monetary policy and banking regulation and supervision is therefore necessary since, in the real world, these arrangements are the outcome of a political process (Masciandaro et al. (2008)). Furthermore, the political choices are a consequence of policymakers’ preferences, which are under-studied. In fact, the policymakers’ objective function in what concerns financial supervisory design is not studied in the economic literature (Masciandaro (2007)).

In this section, we will review the main factors determining the differences in the banking supervision regimes from country to country and, particularly, how political preferences may impact on the design of the financial supervision architecture. The literature review shows that the current institutional arrangements influence the policymakers choices when defining the financial supervision structure. Masciandaro (2004), Masciandaro (2007) and Pellegrina et al. (2010) investigate what features of the present financial supervision institutional regimes are more likely to affect the policymakers’ decisions. On the other hand, Masciandaro et al. (2008), Masciandaro (2009) and Franck and Krausz (2008) analyse the most important political characteristics explaining the financial supervision architectures.

Masciandaro (2004) highlights the heterogeneity between banking supervisory regimes. By building up indices of the degree of unification in financial sector supervision and the central bank’s involvement in financial supervision, based on institutional arrangements from 69 countries, the author concludes that the degree of unification of supervisory powers in developed countries is increasing, particularly in European Union states. In addition, the study identifies two distinct institutional arrangements, that are more common across the world: a model with high level of unification of supervisory powers and a weak central bank’s involvement, opposed to a model characterised by low levels of unification of powers and strong central bank’s participation. Given these results, it

\[\text{In order to build this index, Masciandaro (2004) considers three possible financial sectors: banking, securities and insurance.}\]
is argued that a trade-off arises between the degree of financial sector unification and the role of the central bank. There are some possible explanations for this central bank fragmentation effect. Masciandaro (2004) argues that the trade-off can emerge due to the blurring hazard effect, which argues that policymakers worry that the central bank role as lender of last resort of the banking system might be extended to other financial sectors, such as insurance and securities industries. On the other hand, the trade-off can be explained from a political economic point of view, in the sense that in a country where the central bank is strongly involved in financial supervision, the government may fear an “overly powerful bureaucratic agency” and it will promote a less consolidated supervisory regime. This interpretation is related to the ‘balance of powers’ argument, discussed above.

Masciandaro (2007) investigates the central bank fragmentation effect using econometric techniques as a complement to the descriptive analysis in Masciandaro (2004). The paper argues that the policymakers’ decision on supervision unification level will depend on the role the central bank plays in banking supervision. Based on the same indices constructed in Masciandaro (2004) an econometric study is performed, where the central bank fragmentation effect is tested. In other words, it is empirically assessed whether the involvement of central banks in financial supervision is an important factor in defining the degree of supervisory unification. The author expects a negative signal between the central bank participation in financial supervision and the degree of financial supervision consolidation. The results confirm the descriptive trade-off between the participation of the central bank in financial supervision and the degree of supervision unification: “the more the central bank is involved in financial supervisory powers, the lower the degree of concentration of those powers is likely to be”.

The empirical study by Pellegrina et al. (2010) focus specifically on the effect of central bank independence and monetary policy settings on the probability of allocating banking supervision to central banks. The dataset comprises 88 countries at different stages of economic development. Findings suggest that higher central bank operational independence is associated with a reduced degree of supervisory powers and tighter monetary

\footnote{For clarification, unification refers to single financial authorities regimes, in which banking, securities and insurance supervision are ruled by a same agency.}

\footnote{The econometric models adopted are an ordered Logit model and an ordered Probit model. The dependent variable is the Financial Authority Index, as described in Masciandaro (2004). The key independent variable is the Central Bank Financial Authority Index, that indicates the involvement of the central bank in supervision. The control variables are index for the private governance factor, market capitalization over GDP, quality of public sector governance, GDP, binary variables for OECD and European countries, binary variables for the law factor and latitude, for the endowment view.}
policy goals are related to higher central bank involvement in supervision.

Franck and Krausz (2008) present a political-economy explanation to the selection of one of the two possible institutional frameworks. Using the contract theory framework, they analyse whether the separation between monetary policy and banking regulation is influenced by the political preferences on inflation of the Conservative and Liberal parties. They assume that the Conservative party is more favourable to a price stability environment and, in opposition, the Liberal party prefers inflation and lower unemployment. Results show that separation between those tasks better serves the interests of the Conservative party, that aims for low-inflation policies and banking stability, once the banking system is considered solid and the probability of banking failures is low. The main conclusion is that different political objectives regarding inflation have an impact on the choice of the monetary policy and banking regulation’s institutional regimes.

2.6 Macroprudential regulation and monetary policy

The recent crisis not only has revived the debate with respect to the role of the central bank in banking supervision, but also highlighted the need for a macroeconomic dimension of traditional regulatory and prudential framework. As Blanchard et al. (2010) pointed out, financial regulation has played a key role in the crisis, by contributing to amplify the effects that converted the US housing bubble into a major world economic crisis. The financial regulation framework, by being characterised by a limited perimeter of action, encouraged banks to create off-balance-sheet entities to avoid some prudential rules and increase leverage ('shadow banking'). Moreover, mark-to-market rules, together with constant capital ratios, forced financial institutions to reduce their balance-sheets, aggravating asset fire sales, and deleveraging.

The crisis has also shown the lack of effective mechanisms to deal with systemic risk, stemming, for example, from systemically important institutions. The Fund (2011) argues that this occurred because of an underlap issue in the financial supervisory architecture: neither macroeconomic policymakers nor prudential regulators were responsible for promoting the stability of the financial system as a whole. In particular, monetary policy was apparently insufficient to deal with credit and asset-price booms without inducing adverse collateral effects on economic activity (Bean et al., 2010).

In the pre-crisis period, banking regulation and supervision was predominantly micro-oriented, in the sense that aimed at “preventing the costly failure of individual financial
institutions” (Hanson et al., 2010), and was concerned with the protection of the consumers (depositors and investors). Macroprudential policy, on the other hand, is a regulatory approach that “recognises the importance of general equilibrium effects, and seeks to safeguard the financial system as a whole”, as argued by Hanson et al. (2010). In this crisis context, macroprudential policy has hence been highlighted as having a potentially significant role in addressing system-wide risks and promoting financial stability.

In the aftermath of the crisis, a reform of the international regulatory framework is being implemented to encompass a macroprudential oversight of systemic risk, among other things. The ongoing debate among scholars and institutional authorities focuses on the role of macroprudential policy and how it should relate to other macroeconomic policies, particularly monetary policy and microprudential policy.

Among other questions that are being discussed, the introduction of a macroprudential approach to the financial system brings new challenges for the financial supervisory architecture and, in particular, for the institutional mandates of monetary policy, including how policy coordination should put in place.

2.6.1 Objectives and Instruments of Macroprudential Policy

Although macroprudential policy generic goal is to promote financial stability, there is not a single definition of financial stability, as Galati and Moessner (2012) argue. In the

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29 There is an old debate on whether monetary policy should react to expected inflation only or to asset prices as well. For instance, Taylor (2010) considers that there is no need for “new policy instruments, such as discretionary countercyclical capital buffers, to ward off financial crises in the future”. He argues that “the motivation for using such instruments is lacking. (…) If one believes that low policy rates were only a “modest” factor in the boom, then one is drawn to these alternatives”.

30 According to Galati and Moessner (2012), the term “macroprudential” firstly appeared in the late 1970’s in unpublished documents prepared by the Cooke Committee, the precursor of the present Basel Committee on Banking Supervision, and in a document of the Bank of England.


32 In what regards macroprudential policy specific goals, the literature is fruitful in definitions as surveyed by Galati and Moessner (2012):
- Countervailing force to the natural decline in measured risks in a boom and the subsequent rise in measured risks in the subsequent bust;
- Avoiding bubbles;
- Limiting the risk of episodes of system-wide distress that have significant macroeconomic costs;
- Reducing systemic risk by explicitly addressing the interlinkages between, and common exposures of, all financial institutions, and the procyclicality of the financial system;
- To discourage individual bank strategies which cause systemic risk, a negative externality on the financial system;
- Controlling the social costs of a generalized reduction of assets in the financial system.
literature, financial stability could be referred to as the robustness of the financial system to external shocks or can be interpreted as the resilience to shocks originated within the financial system (endogenous nature of financial distress). Overall, macroprudential policy aims at limiting the risks and costs of systemic crises, thereby promoting financial stability. Macroprudential policy is, therefore, intimately related with the concept of systemic risk and its sources, but there is no consensus definition for systemic risk, as surveyed by Galati and Moessner (2012). Systemic risk can be defined as a risk of experiencing systemic events where institutions affected in the second stage or later fail as a consequence of the initial shock, even though they have been fundamentally solvent before the shock. In alternative, systemic risk is seen as propagation risk, when shocks disseminate beyond their direct economic impact, resulting in diffused distress and disruption of the real economy. The endogenous nature of systemic risk is also emphasized, by suggesting that systemic risk results from exposures to the evolution of systematic risk through time, which is intimately linked to the business cycle.

Since systemic risk has different sources, the literature offers a wide variety of potential instruments that can be used to mitigate systemic risk and prompt financial stability. The most popular is regulatory capital, such as capital surcharges for systemically important institutions, increasing regulatory capital requirements for particular exposure types or time-varying capital requirements. Funding liquidity requirements are also an alternative instrument, for instance, cyclically-dependent funding liquidity requirements or concentration limits, as well as collateral arrangements, such as time-varying loan-to-value (LTV) ratios. Risk concentration limits, quantitative limits to growth of individual types of exposures and profit distribution restrictions are other examples that could be included in the macroprudential toolkit.

As an example of how a macroprudential tool could work, let us describe time-varying capital requirements. This instrument requires banks to keep higher solvency ratios in the upswing of the business cycle (good times) than in the downturn (bad times), with the purpose of reducing balance-sheet shrinkage, due to credit crunches and fire-sales. Under such a rule, banks can release their capital buffers when an adverse shock hits the economy and, as a result, the pressure to reduce assets or increase capital would decrease in bad times. In bad times, the markets can be more demanding than regulators vis-a-vis bank capital ratios, given a rise in the assets risks. Thus, in good times, the time-varying capital requirements should be significantly above the market-imposed standards in bad times.

Financial stability is a primary goal of macroprudential policy, but it could also be
fostered by alternative policies. In particular, monetary policy is also concerned with financial imbalances, due to the fact that financial stability is crucial to achieve stability of prices. Therefore, monetary and macroprudential policies are interconnected, because they share the same concerns in what regards the stability of the financial system, but while for macroprudential policy it can be interpreted as an end in itself, for monetary policy it can be viewed as a mean to achieve price stability. Against this background, the advantages and disadvantages of combining monetary policy with macroprudential policy are surveyed in the next section.

2.6.2 Institutional arrangements of macroprudential and monetary policies

The mechanism of governance, accountability, transparency and coordination of macroprudential policy with other public policies that also aim at preserving financial stability are central features that should be addressed when designing the institutional architecture of macroprudential policy.

In this section, we focus our analysis on the interplay with monetary policy. Benes et al. (2014) enumerates some basic distinctions of macroprudential policy analysis and traditional monetary policy analysis. First, monetary policy is conducted over regular business cycles, whereas macroprudential policy functions with macro-financial cycles that are longer and more asymmetric. Second, monetary policy analysis is based on the assessment of risks, which generally follows a normal pattern. Macroprudential policy, in turn, deals with tail risks, i.e., plausible yet very unlikely scenarios. Third, monetary policy analysis is based on flow variables and prices, while macroprudential policy analysis is focused on balance sheets, stock-flow relationships and aggregate risk. Fourth, monetary policy in normal times can be modelled as a linear-quadratic optimal control problem. In turn, macroprudential policy should be addressed as a highly nonlinear robust control problem. Fifth, macroprudential policy deals with much more uncertain events than monetary policy, which is characterised by stable trade-offs that can be, most of the times, empirically quantifiable by the use of standard empirical methods. Hence, given the nonlinearities arising when the economy is subject to large distress, macroprudential policy analysis must rely much more on judgement and simulation-based validation than in empirical methods.

In practice, there are different macroprudential policy institutional models that can be
grouped in the following types, according to the \[\text{Fund (2011)}\] \footnote{Recent examples from a International Monetary Fund survey include European Union, Malaysia, Mexico, United Kingdom and United States.}: i) “a model where a specific institution is given a macroprudential mandate”; ii) “a model where a single institution is tasked with carrying out macroprudential policy \(\ldots\), but the decisions are taken by some attached policy committee”; and “a model where an independent committee or council fulfills the role of macroprudential authority”.

Considering these challenges, the literature provides both arguments for and against a separate institutional regime, although they are not systematised as the ones we find related to traditional view of banking regulation and supervision (microprudential policy), due to the novelty of the topic. We suggest a similar classification of the arguments as presented before for the institutional mandates of monetary policy and banking supervision from a microprudential approach point of view.

Arguments against separation of macroprudential and monetary policies

- ‘Information Gains’ argument

According to the \[\text{Fund (2011)}\], there are informational advantages to both policies. On one hand, the macroprudential policy may be interested on the financial stability risks associated with a given monetary policy mindset in formulating its polices. On the other hand, monetary policymakers may want to be informed of action or inaction of macroprudential authority when calibrating monetary policy. Moreover, \[\text{Borio (2011)}\] highlights that central banks have a comparative advantage due to their knowledge about the functioning of financial markets and the macro-economy, which justifies their leading role as macroprudential policymakers. \[\text{Brunnermeier et al. (2009)}\] agree with the observation of the G-30 (2008), regarding the critical importance for central banks of having information about large systemically important financial institutions.

- ‘Qualified Staff’ argument

The \[\text{Fund (2011)}\] particularly enhances the advantage related to the accumulated expertise of the central banks and argues that it could be used to ensure effectiveness of macroprudential policy. For instance, the central banks have expertise in the analysis of systemic risks and in monitoring financial markets and aggregate and sectoral
developments, given his role in monetary policy and payment systems. In addition, expertise related to his role as a lender of last resort is also important for the definition of macroprudential policy measures that aim to reduce the likelihood of individual failures. Another example concerns the analytical skills of central bank staff that can be used to clarify the benefits and costs of macroprudential policies.

Furthermore, the central bank has a strong interest in ensuring the effectiveness of macroprudential policy. Otherwise, the costs of a failure of macroprudential policy will be borne by the central bank, namely by ‘leaning-against-the-wind’ operations, comprising the main goal of price stability, or by cleaning, providing liquidity ex post. For this reason, the central banking expertise should be seized to help the design of macroprudential policy, having in mind the ultimate goal of effectiveness.

Arguments for separation of macroprudential and monetary policies

- ‘Conflict of Interest’ arguments

The price stability is the primary goal of monetary policy and financial stability objectives must have a secondary role. In other words, changes in monetary policy, such as changes in interest rates, should not be recommended by the macroprudential authority, because they can conflict with the principal monetary policy goal and jeopardize the monetary policy independence [Fund (2011)]. Nonetheless, it is important to promote the mutual internalization of policy action in order to lead to an optimal policy mix.

Blanchard et al. (2010) also recognises that conflict of interest may occur, leading to a more flexible mandate on inflation, since increases in interest rates may have an adverse effect on bank balance sheets. However, these authors consider that this disadvantage can be overcome by reinforcing transparency.

Beau et al. (2011) consider that the conflict of interest outcome will depend on the type and dissemination of supply and demand imbalances across the financial system and the real economy. They present the following example. Consider a situation characterised by an asset bubble and by downside risks to price stability. In this case, macroprudential policy would limit credit and liquidity growth, but such stance could have adverse effects in aggregate activity and could increase downside risks to price stability. If the prices fall as a consequence of macroprudential policy, than that may require the intervention of the central bank, by further lessening the monetary policy stance. Therefore, the
necessary measures to control financial stability would have a negative impact on price stability, resulting in a conflicting outcome.

In turn, an expansionary monetary policy can also impact adversely on financial stability. Lower interest rates can create incentives for banks and other financial agents to take more risk, when they operate in an environment featuring asymmetric information and limited responsibility.

Under different economic circumstances the outcomes on financial and price stability of both policies could be complementary, independent or conflicting (Beau et al., 2011). Table 2.4 presents the circumstances where the conflicts between both policies could arise:

<table>
<thead>
<tr>
<th>Table 2.4: Conflicting outcomes of monetary and macroprudential policies</th>
</tr>
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<tbody>
<tr>
<td><strong>Financial exuberance</strong></td>
</tr>
<tr>
<td>Financial deflation</td>
</tr>
<tr>
<td>No imbalance</td>
</tr>
</tbody>
</table>

Source: Beau et al. (2011)

Therefore, conflicting goals are likely to arise when the economic business cycle is characterised by financial deflation and inflation above the target or by financial exuberance and inflation below the target. Source: Beau et al. (2011)

- ‘Reputation Risk’ argument

Blanchard et al. (2010) argue that a disadvantage that comes from a single authority for monetary and macroprudential policies is that the institutional regime would be more complex and, therefore, less accountable. In these circumstances, there is, again, a need for further transparency.

Discussion

Despite the arguments in favour of a separate mandate, there is a convergent stance in the literature towards the back-up of a unified institutional arrangement of macroprudential
and monetary policies or, at least, towards a regime that promotes close cooperation between the two.\textsuperscript{34}

\textbf{Blanchard et al. (2010)} defend that the “macro institution will be the national central bank and the micro institutions(s) will be one, or more, Financial Services Supervisory institutions”. They enumerate three reasons by which the central bank must conduct macroprudential policy. Firstly, central banks monitor macroeconomic developments, so they can use this expertise to analyse financial trends. Moreover, the combination of both functions into a single agency would avoid problems of coordinating the actions of separate agencies during a crisis. Finally, monetary policy decisions have potential implications for leverage and risk taking, which are areas concerning macroprudential policy. Against this background, the authors consider that the decision for a unified, single peak, approach in the United Kingdom was wrong and clearly recommend “a reversion to the prior twin-peaks approach, with one peak being the macro, systemic, economic Central Bank, and the other being the micro, individual prudential (...)", legal and accounting FSA”.

\textbf{Garicano and Lastra (2010)} argue that macroprudential measures should be allocated to the central bank, because this institutional arrangement “makes it possible to capture the main synergies while avoiding most of the organizational costs”. In particular, the authors advocate that the multitasking, informational economies of scope and ‘reputation risks’ apply typically to microprudential policy, as well as the ‘conflict of interests’ arise from the connections of that function and monetary policy. In turn, the role of lender of last resort is a function that is more related with macroprudential supervision. For these reasons, the authors support an institutional regime featuring the combination of macroprudential supervision tasks with central banking, but leaving microprudential responsibilities outside the scope of central banks, since this framework seems to provide relevant benefits while avoiding the main ‘organizational costs’ associated to microprudential regulation.

\textbf{Blinder (2010)}, in his analysis of the U.S. context, has the view that the macroprudential policy and the supervision of systemically important financial institutions should be assigned to the Fed, while the supervision and regulation of small institutions could be allocated to a separate institution, since it lacks economies of scope compared to the other functions. The reasons are: i) the separation of functions neglects the strong economies of scope between financial stability and monetary policy; ii) the role of lender

\textsuperscript{34}Brunnermeier et al. (2000), Blanchard et al. (2010), Garicano and Lastra (2010), and the Fund (2011).
of last resort is an important instrument to pursue financial stability, iii) a single agency responsible for financial stability is more accountable than a committee. Mishkin (2011) also agrees with the view that a systemic (macroprudential) regulator should exist and that it should be allocated to central banks, due to coordination advantages between monetary policy and macroprudential regulation. In particular, Mishkin (2011) considers that macroprudential policies are mainly useful to control the development of credit bubbles (and not asset price bubbles in general).

In turn, the Fund (2011) does not have a clear perspective on this, concluding that there are advantages and disadvantages of specific institutional mandates for the macroprudential policymaking and, thus, these issues requires further analysis, particularly focusing on the interplay of macroprudential and monetary policies. The interlinkages between both policies are surveyed in the following section.

2.6.3 The interactions of macroprudential and monetary policies

A main topic in the design of an effective institutional mandate for macroprudential policy is how it interacts with monetary policy, since both promote macroeconomic stability and affect real macroeconomic variables. The key questions we find in the literature are the following:

- How macroprudential policy tools should be set in conjunction with monetary policy?
- Should the same institution (i.e. the central bank) set the two policy instruments to achieve both price and financial stability?
- Or should each instrument be designed to deal with each policy objective?
- Are there any gains from coordinating monetary policy and macroprudential policy?
- Attending to the fact that both policies are likely to affect aggregate demand and supply and conditions in the banking sector, is it possible that they are in effect perfect substitutes?
- Or, if they are sufficiently independent and the instruments are set by different policymakers, would there be the case for a “push-me, pull-you” effect?
As this is a very recent topic in the literature, the answers to this questions are scarce. According to Galati and Moessner (2012), the interaction between these policies depends on whether financial imbalances play a role in the monetary policy framework and they also argue that the challenge of combining both policies is similar, to some extent, to the challenge of coordinating monetary policy and fiscal policy. As for the case of the monetary policy and fiscal policy game, the authors suggest that the problem may be addressed by monetary policy taking macroprudential policy as given when setting short-term interest rates since the frequency of macroprudential policy decisions is likely to be lower than of monetary policy decisions. Beau et al. (2014) argue that macroprudential policies may alter the monetary policy transmission mechanism, because the former will act via the same channels as monetary policy, in particular the bank lending and the balance-sheet channels, as already discussed above. To the extent that spillovers may arise, fully optimal policy calls for at least some sort of coordination between these two policies.

A number of papers offer preliminary insights and suggest different ways of combining the macroprudential tool with the monetary policy instrument. De Paoli and Paustian (2012) address these questions by adapting a New-Keynesian model from Carlstrom et al. (2010). This microfounded macroeconomic model features an agency problem, that gives rise to credit constraints and a ‘risk premium’ that depends on the degree of the credit constraints. The macroprudential instrument is a time-varying leverage ratio. The interaction between monetary and macroprudential policies is analysed in a cooperative solution under commitment and under discretion, in one hand, and in a Nash-equilibrium and a leadership equilibrium games, on the other hand. Findings suggest that, under a cost-push shock, welfare is improved if policy authorities coordinate and commit to a specific policy stance. In the case macroprudential policy and monetary policy do not cooperate and act under discretion, assigning a conservative policy mandate to both institutions improves welfare. In particular, the assignment of a leadership role to the macroprudential authority is also welfare beneficial. Finally, authors show that selecting a macroprudential instrument that resembles closely a monetary tool can cause costly coordination issues.

Bean et al. (2010) extend a New-Keynesian DSGE model to incorporate both physical capital and a simple banking sector, in order to analyse how the macroprudential policy tools might impact on the conduct of monetary policy. As a macroprudential policy instrument, it was selected a (lump-sum) levy / subsidy on the banking sector, which is

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35 The authors adapt the model from Gertler and Karadi (2011).
used to influence the amount of bank’s capital that is carried forward. First, they analyse the conduct of monetary policy and macroprudential policy when a single policymaker is in charge of both functions. Then, they compare the outcomes with the ones resulting from a distinct arrangement, in which macroprudential policy is delegated to a different agency. The results suggest that the possibility of a “push-me, pull-you” outcome arise under a mark-up shock, since macroprudential policy moves to maintain bank capital, ignoring the impact on the inflation gap and, in turn, monetary policy raises the policy rate more aggressively to contain inflation, not taking into account the capital gap. In this case, conflicting outcomes arise, suggesting that both policies should be coordinated.

Angelini et al. (2014) develop a dynamic general equilibrium model with a banking sector following Gerali et al. (2010) to analyse the interactions of the macroprudential policy and monetary policy in order to determine if they can cooperate to stabilise the economy. In this model, macroprudential policy is concerned with “excessive” lending and cyclical fluctuations of the economy. Therefore, the macroprudential policy authority minimises a loss function whose elements are variances of the loans-to-output ratio and of the output. The two instruments suggested are a capital requirement and a loan-to-value ratio (LTV). Based on this analytical framework, the interplay between macroprudential and monetary policies is modeled in two difference contexts. One is the cooperative context, where both policies jointly and simultaneously set the parameters of their respective policy rules to minimise the weighted average of their two objective functions. The other is the non-cooperative context where each authority minimises its loss function taking the policy rule of the other as given.

Analysing the effects of a technology shock, their findings suggest that the gains from cooperation are small. In normal times, the contribution to macroeconomic stability of macroprudential policy is negligible. However, in the non-cooperative case, conflicts may arise, due to the macroprudential policy authority’s incentive to stabilise the loans-to-output ratio, neglecting the impact of its behaviour on the objectives of the monetary authority. In particular, macroprudential policy becomes procyclical and monetary policy countercyclical. In this situation, it is also observed a substantial increase in the variability of the policy instruments. In the presence of financial and housing market shocks, advantages of macroprudential policy become sizeable. In the cooperative game, the central bank deviates from strict adherence to its objectives to help macroprudential policy achieving its goals. Hence, when the economy is hit by sector shocks, it is possible to observe a higher inflation volatility.
In brief, this recent literature offers different ways of setting up macroprudential policy together with monetary policy, exploring not only the distinct sources of financial frictions and macroprudential instruments, but also the possible institutional arrangements that can be set. Overall, findings suggest that these policies are not perfect substitutes, thus macroprudential policy may play a role in promoting financial stability, even though the magnitude of the gains of employing this type of policy depends on the type of shock that impacts the economy. Furthermore, the papers suggest that there are gains from coordination of policies, because when the instruments are set separately by different institutions, a “push-me, pull-you” effect is likely to arise, under special economic situations. Thus, the “conflict of interest” argument seems to have some support in analytical frameworks.

However, as Taylor (2010) points out, the stylised nature of this kind of models “illustrate how far we are from a monetary framework to evaluate such policies”.

2.8 Concluding remarks

This survey clearly shows that the occurrence of the financial crisis of 2008 and the subsequent explicit introduction of financial stability policy in the macroeconomic policies set irreversibly changed the debate regarding the institutional arrangements of monetary policy and banking regulation. In the aftermath of the financial crisis, we have witnessed a change in the taxonomy used to refer to banking regulation and supervision to a more general concept of prudential regulation, comprising both macroprudential and microprudential approaches. This clear distinction between the macro and the micro prudential purposes of banking regulation and supervision brought a new view in the discussion of the design of monetary and financial supervisory architecture, that, although far from being settled, in certain dimensions there is a more consensual understanding of what the role of central banks should be on these grounds.

In addition, this review finds that nowadays there is a common view that central banks should have an explicit financial stability mandate, by playing a role in macroprudential policy, but the microprudential dimension of banking regulation and supervision should be assigned to an independent authority. This view is raised upon the stronger similarities between monetary and macroprudential policies, as underpinned above, and the allocation of financial stability objectives would take the most of the synergies arising from the interaction of the two policies (Smets, 2014). Nonetheless, this survey also
highlights the need for empirical and theoretical evidence, which is still scarce, suggesting that this view is not yet informed by empirical and theoretical analysis, but mostly by personal opinions of researchers and policymakers.

As Smets (2014) clearly puts it, the design of optimal institutional setups of monetary and macroprudential policies depends on the “different appreciation of the pervasiveness of this interaction, the effectiveness of independent macroprudential policies, the extent to which monetary policy may be a source of financial instability, and the extent to which monetary policy can avoid being drawn into financial stability concerns—in particular, in times of crisis”. There is not yet a clear answer to all of these aspects and research is therefore needed.
Chapter 3

The Effect of Financial Regulation Mandate on Inflation Bias: A Dynamic Panel Approach

3.1 Introduction

It is now well documented that many macroeconomic variables in several economies have gone through the so-called ‘Great Moderation’ period, which broadly corresponded to lower levels and volatility of inflation rates, coupled with stable growth and low unemployment. Until recently, financial regulation did not feature prominently as a macroeconomic policy tool, but, nevertheless, recent decades have seen substantial changes in the institutional architecture of monetary policy and banking regulation across many countries. It seems, therefore, relevant to assess how these changes have contributed to macroeconomic outcomes and, in particular, inflation.

Historically, the institutional arrangements concerning the monetary policy and banking regulation were mainly influenced by two distinct traditions; the Anglo-Saxon influence, where monetary policy and banking supervision are combined under the central bank, and a German-influenced approach, where these functions are separated. According to Haubrich (1996), the origin of these different traditions is related to the evolution of the payment system. Countries that adopted the Anglo-Saxon tradition experienced a rapid

For example, countries with an Anglo-Saxon influence include the United States, United Kingdom, Australia and Hong Kong, whereas countries with German influence include Austria, Germany, Denmark, and Switzerland.
expansion of credit through the introduction of alternative forms of money, where the central banks naturally became the guarantors of the smooth functioning of the payment system and the regulators in these market-based financial systems. In contrast, countries that experienced a slow expansion of credit developed a bank-based financial system of well-capitalised banks that were regulated by an independent authority following the German tradition.

However, in the late nineties there was a tendency for the separation of these functions following the German-style framework. Indeed, over the period from 1986 to 2006 for a sample of 91 countries, Masciandaro (2009) demonstrates that 94% chose to reform their financial supervisory architecture and unify the financial system regulators within the same agency, but different from the central bank. In particular, it is shown that the degree of unification of financial regulators is inversely related to the central bank’s role in banking regulation and supervision. More recently, the 2008 financial crisis questioned this apparent consensus towards the separation of functions, and several countries, including the United Kingdom, Ireland and Iceland, but also the euro area, implemented reforms towards the reinforcement of the role of the central bank in banking supervision (Pellegrina et al., 2010).

Notwithstanding the financial supervisory architecture trends around the world, there are strong arguments for and against separation of banking supervision from the central bank in the academic literature. On the one hand, a combined institutional mandate, in which the central bank is also in charge of banking supervision, provides gains in terms of information, in the sense that the central bank has access to confidential information regarding banks’ financial situation. This type of information is useful in situations in which the lender-of-last-resort support is deployed, since the decision to use this mechanism to support banks in financial distress should be based on accurate information regarding the solvency of these institutions.

On the other hand, it is argued that a combined institutional mandate may lead to con-

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2Most notably, in 1999 the European Central Bank was assigned the responsibility for the conduct of monetary policy in the euro area and the national authorities became in charge of the banking regulation and supervision. Likewise, the United Kingdom and Australia have opted for the separation of these functions.

3There are other arguments in favour of combined institutional mandates, such as the access to expertise and qualified staff argument (Garicano and Lastra, 2010) and the independence argument (Tuya and Zamalloa, 1994).

4Supervisory data is also relevant as a source of information regarding economic conditions and, therefore, it can also be used to improve the accuracy of economic forecasting, which is commonly one of the core functions of central banks.
flicts in the objectives of monetary policy and banking supervision, in certain economic circumstances. This argument in favour of the separation of policy regimes states that a central bank responsible for banking regulation will be more flexible in its inflation mandate if it fears that tight monetary conditions may cause bank distress due to adverse effects of high interest rates on the profitability and soundness of the banking sector (Goodhart and Schoenmaker [1993, 1995]).

The aim of this paper is, thereby, to empirically examine the implications of different designs of monetary and financial supervisory architecture on the inflation rate dynamics. In particular, this study investigates the potential monetary policy and banking regulation conflicting goals by assessing whether institutional mandates in which the central bank plays a banking supervisory role have, on average, led to higher inflation rates in relation to a separate regime. In addition, we consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the establishment of deposit insurance systems with the view to enhancing financial stability by protecting deposits may influence the monetary policy stance.

Building upon the work by DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008), we address several limitations in their models and extend the analysis in several ways. As Copelovitch and Singer (2008) point out, some of their results should be interpreted carefully due to the small size of the sample they are using, which is a panel data that comprises 23 industrialised countries ranging from 1975 to 1999. Since they opt for transforming the annual data into five-year averages, the sample size is even more reduced. To overcome problems related to sample size, we introduce two innovations. First, we suggest the use of annual panel data, instead of the five-year average inflation rate approach. We also undertake the estimation of a dynamic panel data model for inflation analysis, taking into consideration empirical evidence on the persistence of inflation rates. Even more relevant are the improvements regarding the estimation approach. Despite the construction of a panel data sample to measure the effect of the separation of banking supervisory powers from the central bank on inflation outcomes, previous studies adopt simple estimation methods, such as ordinary least squares, which do not take into account unobserved effects that are typical of panel data.

Another argument against the combination of monetary policy and banking regulation refers to the reputation risk that is associated to this type of institutional arrangement. It is argued that public perception of central bank credibility may likely be affected by its performance as a banking supervisor, mainly if a bank failure occurs.
analysis. We use appropriate methods to estimate panels, both static and dynamic, namely the Fixed Effects and the Arellano-Bover approaches.

Second, we extend the time span from 1999 to 2012, which results in a dataset covering a sufficiently wide time span of 38 years to allow for some of these countries to change their institutional mandates of banking supervision more than once. For the remaining countries, there is a predominance of jurisdictions that never changed their supervisory arrangements (16 out of 25) and 7 countries introduced reforms during this period. The period of the sample is wide enough to capture normal macroeconomic and financial times, characterised by the ‘Great Moderation’ period, and a worldwide financial and economic crisis period.

Finally, we allow for the inclusion of additional explanatory variables that were not considered in past analyses and that are likely to explain inflation behaviour. Indeed, variables that aim at capturing other aspects of the financial and monetary architecture, such as the monetary policy regime (in particular whether or not an inflation targeting regime is in place) and the presence of deposit insurance schemes, together with variables that account for the degree to which open economies are exposed to ‘imported’ inflationary shocks, are of crucial importance in studies on this topic.

Estimation results show that the institutional separation of banking supervision from central banks does not have a significant impact on inflation, suggesting that inflation rates are not systematically above in countries in which a combined mandate of monetary policy and banking regulation is in place. This result is robust to time spans not including the financial crisis period and to the dynamic version of the panel data model. More interestingly, our findings suggest that there are other characteristics of the monetary and financial supervisory architectures that are driving forces of low inflation rates, such as inflation targeting and deposit insurance systems. Developed economies implemented major reforms in their monetary and financial institutional setup in the last decades of the twentieth century. These reforms included changes in the central banks’ institutional mandates, turning these institutions more independent from the political system and transparent in what their goals are concerned, and the introduction of explicit deposit guarantee schemes, which have a crucial role in restoring depositors confidence in the banking system thereby promoting financial stability. Our findings show that these aspects of the institutional architecture of the monetary and financial systems are im-

\footnote{This is the case for Ireland which reviewed its banking supervisory institutional arrangement in 2003 and again in 2010, after the subprime crisis, and Luxembourg, which reviewed its supervisory mandate in 1983 and 1999.}
important to promote price stability in these economies. Deposit insurance schemes, in particular, are seen as incentives to the banking industry to undertake riskier activities, putting the stability of the banking system at stake. This study suggests that, on the contrary, deposit insurance schemes are important institutional cornerstones for the stability of prices, by steering confidence in the well functioning of the banking system. As such, they contribute in a non-negligible manner to the stability of the overall economy. The negative impact of these elements on inflation is a robust result for both normal and crisis times. Finally, economic factors, such as the output gap, trade and capital account openness, are also important determinants of inflation.

The paper proceeds as follows. Section 3.2 describes the transmission mechanisms of monetary policy and how banking regulation and supervision may affect these channels. Section 3.3 presents the data, describes the methodology used in the empirical analysis and the estimation results. Section 3.4 concludes.

3.2 Interactions of monetary policy and banking supervision - a review

Monetary policymakers have distinct policy goals from banking supervisors. While the former are focused on price stability, the latter look after the solvency of the individual banks and the resilience of the banking system as a whole (microprudential and macroprudential approaches of banking supervision, respectively). Although they are distinct policy objectives per se, they are likely to positively contribute to the ultimate goal of macroeconomic stability. In this sense, policy objectives of monetary authorities and banking supervisors are complementary at least in the long-run, since both promote the economic and financial conditions needed to achieve stability at the macroeconomic level.

Nonetheless, under specific economic circumstances, the outcomes on financial and price stability of banking supervision and monetary policy, respectively, can be conflicting, due to the fact that banking supervision may alter the monetary policy transmission mechanism. The monetary policy propagation channels more likely to interact with bank stability and ultimately with the stability of the financial system are mainly three: i) the borrowers’ balance-sheet channel, ii) the bank lending channel, and iii) the risk-taking channel.7

7In this section we address only the transmission channels of conventional monetary policy.
Through the borrowers’ balance-sheet and bank lending channels, monetary policy shocks have an impact not only on the level of interest rates, but also on the size of the external financial premium (i.e. the difference between the cost of funds raised externally and the opportunity cost of internal funds) (Bernanke and Gertler, 1995). The borrowers’ balance-sheet and the bank lending channels illustrate the link between monetary policy decisions and the external finance premium. The borrowers’ balance-sheet channel is based on the assumption that the external finance premium is directly related to the borrowers’ financial condition, which, in turn, is positively determined by their net worth (which may be thought as the sum of the liquid assets and the market value of collaterals). Given that the borrowers’ financial situation affects the external finance premium, thus determining the general credit conditions available to them, variations in the quality of borrowers’ balance-sheets should likewise impact on credit terms they face and, consequently, on their investment and spending decisions. Changes in interest rates affect the borrowers’ net worth, at least in two ways. A rise in policy interest rates increases the cost of liabilities, reducing cash flows and deteriorating borrowers’ financial position. In addition, it decreases the price of assets that can be used as collateral, deteriorating borrower’s financial position and limiting the amount of lending provided to borrowers. Indirectly, a rise in interest rates may also reduce demand for a certain product, also affecting firms’ net cash flows and collateral values. In both situations, a tightening in monetary policy interest rates increases the external finance premium, negatively affecting the borrowers’ ability to make loans (i.e. it reduces credit demand in general) (Bernanke and Gertler, 1995).

The bank lending channel of monetary policy operates through the banks’ balance-sheet. Specifically, monetary policy may affect the external finance premium by changing the financial intermediaries’ supply of funds. A rise in interest rates induces a reduction in the supply of funds, by raising the relative funding costs faced by banks, leading to a fall in credit supply. In the case of a decline in credit supply, the most bank-dependent borrowers, although they may not be completely excluded from credit, may have to face higher funding costs themselves. The higher costs are likely to increase their external finance premium and reduce real activity (Bernanke and Gertler, 1995).

The risk-taking channel, as first argued by Borio and Zhu (2012), claims that low interest rates boost assets and collateral prices and if the market believes that this is a sustainable rise, it prompts banks and borrowers to accept higher risks. Then, a softening of credit standards can follow, which may lead to an excessive increase in loan supply. By the means of the risk-taking monetary policy channel, low interest rates reduce risk
perceptions and/or improve risk tolerance, thereby encouraging risk taking behaviour. By promoting risk taking and search for yield behaviours, monetary policy may sow the seeds for financial instability.

Due to the sharing of transmission channels, interactions of banking supervision and monetary policy may have conflicting goals. For example, in an economic downturn, monetary policymakers’ response is to avert deflationary pressures by decreasing interest rates, whereas the banking supervisor, under the same economic circumstances, may favour raising capital requirements to guarantee the resilience of the banking system to economic shocks (Goodhart et al., 1993, 1995). The raise in capital requirements in a deflationary economic environment may lead to a reduction on credit supply, exacerbating the adverse economic conditions and counteracting the monetary stimulus promoted by the decrease in interest rates. This example illustrates a potential conflict between the objective of monetary authorities, which aim at keeping inflation around the target by decreasing interest rates, and banking supervisors, whose actions may constrain the transmission mechanism of monetary policy.

Another example comes from a situation in which strong inflationary pressures are detected and the central bank increases interest rates to counteract the upward developments in prices. Nevertheless, high increases in interest rates may negatively affect banks’ profitability and solvency, depending on their magnitude (high interest rates may pose more serious risks to banks’ profitability than lower rates), and on banks’ balance sheet structures. A high increase in short-term interest rates is likely to be an important determinant of systemic banking crisis, since it may deteriorate banks’ balance sheets. Consider an increase in short-term interest rates. Banks adjust by raising the deposits rate. Assuming that the assets side of the balance sheet is mainly composed by loans with longer maturities at fixed interest rates, the banks cannot pass through to borrowers the increase in interest rates, and, as a result, the interest margins compress, reducing banks’ profits. Even if the banks’ loans are provided at a variable rate, allowing them to pass on the rise in interest rates to borrowers, losses may result from a larger fraction of non-performing loans, since the debt service augments, making some borrowers unable to meet their obligations. Therefore, banking supervisors may prefer a gradual monetary policy tightening in the presence of inflationary pressures than a sudden large increase in interest rates.

Conflicts of this sort challenge the institutional arrangements of monetary policy and banking supervision. In the case central banks are in charge of banking supervision, they have to deal with these potentially conflicting goals: controlling inflation at the target
levels, while maintaining financial stability. These decisions may depend on the emphasis that is given to financial stability, but the conflict of interest argument states that central banks may opt for being more flexible in their inflation mandates, when financial stability is at stake. Goodhart and Schoenmaker (1993) and Goodhart and Schoenmaker (1995), among others, argue that central banks responsible for banking supervision have incentives to be particularly attentive to the effects of their interest rate decisions on the profitability and stability of the banking sector. Against this background, it is therefore argued that an inflation bias may arise in institutional mandates characterised by central banks with supervisory functions, in opposition to an institutional set-up in which banking regulation is assigned to a separate authority.

The potential inflation bias stems from a less strict monetary policy stance towards inflation than in the case in which the monetary policymaker is not concerned about financial stability. In this sense, the argument can be stated as follows: countries in which central banks have banking supervisory powers will experience larger inflation rates, on average, than countries in which banking supervision is assigned to an agency other than the central bank.

The evidence in the literature supports the existence of conflicting goals between monetary policy makers and bank regulators. Using data from the United States over the period 1990-1998, Ioannidou (2005) examines whether monetary policy responsibilities have implications in the conduct of the bank supervision when the Federal Reserve System (Fed) is responsible for both functions. The results suggest that monetary policy influences Fed’s supervisory actions as it turns out to be more flexible in its banks’ supervisory role when it tightens the monetary policy stance. Moreover, focusing on 25 industrialised countries over the period 1960-1996, DiNoia and DiGiorgio (1999) find evidence that average inflation rate is explained by countries’ institutional mandate when controlling for central bank independence from the government. The authors conclude that central banks are less effective in controlling inflation when they are responsible for the regulation of the banking sector.

In a similar study, Copelovitch and Singer (2008) consider 23 industrial countries from 1975 to 1999 and found empirical evidence that inflation rates have been significantly lower, on average, in countries where the central bank and the banking supervisor are

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8Note that the regulatory architecture of the banking system in the United States is such that the Fed, along with the Office of the Comptroller of the Currency (OCC) and the Federal Deposit Insurance Corporation (FDIC), all share the supervisory powers, but the Fed is the only regulator responsible for monetary policy.
The interlinkages between monetary policy and banking regulation are poorly addressed in the theoretical literature. The few examples of studies investigating upon these issues are from Cecchetti and Li (2008) and Cecchetti and Kohler (2014). Cecchetti and Li (2008) develop a model through which the conflict of interest that arise from diverse policy objectives of monetary policymakers and banking regulators is analysed. The model extends the Blum and Hellwig (1995) banking sector framework to include a central bank and derive an optimal monetary policy rule, in which the potential procyclicality of capital requirements is incorporated. The central bank and the banking regulator are separate authorities and, due to the fact that monetary policy is usually conducted on a daily basis, whereas banking regulation change slowly, interactions between the two are modelled by assuming that the central bank moves first and it is followed by the banking regulator. Results show that the central bank should respond to the banking system’s balance sheet in order to neutralize the procyclical effect of prudential capital regulation. Thus, in a situation of financial distress and economic downturn, the optimal monetary policy stance should decrease interest rates more aggressively when the banking system is capital constrained, counteracting the procyclicality of capital regulation and, simultaneously, stabilising the aggregate economic activity. The authors show that capital regulation requires adjustments by monetary authorities, but they are not an obstacle to

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9This paper uses as control variables: central bank independence (Cukierman’s methodology 1992, from Comparative Political Dataset), exchange rate regime (dummy, IMF classification), trade openness (measured as imports plus exports as a percentage of GDP, World Development Indicators database), capital account openness (Chin-Ito index), log of GDP, GDP per capita (World Development Indicators database), dummy variables (sum of individual year observations for each period of five years, divided by 5) for currency crisis and banking crisis (Glick and Hutchinson, 1999), dummy for explicit deposit insurance (World Bank’s Deposit Insurance Around the World database), size of the domestic credit provided by the banking sector as a % of GDP (proxy for the size of the domestic banking sector, World Development Indicators), time trend variable (ranges from 1 to 5).

The authors also test for additional explanatory variables, such as lagged dependent variable, union density, centralization and coordination of wage bargaining, veto players, the partisan composition of government, unemployment rates, GDP growth, and a dummy for an election year and conclude that these variables do not affect the basic results.

10Under a floating exchange rates regime, the central bank maintain the ability to conduct autonomous monetary policy, while, in contrast, with fixed exchange rate regimes, central banks do not have independent monetary policy. In the latter case, institutional features are of little importance.

11Cecchetti and Li (2008) show that, from 1989 to 2000, the Fed has optimally decreased the federal funds rate in response to a higher leverage ratio, that was embedded in its reaction function to capture greater banking system distress under capital regulation.
the effective conduct of monetary policy. Hence, the potential conflicts between policies’ objectives can be overcome in a type of game where the central bank response takes into account whether the banking system is capital constrained.

Cecchetti and Kohler (2014) extend the Cecchetti and Li (2008) methodology to investigate whether interest rates and capital requirements are interchangeable instruments in stabilising the economy. They find that the instruments are full substitutes for achieving a standard monetary policy goal of output and price stability, due to their similarities regarding the transmission mechanism. They also show that introducing a financial stability goal impacts on the substitutability between interest rates and capital requirements. Coordination is, in this case, suggested to achieve full substitutability, but the type of coordination also matters. In the case in which partial coordination is assumed (where the authority in charge of financial stability moves first), the worse outcomes may be attained, given that the policymakers do not take each other’s reactions into their optimisation problem.

3.3 Empirical Analysis

The empirical analysis has the purpose to investigate the interactions of monetary and financial supervisory institutional arrangements. In particular, we aim at assessing the validity of the conflicting goals argument, by analysing the impact of a combined mandate of monetary policy and banking supervision on inflation rates. We choose to study the impact of institutional mandates of monetary policy on inflation outcomes instead of output not only because the 'conflict of interest argument' explicitly refers to inflation rates, but more importantly central banks mandates on price stability are mainly focused on controlling inflation rates around a certain level (target) or on targeting price growth only. We also consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the country has a deposit insurance scheme to protect depositors from bank failures.

Our dataset covers 25 developed countries along the time period from 1975 to 2012. We consider distinct model specifications and use appropriate estimation methods for each type of model specification. Subsection 3.3.1 describes the data, subsection 3.3.2 presents the regression model specifications and estimation results are reported in subsection 3.3.3.
3.3.1 Data

We consider annual time series data for 25 OECD countries over the period 1975-2012. The dependent variable is the logarithm of the annual inflation rate while, in addition to the explanatory variables considered in related empirical literature, a number of other regressors is included in the analysis, since we expect they can be also related to inflation. The regressors are grouped in four categories: institutional, external, economic and banking structure. Descriptive statistics for each variable are presented in the Appendix, together with a summary of the expected impact of each explanatory variable on inflation rates, which can be found in Tables 3.5.4 and 3.5.1 respectively.

3.3.1.1 Institutional Factors

The characteristics of the monetary and financial supervisory architecture in each country are captured by several variables. The main institutional variable incorporated in this study controls for monetary policy and banking regulation institutional arrangements in each country. This variable is referred to as separate banking supervision and represents the mandate of each central bank in terms of banking supervision responsibilities and captures its impact on inflation rates behaviour. This is captured by a dummy that takes value of 1 if the function of banking regulation is assigned to an authority independent from the central bank, and value of 0 if banking supervision is a central bank’s responsibility (the latter case refers to a combined institutional arrangement). The classification of countries into these two groups (i.e. separate banking supervision or combined mandate) is based on information disclosed in the Bank Regulation and Supervision Surveys (updated June 2008 and 2012) provided by the World Bank, which collects information


13Note that the variable separate banking supervision does not account for whether a separate banking supervision also oversees securities markets and / or insurance companies. The classification only captures the allocation (or exclusion) of banking supervision to central banking responsibilities. The classification of countries in terms of separate and combined institutional mandates is presented in Table 3.1 in Appendix B. For the euro area Member States, we consider a combined banking supervision regime after their entrance in the European Monetary Union, in 1999 (except for Greece which joined the European Monetary Union in 2001), due to the fact that national central banks are part of the Euro system, which also comprises the European Central Bank, responsible for the conduct of monetary policy. It can also be argued, though, that the European Monetary Union should be treated as a separate mandate, given that monetary policy is centralised in the European Central Bank. We perform a sensitivity analysis to assess for the latter case, in which we assume a separate institutional mandate between monetary policy and banking supervision, whenever the national central bank is in charge of supervisory responsibilities. The estimation results do not change substantially and are shown in Appendix B, Tables 3.5.9 and 3.5.10.
regarding the main aspects of regulation and supervision from supervisory authorities located in 143 jurisdictions for the years 2008 and 2012.\textsuperscript{14}

Data is complemented with other information sources. We consulted Copelovitch and Singer (2008)'s classification and in the cases for which there was uncertainty about the type of mandate, the central banks and supervisory agencies websites were also employed for cross-check. The survey by Courris (2011) on international supervision arrangements was also useful to confirm our previous classifications. Still, there are some countries for which a clear-cut separation of banking supervision responsibilities is difficult to undertake.

Table 3.1 shows the evolution of inflation rates and the institutional arrangements in the 25 countries included in our sample along the period 1975-2012. Over the sample period, inflation rates decreased substantially: in 1975, the global sample inflation was 13.5% on average, continuously falling during the 1980’s and the 1990’s, and stabilising around 2% in the 2000’s (i.e. in 2012 the country average inflation was 2.2%). This decreasing trend was observed not only in countries with combined mandates of banking supervision, but also in countries in which separate regimes of banking supervision were in place, although the inflation rate average between 1975 and 2012 was lower in countries with separate mandates (4.7%) than in countries with combined regimes (6.4%).

<table>
<thead>
<tr>
<th>Year</th>
<th>Mandates</th>
<th>Inflation Rates (%; average)</th>
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<tbody>
<tr>
<td></td>
<td>Separate</td>
<td>Combined</td>
</tr>
<tr>
<td>1975</td>
<td>8</td>
<td>17</td>
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<tr>
<td>1980</td>
<td>8</td>
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<td>1985</td>
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<td>1990</td>
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<td>1995</td>
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<td>2000</td>
<td>12</td>
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<td>2005</td>
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<td>2012</td>
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<td>14</td>
</tr>
</tbody>
</table>

According to our classification, banking supervision responsibilities were assigned to

\textsuperscript{14}This classification is based on the answers given by the countries in this sample to questions 12.1 of the World Bank survey for 2008 utilized by the authors to compile the dataset. The questions are stated as follows: in the 2008 survey, “What body or agency supervises banks?” or, in the 2012 update, “What body/agency supervises commercial banks for prudential purposes?”.
the central bank in 17 OECD countries in 1975, whereas only 8 countries preferred to allocate this responsibility to an independent authority. This distribution remained stable until the late 1990’s, a period from which it is observed an increase in the number of countries that have opted to separate banking supervisory responsibilities from the central bank. In the early 2000’s, there was a balance in this sample between countries with separate institutional arrangements of banking supervision and monetary policy (12) and countries with combined mandates (13). In the 2000 decade, the number of countries with separate banking supervision mandates outpaced the number of countries with combined regimes, reaching a peak of 14 countries out of 25 from 2003 to 2009. After the onset of the financial crisis of 2007/2008, and as a response to it some countries reformed their institutional settings of banking supervision towards its allocation to the central bank. This tendency is already to some extent reflected in 2012 figures, which illustrate a decrease in the number of countries with separate banking supervision mandates, from 14 in 2009 to 11 in 2012.

This can be considered a rich dataset in the sense that it covers a sufficiently wide time span to allow for some of these countries to change their institutional mandates of banking supervision more than once. This is the case for Ireland which reviewed its banking supervisory institutional arrangement in 2003 and again in 2010, after the subprime crisis, and Luxembourg, which changed its supervisory mandate in 1983 and 1999. Iceland and the United Kingdom also have recently reformed their supervisory arrangements for the second time since 1975, but since their entering into effect was in 2013 and 2014 respectively, these changes are not covered by our database. For the remaining countries, there is a predominance of jurisdictions that never changed their supervisory arrangements (16 out of 25) from 1975 to 2012 and only 5 introduced reforms during this period.

There is a large literature following Cukierman et al. (1992) claiming that the degree of independence of the central bank (thereafter CBI) has a significant negative impact on inflation outcomes. Accordingly, it is expected that a country with a higher degree of central bank independence will also experience lower average inflation rates. The CBI variable used in this study is based on the work of Arnone et al. (2007) who update the Cukierman et al. (1992) and Grilli et al. (1991) measures for central bank political and economic autonomy. Political autonomy is interpreted as the power of central banks to define and implement monetary policy, whereas economic autonomy evaluates the central banks operational independence. Following the literature, we assume that CBI measures computed in the late 80’s do not vary until 2003, the year for which Arnone
et al. (2007) update the index.\footnote{As CBI measures are usually computed for specific periods of time, researchers circumvent the problem of using a CBI index in panels by considering that CBI measures do not change significantly across time. We built the dataset based on the same assumption.}

The insurance of bank deposits is another common pillar of the financial supervisory architecture. Deposit insurance systems are considered necessary for the stability of the financial system and the protection of depositors. In 1933, the United States was the first country to establish a national deposit insurance system, but it was only over the last quarter of the twentieth century that explicit deposit insurance has spread across countries, rising from 12 in 1974 to 71 in 1999 (Demirguc-Kunt and Kane, 2002). Currently, most OECD countries and an increasing number of developing countries feature some sort of explicit depositor protection.

A country with an explicit deposit insurance scheme that provides depositors with protection from losses in the event of a bank failure will experience lower average inflation rates. This is because the central bank can be aggressive on its inflation mandate as it is less concerned about the effect of interest rates on banking stability (Copelovitch and Singer, 2008). In our dataset, the deposit insurance variable takes value of 1 for countries with explicit deposit insurance and of 0 otherwise. The classification uses information from the World Bank Deposit Insurance Around the World Dataset, from 1975 to 2003, and from the International Association of Deposit Insurers (IADI), for the remaining years.

To account for the effects of inflation targeting on inflation behaviour, a dummy variable is introduced taking the value of 1 at the year that a country adopted inflation targeting and onwards, and the value of 0 in the remaining cases based on Roger (2010)’s classification. Since this approach pursues an explicit public commitment to control inflation as the principal policy goal, we expect that a country that has adopted inflation targeting will experience lower inflation rates.

In addition, we include a “Great Moderation Period” dummy variable to control for the persistent decline of inflation rates (and their volatilities) in the developed world since the early 1980’s. The breakpoingt is 1984, according to McConnell and Perez-Quiros (2000), the year from which we consider the beginning of the great moderation period. We build a dummy that takes value of 1 from 1984 until 2007, when the crisis

\footnote{In our sample, the countries that use inflation targeting are New Zealand (since 1990), Canada (since 1991), United Kingdom (since 1992), Sweden (since 1993), Australia (since 1993), Iceland (since 2001) and Norway (since 2001). Finland and Spain adopted inflation targeting, in 1993 and 1995 respectively, but abandoned it when they entered the in 1999.}
started. The remaining years covered in the dataset are assigned a value of 0. We also condition our inflation estimations on an exchange rate regime variable that takes value of 1 for all varieties of “hard” fixed exchange rates and 0 for floating or managed floating regimes. Data are based on the International Monetary Fund classification by Ilzetzki et al. (2008). Finally, in what institutional factors are concerned, euro membership is included to control for the euro area countries’ specific monetary policy mandate and it takes the value of 1 from 1999 onwards for the euro area member countries, except for Greece that entered the European Monetary Union two years later (2001).

3.3.1.2 External and Economic Factors

In order to capture the impact of external factors on inflation outcomes, we consider the following explanatory variables: trade openness, capital account openness and oil imports as percentage of GDP. Trade openness is measured as the sum of imports and exports as a percentage of GDP and data are taken from the Comparative Political Dataset (1960-2011). An inverse relation between trade openness and inflation is expected as more open economies benefit from lower inflation, on average. According to Romer (1993), the degree of openness of the economies affects inflation through two different channels. First, a more closed economy has a higher incentive to engage in surprise inflation since its impact on the real depreciation is less costly, given that the fraction of imported goods is lower in this economy.\footnote{In these models it is assumed that domestic and foreign goods are not perfect substitutes.} Second, openness affects the output-inflation trade-off: for a given increase in output, the rise in domestic prices will be higher as more open the economy is, given the exchange rates disciplining effect. Thus, monetary policymakers incentives to engage in expansionary policies are lower in more open economies, and therefore inflation is expected to be smaller. There is a broad empirical support for this view, in which a strong and robust negative impact of openness on inflation outcomes is shown to be present.

Capital account openness is measured using the Chinn-Ito index, developed in Chinn and Ito (2008) for the period ranging from 1970 to 2012.\footnote{The Chinn-Ito index is taken from the Comparative Political Dataset (1960-2009).} This index accounts for restrictions on capital account transactions, current account transactions, requirements of the surrender of exports proceeds and the presence of multiple exchange rates. Similarly to trade openness, empirical evidence shows a negative relationship between financial openness and inflation (Gruben and McLeod 2002, Gupta 2008). For oil import countries, we expect that oil prices will have a positive effect on inflation. The data for the
value of oil imports is from the World Economic Outlook Database, published by the International Monetary Fund. We consider the oil imports as percentage of national GDP, to account for the different dimensions across countries.

To account for the effect of economic conditions on inflation, we include as regressors the output gap, currency and banking crisis. Output gap measures the difference between the actual level of national output and the estimated potential level. A positive output gap implies upward pressures on inflation. Currency and banking crisis are dummy variables that take value of 1 whenever the country is experiencing a currency or a banking crisis.\textsuperscript{19} The impact of banking crisis on inflation depends to a certain extent on the monetary stance that can be maintained during a crisis and whether inflation is kept as the primary policy objective (Garcia-Herrero 1997). Currency crisis, on the other hand, may have inflationary consequences.

3.3.1.3 Banking Sector Factors

In order to capture the possible influence on inflation outcomes of the characteristics of the banking system in each country, we control for the size of the banking system, which is measured by domestic credit over GDP. In our sample of industrialised countries, there is significant variation in the size of the banking systems. While the weight of the banking system in the total economy has an average around 85%, the variation across countries ranges from 15% to 311% (see Table 3.5.4 in appendix).

As argued by Copelovitch and Singer (2008), central banks with regulatory powers may be more concerned with banking stability when facing a large banking system relative to the overall size of the economy, due to the reputation costs stemming from bank distress. In institutional frameworks in which central banks are also in charge of banking

\textsuperscript{19} Although credit spreads could be used as a control variable to capture moments of financial distress in the banking sector, the lack of data for each individual country and for such a large time span undermines its inclusion in the econometric model. Indeed, credit spreads are provided in an annual basis by the International Monetary Fund, in its Financial Soundness Indicators (FSI) dataset for 14 countries since 2005, but still with important limitations (for some of these countries there are only few data points). Given that the sample used in this econometric study has a time dimension that starts at 1975 and ends at 2012 and covers 25 countries, data unavailability for credit spreads limits its inclusion in the model. Nonetheless, cases of financial distress of the banking sector are already controlled for through a dummy variable accounting for banking sector crisis.

\textsuperscript{20} Banking crisis data is based on Glick and Hutchison (1999), except for Australia and USA, for which data comes from Caprio and Klingebiel (2003). For the remaining years (2000-2010), data comes from Laeven and Valencia (2008). Currency crisis data is based on Glick and Hutchison (1999), except for Australia and USA, for which the data comes from Laeven and Valencia (2008). For the time span 2000-2010, data comes from Laeven and Valencia (2008).
supervision, a large banking system may aggravate the inflation bias - therefore, we may expect the size of the banking system to have a positive impact on inflation outcomes, since when the banking system contributes to a larger share of the domestic economy, central banks may fear to a greater extent the monetary policy effects on bank stability.

3.3.2 Model Specifications

The following panel data regression model is adopted to estimate the relationship between inflation rates and institutional arrangements of banking regulation and supervision:

\[ \pi_{i,t} = \beta_0 + \beta_1 \text{separate\_sup}_{i,t} + \lambda X_{i,t} + \nu_i + u_{i,t}, \]  

(3.1)

where \( \pi_{i,t} \) is the (log) inflation rate for country \( i \) in year \( t \), \( \text{separate\_sup}_{i,t} \) is a binary variable that takes value of 1 if the country is classified as having a separate banking supervision at time \( t \) and value of 0 otherwise, \( X_{i,t} \) is a vector of control variables, as described in the previous subsection, \( \nu_i \) accounts for unobserved country specific effects and \( u_{i,t} \) is the error term.

We consider three alternative specifications of this model. Model 1 is a simplified form version of model in equation (3.1), in which the vector of controls is not included, keeping only the variable of interest, \( \text{separate\_sup}_{i,t} \). Model 2 is the regression model in equation (3.1), Models 1 and 2 are called hereafter static panel data models. Model 3 is an extension of Model 2, allowing for the study of inflation dynamics, by adding to the vector of regressors the one period lagged inflation:

\[ \pi_{i,t} = \beta_0 + \beta_1 \text{separate\_sup}_{i,t} + \beta_2 \pi_{i,t-1} + \lambda X_{i,t} + \nu_i + u_{i,t}, \]  

(3.2)

The inclusion of lagged inflation as an independent variable is motivated by a strand of the literature regarding a hybrid version of the Phillips curve, in which inflation depends on a combination of expected future inflation and lagged inflation.\(^{21}\) The lagged inflation term in the hybrid Phillips curve has the purpose of capturing inflation persistence. As pointed out by Gali and Gertler (1999), empirically, the hybrid Phillips curve provides a good characterization of inflation dynamics at the annual frequency.

\(^{21}\)See Gali and Gertler (1999) for an overview of the Phillips curve literature, from the traditional version to the hybrid approach.
We suggest the use of annual panel data, with a time-series dimension \((T = \text{the number of years})\) of 38 years, from 1975 to 2012, and a cross-section pool \((N = \text{the number of countries})\) of 25 advanced countries, which allows to capture the richness of the dynamics of many variables, while simultaneously integrating cross-country heterogeneity in the means of the dependent variable. Nonetheless, given that in panel data is highly likely that country-specific characteristics (such as cultural factors, geographic location, language, etc.) are correlated with the explanatory variables, we resort to panel data estimation with fixed effects using heteroskedasticity-robust standard errors. Fixed Effects is an estimation method that deals directly with this source of correlation, by applying a means-deviation transformation to each variable, in which the mean is computed at the country level. This transformation rules out the unobserved individual effect from the original model and, in consequence, it enables to obtain coefficients on the regressors that do not suffer from bias due to the omission of relevant individual attributes.

With respect to Model 3, the dynamic panel data version of model 3.1, the inclusion of the lagged dependent variable \(\pi_{i,t-1}\) in a model with unobserved individual-specific time-invariant effects turns the OLS estimator inconsistent, since the error term is positively correlated with the explanatory variable \(\pi_{i,t-1}\) (Arellano and Bond, 1991). This correlation does not disappear as the number of individuals in the sample gets larger.

---

22 Namely with the variable of interest in this analysis, which refers to the separate banking supervision, since, as already mentioned, the institutional arrangements of banking supervision are influenced by the Anglo-saxon and the German traditions.

23 Random effects, on the other hand, assume that the unobserved individual effects are uncorrelated with the observed exogenous variables.

24 In terms of estimation methods, previous studies, such as DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008), adopt pooled Ordinary Least Squares with corrected standard errors.

25 In this model we also assume that slopes are homogeneous across countries, as widely used, mainly when the pooled and the fixed effects estimators are adopted. This is justified by the panel dataset composition, which comprises 25 countries that are considered the world's most advanced economies. This classification reflects similar basic economic country conditions that are used to distinguish these economies from economies in transition or developing economies. As such, given that this is a model to explain inflation rates dynamics, we may assume that the underlying drivers of inflation may be similar across advanced economies, even because they are closely interconnected and are affected by the same shocks. In addition, the modus operandi of central banks to keep inflation close to the target has widespread across developed countries, in which the institutional arrangements that ensure independence and credibility to the monetary authority are widely implemented in these countries. Against this background, we may assume that the slopes across countries are homogeneous. Still, we recognize that this assumption may be too strong and therefore, we undertake the estimation of the model using estimators suitable to estimate models in which this assumption is relaxed. For this, we use the Pesaran and Smith (1995) mean group estimator, and we conclude that assuming heterogeneous slopes does not change the main results regarding the lack of a statistically significant effect of the variable separate banking supervisor on inflation rates. Results from estimation are available upon request.
Moreover, the Fixed Effects estimator is also generally inconsistent, namely in the case when \( N \) tends to infinity and \( T \) is fixed, because of the problem of incidental parameters (Nickell 1981). However, contrary to the OLS estimator, the Fixed Effects estimator becomes consistent when both \( T \) and \( N \) tend to infinity.

On the other hand, the Arellano-Bond estimator is a dynamic panel data estimator with the advantage that is designed to fit linear functional relationships with a dependent variable that depends on its own past values, additional independent variables, fixed individual effects and heteroskedasticity and autocorrelation within individuals but not across them (Roodman 2009). In addition, it is a more appropriate estimator for short, wide dynamic panels (i.e. small \( T \), large \( N \) type of panel datasets). Arellano-Bond estimator (also known as Arellano-Bond difference GMM estimator) thereby corrects those problems by first-differencing all regressors to eliminate \( \nu_i \) (i.e. unobserved country specific effects) and produce an equation estimable by instrumental variables:

\[
D.\pi_{i,t} = \beta_0 + \beta_1 D.\text{separate} \sup_i,t + \beta_2 D.\pi_{i,t-1} + \lambda D.X_{i,t} + D.\upsilon_{i,t},
\]

(3.3)

where \( D \) stands for the first-difference operator and the variables and parameters are defined as in equation (3.2).

Dynamic panel data estimators do not assume that good instruments are available outside the immediate dataset. Instead, they assume that the only available instruments are internal – based on lags of the instrumented variables. The Arellano-Bond estimator uses as instruments the levels of the dependent variable lagged two or more periods, the levels of endogenous variables, the lagged two or more periods and the first differences of the strictly exogenous regressors, which are used as their own instruments.

In the case we assume that the explanatory variables are not correlated with the individual effects, there are more moment conditions that can be used as instruments for the levels equation, such as the lagged differences of the covariates and of the dependent variable (see Arellano and Bover (1995)). The Arellano-Bond difference GMM estimation is thereby augmented by estimating simultaneously two equations, one in differences and another in levels, which are distinctly instrumented, originating the system GMM estimator. As shown by Blundell and Bond (1998), this system GMM estimator is more suitable than that of Arellano-Bond estimator when the dependent variable and / or the independent variables are persistent.

\[26\] Nonetheless, they allow for the inclusion of instruments from outside the dataset.
Both difference and system GMM estimators are more adequate for small $T$, large $N$ samples, while the Fixed Effects estimator is suitable for a dynamic panel data when we have a sample with large $T$ and small $N$ type of panel data, because the panel data bias tends to disappear as the $T$ component expands. Taking into account that our panel dataset features a $T=38$ and $N=25$, it can be considered one with large $T$ and small $N$ type of panel data, Fixed Effects estimator seems to be more adequate to estimate the dynamic version of the model.

Against this background, considering the features of a dynamic panel data model and recognizing the unsuitability of the OLS estimator for these type of models, we opt to estimate the dynamic panel data model specification (Model 3) using both Fixed Effects and Arellano-Bover estimators.

### 3.3.3 Estimation Results

#### 3.3.3.1 Static Panel Data Models

The regression results based on the estimation of Model 1 and Model 2 for the period 1975-2012 are presented in Table 3.2 which are, respectively, the reduced and the full versions in equation (3.1). The estimation procedure for both models follows the Fixed Effects estimator. $F$ test and Wald $\chi^2$ statistics for the global statistical significance are also reported.
Table 3.2: Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 1 Fixed Effects</th>
<th>Model 2 Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.606***</td>
<td>0.966***</td>
</tr>
<tr>
<td>(0.031)</td>
<td>(0.130)</td>
<td></td>
</tr>
<tr>
<td>Separate Banking Supervision (1 = Yes)</td>
<td>-0.229**</td>
<td>-0.036</td>
</tr>
<tr>
<td>(0.083)</td>
<td>(0.052)</td>
<td></td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-</td>
<td>-0.165**</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td></td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-</td>
<td>-0.130</td>
</tr>
<tr>
<td></td>
<td>(0.097)</td>
<td></td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-</td>
<td>-0.117**</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td></td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-</td>
<td>-0.052</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td></td>
</tr>
<tr>
<td>Euro Area Member (1 = Yes)</td>
<td>-</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td></td>
</tr>
<tr>
<td>Time (1 = 1975; ... 38 = 2012)</td>
<td>-</td>
<td>-0.019***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-</td>
<td>-0.133***</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td></td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>-</td>
<td>0.001**</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Output Gap</td>
<td>-</td>
<td>2.428***</td>
</tr>
<tr>
<td></td>
<td>(0.654)</td>
<td></td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.046)</td>
<td></td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>-</td>
<td>0.049</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>-</td>
<td>0.003**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-</td>
<td>-0.073***</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>-</td>
<td>2.245**</td>
</tr>
<tr>
<td></td>
<td>(0.931)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>961</td>
<td>639</td>
</tr>
<tr>
<td>No of Countries</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>F Test / Wald Chi2 Test</td>
<td>7.65***</td>
<td>171.15****</td>
</tr>
<tr>
<td>[global significance]</td>
<td>(1, 24)</td>
<td>(15, 23)</td>
</tr>
<tr>
<td>R squared (within)</td>
<td>0.02</td>
<td>0.56</td>
</tr>
</tbody>
</table>

* p ≤ .10; ** p ≤ .05; *** p ≤ .01
Robust standard errors are in brackets.
Focusing first on the institutional factors of inflation dynamics and starting with the estimation results obtained for the variable *separate banking supervision*, we observe that it is statistically significant in the reduced form of the model (Model 1) in accordance with DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008) findings. However, this result does not subsist when we control for more explanatory variables (Model 2), including the remaining institutional factors. Estimation results of Model 1 suggest thereby that, at a first glance, it seems to exist an inflation bias, as advocated by the conflicting goals thesis, but it tends to disappear when other factors are controlled for, as in Model 2.

These findings are robust to alternative specifications of the variable *separate banking supervision*, namely for i) countries for which doubts concerning the classification of the institutional mandates were raised (this was the case of Australia, Austria, Denmark and Finland), and ii) countries which joined the euro area. As an alternative option, for this latter group it was assumed that the institutional arrangement is separate from the moment it joined the euro area, regardless of the central bank having or not supervisory powers. This assumption is based on the argument that the conduct of monetary policy in the euro area was centralised within the European Central Bank, leaving the national central banks powerless in this regard. Estimation results obtained under this sensitivity analysis are reported in Appendix 3.5.4.

Regarding the other components of the monetary and financial supervisory architecture, our findings from the estimation of Model 2 show that inflation targeting countries benefit from lower inflation rates than countries that do not pursue this specific type of monetary policy mandate. The explanatory variable inflation targeting is statistically significant and it has an estimated impact on inflation rates of approximately $-15\%$. By the same token, according to our results, a country with an explicit deposit insurance scheme will have inflation rates that are on average $-11\%$ lower than a country without deposit protection, all else equal. The other institutional variables, such as central bank independence and exchange rate regimes, appear to have had a less significant effect on inflation outcomes.

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27 With the creation of the Single Supervisory Mechanism (SSM) in 2013, which conferred banking supervisory powers upon the European Central Bank, additional issues regarding the classification of the euro area countries in terms of their banking supervisory mandates will be raised. The SSM Regulation empowers the ECB to supervise the significant banks in each Member State, but the responsibility to supervise the less significant banks is still under in the national supervisory authorities domain.

28 Since the dependent variable in our model is the log of inflation, the coefficients of dummy variables should be read as $e^{\hat{\beta}} - 1$. 

---
In particular, it is worth discussing in more detail the results for central bank independence. There is a vast literature investigating the impact of central bank independence on inflation rates which highlights its role on determining inflation outcomes. Although early studies indicate a significant negative effect of CBI on inflation rates (Grilli et al., 1991; Cukierman et al., 1992), recent empirical work fails to find a strong impact (Mangano, 1998; Crowe and Meade, 2007). Our findings are in line with studies that do not find a strong relationship between central banks independence and inflation. Estimation results show that, although central bank independence enters the regressions with the expected negative sign, it is not statistically significant in explaining inflation outcomes.

The CBI variable used in our analysis is based on the work of Arnone et al. (2007), which update a de jure measure of independence (following Cukierman et al., 1992) and it assesses regulations only. As suggested by Cukierman et al. (1992), de facto measures of central bank independence are also important to assess how regulations work in practice. Our results seem to suggest that the degree of legal independence per se is not sufficient to guarantee a significant negative impact on inflation outcomes. The lack of significance of central bank independence may be due to measurement issues (given that it does not address how regulations are implemented), which perhaps could lead to a theoretical reconsideration of the association between central bank independence, the banking structure and inflation.

Explanatory variables such as output gap, size of the banking system as percentage of GDP and great moderation period are also statistically significant and the estimated coefficients enter the regression with the expected sign. Furthermore, our results suggest that a more open economy in terms of trade and capital flows has a statistically significant impact on inflation rates, all else equal. The results for the degree of capital account openness are consistent with previous empirical evidence by Gupta (2008) and consistent with Copelovitch and Singer (2008), since they also observe a negative significant effect of capital account openness on inflation rates. As for the degree of trade openness, results suggest a positive significant impact on inflation outcomes, which contradicts previous empirical findings (see, for instance, Romer (1993)), in which a negative significant impact is reported. The effect on inflation rates of the weight of oil imports in GDP is also statistically significant, implying that, in sum, external factors have an important role in determining inflation behaviour.

The positive (although modest in magnitude) statistically significant impact on inflation rates of the size of the banking system relative to the economy suggests that countries characterised by large banking sectors experience, on average, higher inflation rates than
countries in which the banking sector is small. According to these findings, banking system features may be relevant determinants of the regulatory central bank’s bias.

As such, it would be interesting to empirically explore further this result in future analysis, not only by considering the size of the banking sector, but also its degree of concentration and how these features may impact on the transmission channels of monetary policy and influence inflation outcomes. There are two distinct views in the literature concerning the impact of banking concentration on the monetary policy transmission mechanism. The more common perspective states that higher concentration implies less competition, hence higher profitability due to greater interest margins between deposits and loans, and therefore a less efficient transmission mechanism of monetary policy to the real economy. In this case, we would expect higher bank concentration measures to lead to higher levels of inflation. Alternatively, the efficient-structure theory (Demsetz 1973) argues that cost-efficient banks could drive cost-inefficient banks out of the market and increase their market share, which would lead to higher concentration and greater profitability. In this case, profitability is generated due to cost efficiency and the transmission of monetary policy is not affected as interest margins remain unchanged. Therefore, according to this approach, a higher degree of concentration in the banking industry would lead to lower inflation rates.

Finally, results suggest that the remaining explanatory variables, such as the ones that control for the occurrence of currency and banking crisis, appeared to have had a less significant impact on inflation in industrialised countries. This finding may be related to the fact that the occurrence of banking and currency crisis is not very frequent along the period from 1975 to 2012 in our sample. Industrialised countries, such as the ones included in our database, have more mature banking systems and economies, and, as such, they are not so prone to be affected by banking and currency crisis as emergent or less developed economies.

In summary, estimation results of the static panel data models suggest that the design of monetary and financial supervisory architectures has a non-negligible influence on inflation rates in industrialised countries. Inflation rates are affected by institutional features, such as inflation targeting and deposit insurance, but not by the institutional mandates of monetary policy and banking supervision. Other factors, such as the degree of openness of the economy or economic developments are also important determinants of inflation behaviour.
3.3.3.2 Dynamic Panel Data Model

Tables 3.3 and 3.4 report the estimation results for the dynamic panel data model in equation 3.2 obtained from using both Fixed Effects and Arellano-Bover estimators. The main conclusion is that the estimation results obtained for the static version of the model (Model 2) are fully supported by the estimation results for the dynamic panel data version (Model 3), particularly in what regards the lack of evidence of a significant impact of the institutional arrangements of banking supervision and monetary policy on inflation outcomes.\footnote{Estimation results confirm, though, that one year lagged inflation is statistically significant in explaining current inflation behaviour and it has, as expected, a positive impact on inflation, providing empirical support to the hybrid version of the Phillips curve, to a certain extent.}

Institutional factors such as deposit insurance schemes, belonging to the euro area, the exchange rates regime or even inflation targeting practices do not reveal empirical evidence of their influence on inflation rates. Exception is made to the independence of central banks, which has a significant impact on inflation when a dynamic panel data model is considered.

External factors such as oil imports as percentage of GDP and the degree of capital openness have a statistically significant impact on inflation. This result is robust in the sense that it holds across different model specifications. The same is observed for the output gap: its impact on inflation is positive, as expected according to the Phillips Curve theory, and very strong. The negative influence of the great moderation period on inflation outcomes is also statistically significant according to the dynamic panel data estimation results.

\footnote{This finding holds even in the case we consider raw inflation as the dependent variable (instead of the logarithm of inflation). We have performed the estimation of Models 1-3 assuming an alternative measure of inflation rates, and we employed the same estimation procedure. Results obtained in this robustness test stress the lack of statistical significant of the variable separate banking supervision also in this model specification. Estimation results are available upon request.}
Table 3.3: Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 3</th>
<th>Arellano-Bover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.554***</td>
<td>0.783***</td>
</tr>
<tr>
<td></td>
<td>[0.089]</td>
<td>(0.334)</td>
</tr>
<tr>
<td>Lagged Inflation [t-1]</td>
<td>0.336***</td>
<td>0.384***</td>
</tr>
<tr>
<td></td>
<td>[0.018]</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Separate Banking Supervision (Yes = 1)</td>
<td>-0.012</td>
<td>-0.039</td>
</tr>
<tr>
<td></td>
<td>[0.050]</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-0.102**</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>[0.040]</td>
<td>(0.046)</td>
</tr>
<tr>
<td>CBI [index]</td>
<td>-0.132*</td>
<td>-0.117**</td>
</tr>
<tr>
<td></td>
<td>[0.062]</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-0.085*</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>[0.041]</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-0.029</td>
<td>-0.025</td>
</tr>
<tr>
<td></td>
<td>[0.024]</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-0.033</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>[0.028]</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Time (1 = 1975; ... ; 38 = 2012)</td>
<td>-0.012***</td>
<td>-0.008***</td>
</tr>
<tr>
<td></td>
<td>[0.002]</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-0.101***</td>
<td>-0.001***</td>
</tr>
<tr>
<td></td>
<td>[0.030]</td>
<td>(0.036)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001*</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>[0.000]</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.653***</td>
<td>1.986***</td>
</tr>
<tr>
<td></td>
<td>[0.501]</td>
<td>(0.638)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-0.010</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>0.040</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>[0.061]</td>
<td>(0.049)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.004***</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>[0.001]</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.030***</td>
<td>-0.087***</td>
</tr>
<tr>
<td></td>
<td>[0.002]</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>1.613*</td>
<td>1.556**</td>
</tr>
<tr>
<td></td>
<td>[0.808]</td>
<td>(0.707)</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01

Notes: Observations: 623; No. countries: 24 and 22, respectively. For Fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer's correction). Since the variable output gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.
3.3.3.3 Robustness checks

The empirical findings are tested for robustness by using alternative specifications of some important variables used in the analysis. With regard to the variable separate, the classification of the institutional mandates is ambiguous for Australia, Austria, Denmark and Finland, as well as for countries that joined the Euro-area. In Australia, the institutional setup was classified as separate from 1998 onwards, based on the fact that the Australian Prudential Regulation Authority, responsible for the regulation and supervision of the banking system, was established in that year as a single agency. Nonetheless, the Reserve Bank of Australia (RBA) always had responsibility for the overall financial system and it is currently tasked to deal with threats to financial stability which have the potential to spill over to economic activity and consumer and investor confidence. In Austria, the Austrian Central Bank shares responsibilities in the banking supervisory domain with the Financial Market Authority (FMA), which justifies the classification into a combined institutional arrangement. Nevertheless, we test for the possibility of a separate setup since the inception of the FMA, in 2002.

As for Denmark, classification of institutional frameworks for banking regulation and supervision are more difficult. The Danish Financial Supervisory Authority (FSA), an independent agency, was established in 1988 and was formed as part of the restructuring of the Danish Ministry of Industry, suggesting that the Danish central bank has never enrolled in supervisory tasks before that period. However, in the 2011 World Bank dataset, is referred that the central bank and the Danish FSA were jointly responsible for the supervision of the banking system. In addition, there is a memorandum of understanding dating from April 2005 between the central bank and the financial supervisor, which introduces more clarity into the division of financial stability functions between the two, indicating the engagement of the central bank, although they were not reported in previous surveys. Taking this information into account, a combined setup classifica-
tion was tested from 1975 to 2012. The case of Finland appears simple to deal with, given that the Finnish Financial Supervisory Authority (FIN-FSA) was established in 1922, being named as the Bank Inspectorate before 1993. In the World Bank surveys it is always answered that the Financial Supervision Authority has the supervisory task while no role is assigned to the central bank. As other authors, we have thereby classified as separate. Nonetheless, looking deeper into its history, Bank of Finland was always responsible for the stability of the financial system, suggesting an alternative classification as a combined setup.

Countries that joined the common currency can be considered instead to have a separate institutional arrangement as the conduct of monetary policy in the Euro-area is centralised within the European Central Bank, leaving the national central banks powerless in this regard. The robustness of our estimation results is tested against alternative configurations of the institutional mandates and is reported in the Appendix in Tables [3.5.7] and [3.5.9] for Australia, Austria, Denmark and Finland. Tables [3.5.10] and [3.5.12] provide the estimation results for the Euro-area countries. As already mentioned, findings are robust to alternative specifications of the variable separate banking supervision. Findings are robust to either alternative classifications of the variable separate banking supervision. For countries for which doubts concerning the classification of the institutional mandates were raised (this was the case of Australia, Austria, Denmark and Finland), estimation results do not change significantly and majority of conclusions hold. Changes in the classification of institutional set ups in countries which joined the euro area were performed more extensively, assuming that a previously considered separate regime, could in fact be understood as a combined mandate. Still, estimation results were very similar to those obtained before, suggesting that in the the euro area supervisory tasks were under the national domain until 2012.

Moreover, in order to test whether the 2008 crisis has an effect on the empirical findings obtained, given that it motivated the reformulation of the institutional set ups of banking regulation and supervision in several countries, the three models are estimated for the period from 1975 to 2007. This time period allows to capture in full the so-called ‘Great Moderation’ period, which corresponded to an economic environment characterised by lower levels and volatility of inflation rates, coupled with stable growth and low unemployment. Appendix 3.5.4 - Robustness Checks, Tables [3.5.12] and [3.5.13] presents the estimation results.

Estimation results are consistent to those obtained for the larger sample period, covering both normal times until 2007 as well as the onset of the financial crisis in 2008 until
2012, both for static and dynamic specifications of the annual panel data model, mainly in what concerns the lack of a significant statistical effect of the variable *separate banking supervision* on inflation rates. We again observe that, in the reduced form of the model in equation (3.1), this variable is statistically significant and has a negative effect on inflation rates. However, when controlling for other factors, the estimated coefficient of *separate banking supervision* no longer significant in all of the econometric model specifications.

In addition, main findings hold in normal times. In particular, results show that both institutional factors *inflation targeting* and *explicit deposit insurance schemes* have negative and statistically significant impact on average inflation rates and the magnitude of this impact is close to the that obtained for each model specification. The variables such as output gap, the degree of capital openness, the share of oil imports in GDP and great moderation period remain as statistically significant, indicating similar estimated values of the coefficients. All in all, results from robustness checks confirm that the separation of banking supervisory powers from the central bank is not a significant institutional determinant of low inflation rates in industrialised countries.

### 3.4 Conclusions

The paper aims at investigating the implications of different designs of the monetary and financial supervisory architecture on the inflation rate outcomes. In particular, the paper empirically examines if monetary policy and banking regulation have conflicting goals by assessing whether institutional mandates in which the central bank with a banking supervisory mandate has, on average, led to higher inflation rates than a separate regime. In addition, we consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the establishment of deposit insurance systems with the view to enhancing financial stability by protecting deposits may influence the monetary policy stance.

This conflicting goals argument in favour of the separation of policy mandates states that a central bank responsible for banking regulation will be more flexible in its inflation mandate if it is concerned with the impact of tight monetary conditions on bank’s profitability and soundness ([Goodhart and Schoenmaker](1993) [1995]). Under these circumstances, it is likely that the flexibility in guiding monetary policy will lead to higher
inflation rates. We build a panel data set comprising 25 OECD countries from 1975 to 2012 and we specify a regression model to explain the effect of a separate mandate of banking supervision on the inflation rate. We consider additional regressors to control for other possible determinants of inflation rates.

Our analysis differs from other studies in three ways. First, we have expanded the time span of the sample (while maintaining the same group of countries under scrutiny); second, we adopt more appropriate estimation methods to deal with country specific effects and their correlation with the explanatory variables; and third, we consider additional explanatory variables to control for the effect on inflation rates, such as of inflation targeting practices, oil imports over GDP, and output gap, among others. We have also performed a battery of robustness tests, which supported the main conclusion of this study.

Estimation results for both static and dynamic panel data specifications show that the separation of banking supervision from the central bank does not have a statistically significant impact on inflation. In this sense, the conflicting goals argument against a monetary and financial supervisory architecture in which the central bank has a supervisory role is not supported by our empirical findings. Indeed, these results contradict previous empirical evidence (see, as examples, DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008)). A possible explanation may lay in the argument that, even in institutional mandates in which central banks do not have supervisory powers, they may still be concerned with the stability of the banking system, since distress in the banking sector may disrupt the bank transmission channels of monetary policy, impairing its effectiveness. Being this the case, central banks with a price stability mandate may guide their monetary policy decisions also by attending to their impact on the banking system.

Although the allocation of banking regulation and supervision inside or outside the central bank does not seem to be relevant in determining inflation rates, our findings indicate that there are other features of the monetary and financial supervisory architecture that may play a role in maintaining inflation rates in low levels, thereby contributing for the stability of the economy. On one hand, results underline the importance of the establishment of deposit insurance schemes in determining lower levels of inflation rates. In fact, the central bank can be more aggressive in their inflation mandate when deposits are protected, in a large extent, by these insurance systems. Therefore, our results suggest that deposit insurance schemes can be seen not only as an important institutional pillar in fostering financial stability, but also in contributing to attaining the goal of price stability.
Another institutional feature related to low levels of inflation is the adoption of inflation targeting mandates. Curiously, central bank independence does not arise as an indicator of low inflation rates, even though there is an extensive literature suggesting its important effect on this macroeconomic variable. This result might be explained by the use of imperfect measures of the degree of independence of central banks (Posso and Tawadros, 2013). Finally, economic factors, such as trade openness and capital account openness have also strong effects on inflation behaviour, but the output gap stands out in terms of the magnitude of its impact on inflation.

Policy implications are that, given our empirical findings, the ‘conflict of interests’ argument should not be considered a major obstacle when designing the institutional architecture of banking supervision and monetary policy in developed countries. Other concerns, such as ‘reputation risks’ and ‘organisational costs’, may pose higher challenges for central banking than the ‘conflict of interests effect’. Recent reforms to assign an explicit financial stability mandate to monetary authorities may imply new sources of conflicts with monetary policy - see Smets (2014) for a review of potential conflicts and a discussion on the optimal institutional arrangements of macroprudential and monetary policies.

In this new institutional and supervisory environment in which central banks have price and financial stability mandates, the most important challenge for central banks is to avoid that severe disruptions in the banking system or regulatory capture by the banking industry damage its reputation as a monetary policymaker. In order to accomplish such an outcome, Smets (2014) suggests that price stability remains as the ultimate goal for central banks, while the objective of financial stability should lay under the primacy of stability of prices.

Future research should be focused on understanding the economic circumstances in which these conflicts are more likely to arise, taking into account the interactions of monetary, macroprudential and microprudential policies. In addition, deeper knowledge is needed on the influence of each institutional component of the financial and monetary architecture in promoting the stability of macroeconomic aggregates.
### 3.5 Appendix

#### 3.5.1 Variables: definitions, expected impact on inflation and sources

Table 3.5.1: Variables’ description and expected impact on inflation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Exp. Impact on Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institutional Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separate CB</td>
<td>Yes = 1</td>
<td>–</td>
</tr>
<tr>
<td>CBI</td>
<td>Central Bank Independence Index</td>
<td>–</td>
</tr>
<tr>
<td>Inflation Targeting</td>
<td>Yes = 1</td>
<td>–</td>
</tr>
<tr>
<td>Great Moderation</td>
<td>1975-83 &amp; 2008-12 = 0; 1984-2007 = 1</td>
<td>–</td>
</tr>
<tr>
<td>Deposit Insurance</td>
<td>Yes = 1</td>
<td>–</td>
</tr>
<tr>
<td>Exchange Rate Regime</td>
<td>Fixed = 1</td>
<td>+</td>
</tr>
<tr>
<td>Euro Membership</td>
<td>Yes = 1</td>
<td>?</td>
</tr>
<tr>
<td><strong>External Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>Index</td>
<td>–</td>
</tr>
<tr>
<td>Capital Accounts Openness</td>
<td>Chinn-Ito Index</td>
<td>–</td>
</tr>
<tr>
<td>Oil Imports (% GDP)</td>
<td>Controls for oil importing countries</td>
<td>+</td>
</tr>
<tr>
<td><strong>Economic Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Gap</td>
<td>Controls for economic growth</td>
<td>+</td>
</tr>
<tr>
<td>Banking Crisis</td>
<td>Yes = 1</td>
<td>+</td>
</tr>
<tr>
<td>Currency Crisis</td>
<td>Yes = 1</td>
<td>+</td>
</tr>
<tr>
<td><strong>Banking Structure Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Credit (% GDP)</td>
<td>Controls for the banking sector size</td>
<td>–</td>
</tr>
</tbody>
</table>
Table 3.5.2: Variables - Sources and Definitions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sources and Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation Rate (log)</td>
<td>World Economic and Financial Surveys, World Economic Outlook database April 2003 (site IMF). Inflation (consumer prices; index and annual percent change). Data for inflation are averages for the year, not end-of-period data. The index is based on 1995=100.</td>
</tr>
<tr>
<td>Separate Banking Supervisor</td>
<td>DiNoia and DiGiorgio (1999); Copelovitch and Singer (2008); World Bank - Banking Regulation Survey 2000 and 2008; Central Banks and Banking Supervisors webpages for the years missing. Dummy = 1 if a country has separated mandates for monetary policy and banking regulation/supervision.</td>
</tr>
<tr>
<td>Output Gap</td>
<td>Output gap is calculated by applying the HP filter to GDP at constant prices. GDP is obtained from World Bank (2011): World Development Indicators (Edition: September 2011). ESDS International, University of Manchester. GDP (constant LCU): GDP at purchaser’s prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant local currency.</td>
</tr>
<tr>
<td>Banking Crisis</td>
<td>Glick and Hutchison (1999); for Australia and USA, data comes from Caprio and Klingebiel (2003); for the years 2000-2010, data comes from Laeven and Valencia (2010). Dummy = 1 when the country has a banking crisis.</td>
</tr>
<tr>
<td>Currency Crisis</td>
<td>Glick and Hutchison (1999); for Australia and USA, the data comes from Laeven and Valencia (2008). Dummy = 1 when the country has a currency crisis, 0 otherwise. For the years 2000-2010, data comes from Laeven and Valencia (2010).</td>
</tr>
<tr>
<td>Openness of the economy</td>
<td>Armingeon et al. (2011). Openness of the economy in current prices, measured as total trade (sum of import and export) as a percentage of GDP, 1960-2009.</td>
</tr>
</tbody>
</table>
Table 3.5.3: Variables - sources and definitions (cont.)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sources and Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit Insurance Scheme</td>
<td>World Bank Deposit Insurance Around The World dataset. Deposit Insurance Fund Dummy = 1 if a country has deposit insurance, 0 if not.</td>
</tr>
<tr>
<td>Exchange Rate Regime</td>
<td>Ilzetzki et al. (2008). It takes the value of 0 for floating or managed floating regime and 1 for all varieties of hard fixed exchange rates.</td>
</tr>
<tr>
<td>Euro Membership</td>
<td>Dummy that takes a value of 1 if a country belongs to the euro area and 0 otherwise.</td>
</tr>
<tr>
<td>Domestic Credit over GDP</td>
<td>Domestic credit provided by banking sector (% of GDP). Source: World Bank World Development Indicators (Financial Sector).</td>
</tr>
<tr>
<td>Time</td>
<td>From year 1975 to 2012 takes value 1 to 38.</td>
</tr>
<tr>
<td>Inflation targeting</td>
<td>Roger (2010); for Finland and Spain, data comes from Little and Romano (2009). Dummy = 1 if the country has Inflation Targeting, 0 otherwise. We assume that the Member States of Euro zone have inflation targeting.</td>
</tr>
</tbody>
</table>
3.5.2 Descriptive Statistics

Table 3.5.4: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th># Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation (%)</td>
<td>950</td>
<td>5.34</td>
<td>6.78</td>
<td>-1.89</td>
<td>84.28</td>
</tr>
<tr>
<td>Separate Bank. Supervision</td>
<td>950</td>
<td>0.38</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Output Gap</td>
<td>950</td>
<td>0</td>
<td>0.02</td>
<td>-0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Degree of Commercial Openness</td>
<td>900</td>
<td>82.25</td>
<td>71.23</td>
<td>9.18</td>
<td>440.43</td>
</tr>
<tr>
<td>Degree of Capital Openness</td>
<td>876</td>
<td>1.44</td>
<td>1.32</td>
<td>-1.88</td>
<td>2.42</td>
</tr>
<tr>
<td>Deposit Insurance Scheme</td>
<td>950</td>
<td>0.67</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Inflation Targeting</td>
<td>950</td>
<td>0.15</td>
<td>0.35</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bank Crisis</td>
<td>925</td>
<td>0.11</td>
<td>0.32</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Currency Crisis</td>
<td>925</td>
<td>0.01</td>
<td>0.11</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Domestic credit / GDP (%)</td>
<td>912</td>
<td>84.36</td>
<td>44.28</td>
<td>14.84</td>
<td>311.06</td>
</tr>
<tr>
<td>Exchange Rate Regime</td>
<td>887</td>
<td>0.55</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Euro area member</td>
<td>950</td>
<td>0.17</td>
<td>0.38</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Great Moderation Period</td>
<td>950</td>
<td>0.63</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Oil imports / GDP (%)</td>
<td>803</td>
<td>0.04</td>
<td>0.06</td>
<td>0</td>
<td>0.66</td>
</tr>
<tr>
<td>Central Bank Independence Index</td>
<td>950</td>
<td>0.52</td>
<td>0.23</td>
<td>0.19</td>
<td>0.94</td>
</tr>
<tr>
<td>Time</td>
<td>950</td>
<td>19.50</td>
<td>10.97</td>
<td>1</td>
<td>38</td>
</tr>
</tbody>
</table>
### 3.5.3 Countries classification into separate and combined mandates of monetary policy and banking supervision

Table 3.5.5: Countries classification - separate and combined mandates

<table>
<thead>
<tr>
<th>Countries</th>
<th>Combined Mandate</th>
<th>Separate Mandate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Separate Bank. Sup. = 0)</td>
<td>(Separate Bank. Sup. = 1)</td>
</tr>
<tr>
<td>Austria</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Belgium</td>
<td>2011-2012</td>
<td>1975-2011</td>
</tr>
<tr>
<td>Canada</td>
<td>-</td>
<td>1975-2012</td>
</tr>
<tr>
<td>Denmark</td>
<td>2011-2012</td>
<td>1975-2011</td>
</tr>
<tr>
<td>Finland</td>
<td>-</td>
<td>1975-2012</td>
</tr>
<tr>
<td>France</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Greece</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Norway</td>
<td>-</td>
<td>1975-2012</td>
</tr>
<tr>
<td>Portugal</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Singapore</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Spain</td>
<td>1975-2012</td>
<td>-</td>
</tr>
<tr>
<td>Sweden</td>
<td>-</td>
<td>1975-2012</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-</td>
<td>1975-2012</td>
</tr>
<tr>
<td>United States</td>
<td>1975-2012</td>
<td>-</td>
</tr>
</tbody>
</table>
3.5.4 Robustness Checks

Tables 3.5.6 and 3.5.7 show the estimation results for Models 1-3, to test for the robustness of results to alternative classifications of the institutional mandates in countries for which doubts were raised. This is the case for Australia, Austria, Denmark and Finland, where there is indication that central banks, in specific periods of time, have also played a role in banking supervision.
Table 3.5.6: Fixed Effects Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.590*** (0.024)</td>
<td>0.954*** (0.131)</td>
</tr>
<tr>
<td>Separate Bank. Superv. Alternative (1 = Yes)</td>
<td>-0.240** (0.081)</td>
<td>-0.046 (0.049)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-</td>
<td>-0.167*** (0.064)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-</td>
<td>-0.122 (0.100)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-</td>
<td>-0.121** (0.056)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-</td>
<td>-0.050 (0.048)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-</td>
<td>-0.008 (0.047)</td>
</tr>
<tr>
<td>Time (1975: 1, ...., 2012: 38)</td>
<td>-</td>
<td>-0.020*** (0.004)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-</td>
<td>-0.132*** (0.041)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>-</td>
<td>0.001** (0.000)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>-</td>
<td>2.421*** (0.653)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-</td>
<td>-0.007 (0.046)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>-</td>
<td>0.050 (0.064)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>-</td>
<td>0.004** (0.002)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-</td>
<td>-0.072*** (0.022)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>-</td>
<td>2.225** (0.934)</td>
</tr>
<tr>
<td>Observations</td>
<td>961</td>
<td>639</td>
</tr>
<tr>
<td>No of Countries</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>F Test / Wald Chi2 Test (global significance)</td>
<td>8.66*** (1, 24)</td>
<td>165.74*** (15, 23)</td>
</tr>
<tr>
<td>R squared (within)</td>
<td>0.02</td>
<td>0.58</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Robust standard errors are in brackets.
Table 3.5.7: Dynamic Panel Data Model - Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.547***</td>
<td>0.778***</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.135)</td>
</tr>
<tr>
<td>Lagged Inflation (t-1)</td>
<td>0.356***</td>
<td>0.383***</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(0.094)</td>
</tr>
<tr>
<td>Separate Bank. Superv. Alternative</td>
<td>-0.039</td>
<td>-0.020</td>
</tr>
<tr>
<td>[1 = Yes]</td>
<td>(0.040)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Inflation Targeting [1 = Yes]</td>
<td>-0.101**</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>CBI [index]</td>
<td>-0.126*</td>
<td>-0.114**</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Deposit Insurance [1 = Yes]</td>
<td>-0.088**</td>
<td>-0.023</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>Exchange Rate Reg. [1 = fixed]</td>
<td>-0.027</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Euro Area Member [1 = Yes]</td>
<td>-0.034</td>
<td>0.066*</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>Time [1975: 1, ..., 2012: 38]</td>
<td>-0.018****</td>
<td>-0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Great Moderation Period [1 = 1984-2007]</td>
<td>-0.101***</td>
<td>-0.088**</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001*</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.659***</td>
<td>1.033***</td>
</tr>
<tr>
<td></td>
<td>(0.503)</td>
<td>(0.630)</td>
</tr>
<tr>
<td>Banking Crisis [1 = Yes]</td>
<td>-0.007</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Currency Crisis [1 = Yes]</td>
<td>0.040</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.004***</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.039***</td>
<td>-0.089***</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>1.626*</td>
<td>1.610**</td>
</tr>
<tr>
<td></td>
<td>(0.800)</td>
<td>(0.752)</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Table 3.5.8: Dynamic Panel Data Model - Estimation Results (1975-2012) (cont. Table 3.5.7)

<table>
<thead>
<tr>
<th>Statistical Tests</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Test / Wald Chi2 Test</td>
<td>656.17***</td>
<td>3467.75***</td>
</tr>
<tr>
<td>(global significance)</td>
<td>(16, 23)</td>
<td>(16)</td>
</tr>
<tr>
<td>Sargan Test (p-value)</td>
<td>-</td>
<td>0.319</td>
</tr>
<tr>
<td>AR(2) (p-value)</td>
<td>-</td>
<td>0.874</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01

Notes: Observations - 623. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on two step system-GMM, using robust standard errors corrected for finite samples (using Windmeijer’s correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

Tables 3.5.9 and 3.5.10 show the estimation results for Model’s specifications 1-3, to test for the robustness of results to alternative classifications of the institutional mandates in countries that joined the euro area. It is assumed that countries that joined the euro area have separate institutional mandates of banking supervision, even in the cases in which the central bank is the supervisory authority.
Table 3.5.9: Fixed Effects Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.717*** (0.025)</td>
<td>0.969*** (0.126)</td>
</tr>
<tr>
<td>Separate Bank Supervisor - euro area (1 = Yes)</td>
<td>-0.380*** (0.049)</td>
<td>-0.038 (0.049)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = yes)</td>
<td>-</td>
<td>-0.163** (0.065)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-</td>
<td>-0.138 (0.095)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-</td>
<td>-0.114* (0.056)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-</td>
<td>-0.052 (0.048)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-</td>
<td>-0.023 (0.061)</td>
</tr>
<tr>
<td>Time (1975: 1, ...., 2012: 38)</td>
<td>-</td>
<td>-0.020*** (0.004)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-</td>
<td>-0.134*** (0.040)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>-</td>
<td>0.001** (0.000)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>-</td>
<td>2.432*** (0.644)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-</td>
<td>-0.009 (0.046)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>-</td>
<td>0.030 (0.064)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>-</td>
<td>0.003** (0.002)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-</td>
<td>-0.072*** (0.022)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>-</td>
<td>2.264** (0.929)</td>
</tr>
<tr>
<td>Observations</td>
<td>961</td>
<td>639</td>
</tr>
<tr>
<td>No of Countries</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>F Test / Wald Chi2 Test (global significance)</td>
<td>60.20*** (1, 24)</td>
<td>197.26*** (15, 23)</td>
</tr>
<tr>
<td>R squared (within)</td>
<td>0.12</td>
<td>0.56</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01

Robust standard errors are in brackets.
Table 3.5.10: Dynamic Panel Data Model - Estimation Results (1975-2012)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.556***</td>
<td>0.787***</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.133)</td>
</tr>
<tr>
<td>Lagged Inflation (t-1)</td>
<td>0.356***</td>
<td>0.382***</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.095)</td>
</tr>
<tr>
<td>Separate Bank. Superv. - Alternative (Yes=1)</td>
<td>-0.017 (0.015)</td>
<td>-0.038 (0.030)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-0.301**</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-0.136*</td>
<td>-0.120**</td>
</tr>
<tr>
<td></td>
<td>(0.067)</td>
<td>(0.055)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-0.083*</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-0.029</td>
<td>-0.025</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-0.019</td>
<td>0.088**</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Time (1975: 1, ..., 2012: 38)</td>
<td>-0.012***</td>
<td>-0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-0.101***</td>
<td>-0.089**</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001*</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.657****</td>
<td>1.980***</td>
</tr>
<tr>
<td></td>
<td>(0.497)</td>
<td>(0.629)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-0.009</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>0.040</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.004***</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.039***</td>
<td>-0.088***</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>1.631*</td>
<td>1.621**</td>
</tr>
<tr>
<td></td>
<td>(0.806)</td>
<td>(0.691)</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Table 3.5.11: Dynamic Panel Data Model - Estimation Results (1975-2012) (cont. Table 3.5.10)

<table>
<thead>
<tr>
<th>Statistical Tests</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Test / Wald Chi2 Test (global significance)</td>
<td>843.13*** (16, 23)</td>
<td>2856.91*** (16)</td>
</tr>
<tr>
<td>Sargan Test (p-value)</td>
<td>-</td>
<td>0.326</td>
</tr>
<tr>
<td>AR(2) (p-value)</td>
<td>-</td>
<td>0.895</td>
</tr>
</tbody>
</table>

*\(p \leq .10\); **\(p \leq .05\); ***\(p \leq .01\)

Notes: Observations - 623. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer’s correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

Tables 3.5.12 and 3.5.13 report estimation results for the period prior to the financial crisis of 2008.
Table 3.5.12: Fixed Effects Estimation Results (1975-2007)

<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.689*** (0.136)</td>
<td>1.069*** (0.122)</td>
</tr>
<tr>
<td>Separate Bank. Superv. (Yes =1)</td>
<td>-0.334** (0.049)</td>
<td>-0.083 (0.066)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-0.119 (0.134)</td>
<td>-0.179** (0.069)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-0.119 (0.134)</td>
<td>-0.179** (0.069)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-0.130** (0.058)</td>
<td></td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-0.064 (0.047)</td>
<td></td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>0.051 (0.052)</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>-0.020*** (0.005)</td>
<td></td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-0.154*** (0.046)</td>
<td></td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001** (0.001)</td>
<td></td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.152*** (0.660)</td>
<td></td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>0.064 (0.048)</td>
<td></td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>0.030 (0.060)</td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.002 (0.002)</td>
<td></td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.071*** (0.022)</td>
<td></td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>1.842** (1.137)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>804</td>
<td>584</td>
</tr>
<tr>
<td>No of Countries</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>F Test / Wald Chi2 Test (global significance)</td>
<td>5.99** (1, 24)</td>
<td>281.82*** (15, 23)</td>
</tr>
<tr>
<td>R squared (within)</td>
<td>0.04</td>
<td>0.58</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Robust standard errors are in brackets.
<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.554*** (0.085)</td>
<td>0.748*** (0.178)</td>
</tr>
<tr>
<td>Lagged Inflation (t-1)</td>
<td>0.428*** (0.043)</td>
<td>0.425*** (0.126)</td>
</tr>
<tr>
<td>Separate Banking Supervision (1 = Yes)</td>
<td>-0.037 (0.073)</td>
<td>-0.033 (0.043)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-0.085** (0.039)</td>
<td>-0.005 (0.056)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-0.120 (0.078)</td>
<td>-0.108 (0.070)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-0.076* (0.041)</td>
<td>-0.028 (0.041)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-0.026 (0.020)</td>
<td>-0.029 (0.025)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-0.026 (0.027)</td>
<td>0.082* (0.044)</td>
</tr>
<tr>
<td>Time</td>
<td>-0.012*** (0.003)</td>
<td>-0.008*** (0.002)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-0.098*** (0.028)</td>
<td>-0.079* (0.042)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001* (0.000)</td>
<td>-0.000 (0.001)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.280*** (0.432)</td>
<td>2.368*** (0.704)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>0.036 (0.041)</td>
<td>0.004 (0.027)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>0.021 (0.059)</td>
<td>-0.002 (0.063)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.003*** (0.001)</td>
<td>-0.001 (0.001)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.036*** (0.010)</td>
<td>-0.069*** (0.026)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>0.945 (0.785)</td>
<td>1.169 (0.908)</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Table 3.5.14: Dynamic Panel Data Model - Estimation Results (1975-2007) (cont. Table 3.5.13)

<table>
<thead>
<tr>
<th>Statistical Tests</th>
<th>Fixed Effects Estimation</th>
<th>Arellano-Bover Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Test / Wald Chi2 Test</td>
<td>576.57***</td>
<td>2668.33***</td>
</tr>
<tr>
<td>(global significance)</td>
<td>(16, 23)</td>
<td>(16)</td>
</tr>
<tr>
<td>Sargan Test (p-value)</td>
<td>-</td>
<td>0.036</td>
</tr>
<tr>
<td>AR(2) (p-value)</td>
<td>-</td>
<td>0.997</td>
</tr>
</tbody>
</table>

* \( p \leq .10; ** p \leq .05; *** p \leq .01 \)

Notes: Observations - 575. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer’s correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

### 3.5.5 Test for strict exogeneity of the variable separate banking supervisor

Following Wooldridge (2010), we can test for strict exogeneity using fixed effects when \( T > 2 \), by specifying the model (static version) as in equation (3.1) but adding a new term, that is the lead values in \( t+1 \) of the variable “separate banking supervisor”:

\[
\pi_{i,t} = \beta_0 + \beta_1 \text{separate}_\text{sup}_{i,t} + \alpha \text{separate}_\text{sup}_{i,t+1} + \lambda X_{i,t} + \nu_i + u_{i,t},
\]  

(3.4)

Then, we estimate the model using fixed effects and we obtain an estimate for the coefficient for the new variable \( \text{separate}_\text{sup}_{i,t+1} \). Under null hypothesis of strict exogeneity, \( \alpha = 0 \) and we can perform a Wald test to verify whether the estimated coefficient is statistically different from 0. Results of the test show that we cannot reject the null hypothesis of strict exogeneity.
<table>
<thead>
<tr>
<th>Dependent Variable: (log) inflation</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.975*** (0.128)</td>
</tr>
<tr>
<td>Separate Bank. Supervisor (t)</td>
<td>0.177 (0.189)</td>
</tr>
<tr>
<td>Separate Bank. Supervisor (t+1)</td>
<td>-0.226 (0.169)</td>
</tr>
<tr>
<td>Inflation Targeting (1 = Yes)</td>
<td>-0.158** (0.063)</td>
</tr>
<tr>
<td>CBI (index)</td>
<td>-0.141 (0.096)</td>
</tr>
<tr>
<td>Deposit Insurance (1 = Yes)</td>
<td>-0.118* (0.055)</td>
</tr>
<tr>
<td>Exchange Rate Reg. (1 = fixed)</td>
<td>-0.053 (0.049)</td>
</tr>
<tr>
<td>Euro area member (1 = Yes)</td>
<td>-0.005 (0.046)</td>
</tr>
<tr>
<td>Time (1975: 1, ...., 2012: 38)</td>
<td>-0.019*** (0.004)</td>
</tr>
<tr>
<td>Great Moderation Period (1 = 1984-2007)</td>
<td>-0.131*** (0.040)</td>
</tr>
<tr>
<td>Domestic Credit (% of GDP)</td>
<td>0.001* (0.000)</td>
</tr>
<tr>
<td>Output Gap</td>
<td>2.489*** (0.662)</td>
</tr>
<tr>
<td>Banking Crisis (1 = Yes)</td>
<td>-0.013 (0.047)</td>
</tr>
<tr>
<td>Currency Crisis (1 = Yes)</td>
<td>0.047 (0.064)</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.003** (0.002)</td>
</tr>
<tr>
<td>Capital Account Openness</td>
<td>-0.072*** (0.021)</td>
</tr>
<tr>
<td>Oil imports (% GDP)</td>
<td>2.246** (0.922)</td>
</tr>
<tr>
<td>Observations</td>
<td>639</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01

Robust standard errors are in brackets.
Table 3.5.16: Results for Strict Exogeneity Test on “separate banking supervisor”

<table>
<thead>
<tr>
<th>Statistical Test</th>
<th>Fixed Effects Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Test</td>
<td>1.79</td>
</tr>
<tr>
<td>(global significance)</td>
<td>(1, 23)</td>
</tr>
</tbody>
</table>

*p ≤ .10; **p ≤ .05; ***p ≤ .01
Chapter 4

Policy Mandates for Macroprudential and Monetary Policies in a New Keynesian Framework

“The conjunction of liberalised financial markets with credible price-stability-oriented policies can result in significant changes in the dynamics of the economy. Reaping the full benefits of the new environment while minimising its potential costs calls for closer cooperation between monetary and prudential authorities.” - Borio and White (2003)

4.1 Introduction

Prior to the financial crisis of 2007 there was a convergent mindset on policy goals, the instruments necessary to achieve them, and their implications for stabilising the economy. Back then, there was a common view that central banks should focus on price stability goals and clean up after bubbles burst. As a consequence of the financial crisis and its disruptive effects on economic welfare, the debate regarding the role of monetary policy and traditional regulatory and prudential frameworks on promoting macroeconomic stability was revived. It is argued that the great recession was a consequence of an excessively lax monetary policy stance that contributed to the increasing of housing price inflation (Taylor 2007, 2010; Hofmann and Bogdanova 2012). On the other hand, see Mishkin (2011) for a summary of the general doctrine stating that monetary policy should only focus on inflation and output stability.
hand, a large literature emphasizes the failure of financial and banking regulation as a financial stabilisation tool (Blanchard et al., 2010; Fund, 2011).

Although it is clear that the achievement of financial stability is crucial for the pursuit of macroeconomic stability, there is no consensus on what economic policy should target the stability of the financial system.² Mishkin (2011) suggests that monetary policy should lean against credit-driven bubbles only (rather than responding to irrational exuberance bubbles), pointing out that in the case of credit bubbles the argument about the difficulty in detecting asset price bubbles is no longer valid. On the other hand, Vinals (2012) considers that monetary policy rules should also lean by reacting to financial variables, such as credit and indebtedness, but only in the pursuit of price stability. In addition, Curdia and Woodford (2010) suggest a Taylor Rule that also reacts contemporaneously to credit spreads, showing that a modified Taylor Rule of this kind can not only decrease the distortions originated by a financial shock, but also improve the economy’s reaction to different types of shocks.

In turn, it is argued that macroprudential regulation should deal with financial market distortions, while monetary policy should concentrate solely on stabilising inflation in order to counter-act the fluctuations of output caused by price rigidities. This type of institutional framework raises some concerns. A main topic in the design of an effective institutional mandate for macroprudential policy is how it should interact with monetary policy. Even though we agree that price and financial stability are intermediate objectives to attain the ultimate goal of macroeconomic stability, there are side effects from monetary policy on macroprudential targets (such as credit or leverage) and from macroprudential policies on monetary targets (such as output and inflation). For instance, as pointed out by Beau et al. (2011), it is likely that the implementation of a macroprudential policy can alter the transmission mechanism of monetary policy, since it acts through the same bank lending and balance sheet channels of monetary policy.

Under different economic circumstances, the outcomes on financial and price stability of both policies can be complementary, independent or conflicting (Beau et al., 2011). In particular, the conflicting outcome will depend on the type and dissemination of shocks.

² There is still a lack of a common definition of financial stability. As summarized by Galati and Moessner (2012), financial stability can be defined in terms of the degree of robustness of the financial system to external shocks or, in turn, it can be interpreted as the resilience of the financial system to shocks originated from within the system that can be associated to bank fragility. For the Bank of England (2009), the source of shocks is not so relevant, since financial stability should be "fundamentally concerned with maintaining a stable provision of financial services to the wider economy - payments services, credit supply, and insurance against risk".
supply and demand imbalances across the financial system and the real economy and on whether financial imbalances play a role in the monetary policy framework (Beau et al., 2011; Galati and Moessner, 2012). Moreover, some authors advocate the existence of a risk taking channel, through which a loose monetary policy can contribute and even promote the creation of asset bubbles, requiring a more aggressive intervention from the macroprudential regulator to mitigate its effects in the banks’ balance-sheets and in the financial systems (Borio and Zhu, 2008). In turn, considering a situation characterized by an asset bubble and by downside risks to price stability, macroprudential policy would limit credit and liquidity growth. This action could have adverse effects in aggregate activity increasing the deflationary pressures and forcing the monetary policymaker to intervene by lessening even further the monetary policy stance. Under these economic conditions, the necessary measures to control financial stability may have a negative impact on price stability, resulting in a conflicting outcome (Beau et al., 2011).

Therefore, a main question in this debate is how macroprudential policy tools should be set together with monetary policy, since both ultimately target macroeconomic stability. Following the Tinbergen principle, there should be at least one instrument associated to each policy goal. Assuming price and financial stability as two distinct objectives, then monetary policy should target the first one and macroprudential policy should concentrate on counterveiling financial imbalances. If we agree with this straight assignment of policy objectives, a consequent issue refers to the allocation of the policy instruments, namely whether the central bank, as the monetary policy maker, should set the two policy instruments to achieve both price and financial stability, or macroprudential tools should be allocated to an independent authority.

The economic literature investigating these issues is still in its infancy, though there are a number of papers offering preliminary insights and suggesting different ways of combining monetary policy and macroprudential regulation. Despite the distinctive features of the models used to assess these questions, all in all the findings suggest that there are sources of conflict, mainly when these policies are not coordinated and shocks affect the demand side of the economy (De Paoli and Paustian, 2012; Bean et al., 2010; Beau et al., 2011; Angelini et al., 2011; Angeloni, 2010).

This paper contributes to both sides of the debate and has two main purposes. Based on a New Keynesian model with financial frictions, the first aim is to investigate whether there is a welfare benefit from monetary policy that ‘leans against the wind’ by performing welfare analysis. In this part of the study, macroprudential policies are absent. Specifically, our model-based analysis enables us to examine the potential trade-offs of
using simple monetary policy rules that feed back on financial variables, such as deviations of credit, credit spreads or asset prices from its steady state values, by comparing it with a standard Taylor rule. Two policy mandates are suggested to conduct this analysis. A policy mandate featuring a conventional monetary policy stance encompassing a standard Taylor rule with interest rate smoothing and responding to inflation and output gaps and a policy mandate in which the standard Taylor rule is augmented to feed back on financial variables. The former policy mandate is used throughout the paper as a baseline case.

The main findings of this analysis suggest that it is welfare improving to have a monetary policy stance that responds countercyclically to asset prices. Nonetheless, there is a trade-off in terms of inflation stabilization, since an augmented Taylor rule of this type would involve more prices volatility than a standard one. A compromise between welfare maximization and inflation stability seems to be achieved under a policy regime characterised by an augmented Taylor rule that feeds back on deviations of credit from its steady state path.

The second main goal is to analyse the impact on welfare of introducing in the model macroprudential policies reacting counter-cyclically to financial imbalances. Again, the financial imbalances are captured by financial variables like deviations of credit, credit growth, credit spreads and loans-to-output ratio from their steady state values. By extending the framework to include macroprudential tools alongside with a monetary policy instrument (i.e. the policy interest rate), it is possible to assess how the institutional arrangements of monetary policy and macroprudential regulation could be designed in the most effective way. In fact, it is not consensual in the academic literature whether the monetary authority should also concentrate responsibilities in banking regulation and supervision. Arguments favouring an independent banking regulator, namely potential sources of conflict between the two policies and reputation damage for the central bank in the event of financial distress or bank failures, oppose to arguments benefiting a unified mandate, which privileges the central bank's role as lender-of-last-resort and coordination synergies.

Against this background, we suggest two more policy mandates which we can compare and evaluate in terms of their social welfare implications. The criterion used to assess the most effective institutional mandate is obtained from the welfare analysis, in which policy rules are optimised to deliver the best level of lifetime utility. We start by examining a separate policy mandate, in which each policymaker targets their own policy goal: the monetary policymaker (i.e the central bank) pursues price stability and the macro-
prudential regulator focus on financial stability. This institutional mandate is compared with a unified regime, where both monetary and macroprudential policies react to financial imbalances. This comparison is made across all policy mandates considered in the analysis, to rank the ones that minimize welfare losses.\footnote{The separate mandate aims at mimicking the institutional arrangements of monetary and macroprudential policies in Germany, Finland and Norway, while the unified mandate represents the institutional regimes in New Zealand, United Kingdom, Belgium and in the euro area.}

Given the way banking regulation is introduced in the macroeconomic model, it is feasible to assess the impact on welfare of a macroprudential toolkit comprising a tax on loans and a subsidy on bank net worth. This is a innovative feature of the framework, since previous studies considering banking regulation instruments usually focus on a single tool. We show that a tax on loans proves to be less welfare improving than a tool targeting directly the net worth of banks, such as a subsidy on net worth, although the former does in general a better job in promoting the stability of prices. The use of either instrument is always welfare maximizing related to a baseline scenario in which a standard Taylor rule is assumed. We describe in detail the optimal policy exercises when a tax on loans is considered, although we also comment briefly on the results attained when the macroprudential instrument is a subsidy on net worth.

Findings from these optimal policy exercises suggest that there are welfare gains from introducing macroprudential regulation, even when considering a separate regime given by two independent agencies reacting to their own policy goal. In particular, gains are slightly higher under a unified regime, in which both policies feed back on credit and spreads. However, these gains are small as also shown by Angelini et al. (2011), De Paoli and Paustian (2012) and Bailliu et al. (2012).

The model developed in this study extends the Gertler et al. (2012) framework in several directions. The most important innovation comes from the introduction of nominal frictions, in order to investigate the interaction of macroprudential regulation and monetary policy. Hence, our focus is on conventional monetary policy rather than credit policy. In addition, we simplify the banking sector component of the model, ruling out the role of outside equity. In this case, banks’ net worth increases are given solely by retained profits. The macroprudential tool is also distinct, since we suggest a non-neutral tax / subsidy scheme.

The remaining of the paper is organized as follows. Section 2 describes the model, by first considering an unregulated banking sector and then comparing this baseline model with one extended to introduce macroprudential regulation. Calibration of fundamental
parameters is also described in this part of the paper. Section 3 explains and performs welfare analysis. This section shows and interprets the optimal policy results for the policy mandates described above (standard monetary policy stance, a monetary policy rule that leans against the build up of financial imbalances, and for alternative policy regimes that encompass a macroprudential policy rule). Section 4 concludes.

4.2 The Model

In this section, we introduce a model with financial frictions and macroprudential regulation. The model follows closely Gertler et al., 2012, but it is extended to include New Keynesian features, in order to address the interplay between conventional monetary policy and macroprudential regulation. Financial frictions impact on real economy through the amount of funds that are available to the banks, affecting the liabilities side of their balance sheet. The economy is populated by four types of economic agents: households, final goods producers, capital goods producers, retail producers and banks.

4.2.1 Households

In this model, there is a continuum of households of measure unity. Each household consumes, saves and provides labour. The individuals belonging to each household can be either workers or bankers, by a fraction of $f$ and $1 - f$, respectively. The fraction $f$ of workers provides labour and the wages they earn come back to the household. On the other hand, the fraction $1 - f$ of bankers manages one of the banks that is owned by the households and return to the household they belong any dividends they make over the period they manage the bank. It is also assumed that members can interchange roles. Bankers may become workers every period with probability $1 - \sigma_B$, which is independent of how long the individual has performed that role. The probability that a member of the household stays as a banker is given by $\sigma_B$. The banker only returns the accumulated earnings to her family when she exits from the bank.

The assumption of a finite horizon for bankers is needed in order to avoid the accumulation of net worth beyond a certain threshold that would made them independent of external funding. Conversely, every period a similar number of workers randomly becomes bankers.

Households’ utility is given by
\[ \Lambda_t = \Lambda(C_t, L_t) = \frac{((C_t - \chi C_{t-1})^{(1-\varrho)} L_t^\varrho)^{1-\sigma_c} - 1}{1 - \sigma_c} \]  

(4.1)

where single period utility \( \Lambda_t \) is an increasing non-separable Cobb-Douglas function of real consumption, \( C_t \), relative to external habit, \( \chi C_{t-1} \), and leisure \( L_t \) and has a functional form consistent with a balanced growth path. The parameters \( \sigma_c \) and \( \varrho \) refers to the elasticity of consumption and the households preferences, respectively.

Let \( D_t \) be the amount of deposits made by households on banks at time \( t \), that pay \( R_t^{ex} \) ex post gross real interest rate adjusted for gross inflation, \( T_t \) lump sum taxes, \( \Upsilon_t \) the net transfers from financial and non-financial firms owned by households and \( W_t \) the nominal wage.\(^4\)

Therefore, the household budget constraint is given by

\[ C_t + D_{t+1} = W_t L_t + \Upsilon_t + R_t^{ex} D_t + T_t \]  

(4.2)

In a cashless version of the model, household behaviour is then described in equilibrium by

\[
\begin{align*}
\Lambda_t &= \Lambda(C_t, L_t) = \frac{((C_t - \chi C_{t-1})^{(1-\varrho)} L_t^\varrho)^{1-\sigma_c} - 1}{1 - \sigma_c} \\
\Lambda_{C,t} &= (1 - \varrho)(C_t - \chi C_{t-1})^{(1-\varrho)(1-\sigma_c)-1}(1 - h_t)^{\varrho(1-\sigma_c)} \\
\Lambda_{L,t} &= \varrho(C_t - \chi C_{t-1})^{(1-\varrho)(1-\sigma_c)} L_t^{\varrho(1-\sigma_c)-1} \\
R_t^{ex} &= \frac{R_{n,t-1}}{\Pi_t} \\
\Lambda_{C,t} &= \beta E_t[R_t^{ex} \Lambda_{C,t+1}] \\
\Lambda_{L,t} &= \frac{W_t}{P_t} \\
L_t &\equiv 1 - h_t
\end{align*}
\]  

(4.3)

(4.4)

(4.5)

(4.6)

(4.7)

where \( R_{n,t} \), our monetary policy instrument, is the gross nominal interest rate set in period \( t \) to pay out interest in period \( t + 1 \), \( \Pi_t \equiv \frac{P_t}{P_{t-1}} \) where \( P_t \) is the retail price level, \( h_t \) is hours worked and \( \frac{W_t}{P_t} \) is the real wage. The Fischer and Euler equations are described by equations (4.4) and (4.5) respectively.

The Euler consumption equation (4.5), where \( \Lambda_{C,t} \equiv \frac{\partial \Lambda_t}{\partial C_t} \) is the marginal utility of consumption and \( E_t[\cdot] \) denotes rational expectations based on agents observing all current

\(^4\)Both deposits and government debt are one period real bonds that pay the same gross real return from \( t \) to \( t - 1 \).
macroeconomic variables (i.e., ‘complete information’), describes the optimal consumption-
savings decisions of the household. It equates the marginal utility from consuming one
unit of income in period \( t \) with the discounted marginal utility from consuming the gross
income acquired, by saving the income. Equation (4.6) equates the real wage with the
marginal rate of substitution between consumption and leisure.

### 4.2.2 Goods Producers

Goods producers behaviour is given by

\[
Y_t = F(A_t, h_t, K_t) = (A_t h_t)^\alpha K_t^{1-\alpha} \tag{4.8}
\]

\[
Y_t = (1-c)Y_t^W \tag{4.9}
\]

\[
\frac{P_t^W}{P_t} F_{h_t} = \frac{P_t^W}{P_t} \frac{\alpha Y_t^W}{h_t} = \frac{W_t}{P_t} \tag{4.10}
\]

\[
K_t = (1-\delta)K_{t-1} + \psi_{t+1}(1-S(X_t))I_t \tag{4.11}
\]

Demand for capital is given by

\[
R_{k,t} = \psi_t \frac{(1-\alpha) \frac{P_t^W}{P_t} Y_t^W / K_{t-1} + (1-\delta)Q_t}{Q_{t-1}} \tag{4.12}
\]

Equation (4.8) is a Cobb-Douglas production function for the wholesale sector, being
the wholesale product given by \( Y_t^W \), that is converted into differentiated goods, given
by \( Y_t \) in (4.9) at a cost \( cY_t^W \). \( K_t \) is physical capital that goods producers buy to capital
producers at price \( Q_t \), \( \alpha \) and \( (1-\alpha) \) are the output elasticities to labour and capital
respectively, and \( A_t \) is the productivity shock. From the optimization problem we get
equation (4.10) for the demand of labour, where \( F_{h,t} \equiv \frac{\partial F_t}{\partial h_t} \) equates the marginal product
of labour with the real wage, and (4.11) for the demand for capital. Demand for capital is
given by the return on capital \( R_{k,t} \), that equalizes the gross marginal product of capital
net of depreciation (\( \delta \)). \( P_t \) and \( P_t^W \) are the aggregate price indexes in the retail and
wholesale sectors respectively. Capital accumulation is given by (4.11) and we assume
convex investment adjustment costs \( a la \text{ Smets and Wouters (2007)} \). Note here \( K_t \) is
end-of-period \( t \) capital stock and \( \psi_t \) is a capital quality shock, which destroys or enhances
capital available in period \( t \) to be used in period \( t+1 \). The production of physical capital
is determined in the next subsection.
4.2.3 Capital Producers

To determine investment, following Smets and Wouters (2007), we introduce capital producing firms that at time $t$ convert $I_t$ of output into $(1 - S(X_t))I_t$ of new capital sold to goods producers at a real price $Q_t$, commonly known as Tobin’s Q. They then maximize with respect to $\{I_t\}$ expected discounted profits

$$E_t \sum_{k=0}^{\infty} D_{t,t+k} [Q_{t+k}(1 - S(I_{t+k}/I_{t+k-1}))I_{t+k} - I_{t+k}]$$

where $D_{t,t+k} = \beta^k \left( \frac{\Lambda_{t+k}}{\Lambda_{C,t}} \right)$ is the real stochastic discount rate over the interval $[t, t+k]$. Defining $X_t \equiv \frac{I_t}{C_t}$ results in the first-order condition

$$Q_t(1 - S(X_t) - X_tS'(X_t)) + E_t [D_{t,t+1} Q_{t+1} S'(X_{t+1}) X_{t+1}^2] = 1$$

We complete this set-up with the functional form for $S(X)$,

$$S(X) = \phi(X_t - (1 + g_t))^2$$

where $g$ is the balanced growth rate. Note that along a balanced growth path $X_t = 1 + g_t$ and investment costs disappear. This is a convenient property because then the steady state is unchanged from introducing investment costs.

4.2.4 Retail Producers

In order to introduce sticky prices, we follow the technique proposed by Calvo (1983). We assume that there is a probability of $1 - \xi$ at each period that the price of each retail good $m$ is set optimally to $P^0_t(m)$. If the price is not re-optimised, then it is held fixed. For each retail producer $m$, given its real marginal cost $MC_t$, the objective is at time $t$ to choose $\{P^0_t(m)\}$ to maximize discounted nominal profits

$$E_t \sum_{k=0}^{\infty} \xi^k D N_{t,t+k} Y_{t+k}(m) \left[ P^0_t(m) - P_{t+k} MC_{t+k} \right]$$

subject to the equation for demand for investment by each producer
\[ Y_{t+k}(m) = \left( \frac{P_0^0(m)}{P_{t+k}} \right)^{-\zeta} Y_{t+k} \]  

(4.14)

where \( DN_{t,t+k} \equiv \beta^k \frac{AC_{t+k}/P_{t+k}}{AC_{t}/P_t} \) is the nominal stochastic discount factor over the interval \([t, t + k]\). The solution to this is

\[
E_t \sum_{k=0}^{\infty} \xi^k DN_{t,t+k}Y_{t+k}(m) \left[ P_0^0(m) - P_{t+k}MC_{t+k}MS_{t+k} \right] = 0
\]

(4.15)

where an exogenous stochastic mark-up to the steady state \( MS \equiv \frac{1}{1-\zeta} \) has been introduced. The mark-up shock follows a AR1 process, which is described in subsection 4.2.7.

With indexing by an amount \( \gamma \in [0, 1] \), price dynamics in equilibrium are given by

\[
H_t - \xi \beta E_t[\Pi_{t+1}^{-1}H_{t+1}] = Y_t\Lambda_{C,t}
\]

(4.16)

\[
J_t - \xi \beta E_t[\Pi_{t+1}^{\zeta}J_{t+1}] = \left( 1/(1 - (\zeta)) \right) MC_tMS_tY_t\Lambda_{C,t}
\]

(4.17)

\[
\Pi_t = \frac{\Pi_t}{\Pi_{t-1}}
\]

(4.18)

\[
1 = \xi \Pi_t^{\zeta-1} + (1 - \xi) \left( \frac{J_t}{H_t} \right)^{1-\zeta}
\]

(4.19)

\[
\Delta_t = \xi \Pi_t^{\zeta}\Delta_{t-1} + (1 - \xi) \left( \frac{J_t}{H_t} \right)^{-\zeta}
\]

(4.20)

where \( \Delta_t \) is a measure of price dispersion across retail firms each setting their prices at different periods.

Real marginal costs in the retail sector are given by

\[
MC_t = \frac{P_W}{P_t}
\]

(4.21)

The aggregate resource constraint in the economy is expressed by

\[
Y_t = C_t + G_t + I_t
\]

(4.22)

The real side of the model is completed with a balanced budget constraint with lump-sum taxes:
\[ G_t = h_t \frac{tax_t W_t}{P_t} \]  

(4.23)

where \( G_t \) is a government spending shock, which follows a AR 1 shock, as described in subsection 4.2.7 and \( tax_t \) is the tax rate, that is charged on households’ income.

4.2.5 Banks

The banking sector model is inspired in Gertler and Karadi (2011) and Gertler et al. (2012), with some differences. First, we assume that total net worth is given by the initial transfer from households to new bankers and it accumulates through retaining profits. In our model, we rule out the role of outside equity and therefore increases in the net worth of the banks are made exclusively through retained earnings. This feature has an important implication for macroprudential policy, since a bank is likely to need more time to recover from a shortage of net worth, making the impact of macroprudential regulation more significant (Angelini et al., 2011).

Financial frictions affect real activity via the impact of funds available to the banks, but there is no friction in transferring funds between banks and non-financial firms. Given a certain deposit level a bank can lend frictionlessly to non-financial firms against their future profits. In this regard, firms offer to banks a perfect state contingent security.

First, we start by describing a \textit{laissez-faire} version of the banking sector, in which banking regulation is not enforced. Then, macroprudential regulation is introduced and we show how it changes the banking sector equilibrium.

\textbf{The \textit{Laissez-Faire} Banking Sector}

The activity of the bank can be summarized in two stages. In the first one, banks raise deposits and equity from the households, over the period \([t, t + 1]\), the ’time period \( t’\). In the second stage banks use these deposits to make loans to firms. Loans \((s_t)\) are priced at a price \(Q_t\). Therefore, \(Q_t s_t\) corresponds to the amount of loans that banks provide in period \( t \). The asset against which the loans are obtained is end-of-period capital \( K_t \). Capital depreciates at a rate \( \delta \) in each period.

The banking sector’s balance sheet is simple: the assets side is determined by loans, while the liabilities side comprises household deposits and net worth. This implies a
banking sector’s balance sheet of the form:

\[ Q_t s_t = n_t + d_t \]  \hspace{1cm} (4.24)

where \( s_t \) are claims on future returns from one unit of a goods producer’s capital at the end-of-period \( t \) to finance capital acquired at the end of period \( t \) for use in period \( t + 1 \). \( Q_t \) is the price of a unit of capital. Therefore \( Q_t s_t \) is the amount of loans that coincide fully to the assets of the bank and they equal the sum of deposits (\( d_t \)) and net worth (\( n_t \)).

Net worth of the bank accumulates according to:

\[ n_t = R_{k,t} Q_{t-1} s_{t-1} - R_{t}^{ex} d_{t-1} \]  \hspace{1cm} (4.25)

\( R_{k,t} \) are real returns on bank assets given by

\[ R_{k,t} = \frac{Z_t + (1 - \delta)Q_t}{Q_{t-1}} \]

where \( Z_t \) is the gross return (marginal product) of capital and \( Z_t + (1 - \delta)Q_t \) represents the net return after depreciation.

Banks face an exogenous probability of exiting of \( 1 - \sigma_B \in [0, 1] \) per period and therefore survive for \( i - 1 \) periods and exit in the \( i \)th period with probability \( (1 - \sigma_B)\sigma_B^{i-1} \). Given the fact that the representative bank pays dividends only when it exits, the banker’s objective is to maximize expected discounted terminal wealth \( V_t \)

\[ V_t = E_t \sum_{i=0}^{\infty} (1 - \sigma_B)\sigma_B^{i} \Lambda_{t,t+1+i} n_{t+1+i} \]  \hspace{1cm} (4.26)

where \( \Lambda_{t,t+i} = \beta_i \frac{\Lambda_{C,t+i}/P_{t+i}}{\Lambda_{C,t}/P_t} \) is the stochastic discount factor, subject to an incentive constraint for lenders (households) to be willing to supply funds to the banker.

To understand this dynamic problem better we can substitute for \( d_t \) from (4.24) and rewrite (4.25) as

\[ n_t = R_{t}^{ex} n_{t-1} + (R_{k,t} - R_{t}^{ex})Q_{t-1} s_{t-1} \]  \hspace{1cm} (4.27)

which says that net worth at the end of period \( t \) equals the gross return at the real riskless rate \( R_{t}^{ex} n_{t-1} \) plus the excess return over the latter on the assets. With these

\[ \text{In a slight departure from notation elsewhere, lower case denotes the representative bank. Upper case variables later denote aggregates.} \]
returns and $Q_t$ exogenous, the bank net worth in all future periods is determined by its choice of $\{s_{t+i}\}$ subject to a borrowing constraint.

To motivate an endogenous constraint on the bank’s ability to obtain funds, we introduce the following simple agency problem as in Gertler and Kiyotaki (2010). We assume that in the period of time from having obtained funds from households and making loans, but before paying their debts to its creditors, the bankers may steal a fraction of assets $\Theta \in [0, 1]$ to her family. In the recognition of this possibility, households limit the funds they lend to banks. The fraction of funds that a banker can divert is determined by the balance sheet composition. If a banker diverts assets for her personal gain, he defaults on his debt and shuts down and the creditors may reclaim the remaining fraction $1 - \Theta$ of funds. Since creditors are aware of the banker’s incentive to divert funds, they will restrict the amount of funds they provide to the bank.

In this way a borrowing constraint may arise. In order to ensure that bankers do not divert funds the following incentive constraint must hold:

$$V_t \geq \Theta Q_t s_t$$  \hspace{1cm} (4.28)

The incentive constraint states that for households to be willing to supply funds to a bank, the banker’s franchise value $V_t$ must be at least as large as her gain from diverting funds.

The optimization problem for the bank is to choose a path for borrowing, $\{s_{t+i}\}$, to maximize $V_t$ subject to (4.24) and (4.25) or equivalently (4.27) and (4.28). To solve this problem we guess a linear solution of the form:

$$V_t = V_t(s_t, n_t) = \mu_{s,t} Q_t s_t + \nu_{d,t} n_t$$  \hspace{1cm} (4.29)

where $\mu_{s,t} \equiv \frac{\nu_{s,t}}{Q_t} - \nu_{d,t}$ is the excess value of bank assets over deposits and $\nu_{d,t}$ is the marginal value of deposits.

The banker’s Bellman equation for a given path of $n_t$ can be written in the form

$$V_{t-1}(s_{t-1}, n_{t-1}) = E_t \Lambda_{t-1,t} [(1 - \sigma_B) n_t + \sigma_B \max_{s_t} V_t(s_t, n_t)]$$  \hspace{1cm} (4.30)

Then, we perform the optimization by $\max_s V_t(s_t, n_t)$ subject to the incentive constraint
The Lagrangian for this problem is

\[ \mathcal{L}_t = V_t + \lambda_t [V_t - \Theta Q_t s_t] = (1 + \lambda_t) V_t - \lambda_t \Theta Q_t s_t \]

where \( \lambda_t > 0 \) if the constraint binds and \( \lambda_t = 0 \) otherwise.

The first order conditions for the optimization problem are:

\[
\begin{align*}
  s_t &: (1 + \lambda_t) \mu_{s,t} = \lambda_t \Theta \\
  \lambda_t &: \mu_{s,t} Q_t s_t + \nu_{d,t} n_t \geq \Theta Q_t s_t
\end{align*}
\]

We now define \( \phi_t \) to be the leverage ratio of the representative bank that satisfies the incentive constraint:

\[ Q_t s_t = \phi_t n_t \] (4.32)

where \( \phi_t \) is given by

\[ \phi_t = \frac{\nu_{d,t}}{\Theta - \mu_{s,t}} \] (4.33)

Using (4.32) we can write (4.29) as

\[ V_t = [\mu_{s,t} \phi_t + \nu_{d,t}] n_t \] (4.34)

and hence (4.30) becomes

\[
\begin{align*}
  V_t(s_t, n_t) &= E_t \Lambda_{t,t+1} [1 - \sigma_B + \sigma_B (\mu_{s,t+1} \phi_{t+1} + \nu_{d,t+1})] n_{t+1} \\
&\equiv E_t \Lambda_{t,t+1} \Omega_{t+1} n_{t+1} \\
&= E_t \Lambda_{t,t+1} \Omega_{t+1} [R_{k,t+1} Q_t s_t - R_{t+1}^x d_t]
\end{align*}
\]

(4.35)

using (4.25) and defining \( \Omega_t = 1 - \sigma_B + \sigma_B (\nu_{d,t} + \phi_t \mu_{s,t}) \). \( \Omega_{t+1} \) is a term augmenting \( \Lambda_{t,t+1} \), the household’s stochastic discount factor, given that banker’s horizon is different from household’s, due to the exit probability bankers have to face. With \( \sigma_B > 0 \), \( \Omega_{t+1} \) represents the shadow value of an extra unit of net worth.

Comparing (4.35) with (4.29) and equating coefficients of \( s_t \) and \( d_t \), we arrive at the determination of \( \nu_{s,t} \) and \( \nu_{d,t} \):

\[
\begin{align*}
  \nu_{d,t} &= E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1}^x \\
  \nu_{s,t} &= E_t \Lambda_{t,t+1} \Omega_{t+1} Q_t R_{k,t+1}
\end{align*}
\]

(4.36)
Hence

\[ \mu_{s,t} = \frac{\nu_{s,t}}{Q_t} - \nu_{d,t} = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{k,t+1} - R_{t+1}^{ex}) \] (4.36)

At the aggregate level, the banking sector balance sheet is:

\[ Q_t S_t = N_t + D_t \]

and net worth is the sum of existing (old) bankers and new bankers:

\[ N_t = N_{o,t} + N_{n,t} \]

Net worth of existing bankers equals earnings on assets held in the previous period net cost of deposit finance, multiplied by a fraction \( \sigma_B \), the probability that they survive until the current period:

\[ N_{o,t} = \sigma_B \{(Z_t + (1 - \delta)Q_t)S_{t-1} - R_t^{ex}D_{t-1}\} \]

Since new bankers cannot operate without any net worth, we assume that the family transfers to each one the fraction \( \xi_B/(1 - \sigma_B) \) of the total value assets of exiting entrepreneurs. This implies:

\[ N_{n,t} = \xi_B \{Z_t + (1 - \delta)Q_t\}S_{t-1} \] (4.37)

Introducing a capital quality shock not only affects the capital accumulation process and the return on capital, but, in models with a banking sector in the lines of Gertler and Karadi (2011), it also has an impact on the balance sheet of banks, affecting the accumulation of net worth and the credit spread. A negative shock in the quality of capital reduces output in period \( t + 1 \) and banks’ net worth, thereby tightening the incentive constraint. This disturbance is used to model a financial crisis.
The complete banking sector model is, thus, given by:

\[
S_t = K_t \\
(1 + \lambda_t)\mu_{s,t} = \lambda_t \Theta \\
Q_tS_t = \frac{\phi_tN_t}{(1 + \xi B R_{k,t}\phi_t)} \\
\phi_t = \frac{\nu_{d,t}}{\Theta - \mu_{s,t}} \\
N_t = R_{k,t}(\sigma_B + \xi B)Q_{t-1}S_{t-1}\psi_t - \sigma_B R_{t}^{ex} D_{t-1} \\
D_t = Q_t S_t - N_t \\
\nu_{d,t} = E_{t}\Lambda_{t,t+1}\Omega_{t+1}R_{t+1}^{ex} \\
\mu_{s,t} = E_{t}\Lambda_{t,t+1}\Omega_{t+1}(R_{k,t+1} - R_{t+1}^{ex}) \\
\Omega_t = 1 - \sigma_B + \sigma_B(\nu_{d,t} + \phi_t\mu_{s,t}) \\
R_{k,t} = \frac{Z_t + (1 - \delta)Q_t}{Q_{t-1}} \\
Z_t = \frac{(1 - \alpha)P_W Y_W}{K_{t-1}}
\]

**The Regulated Banking Sector**

In this section we introduce macroprudential regulation, assuming a tax / subsidy scheme, in the lines of Gertler et al. (2012) and De Paoli and Paustian (2012). We assume two different instruments, that alter the balance-sheet composition of the banks. One instrument is a tax / subsidy on loans and it changes according to different macroprudential policy rules. On the other hand, we also introduce a subsidy / tax on the net worth of banks. Based on some recent literature modeling macroprudential regulation, the choice of the instruments does not aim at reproducing exactly the current countercyclical capital requirements defined in Basel III regulatory framework. However, as countercyclical time-varying capital requirements, it also reacts countercyclically to financial variables variations, such as credit, credit-to-GDP ratio and credit spreads.

Total taxes from the macroprudential regulation scheme are given by

\[
T^{MR}_t = \tau_t Q_t S_t - \tau_t^s N_t \quad (4.38)
\]

The macroprudential regulatory scheme differs from Gertler et al. (2012) in the sense that it is non-neutral in terms of its fiscal impact.
The timing of the tax regime is as follows. In period \( t - 1 \), tax and subsidy rates \( \tau_{t-1} \), \( \tau^s_{t-1} \) are set to be paid or received on the value of end-of-period \( t - 1 \) (or beginning of period \( t \)) loans \( Q_{t-1}s_{t-1} \) and end-of-period net worth \( n_{t-1} \) respectively. The net worth of the bank then accumulates in period \( t \) according to:

\[
n_t = R_{k,t}Q_{t-1}s_{t-1} - R^{ex}_t d_{t-1} + \tau^s_{t-1} n_{t-1} - \tau_{t-1} Q_{t-1}s_{t-1} \quad (4.39)
\]

That is, net worth equals gross returns minus gross costs of borrowing, plus subsidies minus taxes carried over from the previous period. Banks are atomistic and take the tax rate and subsidy as exogenous.

With this timing for taxes or subsidies, the balance sheet of the bank in period \( t \) remains as before:

\[
Q_t s_t = n_t + d_t \quad (4.40)
\]

which says that net worth plus subsidies plus deposits can be used to finance loans net of tax.

As before we can substitute for \( d_t \) from (4.40) and rewrite (4.39) to give

\[
n_t = R^{ex}_t n_{t-1} + (R_{k,t} - R^{ex}_t)Q_{t-1}s_{t-1} - T^{MR}_{t-1} \\
= (R^{ex}_t + \tau^s_{t-1}) n_{t-1} + (R_{k,t} - R^{ex}_t - \tau_{t-1}) Q_{t-1}s_{t-1} \quad (4.41)
\]

which says that net worth at the end of period \( t \) equals the gross return at a real riskless rate plus the excess return over the latter on the assets plus subsidies minus taxes carried over from the previous period.

The optimization problem for the regulated banking sector is similar to the one described above, but it takes into account the changes in the balance-sheet derived from the introduction of regulatory tools.

Aggregation follows as before and now total net taxes from the macroprudential regulation scheme are given by

\[
T^{MR}_t = \tau_t Q_t s_t - \tau^s_t N_t \quad (4.42)
\]

The government budget constraint now becomes

\[
G_t = \text{tax}_t h_t \frac{W_t}{P_t} + T^{MR}_t \quad (4.43)
\]

so that tax revenues from the scheme alter the lump-sum taxes required to finance
government expenditure.

The complete banking model is summarized by

\[ S_t = K_t \]
\[ (1 + \lambda_t)\mu_{s,t} = \lambda_t \Theta \]
\[ Q_t S_t = \phi_t N_t \]
\[ \phi_t = \frac{\mu_{n,t}}{\Omega - \mu_{s,t}} \]
\[ N_t = R_{k,t}(\sigma_B + \xi_B)Q_{t-1}S_{t-1}\psi_t - \sigma_B R_{t-1} - \sigma_B T_{t-1}^{MR} \]
\[ D_t = Q_t S_t - N_t \]
\[ T_{t}^{MR} = \tau_t Q_t S_t - \tau_t^s N_t \]
\[ \mu_{n,t} = E_t [\Lambda_{t,t+1} \Omega_{t+1}(R_{t+1}^{ex} + \tau_t)] \]
\[ \mu_{s,t} = E_t [\Lambda_{t,t+1} \Omega_{t+1}(R_{k,t+1} - R_{t+1}^{ex} - \tau_t)] \]
\[ \Omega_t = 1 - \sigma_B + \sigma_B (\mu_{d,t} + \phi_t \mu_{s,t}) \]
\[ R_{k,t} = \frac{Z_t + (1 - \delta)Q_t}{Q_t - 1} \]
\[ Z_t = \frac{(1 - \alpha)P_t^W Y_t^W}{K_t} \]

with \( \tau_t^s \) or \( \tau_t \) exogenous. Clearly in the absence of taxes or subsidies, i.e. \( \tau_t = \tau_t^s = 0 \), we get back to the previous set-up.

It is worth highlighting that \( \mu_{s,t} \), the excess value of assets over deposits, and \( \mu_{n,t} \), the excess value of net worth over debt are similar to \( \nu_{d,t} \) and \( \nu_{s,t} \), apart from the fact that they are affected by the macroprudential regulation instruments, \( \tau_t \) and \( \tau_t^s \). The inclusion of macroprudential instruments of this kind alters the shadow value of assets and net worth, by altering the cost of borrowing and the interest margin of lending (spreads). Therefore, it modifies the franchise value of banks and, in particular, it has an impact on the optimal composition of banks’ balance sheets. The cost of borrowing, \( R_{t+1}^{ex} \), increases by \( \tau_t^s \), the subsidy on net worth, which makes more attractive for banks to fund themselves by raising net worth instead of collecting deposits. On the other hand, the interest margin obtained from lending activities decreases by \( \tau_t \), the tax on loans, making lending less profitable.

Although we impose some strong assumptions on the bank side of the model - no outside equity; net worth is accumulating through retained profits; banks raise deposits and equity from households ruling out money markets as a vehicle to compensate for liquidity
shortages - the features that are embedded in the model are sufficient to motivate a wedge between the funding interest rate and the lending interest rate and to introduce a role to macroprudential policy. Indeed, remaining characteristics of the model based on Gertler and Karadi (2011); Gertler et al. (2012) were kept in the model - a representative bank, which delivers the traditional banking activities of financial intermediation – to raise deposits from households and to grant credit to firms, subject to an incentive constraint. The aim of such a model is to show that, even with a very simplified banking system, macroprudential policy can be useful in dampening the credit cycle and, as a consequence, the economic business cycle.

There are other modelling alternatives to study macroprudential regulation without the inclusion of a explicit model of a banking sector, such as in Bailliu et al. (2012); Brzoza-Brzezina et al. (2013), studies that follow the Bernanke et al. (1999) and the Kiyotaki and Moore (1997) types of financial frictions, respectively. Our model of the banking sector differs from those because it explicitly models a banking sector, allowing the investigation of the role played by leverage-constrained banks in macroeconomic dynamics and how macroprudential instruments may be suitable to regulate leverage and act as a stabilization tool. Our modelling choices also makes it possible to assess the transmission mechanisms of capital requirements, which incorporates a channel to lending and output through funding costs and bank incentive effects.

4.2.6 Policy Rules

To close the model, we introduce monetary and macroprudential policy rules. We suggest not only a standard Taylor rule but also monetary rules that ‘lean against the wind’, by responding to financial variables behaviour, such as deviations of credit and asset prices from their steady state. We also propose alternative macroprudential rules, which also feed back on variables related to the financial sector, to assess the performance of these financial indicators in improving social welfare. A comparison across different policy rules is implemented and the optimal rules are those whose policy coefficients maximize social welfare, measured by the intertemporal utility.

We follow the approach of using optimal simple and conventional rules, which requires the knowledge of the efficient levels of output. For a matter of comparison, we also follow Schmitt-Grohe and Uribe (2007), who recommend the use of implementable rules, given their advantage of setting policy variables as a function of a small number of easily observable, macroeconomic indicators, which do not require the efficient levels of output.
Results for implementable rules are reported in Appendix 4.2. These policy rules provide the same level of welfare as the Ramsey-optimal policy and are commonly used in the macroeconomic literature, see for example \textcite{Bailiu} and \textcite{Lambertini}.

Based on this set of monetary and macroprudential policy rules, four policy mandates are investigated. The first policy regime assumes a sole monetary policy mandate, featuring a standard Taylor rule pursuing inflation stability. In this policy mandate, macroprudential tools are ignored and this institutional framework is set as a baseline case, that will be compared with policy regimes comprising ‘leaning against the wind’ monetary rules and macroprudential policy. This leads us to the second policy regime, in which a ‘leaning against the wind’ monetary policy is considered.

The third and fourth policy regimes result from the extension of the first and second regimes to include macroprudential policy instruments. In the third policy regime, macroprudential rules are introduced alongside with a standard monetary policy rule. This regime mimics an institutional framework in which the central bank is in charge of price stability only and the macroprudential authority is concerned with financial stability. In this case, there are two economic authorities that operate independently of each other. The fourth regime relaxes this assumption by considering a partially unified institutional regime, since it is assumed that both the central bank and the macroprudential authority target financial stability.

**Monetary Policy Rules**

In these study we assume that monetary policy can be a standard Taylor rule, reacting to inflation and output gaps, or it can also respond to financial variables. Following \textcite{Curdia}, we consider an augmented Taylor rule that feeds back on credit spreads. In addition, we also suggest credit and asset prices as alternative financial indicators.

The baseline policy regime is then given by a conventional Taylor rule, of the type:

\[
\log \left( \frac{R_{nt}}{R_n} \right) = \rho_r \log \left( \frac{R_{n,t-1}}{R_n} \right) + (1 - \rho_r) \left[ \theta_{r,\pi} \log \left( \frac{\Pi_t}{\Pi} \right) + \theta_{r,y} \log \left( \frac{Y_t}{Y_t^{F}} \right) \right] + \log(MPS_t)
\]

\footnote{In contrast with a fully unified institutional regime, that would be one in which both the monetary and the macroprudential authorities would target price and financial stability.}
where $Y_t^F$ is the flexi-price level of output, and $\log(MPS_t)$ is the monetary policy shock, as specified in subsection 4.2.7. The conventional Taylor rule stabilises output about its flexi-price level which is that determined by solving the real business cycle core of this model. The coefficient $\rho_r$ controls for the degree of interest rate smoothing, while $\theta_{r,\pi}$ and $\theta_{r,y}$ control for the degree of aggressiveness of the policy rate response to inflation and output. The remaining terms represent the deviation of inflation and deviation of interest rates in $t-1$ from their steady state values.

As already explained, this monetary policy rule is used as a baseline scenario for comparison with the alternative policy rules considered in the analysis.

The general augmented monetary policy rule takes the form:

$$\log \left( \frac{R_{n,t}}{R_n} \right) = \rho_r \log \left( \frac{R_{n,t-1}}{R_n} \right) + (1 - \rho_r) \left[ \theta_{r,\pi} \log \left( \frac{\Pi_t}{\Pi} \right) + \theta_{r,y} \log \left( \frac{Y_t}{Y_t^F} \right) + \theta_{r,Q} \log \left( \frac{Q_t}{Q} \right) \right]$$

$$+ \theta_{r,s} \log \left( \frac{1 + E_t [R_{k,t+1} - R_{k+1}^{ex}]}{1 + R_k - R^{ex}} \right) + \theta_{r,Qs} \log \left( \frac{Q_t s_t}{Qs} \right)$$

where $E_t [R_{k,t+1} - R_{k+1}^{ex}]$ is the credit spread, $Q_t s_t$ is credit and $Q_t$ is Tobin’s $Q$, that represents asset prices in this model. The coefficient $\rho_r$ controls for the degree of interest rate smoothing, while $\theta_{r,\pi}$, $\theta_{r,y}$, $\theta_{r,Q}$, $\theta_{r,s}$, and $\theta_{r,Qs}$ control for the degree of aggressiveness of the policy rate response to inflation, output, asset prices, spreads and credit, respectively. Lastly, $\log(MPS_t)$ is an i.i.d. monetary policy shock. The variables without time subscripts denote their respective steady state values and $Y_t^F$ refers to the flexi-price output.

This general augmented simple rule is divided in four different combinations, depending on the financial indicator(s) chosen to infer the their effectiveness in improving welfare outcomes. Therefore, we examine simple augmented Taylor rules feeding back alternatively on credit, credit spreads, assets prices or credit and credit spreads simultaneously.

**Macroprudential Policy Rules**

The objectives, instruments and targets of monetary policy rules are already quite established in the literature. In contrast, issues still remain concerning the objective of macroprudential policy and what tools should be used in order to achieve its goal. In this paper, we follow the view of the Bank of England, 2009 (BoE, 2009, thereafter), that establishes that macroprudential regulation is implemented to assure financial stability.

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7For a discussion, see Galati and Moessner 2012
through the monitoring of the credit supply during upswings and downturns. The BoE (2009) approach states that macroprudential policy has the role of creating a capital buffer during upswings and relax credit conditions during economic downturns. The view that credit booms are related to financial and business cycle crisis is claimed by Minsky (1972) and it is underpinned in empirical works, including Jorda et al. (2011) and Schularick and Taylor (2012). Against this background, the paper provides a characterization of macroprudential policy as a macroeconomic stabilisation policy instrument rather than as a means of preventing financial crises.

The literature suggests a range of indicator variables related to credit booms, such as credit growth, output growth, credit-to-GDP ratio, credit spreads, among others. The Basel Committee on Banking Supervision (2010) underscores the advantages of using credit-to-GDP ratio over credit growth, namely referring that this measure being a ratio, it is not affected by the cyclical behaviour of credit demand, since it is normalised by the size of the economy (given by output). In addition, it shows smoother behaviour patterns than credit growth.

Focusing our analysis on one financial indicator only may be misleading to assess the effectiveness of macroprudential policy. Based on the literature, we suggest the use of credit, credit spreads, loan-to-GDP ratio and credit growth as deviations from their steady state. We examined different simple Taylor-type macroprudential rules feeding back on these indicator variables.

Regarding the regulatory tools, we first select the tax on loans, $\tau_t$, to be used alongside the nominal interest rate. The general form of the macroprudential regulation rule is then given by

$$\log \left( \frac{1 + \tau_t}{1 + \tau} \right) = \rho_r \log \left( \frac{1 + \tau_{t-1}}{1 + \tau} \right) + (1 - \rho_r)\left( \alpha_{\tau,qs} \log \left( \frac{Q_{t,s}^t}{Q^s} \right) + \alpha_{\tau,s} \log \left( \frac{1 + E_t \left[ R_{k,t+1} - R_{ex}^{t+1} \right]}{1 + R_k - R_{ex}^t} \right) + \alpha_{\tau,qs/y} \log \left( \frac{Q_{t,s}^t}{Q^y_t} \right) + \alpha_{\tau,\Delta \bar{Q}_s / cg _{ss} / c_g} \right) + \log (MRS_t)$$

where $Q_{t,s}^t$ represents the loan-to-GDP ratio at time $t$, $c_g = \frac{Q_{t,s}^t}{Q_{t-1,s-1}^t}$ represents credit growth at time $t$ regarding the previous period $t-1$ and $c_g_{ss}$ is the steady state value.

---


9 For this purpose, we set the subsidy on net worth equal to zero, $\tau_s = 0$. 

136
of $cg_t$. The remaining feedback variables are credit spreads and credit, as already described for the monetary policy rule, and $\log(MRS_t)$ is a i.i.d. macro-prudential policy shock. In addition, the coefficients of the macroprudential policy rule are given by $\rho_{\tau}$, which measures the degree of persistence of the macroprudential instrument, $\alpha_{\tau,Qs}$, $\alpha_{\tau,s}$, $\alpha_{\tau,\Delta Qs}$ and $\alpha_{\tau,Qs/Y}$, which denote the degree of response of the macroprudential policy tool to deviations in credit, credit spreads, credit growth and loan-to-GDP ratio. We expect $\alpha_{\tau,Qs}$, $\alpha_{\tau,Qs/Y}$, $\alpha_{\tau,\Delta Qs} > 0$ and $\alpha_{\tau,s} < 0$, as conditions to ensure a counter-cyclical macroprudential regulation.

If credit, credit growth and loan-to-GDP ratio exceed their respective steady states, taxes are raised thereby lowering loans and dampening the business cycle; on the other hand, if credit spreads exceed their steady state, taxes are lowered, increasing lending and bursting the business cycle. As before, variables without time subscripts denote their respective steady state values and $Y^F_t$ refers to the flexi-price output.

### 4.2.7 Shock Processes

Our dynamic stochastic general equilibrium model features standard macroeconomic shocks as well as a financial crisis shock. Regarding the former, we consider monetary policy ($MPS_t$), macroprudential policy ($MRS_t$), government spending ($G_t$), technology ($A_t$), trend $(1 + g_t)$ and mark-up ($MS_t$) shocks. In what concerns the financial crisis shock ($\psi_t$), we follow Gertler and Karadi (2011), that suggest a capital quality shock to mimic the subprime crisis of 2007/2008. All the disturbances follow a AR1 process of the form:

\[
\begin{align*}
\log(MPS_t) &= \varrho_{MPS} \log(MPS_{t-1}) + \epsilon_{MPS} \quad (4.44) \\
\log(MRS_t) &= \varrho_{MRS} \log(MRS_{t-1}) + \epsilon_{MRS} \quad (4.45) \\
\log(G_t) &= (1 - \varrho) \log G + \varrho_G \log G_{t-1} + \epsilon_G \quad (4.46) \\
\log(A_t) &= \varrho_A \log(A_{t-1}) + \epsilon_A \quad (4.47) \\
\log(1 + g_t) &= \log(1 + g) + \epsilon_{Atrend} \quad (4.48) \\
\log(MS_t) &= \varrho_{MS} \log(MS_{t-1}) + \epsilon_{MS} \quad (4.49) \\
\log(\psi_t) &= \varrho_\psi \log(\psi_{t-1}) - \epsilon_\psi \quad (4.50)
\end{align*}
\]

where $\epsilon_{MPS}$, $\epsilon_{MRS}$, $\epsilon_G$, $\epsilon_A$, $\epsilon_{Atrend}$, $\epsilon_{MS}$, $\epsilon_\psi \sim i.i.d. N(0, \sigma^2_{\epsilon_i})$. 

137
4.2.8 Calibration of Fundamental Parameters

The values for the model parameters are summarized in Table 4.2.1. We choose standard values in the literature for preference and technology parameters and we define as a time unit a quarter.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>( \beta )</td>
<td>0.9921</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>( g )</td>
<td>0.0184/4</td>
</tr>
<tr>
<td>Government expenditure-output ratio</td>
<td>( g_y )</td>
<td>0.20</td>
</tr>
<tr>
<td>Labour Share</td>
<td>( \alpha )</td>
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</tr>
<tr>
<td>Depreciation rate</td>
<td>( \delta )</td>
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</tr>
<tr>
<td>Habit in consumption</td>
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</tr>
<tr>
<td>Substitution elasticity of goods</td>
<td>( \zeta )</td>
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</tr>
<tr>
<td>Fixed cost</td>
<td>( c )</td>
<td>( \frac{1}{\zeta} = 0.14929 )</td>
</tr>
<tr>
<td>Preference parameter</td>
<td>( \varrho )</td>
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</tr>
<tr>
<td>Investment parameter</td>
<td>( \phi_x )</td>
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</tr>
<tr>
<td>Indexing parameter</td>
<td>( \gamma )</td>
<td>0.2</td>
</tr>
<tr>
<td>Elasticity of Consumption</td>
<td>( \sigma_c )</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Banking Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankers Survival Probability</td>
<td>( \sigma_B )</td>
<td>0.975</td>
</tr>
<tr>
<td>Transfer for New Bankers</td>
<td>( \xi )</td>
<td>0.002</td>
</tr>
<tr>
<td>Asset divertibility</td>
<td>( \Theta )</td>
<td>0.410</td>
</tr>
</tbody>
</table>

Regarding the banking sector parameters, our calibration follows closely those adopted in Gertler and Kiyotaki (2010) and Gertler et al. (2012). We set \( \sigma_B \), the rate of survival of banks, by assuming that banks survive for 40 quarters on average (10 years). Therefore, \( 40 = \frac{1}{1-\sigma_B} \) and \( \sigma_B = 0.975 \). The values of the fractions of initial net worth and assets divertibility, \( \xi \) and \( \Theta \) respectively, are computed to hit an economy wide leverage ratio of four and to have an average credit spread of 100 basis points per year. In the AR1 shock processes, standard deviations of i.i.d shocks are calibrated at 1% and persistence parameters at 0.75. The preference parameter \( \varrho \) is calibrated to hit a hours worked steady state target of \( h = 0.35 \).
4.3 Welfare Analysis

We compare the performance of alternative policy regimes in terms of social welfare. This section is structured in two subsections, based on the policy regimes under analysis. The first subsection deals with policy regimes in which only monetary policy rules are considered. Specifically, a standard monetary policy stance is implemented and used as a baseline scenario to which alternative policy regimes are compared. These alternative policy regimes consider augmented Taylor rules responding to financial imbalances. Welfare analysis is then conducted for both policy regimes and results are shown and commented.

The next subsection presents policy regimes featuring not only monetary policy rules, but also macroprudential policy rules, under separate and partially unified mandates. In each policy regime, the optimal policy rules are those whose policy coefficients grant the consumption and hours worked paths that maximize the inter-temporal utility ($\Lambda$), given by

$$\Lambda_t = E_t \left[ (1 - \beta) \sum_{n=0}^{\infty} \beta^n \Lambda_{t+n} \right]$$

where $\Lambda_t = U(C_t, h_t)$ is the household’s single-period utility function.

These welfare comparisons across policy regimes can also be interpreted in terms of consumption equivalence calculation. Given a particular equilibrium path for consumption and hours worked, $C_t$ and $h_t$, we compute the increase in the steady state single-period utility, following a 1% increase in consumption:

$$CE_t \equiv \Lambda_t (1.01C_t, 1.01C_{t-1}, h_t) - \Lambda_t (C_t, C_{t-1}, h_t)$$

Then, we compute the consumption equivalent percentage ($ce_1(\%)$) by first selecting the rule among a set of distinct policy rules that maximizes welfare ($\Lambda^*$) and using it as a

---

\[10\] In Appendix 4.3 we present impulse response functions obtained following some shocks, using simple, not optimized, monetary and macroprudential policy rules. The feedback coefficients used in this exercise were chosen in ad hoc fashion, based on the literature. We acknowledge the scarce information regarding how policymakers may react to certain financial variables dynamics, which have led us to concentrate on the optimal policy outcomes. Still, the exercise presented in this Appendix provides similar conclusions in terms of the dynamics of the model under different regimes of monetary and macroprudential policies.
benchmark. Then, we calculate the welfare deviation of each policy rule from the maximum welfare value (\( \Lambda^* \)) and we normalise it by the percentage change in consumption in the deterministic steady state that would give households the same unconditional expected utility in the stochastic economy, \( CE = 0.00224 \), in our model. Among a subset of policy regimes, figure \( ce_1(\%) \) represents the loss in welfare from considering policy regimes distinct from the one that maximizes welfare. For the policy regime that maximises welfare we set \( ce_1^*(\%) = 0\%. \) The consumption equivalent percentage is useful to compare welfare outcomes within each subset of policy regimes.

Nevertheless, a measure of welfare performance is needed to compare outcomes across all sets of policy regimes, which is represented by \( ce_2(\%) \). The normalisation procedure is then adopted to make the comparison of welfare outcomes across different policy regimes more comprehensible. By considering the consumption equivalent concept, the normalisation is calculated by the welfare deviation of each policy rule (\( \Omega_0 \)) from the welfare figure obtained under laissez-faire (i.e. under a standard Taylor rule). The denominator of this ratio remains the same, \( CE = 0.00224 \). Therefore, we obtain a measure of the change of welfare for each policy regime over the standard Taylor regime. A negative figure indicates a welfare cost and a positive figure indicates a welfare gain.

The parameters of the model are kept constant across all policy regimes.

### 4.3.1 Optimal Standard Taylor Rule and Leaning-Against-The-Wind Monetary Policy

With the aim of investigating whether, in a macroeconomic model with nominal and financial frictions, monetary policy should also respond to financial imbalances, we compute optimal simple rules for monetary policy feeding back on financial variables. For this purpose, we compare an interest rate smoothing standard Taylor rule, that reacts to inflation and output gaps, with augmented rules that also respond to financial variables, such as credit, credit spreads and asset prices. Then, from a set of monetary policy rules, we identify the one that is welfare maximizing. Three different augmented monetary rules are considered in this analysis: a rule reacting to inflation, output and credit gaps; a rule targeting inflation, output and credit spreads gaps and a rule responding to inflation, output and Tobin’s Q gaps. The format of these rules was described in section 4.2.6.

Table 4.3.1 summarises the computation results for the welfare-optimised coefficients for
each of these monetary policy rules.\footnote{The computation procedures are implemented in Dynare 4.2.4, using a second-order perturbation solution of the model with a particular policy rule interfaced with a standard Matlab minimization procedure.}

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>$\rho_r$</th>
<th>$(1-\rho_r)\theta_{r,s}$</th>
<th>$(1-\rho_r)\theta_{r,y}$</th>
<th>$(1-\rho_r)\theta_{r,QS}$</th>
<th>$(1-\rho_r)\theta_{r,qs}$</th>
<th>$(1-\rho_r)\theta_{r,Q}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Std Taylor Rule (TR)</td>
<td>0.1697</td>
<td>4.4243</td>
<td>0.0711</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Aug TR react. Credit</td>
<td>0.7029</td>
<td>5.0000</td>
<td>0.0000</td>
<td>0.0316</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Aug TR react. Spreads</td>
<td>0.5335</td>
<td>4.4803</td>
<td>0.0000</td>
<td>-</td>
<td>-1.9619</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Aug TR react. Tobin’s Q</td>
<td>0.2053</td>
<td>3.4922</td>
<td>0.0000</td>
<td>-</td>
<td>-</td>
<td>0.5174</td>
</tr>
</tbody>
</table>

We find that monetary policy should respond to increases in credit or asset prices regarding their steady state values by raising interest rates, on one hand. On the other hand, monetary policy should lower interest rates in the case of a rise in credit spreads. Thus, results show that an optimal monetary policy that ‘leans against the wind’ would react countercyclically to credit, credit spreads or even asset prices. The finding associated to a simple rule that also reacts to credit spreads is in line with results from Curdia and Woodford (2010), which also demonstrate that monetary policymakers should relax the monetary policy stance whenever credit spreads increase. Previous literature does not back up our result for a rule feeding back on asset prices. In particular, in a model with credit market imperfections, Faia and Monacelli (2007) show that an optimal monetary policy strategy is one that reacts to asset prices increases by lowering interest rates.

Our findings also show that the optimal reaction to output fluctuations around its flexi-price level would be zero, whenever we consider a monetary policy stance feeding back on financial variables.

The policy regimes are ranked using a welfare criterion. Table 4.3.2 shows the computed welfare outcomes, both in absolute ($\Lambda$) and normalised ($ce_2(\%)$) terms. As already mentioned, the normalisation procedure is adopted to facilitate comparison of welfare performance across policy regimes in distinct tables and it is calculated by dividing the welfare outcome in absolute terms for each policy rule by the welfare outcome under laissez-faire, which, in our model, we assume it is given by the welfare outcome under the standard Taylor rule. Table 4.3.2 is completed with the consumption equivalent.
criterion ($ce_1(%)$) and the standard deviations of interest rates ($\sigma_r$), inflation ($\sigma_\pi$) and output ($\sigma_y$).\footnote{As explained in Section 3, we compute the consumption equivalence percentage by first selecting the rule that maximizes welfare ($\Lambda^*$) and using it as a benchmark. Then, we calculate the welfare deviation from each policy rule from the maximum welfare value ($\Lambda^*$) and we normalise it by the percentage change in consumption in the deterministic steady-state that would provide households with the same unconditional expected utility in the stochastic economy.}

Table 4.3.2: Optimal Monetary Policy Rules - Welfare Losses / Gains and Std Deviations

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>$\Lambda$</th>
<th>Welfare Loss</th>
<th>Welfare Gain</th>
<th>$\sigma_r$</th>
<th>$\sigma_\pi$</th>
<th>$\sigma_y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Std TR</td>
<td>-1.886534</td>
<td>0.0615</td>
<td>baseline</td>
<td>0.0119</td>
<td>0.0020</td>
<td>0.0230</td>
</tr>
<tr>
<td>2</td>
<td>Aug TR react. Credit</td>
<td>-1.886529</td>
<td>0.0593</td>
<td>0.0022</td>
<td>0.0097</td>
<td>0.0018</td>
<td>0.0227</td>
</tr>
<tr>
<td>3</td>
<td>Aug TR react. Spreads</td>
<td>-1.886480</td>
<td>0.0375</td>
<td>0.0241</td>
<td>0.0100</td>
<td>0.0027</td>
<td>0.0210</td>
</tr>
<tr>
<td>4</td>
<td>Aug TR react. Tobin’s Q</td>
<td>-1.886396</td>
<td>0.0000</td>
<td>0.0615</td>
<td>0.0103</td>
<td>0.0036</td>
<td>0.0189</td>
</tr>
</tbody>
</table>

Welfare outcomes suggest that the monetary policy rule that minimizes welfare losses is an augmented one that reacts to asset prices (captured by the variable Tobin’s Q in this model). Compared to this rule, the alternative regimes imply welfare losses ranging from 0.04% (policy regime 3) to 0.06% (policy regime 1) in terms of consumption equivalent. Moreover, every augmented Taylor rule considered in this analysis would perform better than the standard, conventional Taylor rule, as indicated by the welfare gains figures. In fact, a standard Taylor rule is more welfare costly than ‘leaning against the wind’ policy mandates in a macroeconomic framework in which financial frictions are also modelled, implying a welfare loss of 0.06% in $ce_1(%)$.

From the point of view of inflation stabilisation however, a rule responding to credit spreads would have a worse performance than a standard one. In fact, rules reacting to credit spreads and asset prices are related to higher inflation volatility, as claimed in the literature. Therefore, our results suggest that the monetary policy rule that seems to make a compromise between welfare maximization and inflation stability is one reacting to fluctuations in credit around its steady state, since it delivers a smaller welfare loss than a standard Taylor rule, at the same time it leads to lower inflation, output and interest rate volatility.
4.3.2 Optimal Monetary and Macroprudential Policies

In this section, we assess the effectiveness of macroprudential policy in terms of welfare maximization and macroeconomic stabilisation. We also determine the most efficient institutional arrangement of monetary and macroprudential policies. The macroprudential instrument adopted in this exercise is a tax on bank loans, $\tau_t$, although given the way the banking regulation is modelled in this paper, it is feasible to apply the same type of welfare analysis using a subsidy on net worth instead. This innovative feature of the model allows us to compare the effectiveness of different macroprudential tools in terms of welfare impact. We opt for showing in detail the optimal policy outcomes when a tax on loans is considered as a macroprudential instrument, although we also comment on the results attained when the macroprudential tool is a subsidy on net worth.

Our analysis is conducted based on two additional policy mandates. First, we consider a policy mandate featuring macroprudential policy rules alongside a standard monetary policy stance. In other words, we assume that each policy maker focuses on their own policy objective, suggesting that the monetary authority sets interest rates to respond to fluctuations in inflation and output, whereas the macroprudential regulator sets taxes on loans to control for deviations of financial variables from their paths. Second, we propose a policy regime in which both monetary and macroprudential rules respond to financial imbalances, to assess a partially unified institutional mandate. In this case, we admit a monetary policy maker that not only pursues price stability, but it is also concerned about the stability of the financial system as a whole, as a mean to maximize households’ utility. Therefore, we suggest an augmented monetary policy rule, alongside a macroprudential policy rule.\footnote{We could have suggested a totally unified policy mandate, by assuming that macroprudential policy reacts not only to financial imbalances, but also to price stability (by considering it was also feeding back on inflation fluctuations around its steady state). Nonetheless, we consider that a partially unified regime is a more realistic scenario, since there is a consensual view among academics and policy makers that the macroprudential policy goals should focus exclusively on financial system stability, leaving inflation volatility as a monetary policy responsibility.}

Then, we recover the welfare and macroeconomic stabilization outcomes from \[4.2.6\] for the baseline case given by a standard Taylor rule, and we contrast them with the results obtained for policy regimes comprising macroprudential regulation.

As before, we assess the welfare losses / gains using consumption equivalent measures. Furthermore, the stabilization effects of adding macroprudential policy on output, inflation and interest rates are investigated as well, by computing the volatility for each of
these three variables. Since we are interested in assessing the impact of macroprudential regulation in normal times as well as abnormal times, a multi-shock environment is considered, including all the shocks already described above: productivity, government spending, mark-up, monetary policy, macroprudential policy, capital quality and trend shocks. Then, we optimize macroprudential policies in this multi-shock scenario, considered more realistic since macroprudential regulation is expected to deal with different sources of economic shocks simultaneously (Angelini et al. 2011).

Results from computation of optimal simple rules are shown in the following sections for each policy mandate: separate and partially unified.

Results for the Separate Policy Mandate

To simulate a separate mandate, we assume that each policymaker is solely concerned with their own policy goal. The monetary policymaker is a conventional one in the sense it targets price stability only, by following a standard Taylor rule. On the other hand, to investigate the role of macroprudential policy in stabilising the economy, we define alternative types of macroprudential policy rules, by considering distinct financial stability targets. Against this background, a macroprudential rule is set so that it reacts exclusively to credit, credit spreads, loan-to-GDP ratio or credit growth. Admitting the possibility of having a macroprudential policy rule feeding back on more than one financial indicator, we also analyse a rule reacting to credit and credit spreads, simultaneously.

The coefficients are computed jointly for each type of rule, and their optimised values are shown below, in Tables 4.3.3 and 4.3.4:

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Monetary Policy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\rho_r$</td>
</tr>
<tr>
<td>1</td>
<td>Std TR</td>
<td>0.1697</td>
</tr>
<tr>
<td>5</td>
<td>Std TR + MR Credit</td>
<td>0.3770</td>
</tr>
<tr>
<td>6</td>
<td>Std TR + MR Credit Spreads</td>
<td>0.9411</td>
</tr>
<tr>
<td>7</td>
<td>Std TR + MR Loan-to-Y Ratio</td>
<td>0.3285</td>
</tr>
<tr>
<td>8</td>
<td>Std TR + MR Credit Growth</td>
<td>0.3814</td>
</tr>
<tr>
<td>9</td>
<td>Std TR + MR Credit &amp; Spreads</td>
<td>0.6128</td>
</tr>
</tbody>
</table>
Table 4.3.4: Separate Mandate - Macroprudential Policy Optimised Coefficients

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Macroprudential Policy Rules</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>STR + MR Credit</td>
<td>0.0000</td>
<td>0.0145</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>STR + MR Credit. Spreads</td>
<td>0.1195</td>
<td>-</td>
<td>-1.5600</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>STR + MR Loan-to-Y Ratio</td>
<td>0.0000</td>
<td>-</td>
<td>-</td>
<td>0.0167</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>STR + MR Credit Growth</td>
<td>0.0000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0146</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>STR + MR Credit &amp; Spreads</td>
<td>0.0000</td>
<td>0.0079</td>
<td>-1.7147</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

There are two main findings from this exercise. First, introducing an additional policy instrument (i.e. a tax on bank loans) leads to a decrease on the aggressiveness of the response of a standard Taylor rule to deviations of inflation from its steady state. Under a standard Taylor rule, the degree of aggressiveness is \((1 - \rho_t)\theta_{r,\pi} = 4.4\), whereas under a policy regime that combines both a standard Taylor rule and a macroprudential rule, it ranges from a minimum of \((1 - \rho_t)\theta_{r,\pi} = 1.6\) when reacting to fluctuations in credit spreads, to a maximum of \(\theta_{r,\pi} = 3.6\), when responding to fluctuations in credit growth around their steady state. Therefore, the need for the monetary policy maker to react strongly to fluctuations of inflation rates around its steady state is attenuated when macroprudential policy is in place. This result may suggest that the macroprudential authority can give a hand to the monetary policy maker in certain economic circumstances. Regarding its effects on the magnitude of monetary policy reaction to the output gap, results are mixed, since although some policy regimes, such as 5 and 8, register output gap optimised coefficients below the baseline rule, there are other policy regimes in which this does not verify (policy regimes 6, 7 and 9).

Second, the optimal reaction of macroprudential policy is a rise in the tax on loans to increases in credit and loan-to-GDP ratio and a cut on taxes following a rise in credit spreads. Hence, results confirm the countercyclical nature of macroprudential regulation. Moreover, it is worth noting that the degree of persistence of the macroprudential instrument is non-existent for almost all the policy rules considered in this analysis, except when a policy regime comprising a standard Taylor rule and a macroprudential rule feeding back on credit spreads is in place. In this policy regime, the optimal response for the macroprudential policy tool is 0.1195.

Table 4.3.5 shows the computed welfare losses and standard deviations for interest rates, inflation and output for each macroprudential rule. An important result of this analysis
is that macroprudential regulation improves welfare. This is observed based on the consumption equivalence outcomes, since the largest loss in consumption is achieved when monetary policy alone reacts to the shocks affecting this economy (0.06% of consumption loss, when comparing with the welfare maximizing policy regime featuring a standard Taylor rule and a macroprudential policy rule feeding back on spreads and credit). In the case macroprudential regulation is deployed, the welfare loss decreases, achieving its minimum in a mandate in which a standard Taylor rule is coupled with a macroprudential rule reacting to both credit and credit spreads. Nonetheless, the gains of having macroprudential policy are small in this economy, varying from a minimum of 0.04% (policy regime 6) to a maximum of 0.06% (policy regime 9). This finding is in line with the conclusions of Angelini et al. (2011) and De Paoli and Paustian (2012), whom also found modest gains of introducing macroprudential regulation based on alternative economic frameworks.

Table 4.3.5: Separate Mandate - Welfare Losses / Gains and Std Deviations

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Λ</th>
<th>Welf. Loss</th>
<th>Welf. Gain</th>
<th>σr</th>
<th>σπ</th>
<th>σy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ce₁ (%)</td>
<td>ce₂ (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>STR only</td>
<td>-1.88653</td>
<td>0.0638</td>
<td>Baseline</td>
<td>0.0119</td>
<td>0.0020</td>
<td>0.0230</td>
</tr>
<tr>
<td>5</td>
<td>STR + MR Credit</td>
<td>-1.88644</td>
<td>0.0228</td>
<td>0.0415</td>
<td>0.0114</td>
<td>0.0021</td>
<td>0.0157</td>
</tr>
<tr>
<td>6</td>
<td>STR + MR Credit Spreads</td>
<td>-1.88645</td>
<td>0.0263</td>
<td>0.0375</td>
<td>0.0094</td>
<td>0.0023</td>
<td>0.0155</td>
</tr>
<tr>
<td>7</td>
<td>STR + MR Loan-to-GDP Ratio</td>
<td>-1.88645</td>
<td>0.0245</td>
<td>0.0392</td>
<td>0.0116</td>
<td>0.0022</td>
<td>0.0159</td>
</tr>
<tr>
<td>8</td>
<td>STR + MR Credit Growth</td>
<td>-1.88644</td>
<td>0.0223</td>
<td>0.0415</td>
<td>0.0113</td>
<td>0.0021</td>
<td>0.0157</td>
</tr>
<tr>
<td>9</td>
<td>STR + MR Credit &amp; Spreads</td>
<td>-1.88639</td>
<td>0.0000</td>
<td>0.0638</td>
<td>0.0102</td>
<td>0.0017</td>
<td>0.0143</td>
</tr>
</tbody>
</table>

The findings suggest that the policy regime that minimizes welfare losses also attains a lower volatility in inflation ($σ_π = 0.0017$) and output ($σ_y = 0.0143$), being thereby more efficient in stabilising the economy.

Apart from this policy regime #9, in terms of inflation stability a “STR only” is preferable to a policy regime comprising macroprudential policy (except regime #9, as already mentioned), since inflation volatility is lower under this regime ($σ_π = 0.0020$). Regarding output stabilization, this is better achieved under policy regimes that couple a standard Taylor rule with a macroprudential rule, reaching its minimum under a “STR + MR reacting to Credit Spreads” mandate (#6).

Rules that target different proxies for credit imbalances, namely credit deviations from steady state values, loan-to-GDP ratio and credit growth, provide very similar results in
terms of welfare. However, the rule that seems to work best is the one reacting to credit growth, since it delivers the lowest welfare loss (0.0223%, in consumption equivalence terms). This rule also minimizes inflation and output volatility, as well as a rule reacting to credit deviations from its steady state values. Among these three policy rules, the one that performs worst is that reacting to the loan-to-GDP ratio, since it does not improve the outcomes produced by the other two alternative rules: inflation and output are more volatile and welfare loss is larger under this policy arrangement. In addition, a macroprudential policy rule feeding back exclusively on credit spreads does not provide better outcomes than the one responding to loan-to-GDP ratio, both in terms of welfare and inflation stabilization.

Furthermore, from the analysis of the standard deviations obtained for interest rates, and given that the volatility of interest rates declines whenever a macroprudential policy arrangement is introduced, the conclusion is that incorporating macroprudential policy in this set up decreases the probability of the economy hitting the zero lower bound.

**Results for the Partially Unified Policy Mandate**

In this section, the welfare and stabilization outcomes from the joint optimization of mandates composed by monetary policy rules reacting to financial variables and macroprudential regulation are explored. This exercise aims at mimicking a partially unified institutional regime, in which both monetary and macroprudential policies feed back on financial stability variables. This regime is different from a complete unified regime, which would be characterized by each policy targeting both price and financial stability. However, it seems unrealistic to assume that macroprudential regulation would be also concerned about inflation stabilization, being more likely to consider a wider scope of intervention for monetary policy.

It should be noted though that, unlike for example De Paoli and Paustian (2012) and Gelain et al. (2013), we are not comparing coordination in the form of joint maximization with a non-cooperative Nash equilibrium for non-coordination. For both regimes the same welfare criteria is used, so with given forms of simple rules a Nash equilibrium would be a ‘team-optimal solution’ and give an identical outcome as with coordination (see Basar and Olsder (1982), chapter 6). Rather the unified and separate mandates both jointly (though it could be in a Nash equilibrium) maximize the welfare, but under different constraints on the rules that reflect the different targets for the nominal and regulatory instruments in the two cases.
In order to simulate a partially unified regime, we consider alternative combinations of augmented Taylor rules and macroprudential regulation rules. First, we assume that both monetary and macroprudential rules feed back on deviations of credit from its steady state. The second and third policy regime alternatives combine a monetary policy and macroprudential rule reacting both to credit spreads and loan-to-value ratio, respectively. As a last combination, we broaden the range of financial targets that policies feed back on, assuming that they react jointly to credit and credit spreads.

Tables 4.3.6 and 4.3.7 show the optimised coefficients under these alternative policy combinations. Results are in line with the ones obtained for a separate regime. First, the optimal magnitude of monetary policy reaction to inflation decreases whenever macroprudential regulation is deployed suggesting that monetary policy does not need to be that aggressive whenever macroprudential tools are in place. Second, the optimal macroprudential policy is of a countercyclical nature, since it responds positively to deviations of credit and loan-to-GDP ratio from their respective steady state values and negatively to deviations of credit spreads from their steady state values.

Table 4.3.6: Partially Unified Mandate - Monetary Policy Optimised Coefficients

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Monetary Policy Rules</th>
<th>Aug TR + MR reacting to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Credit</td>
<td>0.396</td>
<td>3.782</td>
</tr>
<tr>
<td>11</td>
<td>Spreads</td>
<td>0.231</td>
<td>3.212</td>
</tr>
<tr>
<td>12</td>
<td>Loan-to-Y Ratio</td>
<td>0.366</td>
<td>3.566</td>
</tr>
<tr>
<td>13</td>
<td>Credit Growth</td>
<td>0.387</td>
<td>3.715</td>
</tr>
<tr>
<td>14</td>
<td>Cred. &amp; Spreads</td>
<td>0.331</td>
<td>2.808</td>
</tr>
</tbody>
</table>

Table 4.3.7: Partially Unified Mandate - Macroprudential Policy Optimised Coefficients

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Macroprudential Policy Rules</th>
<th>Aug TR + MR reacting to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Credit</td>
<td>0.00</td>
<td>0.014</td>
</tr>
<tr>
<td>11</td>
<td>Spreads</td>
<td>0.00</td>
<td>-2.369</td>
</tr>
<tr>
<td>12</td>
<td>Loan-to-Y Ratio</td>
<td>0.00</td>
<td>-0.016</td>
</tr>
<tr>
<td>13</td>
<td>Credit Growth</td>
<td>0.00</td>
<td>-0.014</td>
</tr>
<tr>
<td>14</td>
<td>Cred. &amp; Spreads</td>
<td>0.00</td>
<td>-0.016</td>
</tr>
</tbody>
</table>

Table 4.3.8 shows computation outputs for welfare losses and standard deviations for the partially unified alternative policy regimes. To facilitate comparison across the alternative policy regimes, this table also displays the baseline policy regime, given by a
standard Taylor rule only, and the policy regime with better performance so far in what concerns welfare maximization, given by a separate regime featuring a standard Taylor rule and a macroprudential policy rule responding to credit and spreads.

In what regards the impact of different policy mandates on welfare losses, we conclude that the partially unified regime promotes an increase in welfare compared to a separate mandate, but only when macroprudential regulation reacts simultaneously to credit and credit spreads (the welfare gain is 0.07%, greater than the attained by policy regime 9, 0.06%). Otherwise, a separate regime is preferable to a partially unified one, according to these outcomes. Nevertheless, the gains from coordination are still modest: in consumption equivalent terms, a separate regime implies a 0.01% welfare loss and a standard Taylor rule implies a 0.07% loss, when compared to a partially unified regime that reacts to credit and credit spreads.

Inflation stabilization, on the other hand, is better achieved in a separate mandate, composed by a standard Taylor rule and macroprudential regulation responding jointly to credit and spreads. Another result worth highlighting is that, as before, a macroprudential policy reacting to the loan-to-GDP ratio does not provide an improvement over a rule responding to credit deviations only. This indicator also performs poorly not only in terms of welfare losses minimization, but also regarding inflation, output and interest rate stabilization.

Table 4.3.8: Partially Unified Mandate - Welfare Losses/Gains and Std Deviations

<table>
<thead>
<tr>
<th></th>
<th>Policy Regimes</th>
<th>Λ</th>
<th>Welfare Loss</th>
<th>Welfare Gain</th>
<th>σ (_r)</th>
<th>σ (_\pi)</th>
<th>σ (_y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Std TR only</td>
<td>-1.88634</td>
<td>0.0740</td>
<td>Baseline</td>
<td>0.0119</td>
<td>0.0020</td>
<td>0.0230</td>
</tr>
<tr>
<td>9</td>
<td>Std TR + MR Credit &amp; Spreads</td>
<td>-1.886391</td>
<td>0.0103</td>
<td>0.0638</td>
<td>0.0102</td>
<td>0.0017</td>
<td>0.0143</td>
</tr>
<tr>
<td></td>
<td><strong>Aug TR + MR reacting to:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Credit</td>
<td>-1.886437</td>
<td>0.0308</td>
<td>0.0433</td>
<td>0.0112</td>
<td>0.0021</td>
<td>0.0156</td>
</tr>
<tr>
<td>11</td>
<td>Spreads</td>
<td>-1.886403</td>
<td>0.0156</td>
<td>0.0584</td>
<td>0.0112</td>
<td>0.0019</td>
<td>0.0151</td>
</tr>
<tr>
<td>12</td>
<td>Loan-to-Y Ratio</td>
<td>-1.886440</td>
<td>0.021</td>
<td>0.0419</td>
<td>0.0113</td>
<td>0.0022</td>
<td>0.0157</td>
</tr>
<tr>
<td>13</td>
<td>Credit Growth</td>
<td>-1.886437</td>
<td>0.0308</td>
<td>0.0433</td>
<td>0.0112</td>
<td>0.0021</td>
<td>0.0155</td>
</tr>
<tr>
<td>14</td>
<td>Credit &amp; Spreads</td>
<td>-1.886368</td>
<td>0.0000</td>
<td>0.0740</td>
<td>0.0108</td>
<td>0.0018</td>
<td>0.0127</td>
</tr>
</tbody>
</table>
4.3.3 Subsidy on Net Worth as a Macroprudential Tool

Since we conceived a model in which it is possible to assess the degree of effectiveness of alternative macroprudential tools, such as a tax on loans or a subsidy on net worth, we performed the same optimal policy approach, but now using the subsidy on net worth as a macroprudential tool. These are distinct tools since the tax on loans has a direct effect on lending, while the subsidy on net worth affects first the net worth of the bank and, only indirectly, the amount of loans. The subsidy on net worth resembles the countercyclical capital buffer, as established in Basel III, which is a time-varying instrument working through the net worth channel of the banks.

The subsidy on net worth works distinctly from the tax on loans. It should be expected that, when credit surpasses its steady state path, subsidies on net worth are reduced, thereby contracting loans and dampening the business cycle. In turn, when credit spreads exceed their steady state values, subsidies on net worth are raised, thereby increasing lending and expanding the business cycle.

Table 4.3.9 summarises these outcomes. The use of a subsidy on net worth is also welfare improving and results from optimal policy suggest that a subsidy on net worth is more welfare improving than a tax on loans. In every policy regime considered in the analysis, the welfare gains are substantially larger from macroprudential policy rules in which a subsidy on net worth is used, ranging from a maximum of 0.16% (in consumption equivalence terms) to a minimum of 0.11%. From a policy perspective, this finding suggests that macroprudential instruments that directly target net worth of banks produce higher welfare gains than instruments that have a direct effect on loans. Nevertheless, a tax on loans does, in general, a better job in promoting the stability of prices.

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Subsidy on Net Worth</th>
<th>Tax on Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ω1 (%)</td>
</tr>
<tr>
<td>1</td>
<td>Std TR only</td>
<td>-1.88653</td>
<td>0.1597</td>
</tr>
<tr>
<td>5</td>
<td>Std TR + MR Credit</td>
<td>-1.88621</td>
<td>0.0161</td>
</tr>
<tr>
<td>6</td>
<td>Std TR + MR Spreads</td>
<td>-1.88625</td>
<td>0.0339</td>
</tr>
<tr>
<td>9</td>
<td>Std TR + MR Credit &amp; Spreads</td>
<td>-1.88618</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>Augmented TR + MR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>React. to Credit</td>
<td>-1.88621</td>
<td>0.0156</td>
</tr>
<tr>
<td>11</td>
<td>React. to Spreads</td>
<td>-1.88628</td>
<td>0.0459</td>
</tr>
</tbody>
</table>
4.4 Conclusions

This paper aims at contributing to the debate regarding the role of monetary policy and traditional regulatory and prudential frameworks on promoting macroeconomic stability. We built a DSGE model with price rigidities and financial frictions *ala* Gertler and Karadi (2011) in order to assess the importance of macroprudential and monetary policies in improving welfare and stabilising the economy. In particular, we investigate whether it is welfare beneficial to have a monetary policy strategy that also leans against the build up of financial imbalances and we compare it with a policy mandate in which macroprudential regulation is also considered.

Our optimal policy exercises, obtained in the context of a linearised model that excludes financial (in)stability and default, provide three main findings. First, it is welfare improving to have a monetary policy stance that reacts countercyclically to asset prices. Nonetheless, there is a trade-off in terms of inflation stabilization, since an augmented Taylor rule of this type would involve more prices volatility than a standard one. A compromise between welfare maximization and inflation stability seems to be achieved under a policy regime characterised by an augmented Taylor rule that feeds back on deviations of credit from its steady state path.

Second, the consideration of a policy mandate in which monetary policy is complemented by macroprudential regulation is welfare improving, regardless of the type of policy mandate adopted. The welfare maximizing mandate is one in which an augmented Taylor rule reacting to credit and credit spreads is combined with a macroprudential rule that responds to credit and credit spreads as well. The welfare gains from a partially unified mandate are of the order of a consumption equivalent improvement of 0.07% when compared with the baseline case, given by a standard Taylor rule only. This improvement is, in fact, small, but aligned with previous findings in the literature (see, for instance, De Paoli and Paustian (2012); Angelini et al. (2011)). Inflation stabilization, on the other hand, is better accomplished in a separate mandate, in which we have a standard Taylor rule feeding back on inflation and output gaps, and a macroprudential rule responding to credit and spreads. Lastly, the countercyclical nature of macroprudential instruments is optimal from the point of view of welfare optimization, as optimal policy simulations show.

Moreover, from the comparison of the effectiveness of macroprudential instruments in maximizing welfare, we show that a tax on loans proves to be less welfare improving than a tool targeting directly the net worth of banks, such as a subsidy on net worth.
Nevertheless, a tax on loans does in general a better job in promoting the stability of prices. The use of either instrument is always welfare maximizing related to a baseline scenario in which a standard Taylor rule is assumed.

The findings of this paper must be interpreted carefully, since they result from DSGE models with typical solution techniques based on log-linearization, which do not allow for the non-linear dynamics that usually characterize boom-bust episodes. Despite the absence of nonlinearities in these models, the importance for monetary policy to ‘lean against the wind’ and for considering macroprudential policy as an ancillary tool to deal with financial imbalances is entirely confirmed by simply granting a non-negligible role to financial intermediation provided by the banking system.
Appendix 4.1

The regulated banking sector

Assuming a tax / subsidy scheme, in the lines of Gertler et al. (2012) and De Paoli and Paustian (2012), total taxes from the macroprudential regulation scheme are given by

\[ T^\text{MR}_t = \tau_t Q_t S_t - \tau_t^s N_t \] (4.53)

The timing of the tax regime is as follows. In period \( t - 1 \), tax and subsidy rates, \( \tau_{t-1} \), and \( \tau_{t-1}^s \) respectively, are set to be paid or received on the value of end-of-period \( t - 1 \) (or beginning of period \( t \)) loans \( Q_{t-1} s_{t-1} \) and end-of-period net worth \( n_{t-1} \) respectively. The net worth of the bank then accumulates in period \( t \) according to:

\[ n_t = R_{k,t} Q_{t-1} s_{t-1} - R_t^\text{ex} d_{t-1} + \tau_{t-1}^s n_{t-1} - \tau_{t-1} Q_{t-1} s_{t-1} \] (4.54)

That is, net worth equals gross returns minus gross costs of borrowing, plus subsidies minus taxes carried over over from the previous period. Banks are atomistic and take the tax rate and subsidy as exogenous.

With this timing for taxes or subsidies, the balance sheet of the bank in period \( t \) remains as before:

\[ Q_t s_t = n_t + d_t \] (4.55)

which says that net worth plus subsidies plus deposits can be used to finance loans net of tax.

As before we can substitute for \( d_t \) from (4.55) and rewrite (4.54) to give

\[ n_t = R_t^\text{ex} n_{t-1} + (R_{k,t} - R_t^\text{ex}) Q_{t-1} s_{t-1} - T^\text{MR}_{t-1} \]
\[ = (R_t^\text{ex} + \tau_{t-1}^s) n_{t-1} + (R_{k,t} - R_t^\text{ex} - \tau_{t-1}) Q_{t-1} s_{t-1} \] (4.56)

which says that net worth at the end of period \( t \) equals the gross return at a real riskless rate plus the excess return over the latter on the assets plus subsidies minus taxes carried over from the previous period.

As for the laissez-faire banking sector model, the optimisation problem for the banks to chose a path for borrowing to maximize \( V_t \) subject to the incentive constraint

153
\[ V_t(s_t, n_t) = \mu_{s,t} Q_t s_t + \mu_{n,t} n_t \quad (4.57) \]

s. t.

\[ V_t \geq \Theta_t Q_t s_t \quad (4.58) \]

and write the Bellman equation for a given path for \( n_t \) in the form

\[ V_{t-1}(s_{t-1}, n_{t-1}) = E_t \Lambda_{t,t+1} [(1 - \sigma_B)n_t + \sigma_B \max_{s_t} V_t(s_t, n_t)] \quad (4.59) \]

Again we perform the optimization \( \max_{s_t} V_t(s_t, n_t) \) subject to the incentive constraint. The first order conditions for this optimization problem are as before with a slight notational difference that \( \nu_{d,t} \) is replaced with \( \mu_{n,t} : \)

\[
\begin{align*}
  s_t & : (1 + \lambda_t^t) \mu_{s,t} = \lambda_t \Theta \\
  \lambda_t & : \mu_{s,t} Q_t s_t + \mu_{n,t} n_t \geq \Theta Q_t s_t
\end{align*}
\]

Again define \( \phi_t \) to be the leverage ratio:

\[ Q_t s_t = \phi_t n_t \quad (4.60) \]

Assuming the incentive constraint always binds, \( \phi_t \) is given by

\[ \phi_t = \frac{\mu_{n,t}}{\Theta - \mu_{s,t}} \quad (4.61) \]

Using (4.61) we can write (4.57) as

\[ V_t = [\mu_{s,t} \phi_t + \mu_{n,t}] n_t \quad (4.62) \]

and hence (4.59) becomes

\[
\begin{align*}
  V_t(s_t, n_t) &= E_t \Lambda_{t,t+1} [1 - \sigma_B + \sigma_B (\mu_{s,t+1} \phi_{t+1} + \mu_{n,t+1})] n_{t+1} \\
  &= E_t \Lambda_{t,t+1} \Omega_{t+1} [(R_{k,t+1} - R_{t+1}^{ex} - \tau_t) Q_t s_t + (R_{t+1}^{ex} + \tau_t^s) n_t]
\end{align*}
\quad (4.63) \]

defining \( \Omega_t = 1 - \sigma_B + \sigma_B (\mu_{n,t} + \phi_t \mu_{s,t}) \), the shadow value of a unit of net worth, and
using (4.39).

The equilibrium of the banking model is given by

\[ S_t = K_t \]
\[ (1 + \lambda_t)\mu_{s,t} = \lambda_t \Theta \]
\[ Q_t S_t = \phi_t N_t \]
\[ \phi_t = \frac{\mu_{n,t}}{\Theta - \mu_{s,t}} \]
\[ N_t = R_{k,t}(\sigma_B + \xi_B)Q_{t-1}S_{t-1} - \sigma_B R_{t-1}^e D_{t-1} - \sigma_B T_{t-1}^{MR} \]
\[ D_t = Q_t S_t - N_t \]
\[ T_t^{MR} = \tau_t Q_t S_t - \tau_t S_t N_t \]
\[ \mu_{n,t} = E_t [\Lambda_{t,t+1}\Omega_{t+1}(R_{t+1}^e + \tau_t)] \]
\[ \mu_{s,t} = E_t [\Lambda_{t,t+1}\Omega_{t+1}(R_{k,t+1} - R_{t+1}^e - \tau_t)] \]
\[ \Omega_t = 1 - \sigma_B + \sigma_B (\mu_{d,t} + \phi_t \mu_{s,t}) \]
\[ R_{k,t} = \frac{Z_t + (1 - \delta)Q_t}{Q_{t-1}} \]
\[ Z_t = \frac{(1 - \alpha)P_t^W Y_t^W}{K_{t-1}} \]

with \( \tau_t^s \) or \( \tau_t \) exogenous. Clearly in the absence of taxes or subsidies, i.e. \( \tau_t = \tau_t^s = 0 \), we get back to the previous set-up.

### Appendix 4.2

In this appendix, we present welfare results for the optimization of implementable rules, i.e., rules that do not require the knowledge of the efficient level of output. Thereby, the standard monetary policy rule is described as such:

\[
\log \left( \frac{R_{n,t}}{R_n} \right) = \rho_r \log \left( \frac{R_{n,t-1}}{R_n} \right) + (1 - \rho_r) \left[ \theta_{r,\pi} \log \left( \frac{\Pi_t}{\Pi} \right) + \theta_{r,y} \log \left( \frac{Y_t}{Y} \right) \right] + \log(MPS_t)
\]

where \( Y \) refers to the steady state level of output and the other arguments are as described above. The macroprudential policy rules remain the same, since they do not depend on the output gap. The instrument used in this exercise is a tax on loans.

Simulation results of optimal policy using implementable rules are close to the ones
obtained by optimizing conventional policy rules, supporting the main conclusions of this chapter. First, a mandate in which the central bank has only the mission to stabilise prices following a optimised standard Taylor rule provides the worst outcomes for social welfare. Second, the first four mandates that grant the highest welfare gains remain the same, regardless of the type of rule being optimised. By order of highest welfare gains, those are: unified regime in which both monetary and macroprudential rules respond to credit and spreads simultaneously; separate regime featuring a standard Taylor rule and a macroprudential rule feeding back on credit and spreads; a augmented monetary policy rule reacting to asset prices and without macroprudential policy intervention and, finally, a unified mandate in which both monetary and macroprudential policymakers respond to credit spreads.

Moreover, another question is whether the optimisation of implementable policy rules allow for highest welfare gains than that of conventional policy rules. Results are mixed given that in some cases, gains are higher under conventional rules and in other situations gains are higher under implementable rules. However, welfare gains are quite similar in general, not pointing out to a stronger type of policy rule for welfare optimisation.

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Policy Regimes</th>
<th>Welfare Gain</th>
<th>Welfare Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Std TR only</td>
<td>-1.88654</td>
<td>Baseline</td>
<td>Baseline</td>
</tr>
<tr>
<td>2</td>
<td>Augmented TR with credit</td>
<td>-1.88653</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>3</td>
<td>Augmented TR with spreads</td>
<td>-1.88650</td>
<td>0.014</td>
<td>0.024</td>
</tr>
<tr>
<td>4</td>
<td>Augmented TR with Tobin’s Q</td>
<td>-1.88639</td>
<td>0.067</td>
<td>0.062</td>
</tr>
<tr>
<td>5</td>
<td>Std TR + MR Credit</td>
<td>-1.88644</td>
<td>0.042</td>
<td>0.041</td>
</tr>
<tr>
<td>6</td>
<td>Std TR + MR Spreads</td>
<td>-1.88644</td>
<td>0.045</td>
<td>0.037</td>
</tr>
<tr>
<td>9</td>
<td>Std TR + MR Credit &amp; Spreads</td>
<td>-1.88638</td>
<td>0.068</td>
<td>0.064</td>
</tr>
<tr>
<td>10</td>
<td>Augmented TR + MR</td>
<td>-1.88644</td>
<td>0.042</td>
<td>0.043</td>
</tr>
<tr>
<td>11</td>
<td>both reacting to Credit</td>
<td>-1.88642</td>
<td>0.053</td>
<td>0.058</td>
</tr>
<tr>
<td>12</td>
<td>both reacting to Credit &amp; Spreads</td>
<td>-1.88635</td>
<td>0.083</td>
<td>0.074</td>
</tr>
</tbody>
</table>

Finally, looking at volatilities of interest rate, inflation and output, the conventional type of policy rules are stronger in the sense that, for interest rates and inflation, they provide lower variability in these variables. Exception is made to output, which achieves lower
volatility under implementable rules, in almost all mandates. 

Appendix 4.3

In this appendix, we present results for the calibrated model without recurring to optimal policy simulations. The main difference is that the coefficients used in the monetary and macroprudential policy rules are chosen ad hoc (i.e. they are not optimized), in accordance to the literature. Main results support the ones obtained from optimal policy.

Table 4.4.2: Separate Mandate - Monetary Policy Coefficients

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Monetary Policy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\rho$</td>
</tr>
<tr>
<td>1</td>
<td>Std TR</td>
<td>0.7</td>
</tr>
<tr>
<td>5</td>
<td>Aug TR with Credit</td>
<td>0.7</td>
</tr>
<tr>
<td>6</td>
<td>Aug TR with Cred. Spreads</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 4.4.3: Separate Mandate - Macroprudential Policy Coefficients

<table>
<thead>
<tr>
<th>#</th>
<th>Policy Regimes</th>
<th>Macroprudential Policy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\rho_{\tau}$</td>
</tr>
<tr>
<td>5</td>
<td>Credit</td>
<td>0.7</td>
</tr>
<tr>
<td>6</td>
<td>Cred. Spreads</td>
<td>0.7</td>
</tr>
</tbody>
</table>

\(^{14}\)Results for volatilities are provided under request.
Figure 4.1: Monetary Policy Rules only: Productivity Shock

Figure 4.2: Monetary Policy Rules only: Capital Shock
Figure 4.3: Monetary and Macroprudential Policies Rules: Productivity Shock

Figure 4.4: Monetary and Macroprudential Policies Rules: Capital Shock
Chapter 5

A macroeconomic framework to assess the interaction of monetary policy and the macroprudential toolkit

5.1 Motivation

As a legacy of the financial crisis and its disruptive effects on economic welfare, policymakers around the globe have enhanced the role of macroprudential supervision in their broader economic policy frameworks. At the same time, the interaction of specific macroprudential policy measures with other policy domains – and in particular with monetary policy – is still subject to important knowledge gaps.

The emerging institutional landscape in the euro area is an interesting case in point: upon inception of the Single Supervisory Mechanism (SSM), the European Central Bank (ECB) is granted certain tools to address macroprudential risks, which will accompany its new task to assess the safety and soundness of individual credit institutions under the microprudential arm of the SSM. But its toolkit remains incomplete: for example, the ECB is authorized to raise countercyclical capital buffers on euro area banks, whereas loan-to-value ratios remain at the discretion of national authorities in euro area countries.

At the same time, the macroprudential tools available to the ECB and those available to national authorities are imperfect substitutes. For example, a real-estate bubble might be best addressed by raising loan-to-value ratios, thus putting the onus of action on national authorities. But what if national authorities refrain from leaning against the
bubble, e.g. because they do not fully internalize the associated financial stability risks, which will partly spill over to other countries?

To the extent such risks complicate the ECB’s task to maintain price stability, there may be monetary policy rationale to respond to them. But, in this simplified example, it would have to choose between policy-controlled interest rates or counter-cyclical capital buffers, both of which could only partly mitigate the risks. The question is which tool would be best suited, in this second-best scenario, to counteract the price stability implications of the bubble.

To capture the problem, it is necessary to model a macroprudential toolkit composed of distinct types of instruments that work through different transmission channels. In particular, the analysis should be focused on the aforementioned macroprudential policy tools: a countercyclical capital ratio and a loan-to-value ratio. On this basis, we will first assess how effective macroprudential policy is in counteracting the effects of shocks in the business cycle, assuming a perfect control of both instruments and considering two scenarios: one including a monetary policy response and the other abstracting from monetary policy.

As a first step towards answering these questions, a New Keynesian (NK) model with two types of financial frictions is developed in this chapter. The inclusion of two distinct sources of financial disruptions aims at providing a motivation for the deployment of different macroprudential policy instruments, such as loan-to-value ratios and countercyclical capital requirements. To the extent of my knowledge, there are so far only a few examples of studies in which more than one type of macroprudential policy instrument is considered (see, for instance, De Paoli and Paustian (2012), Brzoza-Brzezina et al. (2013) and Clerc et al. (2015)). Moreover, studies focusing on the interaction of macroprudential toolkit and monetary policy are even scarcer.

Based on a NK model with a banking sector based on Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), that already incorporates an incentive constraint between households and banks (as already described in Chapter 3), we extend it to include a second financial friction along the lines of Kiyotaki and Moore (1997) and Iacoviello (2005). The latter type of financial disruption arises from the possibility that an entrepreneur may not repay its debt obligations to the bank, giving rise to a collateral constraint between the borrower and the financial intermediary, which limits the amount of funds that the latter is willing to provide to the borrower. While the financial friction a la Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) affects the supply of credit,
the financial friction based on Kiyotaki and Moore (1997) and Iacoviello (2005) constrains the demand for credit. Therefore, in this extended framework, the provision of funds from banks to entrepreneurs is not only constrained by the amount of funds that households are willing to deposit on the banking system, but also by the limits on the borrowing capacity of entrepreneurs that are impacted by the loan-to-value ratio.

This otherwise standard New Keynesian framework will be used to examine the different transmission mechanisms of macroprudential policy instruments and how they interact with monetary policy. In future research, we will assume that the central bank can only deploy one of the instruments at a time. This will allow us to analyse: the consequences of having only one instrument to respond to the different sources of disruptions that affect the economy; the relative effectiveness of countercyclical capital requirements, which are broader in scope (since they imply a rise in the supervisory capital-to-assets ratio, without making considerations on how this ratio may be attained by the individual banks), versus loan-to-value ratios, which are considered sectoral requirements (usually applied to mortgage lending); and most importantly, the monetary policy response to different types of shocks when commanding over an incomplete macroprudential toolkit.

For these purposes, in this chapter, we present the New Keynesian (NK) model with a banking sector modelled to allow the inclusion of both types of financial frictions. To keep track of the dynamics of the model, in a first stage, we opt to not to include any macroprudential policy regulation, developing instead a model with a laissez-faire (non-regulated) banking sector. This model is then compared to a baseline framework, featuring a standard New Keynesian model, and to the versions of the model that result from switching off each one of the financial frictions.

Then, the dynamics of the proposed framework are assessed by conducting a simulation analysis under two shocks - a negative technology shock and a monetary policy tightening shock. Lastly, first insights are provided regarding how a macroprudential instrument such as time-varying loan-to-value ratios may impact on the monetary shock propagation.

The paper is organized as follows. Section 5.2 describes an otherwise standard general equilibrium framework with a laissez-faire banking sector, featuring both collateral and incentive constraints. Section 5.3 discusses, on one hand, the dynamics of the baseline version of the model when a technology shock and a monetary shock are considered. On the other hand, it shows how the model compares to the New Keynesian version of the model (without any financial frictions) and with the frameworks resulting from switching off one financial friction at a time. In Section 5.4 we present a flavour of
what a macroprudential policy could do by assuming an alternative calibration for the loan-to-value ratio and how it could interact with monetary policy. Main preliminary conclusions are reported in Section 5.5.

5.2 The Model with a \textit{Laissez-Faire} Banking Sector

In this section, a New Keynesian framework with a banking sector that is impacted by two sources of financial frictions is described. This economy is populated by households, goods producers, capital producers, retail producers, entrepreneurs and a banking sector. Figure 5.1 provides an illustration of how these economic agents are interlinked in this model. A central bank that is in charge of monetary policy and a government that is responsible for fiscal policy are also important components of the model. In a later stage, the model will be extended as to integrate a macroprudential policymaker.

The model draws considerably on the model described in Chapter 3, namely in what regards the behaviour of households, goods producers, capital and retail producers. The main innovation comes from the introduction of entrepreneurs in the model and by extending the banking sector to incorporate an additional financial friction. Both sectors will be described in detail.

5.2.1 Households, Goods, Capital and Retail Producers

The behaviour of these economic agents was already described in Chapter 3, in the corresponding subsections 4.2.1, 4.2.2, 4.2.3 and 4.2.4. Against this background, we opt for recalling only the equilibrium equations for each sector.

Household behaviour is thus described by, in balanced-growth equilibrium

\begin{equation}
\Lambda_t = \Lambda(C_t, h_t) = \frac{((C_t - \chi C_{t-1}/(1 + Stochg_t))^{(1-\rho)}(1-h_t)^{\rho(1-\sigma_c)} - 1}{1 - \sigma_c} \tag{5.1}
\end{equation}

\begin{equation}
\Lambda_{C,t} = (1 - \rho)(C_t - \chi C_{t-1}/(1 + Stochg_t))^{(1-\rho)(1-\sigma_c)-1}(1-h_t)^{\rho(1-\sigma_c)} \tag{5.2}
\end{equation}

\begin{equation}
R_{t}^{ex} = \frac{R_{n,t-1}}{\Pi_t} \tag{5.3}
\end{equation}

\begin{equation}
\Lambda_{C,t} = \beta(1 + Stochg_{t+1})^{(1-\rho)(1-\sigma_c)-1} E_t [R_{t+1}^{ex} \Lambda_{C,t+1}] \tag{5.4}
\end{equation}

\begin{equation}
\frac{W_t}{P_t} = \frac{\phi(C_t - \chi C_{t-1}/(1 + Stochg_t))^{(1-\rho)(1-\sigma_c)}(1-h_t)^{\rho(1-\sigma_c)-1}}{\Lambda_{C,t}} \tag{5.5}
\end{equation}
where $\frac{W_t}{P_t}$ is the real wage and $R_{n,t}$, our monetary policy instrument, is the gross nominal interest rate set in period $t$ to pay out interest in period $t + 1$, and $\Pi_t \equiv \frac{P_t}{P_{t-1}}$ where $P_t$ is the retail price level. The term $(1 + Stoch_{gt})$ denotes the balanced-growth rate in the model.

The Euler consumption equation ((5.4)), where $\Lambda_{C,t} \equiv \frac{\partial \Lambda_t}{\partial C_t}$ is the marginal utility of consumption and $E_t[\cdot]$ denotes rational expectations based on agents observing all current macroeconomic variables (i.e., 'complete information'), describes the optimal consumption-savings decisions of the household. It equates the marginal utility from consuming one unit of income in period $t$ with the discounted marginal utility from consuming the gross income acquired, by saving the income. Equation ((5.5)) equates the real wage with the marginal rate of substitution between consumption and hours worked.
Goods producers behaviour is given by

\[ Y_t^W = F(A_t, h_t, K_t) = (A_t h_t)^{\alpha} (K_{t-1}/(1 + Stochg_t))^{1-\alpha} / \Delta_t \]  \hspace{1cm} (5.6)

\[ Y_t = (1 - c) Y_t^W \]  \hspace{1cm} (5.7)

\[ \frac{P_t^W}{P_t} F_{h,t} = \frac{P_t^W}{P_t} \frac{\alpha Y_t^W}{h_t} = \frac{W_t}{P_t} \]  \hspace{1cm} (5.8)

\[ K_t = (1 - \delta) K_{t-1}/(1 + Stochg_t) + (1 - S(X_t)) I_t \]  \hspace{1cm} (5.9)

\[ S(X_t) = \phi_x(X_t - (1 + Stochg_t))^2 \]  \hspace{1cm} (5.10)

\[ X_t = \frac{I_t}{I_{t-1}} (1 + Stochg_t) \]  \hspace{1cm} (5.11)

Demand for capital is given by

\[ R_{k,t} = \frac{(1 - \alpha) P_t^W Y_t^W / K_{t-1} + (1 - \delta) Q_t}{Q_{t-1}} \]  \hspace{1cm} (5.12)

Equation (5.6) is a Cobb-Douglas production function for the wholesale sector that is converted into differentiated goods in equation (5.7) at a cost \( cY_t^W \). \( K_t \) is physical capital that goods producers buy to capital producers. From the optimization problem we get equation (5.8), for the demand of labour where \( F_{h,t} = \frac{\partial F_t}{\partial h_t} \) equates the marginal product of labour with the real wage, and equation (5.13) for the demand of capital.

Demand of capital is given by the return on capital that equalizes the gross marginal product of capital net of depreciation. \( P_t \) and \( P_t^W \) are the aggregate price indexes in the retail and wholesale sectors respectively. Capital accumulation is given by equation (5.9) and we assume investment adjustment costs a la Smets and Wouters (2007). Note here \( K_t \) is end-of-period capital stock. The production of physical capital is determined in the next subsection.

Balanced-growth equilibrium for capital producers is given by:
\[ K_t = ((1 - \delta)K_{t-1} + (1 - \phi_x(X_t - (1 + Stochg_t))^2)I_t)\psi_t \]  
(5.13)

\[ X_t = \frac{I_t}{I_{t-1}}(1 + Stochg_t) \]  
(5.14)

\[ DD_{t,t} = \beta \frac{\Lambda_{C,t}}{\Lambda_{C,t-1}}(1 + Stochg_t)^{(1-\rho)(1-\sigma_c)-1} \]  
(5.15)

\[ Z_{1,t} = E_{t-1}[DD_{t,t}Q_t2\phi_x(X_t - (1 + Stochg_t))X_t^2] \]  
(5.17)

\[ Z_{2,t} = (1 - \alpha)\frac{P^W_t}{P_t}K_{t-1}/(1 + Stochg_t) + (1 - \delta)Q_t \]  
(5.18)

\[ R_{k,t} = \psi_t(Z_{2,t}/Q_{t-1}) \]  
(5.19)

For the retail sector, we introduce sticky prices \textit{a la} Calvo (1983).

With indexing, the balanced-growth equilibrium is given by:

\[ H_t - \xi \beta E_t[\tilde{\Pi}_t^{-1}H_{t+1}(1 + Stochg_{t+1})^{(1-\rho)(1-\sigma_c)}] = Y_t\Lambda_{C,t} \]  
(5.20)

\[ J_t - \xi \beta E_t[\tilde{\Pi}_t^{-1}J_{t+1}(1 + Stochg_{t+1})^{(1-\rho)(1-\sigma_c)}] = \left(\frac{1}{1 - (\frac{1}{\zeta})}\right)MC_tMS_tY_t\Lambda_{C,t} \]  
(5.21)

\[ \tilde{\Pi}_t = \frac{\Pi_t}{\Pi_{t-1}} \]  
(5.22)

\[ 1 = \xi \Pi_t^{-1} + (1 - \xi)\left(\frac{J_t}{H_t}\right)^{1-\zeta} \]  
(5.23)

\[ MC_t = \frac{P^W_t}{P_t} \]  
(5.24)

\[ \Delta_t = \xi \Pi_t^\zeta \Delta_{t-1} + (1 - \xi)\left(\frac{J_t}{H_t}\right)^{-\zeta} \]  
(5.25)

### 5.2.2 Entrepreneurs

There is a continuum of entrepreneurs, indexed by \( j \). They consume and acquire physical capital at price \( Q_t \) to capital producers. Consumption and capital acquisitions are financed by revenues from renting capital services to goods producers and also by bank loans. As in Kiyotaki and Moore (1997) and the extended version of the model by Lacoviello (2005), capital acquisitions are financially constrained. We allow for the possibility that an entrepreneur may not repay its debt obligations to the bank. This poses a limit on the amount of funds banks are willing to lend to the entrepreneurs, which
is a function of the expected value of physical capital used as collateral in borrowing operations.

The entrepreneur at time \( t \) maximizes her intertemporal utility that depends only on their consumption:

\[
E_t \left[ \sum_{0}^{\infty} \beta_t^t \Lambda_t^E (C_{E,t}) \right] \tag{5.26}
\]

where

\[
\Lambda_t^E (C_{E,t}) = \frac{(C_{E,t} - \chi_E C_{E,t-1})^{1-\sigma_E}}{1-\sigma_E}
\]

where \( C_{E,t} \) is entrepreneur’s consumption, \( \chi_E \) is the entrepreneur’s habit parameter and \( \sigma_E > 0 \), meaning that entrepreneurs are not risk-neutral.

Entrepreneurs are subject to two constraints. A budget constraint, that in real terms is given by:

\[
C_{E,t} + Q_t K_t + R_{l,t}^e L_{t-1} = R_{k,t} Q_{t-1} K_{t-1} + T_{E,t} + L_t \tag{5.27}
\]

where \( L_t \) are loans in real terms and \( T_{E,t} \) denotes transfers from households to entrepreneurs. The real ex post interest rate, \( R_{l,t}^e \), is given by

\[
R_{l,t}^e = \frac{R_{l,t-1}}{\Pi_t} \tag{5.28}
\]

where \( R_l \) is the loan rate to be decided in the loan contract.

The real ex post gross return of capital follows

\[
R_{k,t} = \frac{Z_t + (1-\delta)Q_t}{Q_{t-1}} \tag{5.29}
\]

where \( Z_t = (1-\alpha)\frac{P_t^W y_t^W}{P_t K_{t-1}} \) is the gross real return of capital.

Given the budget constraint, we can define net worth of the entrepreneurs, \( NW_{E,t} \), as

\[
NW_{E,t} = Q_t K_t - L_t = R_{k,t} Q_{t-1} K_{t-1} + T_{E,t} - C_{E,t} - R_{l,t}^e L_{t-1} \tag{5.30}
\]

\[\footnote{For a clear understanding of the entrepreneurs optimization problem, we opt to assume a zero-growth path in this section, only for description purposes.}\]
This equation means that entrepreneurs’ net worth can be raised by the entrepreneur choosing to reduce her consumption. We then define leverage as

\[ \phi_E \equiv \frac{Q_tK_t}{NW_{E,t}} = \frac{Q_tK_t}{Q_tK_t - L_t} \]  

(5.31)

The second constraint arises from the assumption that entrepreneurs may fail on their obligations, originating a collateral constraint below (in nominal terms)

\[ R_{l,t}L_t \leq mE_t[\Pi_{t+1}Q_{t+1}(1 - \delta)K_t] \]  

(5.32)

The collateral for the loan is provided by end-of-period capital sold in period \( t + 1 \) after depreciation and \( m \) is the loan-to-value ratio. Since we assume \( \beta_E < \beta \), the collateral constraint is binding at the vicinity of the steady state.

Defining the Lagrangian

\[ \ell_t \equiv E_t \left\{ \sum_0^\infty \beta_E^t \Lambda(C_{E,t}) + \lambda_t \left( R_{k,t}Q_{t+1}K_t - T_{E,t} + L_t - C_{E,t} - Q_tK_t - R_{l,t}L_{t-1} \right) \right. \]

\[ \left. + \Theta_{E,t}(m\Pi_{t+1}Q_{t+1}(1 - \delta)K_t - R_{l,t}L_t) \right\} \]  

(5.33)

First Order Conditions:

\[ L_t : \ E_t \left[ \beta_E^0 \lambda_t - \beta_E^0 \lambda_{t+1}R_{l,t+1}^{ex} - \beta_E^0 \Theta_{E,t}R_{l,t} \right] = 0 \]  

(5.34)

\[ K_t : \ E_t \left[ \beta_E^0 \lambda_{t+1}R_{k,t+1}Q_t - \beta_E^0 \lambda_tQ_t + \beta_E^0 \Theta_{E,t}m\Pi_{t+1}Q_{t+1}(1 - \delta) \right] = 0 \]  

(5.35)

\[ C_{E,t} : \ E_t \left[ \beta_E^0 (C_{E,t} - \chi_EC_{E,t-1})^{-\sigma_E} - \lambda_t \right] = 0 \]  

(5.36)

From equation (5.36),

\[ \lambda_t = \Lambda_{C,t}^E \]  

(5.37)

where
\[ \Lambda_{C,t}^E = (C_{E,t} - \chi_E C_{E,t-1})^{-\sigma_E} \]

Replacing it into equation \((5.35)\), we get

\[ E_t \left[ \beta_E \Lambda_{C,t+1}^E R_{k,t+1} + \Theta_{E,t} m \Pi_{t+1} Q_{t+1} (1 - \delta) \right] = \Lambda_{C,t}^E Q_t \]

Then, divide both sides by \( \Lambda_{C,t}^E Q_t \) to get

\[ E_t \left[ \frac{\beta_E \Lambda_{C,t+1}^E R_{k,t+1}}{\Lambda_{C,t}^E} + \frac{\Theta_{E,t} m \Pi_{t+1} Q_{t+1} (1 - \delta)}{\Lambda_{C,t}^E Q_t} \right] = 1 \quad (5.38) \]

which is the first order condition with respect to \( K_t \). This equation is the intertemporal condition driving the choice between capital acquisitions and consumption. It requires the borrower to equate the marginal utility of current consumption to the gain obtained from owning capital. This gain depends on two components: i) the discounted return on capital obtained from renting capital to goods producers and ii) the marginal value of using capital as a collateral, that is proportional to the shadow value of borrowing when \( \Theta_E > 0 \), but disappearing when the constraint is not binding, i.e. when \( \Theta_E = 0 \).

Combining equations \((5.37)\) and \((5.34)\) yields

\[ E_t \left[ \frac{\beta_E \Lambda_{C,t+1}^E R_{t,t+1}^{ex}}{\Lambda_{C,t}^E} + \frac{\Theta_{E,t} \Lambda_{C,t+1}^E R_{t,t+1}^{ex}}{\Lambda_{C,t}^E} \right] = \Lambda_{C,t}^E \]

dividing both sides by \( \Lambda_{C,t}^E \),

\[ E_t \left[ \frac{\beta_E R_{t,t+1}^{ex} \Lambda_{C,t+1}^E}{\Lambda_{C,t}^E} + \frac{\Theta_{E,t} R_{t,t+1}}{\Lambda_{C,t}^E} \right] = 1 \quad (5.39) \]

Equation \((5.39)\) is the first order condition obtained after taking the derivative with respect to \( L_t \). This equation is the intertemporal condition for the choice of assets holdings. It states that with a binding collateral constraint the entrepreneur’s marginal utility of current consumption must be equal to the marginal cost in \( t+1 \) of borrowing an extra unit in period \( t \). The marginal cost of borrowing is given by two components: i) the discounted value of the real cost of loans in \( t+1 \) and ii) the shadow value of borrowing at \( t \) that is positive when the constraint binds.
The balanced-growth equilibrium of the model is then given by:

\[
DDE_{t,t+1} = \beta E \frac{\Lambda^E_{C,t+1}}{\Lambda^E_{C,t}} (1 + Stochg_{t+1})^{-\sigma_E} \quad (5.40)
\]

\[
E_t \left[ DDE_{t,t+1} R^{ex}_{t,t+1} + \Theta_{E,t} R_{l,t} \right] = 1 \quad (5.41)
\]

\[
E_t \left[ DDE_{t,t+1} R^{ex}_{k,t+1} + \Theta_{E,t} m \Pi_{t+1} Q_{t+1} (1 - \delta) \right] = 1 \quad (5.42)
\]

\[
\phi_E = \frac{Q_t K_t}{Q_t K_t - L_t} \quad (5.43)
\]

\[
R_{l,t} L_t = m E_t [\Pi_{t+1} Q_{t+1} (1 - \delta) K_t] \quad (5.44)
\]

\[
C_{E,t} + Q_t K_t + R^{ex}_{t,t} L_{t-1} / (1 + Stochg_t) = R^{ex}_{k,t} Q_{t-1} K_{t-1} / (1 + Stochg_{t-1}) + T_E \quad (5.45)
\]

\[
\Lambda^E_t = \frac{(C_{E,t} - x E C_{E,t-1} / (1 + Stochg_t))^{1-\sigma_E}}{(1 - \sigma_E)} \quad (5.46)
\]

\[
\Lambda^E_{C,t} = (C_{E,t} - x E C_{E,t-1} / (1 + Stochg_t))^{-\sigma_E} \quad (5.47)
\]

\[
R^{ex}_{t,t} = \frac{R^{ex}_{l,t} L_{t-1}}{\Pi_t} \quad (5.48)
\]

### 5.2.3 Banking Sector

The net worth of the bank at period \(t\) accumulates according to:

\[
n_t = R^{ex}_{l,t} L_{t-1} - R^{ex}_{t,t} d_{t-1} \quad (5.49)
\]

Net worth at time \(t\) is determined by the gross real payoff on loans funded at \(t - 1\), \(R^{ex}_{t,t} L_{t-1}\), net of the real cost of deposits \(R^{ex}_{t,t} d_{t-1}\). Banks lend to entrepreneurs only and raise deposits from households. The credit spread is then given by \(R^{ex}_{l,t} - R^{ex}_{t,t}\). As in the model described in the previous chapter, banks raise net worth only through retained earnings. The bank’s balance sheet is given by:

\[
L_t = n_t + d_t \quad (5.50)
\]

Using the balance sheet condition, we replace \(d_t\) into equation (5.50):

\[
n_t = R^{ex}_{l,t} L_{t-1} - R^{ex}_{t,t} (L_{t-1} - n_{t-1})
\]
\[ n_t = (R^e_{t,t} - R^e_{t-1})L_{t-1} + R^e_{t}n_{t-1} \]  

(5.51)

Given that bankers exit with probability \((1 - \sigma_B)\), the objective of the banker at the end of period \(t\) is to maximize the expected present value of the future dividends: \(V_t(L_t, n_t)\).

Thus, we look for a solution of the form:

\[ V_t(L_t, n_t) = \mu_{L,t}L_t + \mu_{n,t}n_t \]  

(5.52)

The Bellman equation is:

\[ V_{t-1}(L_{t-1}, n_{t-1}) = E_t \Lambda_{t+1} \left[ (1 - \sigma_B) n_t + \sigma_B \max_{L_t} V_t(L_t, n_t) \right] \]  

(5.53)

The bankers’ optimization problem is:

\[ \text{Max} \ V_t(L_t, n_t) \text{ s. t. } V_t \geq \Theta_B L_t \]

The incentive constraint is introduced to motivate a limit on the assets expansion by the bank. Following Gertler and Karadi (2011), it is assumed that bankers can steal the fraction \(\Theta_B\) of assets and transfer it to the household of which the banker is an element. This assets diversion by bankers implies a cost, which results from the possibility that depositors may force them to fail and recover the remaining fraction \(1 - \Theta_B\) of assets.

The left side of the incentive constraint is the cost for the banker if he/she decides to divert a fraction of assets, whereas the right side is what the banker gets by stealing it. When the incentive constraint is binding, the banks’ assets are constrained by its net worth.

The Lagrangian is then,

\[ L_t = V_t + \lambda_t [V_t - \Theta L_t] = (1 + \lambda_t)V_t - \lambda_t \Theta_t L_t \]  

(5.54)

where \(\lambda_t = 0\) if the constraint binds and \(\lambda_t > 0\) otherwise.

Recall that

\[ V_t(L_t, n_t) = \mu_{L,t}L_t + \mu_{n,t}n_t \]
First Order Conditions:

\[ L_t : (1 + \lambda_t)\mu_{L,t} - \lambda_t\Theta_t = 0 \]

\[ (1 + \lambda_t)\mu_{L,t} = \lambda_t\Theta_t \] \hspace{1cm} (5.55)

\[ \lambda_t : V_t - \Theta_B L_t = 0 \]

Replacing \( V_t(L_t, n_t) \) by \( \mu_{L,t}L_t + \mu_{n,t}n_t \):

\[ \mu_{L,t}L_t + \mu_{n,t}n_t = \Theta_B L_t \] \hspace{1cm} (5.56)

Defining \( \phi_B \) as the bank’s leverage ratio:

\[ \phi_{B,t} = \frac{L_t}{n_t} \] \hspace{1cm} (5.57)

Then,

\[ L_t = \phi_{B,t} n_t \] \hspace{1cm} (5.58)

Rearranging equation (5.56) in order to \( L_t \) and then replacing it in equation (5.58), yields

\[ \mu_{n,t}n_t = (\Theta_B - \mu_{L,t})L_t \]

\[ \frac{\mu_{n,t}n_t}{\Theta_B - \mu_{L,t}} = L_t \]

\[ \phi_{B,t} = \frac{\mu_{n,t}}{\Theta_B - \mu_{L,t}} \] \hspace{1cm} (5.59)

which can be combined with equation (5.58) to give:

\[ L_t = \frac{\mu_{n,t}}{\Theta_B - \mu_{L,t}} n_t \] \hspace{1cm} (5.60)

As in Gertler and Karadi (2011), if the constraint binds, the amount of loans that the banker can provide to entrepreneurs depends positively on the bank’s net worth, leverage
ratio and the expected discounted marginal gains of assets and net worth. Holding net worth constant, expanding loans raises the banker’s incentive to steal funds. However, the constraint limits the banks leverage ratio to the point where the banker’s incentive to steal is exactly balanced by its cost. In this situation, an endogenous capital constraint arises on the bank’s capacity to raise deposits and, therefore, to acquire assets. Since bank’s net worth is positive, the constraint binds only if \( 0 < \mu_{L,t} < \Theta_B \). It is profitable for the banker to expand assets, because the expected discounted marginal gain of assets \((\mu_{L,t})\) is positive.

Note that the leverage ratio that depositors will tolerate is increasing with \( \mu_{L,t} \). The larger is \( \mu_{L,t} \), the greater is the opportunity cost to the banker from being forced into bankruptcy. If \( \mu_{L,t} \) is greater than \( \Theta_B \), the bank is no longer constrained by its equity capital, and can borrow from depositors as much as he / she desires. In this situation, however, the franchise value of the intermediary is always above the cost from diverting funds, and so there is no incentive to steal.

The higher the fraction of assets that the bankers can steal, the smaller the leverage ratio that households would allow, everything else held constant. Thus, leverage is limited by this fraction.

Now, we can write

\[
V_t(L_t, n_t) = \mu_{L,t}L_t + \mu_{n,t}n_t
\]

as

\[
V_t(L_t, n_t) = \mu_{L,t}\phi_{B,t,n_t} + \mu_{n,t}n_t = (\mu_{L,t}\phi_{B,t} + \mu_{n,t})n_t
\]

by using equation (5.58).

Therefore,

\[
V_{t-1}(L_{t-1}, n_{t-1}) = E_t\Lambda_{t,t+1} [(1 - \sigma_B) n_t + \sigma_B \max_{L,t} V_t(L_t, n_t)]
\]

becomes

\[
V_t(L_t, n_t) = E_t\Lambda_{t,t+1} [(1 - \sigma_B) n_{t+1} + \sigma_B \max_{L,t+1} V_{t+1}(L_{t+1}, n_{t+1})]
\] \hspace{1cm} (5.61)
\[ V_t(L_t, n_t) = E_t \Lambda_{t,t+1} \left[ (1 - \sigma_B) n_{t+1} + \sigma_B (\mu_{L,t+1} \phi_{t+1} + \mu_{n,t+1}) n_{t+1} \right] \]  

(5.62)

Defining

\[ \Omega_t = (1 - \sigma_B) + \sigma_B (\mu_{L,t} \phi_t + \mu_{n,t}) \]  

(5.63)

we get

\[ V_t(L_t, n_t) = E_t \Lambda_{t,t+1} \Omega_{t+1} n_{t+1} \]  

(5.64)

Now, replace \( n_{t+1} \) by equation (5.51), yielding

\[ V_t(L_t, n_t) = E_t \Lambda_{t,t+1} \Omega_{t+1} \left[ (R^{ex}_{t,t+1} - R^{ex}_{t+1}) L_t + R^{ex}_{t+1} n_t \right] \]  

(5.65)

Comparing equation (5.65) with equation (5.52), we get

\[ \mu_{L,t} = E_t \Lambda_{t,t+1} \Omega_{t+1} (R^{ex}_{t,t+1} - R^{ex}_{t+1}) \]  

(5.66)

\[ \mu_{n,t} = E_t \Lambda_{t,t+1} \Omega_{t+1} R^{ex}_{t+1} \]  

(5.67)

Equations (5.66) and (5.67) are, respectively, the shadow value of bank assets and the shadow value of net worth. The variable \( \mu_{n,t} \) is the expected discounted marginal gain to the banker of raising its net worth by one unit, keeping \( L_t \) constant, whereas \( \mu_{L,t} \) is the expected discount marginal gain of expanding assets by a unit, holding net worth constant. The credit spread corresponds to \( (R^{ex}_{t,t+1} - R^{ex}_{t+1}) \), that is, the difference between the gross ex post real interest rate on loans to entrepreneurs and the gross ex post real interest rate on deposits.

Note that there is an important difference between our banking sector setup and the one described in Gertler and Karadi (2011) (hereafter GK’s model). In GK’s model, the non-financial firms acquire capital each period by obtaining funding from banks. To get the funds to buy capital, the firms issue a quantity of claims that equals the number of units of capital acquired and price each claim at the price of a unit of capital (that is given by Tobin’s Q). Hence, in GK’s framework it is assumed that loans are
represented by the value at time $t$ of the financial claims on non-financial firms that the financial intermediary holds. Since there are no frictions in the process of non-financial firms obtaining loans from banks, credit granted to firms is only limited by the incentive constraint affecting the amount of deposits banks can raise.

In turn, in our model we assume the amount of loans is not only limited by the incentive constraint arising from the liabilities side of the balance-sheet (which determines credit supply), but also by the collateral constraint that entrepreneurs face whenever demanding for credit. These distinctive features impacts significantly on the dynamics of the model, as it will be analysed in Section 5.3.

At the aggregate, net worth is the sum of the old banks’ net worth and new banks’ net worth:

$$N_t = N_{o,t} + N_{n,t}$$

For old banks, the evolution of net worth is given by:

$$N_{o,t} = \sigma_B \left[R_{t,t}^{ex}L_{t-1} - R_t^{ex}D_t - 1\right]$$

And the evolution of net worth for new banks follows

$$N_{n,t} = \frac{\xi_B}{(1 - \sigma_B)} (1 - \sigma_B) \left[R_{t,t}^{ex}L_{t-1}\right]$$

where $\frac{\xi_B}{(1 - \sigma_B)}$ is the fraction of assets given by households to new bankers.

Therefore, total net worth can be written as

$$N_t = \sigma_B \left[R_{t,t}^{ex}L_{t-1} - R_t^{ex}D_t - 1\right] + \xi_B \left[R_{t,t}^{ex}L_{t-1}\right]$$

$$N_t = (\sigma_B + \xi_B)R_{t,t}^{ex}L_{t-1} - \sigma_B R_t^{ex}D_t - 1$$

The balanced-growth equilibrium of the banking sector can now be summarised as:
\[(1 + \lambda_t)\mu_{L,t} = \lambda_t \Theta_t \]
\[L_t = \phi_{B,t} N_t \]
\[\phi_{B,t} = \frac{\mu_{n,t}}{\Theta_{B,t} - \mu_{L,t}} \]
\[\mu_{L,t} = \max\left\{0, \Theta_{B,t} - \frac{\mu_{n,t}}{\phi_{B,t}} \right\} \]
\[N_t = (\sigma_B + \xi_B)R^e_{it}L_{i-1}/(1 + Stochg_t) - \sigma_B R^e_{it}D_{i-1}/(1 + Stochg_t) \]
\[D_t = L_t - N_t \]
\[\mu_{n,t} = E_t [\Lambda_{t+1} \Omega_{t+1} R^e_{t+1}] \]
\[\mu_{L,t} = E_t [\Lambda_{t+1} \Omega_{t+1} (R^e_{t+1} - R^e_{t+1})] \]
\[\Omega_t = 1 - \sigma_B + \sigma_B (\mu_{n,t} + \phi_t \mu_{L,t}) \]
\[\Lambda_{t+1} = \beta (\Lambda_{C,t+1} (1 + Stochg_{t+1}))^{(1-\phi)(1-\sigma_c)-1} \]

### 5.2.4 Monetary Policy and Aggregate Resource Constraint

The monetary policy rule is in the lines of a standard Taylor rule, in which interest rates are determined as a response to deviations of inflation and output from their steady state values and by the degree of interest rates persistence:

\[
\log\left(\frac{R_{n,t}}{R_n}\right) = \rho_r \log\left(\frac{R_{n,t-1}}{R_n}\right) + (1 - \rho_r) \left[\theta_{r,\pi} \log\left(\frac{\Pi_t}{\Pi}\right) + \theta_{r,y} \log\left(\frac{Y_t}{Y}\right)\right] + \log(MPS_t) \tag{5.69}
\]

where $R_n$, $\Pi$ and $Y$ correspond to the steady state values of the monetary policy rate, inflation rate and output and $\epsilon_{MPS,t}$ represents the monetary policy shock.

We assume the following calibration for the Taylor Rule, based on Curdia and Woodford (2010):

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Definition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_r$</td>
<td>interest rate smoothing</td>
<td>0.8</td>
</tr>
<tr>
<td>$\theta_{r,\pi}$</td>
<td>response to inflation gap</td>
<td>2.0</td>
</tr>
<tr>
<td>$\theta_{r,y}$</td>
<td>response to GDP gap</td>
<td>0.125</td>
</tr>
</tbody>
</table>
The aggregate resource constraint in the economy is expressed by

$$Y_t = C_t + C^E_t + G_t + I_t$$ \hspace{1cm} (5.70)

The model is completed with a government balanced budget constraint:

$$G = h_t \text{tax}_t \frac{W_t}{P_t}$$ \hspace{1cm} (5.71)

### 5.2.5 Calibration of Fundamental Parameters

The values for the model parameters are summarized in Table 5.2.1. We choose standard values in the literature for preference and technology parameters and we define as a time unit a quarter.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount Factor</td>
<td>$\beta$</td>
<td>0.998</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>$g$</td>
<td>0.0046</td>
</tr>
<tr>
<td>Government expenditure-output ratio</td>
<td>$g_y$</td>
<td>0.20</td>
</tr>
<tr>
<td>Labour Share</td>
<td>$\alpha$</td>
<td>0.70</td>
</tr>
<tr>
<td>Depreciation Rate</td>
<td>$\delta$</td>
<td>0.025</td>
</tr>
<tr>
<td>Habit in Consumption</td>
<td>$\chi$</td>
<td>0.7</td>
</tr>
<tr>
<td>Substitution elasticity of goods</td>
<td>$\zeta$</td>
<td>7.0</td>
</tr>
<tr>
<td>Fixed Cost</td>
<td>$c$</td>
<td>$\frac{1}{\zeta} = 0.14929$</td>
</tr>
<tr>
<td>Preference parameter</td>
<td>$\varrho$</td>
<td>0.903</td>
</tr>
<tr>
<td>Investment parameter</td>
<td>$\phi_x$</td>
<td>2.0</td>
</tr>
<tr>
<td>Indexing parameter</td>
<td>$\gamma$</td>
<td>0.2</td>
</tr>
<tr>
<td>Elasticity of Consumption</td>
<td>$\sigma_c$</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Banking Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankers Survival Probability</td>
<td>$\sigma_B$</td>
<td>0.975</td>
</tr>
<tr>
<td>Transfer for New Bankers</td>
<td>$\xi$</td>
<td>0.002</td>
</tr>
<tr>
<td>Asset divertibility</td>
<td>$\Theta$</td>
<td>0.621</td>
</tr>
<tr>
<td><strong>Entrepreneurs Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Rate</td>
<td>$\beta_e$</td>
<td>0.99</td>
</tr>
<tr>
<td>Elasticity of Consumption</td>
<td>$\sigma_e$</td>
<td>0.5</td>
</tr>
<tr>
<td>Degree of External Habit Formation</td>
<td>$\chi_e$</td>
<td>0.7</td>
</tr>
<tr>
<td>Loan-to-Value Ratio</td>
<td>$m$</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Regarding the banking sector parameters, our calibration follows closely the one adopted in Gertler and Kiyotaki (2010) and Gertler et al. (2012). We set $\sigma_B$, the rate of survival of banks, by assuming that banks survive for 40 quarters on average (10 years). Therefore, $40 = \frac{1}{1-\sigma_B}$ and $\sigma_B = 0.975$. The values of the fractions of initial net worth and assets divertibility, $\xi$ and $\Theta$ respectively, are computed to hit an economy wide leverage ratio of four and to have an average credit spread of 200 basis points per year. The preference parameter $\varrho$ is calibrated to hit a hours worked steady state target, $h = 0.35$. The entrepreneurs’ discount factor is computed to hit a consumption to output ratio of 0.1.

5.2.6 Shock Processes

This dynamic stochastic general equilibrium model features standard macroeconomic shocks, namely monetary policy ($MPS_t$), government spending ($G_t$), technology ($A_t$), trend $(1 + g_t)$ and mark-up ($MS_t$) shocks. All the disturbances follows a AR1 process of the form:

$$\log(MPS_t) = \varrho_{MPS} \log(MPS_{t-1}) + \epsilon_{MPS}$$

$$\log(G_t) = (1 - \varrho) \log G + \varrho_{G} \log G_{t-1} + \epsilon_{G}$$

$$\log(A_t) = \varrho_{A} \log(A_{t-1}) + \epsilon_{A}$$

$$\log(1 + g_t) = \log(1 + g) + \epsilon_{Atrend}$$

$$\log(MS_t) = \varrho_{MS} \log(MS_{t-1}) + \epsilon_{MS}$$

where $\epsilon_{MPS}, \epsilon_{G}, \epsilon_{A}, \epsilon_{Atrend}, \epsilon_{MS}, \sim i.i.d. N(0, \sigma^2_{\epsilon})$.

In the AR1 shock processes, standard deviations of i.i.d shocks are calibrated at 1% and persistence parameters at 0.75.

5.3 Dynamic Simulations for the Model with a Laissez-Faire Banking Sector

So far, we developed a macroeconomic model comprising two sources of financial disruptions, one operating at the assets side of the banks’ balance sheet, and the other impacting on the liabilities side. To the extent that the inclusion of two types of credit...
frictions already involves a certain degree of novelty, in this section we investigate the economic dynamics under this framework.

The aim is to provide qualitative insights into the effects of two sources of financial frictions for the technology and monetary transmission mechanisms.

5.3.1 Negative Technology Shock

We begin by explaining the general dynamics of a negative technology shock. Figures 5.2 and 5.3 illustrate the impulse response functions for a series of economic and banking variables.

Figure 5.2: Impulse response functions to a negative technology shock - a). Note: all variables expressed in % deviation from steady state.

On impact, inflation rises and physical capital and investment drop. At the same time, output rises, but very modestly. The increase in output may be driven by the large increase in entrepreneurs’ consumption, given the relaxation of the collateral constraint at first impact due to an unanticipated rise in asset prices. This counter-intuitive response of output - it expands on impact following a negative productivity shock, but this is a short-lived response - is also a finding in Brzoza-Brzezina et al. (2011) for the model with a collateral constraint type of financial friction.
The monetary policy maker counteracts the increase in prices (both goods and asset prices) by raising policy rates. These policy rates are closely followed by increases in loans’ interest rates. The higher interest rates on credit and the further fall in physical capital that follows lead to a tightening of the collateral constraint and a decline in credit demand by entrepreneurs. Entrepreneurs’ consumption starts declining at this stage. At the banking sector, net worth increases significantly, loans reduce and there is deleveraging of the banks’ balance sheets, inducing a rise in the bank spreads.

The contraction that started at the firms’ level expands to the rest of the economy: hours worked increase; output and consumption fall even further. The economy starts recovering and converging to its steady steady when monetary policy rates are relaxed.

### 5.3.2 Positive Monetary Policy Shock

The impulse response functions from a tightening of the monetary policy interest rate are represented in Figures 5.4 and 5.5.
After an increase in the policy rate, the transmission mechanism goes as follows. On impact, the policy rate rises and inflation and asset prices decline (the latter considerably). The interest rate on loans closely follows the policy rate behaviour, inducing a fall in credit demand from entrepreneurs. Adding to this effect, we observe the tightening of the collateral constraint after a decrease in the value of the collateral, since both physical capital and asset prices drop.

Figure 5.5: Impulse responses to a monetary policy tightening - b).

Banks’ net worth increases, leverage falls and banks’ balance sheet contracts, which
is contrary to what occurs in the Gertler and Karadi (2011) model. In their set up, a fall in asset prices has a negative direct impact on banks’ net worth, because total loans correspond to claims on non-financial firms that equal the value of firms’ capital.\footnote{Recall that the value of physical capital is given by the number of units of physical capital acquired multiplied by the price of a unit of capital, $Q_t$.} Thus, a drastic fall in asset prices implies a drastic fall in banks’ net worth, restraining substantially the amount of funds provided to the economy. This is the so called net worth channel of the Gertler and Karadi (2011) framework and it explains why the amplification mechanism of a negative monetary policy shock is larger under this model. In a two frictions framework of this type, the net worth channel is almost switched off, since banks do not suffer significant losses in their equity after a fall in asset prices. The way we construct the assets’ side of the banks’ balance-sheet, i.e. by assuming a collateral constraint that prevents banks from suffering from entrepreneurs’ credit default, is the reason why banks are better off even if the economy is hit by a sharp decrease in asset prices.

The model dynamics continue as follows. To compensate for the decrease in loans (given the high interest rates), entrepreneurs adjust consumption, which declines drastically. A fall in households’ consumption is also observed, but it is more modest than the one affecting entrepreneurs. Given the fall in consumption and investment, output contracts. After the shock, policy interest rates start declining, bringing the economy back to its steady state. However, while the nominal variables, such as inflation and interest rates, converge to their steady state values after one to two years, some real variables, such as physical capital and investment, take longer to converge.

In our framework, there is an interest rate undershooting issue under a monetary policy shock. As an alternative to the Taylor rule we use, we consider a more aggressive response of monetary policy towards inflation, but it does not change policy rates impulse responses in a significant way and the undershooting issue remains. Under Taylor Rules, in which the response to the inflation gap is more aggressive, inflation rates fall by more as expected, but also output, households’ consumption and investment. In addition, bank loans decrease at impact and increase afterwards by more under inflation targeting rules leading to larger credit cycle swings.
5.3.3 Impulse Responses Comparison

Now, we proceed to compare our two financial frictions framework (thereafter 2 FF Model) with three other models: i) a New Keynesian model without financial frictions (thereafter NK Model); ii) a New Keynesian model with financial frictions in the spirit of Gertler and Karadi (2011) (thereafter GK Model); and iii) a New Keynesian model with financial frictions in the spirit of Kiyotaki and Moore (1997) and Iacoviello (2005) (thereafter KM Model).

Figures 5.6 illustrates the impulse responses differences between our framework and the standard New Keynesian model for a monetary policy shock.

Figure 5.6: Model Comparison - 2 FF Model vs NK Model (IRF to a negative monetary policy shock)

From the comparison of the 2FF Model with the NK model without any financial frictions (Figure 5.6), we conclude that the inclusion of financial frictions in an otherwise standard NK model considerably amplifies the propagation mechanism of the monetary policy shock. In particular, under a two financial frictions model, the impact of an unexpected increase in the policy rate leads to a larger fall in output, capital and investment.

The magnitude of the shock effects on asset prices (represented by Tobin’s Q) is significantly higher under our framework. It is also observed that the persistence of the shock seems to be similar to a standard NK model.
Figure 5.7 reports the dynamic differences across the other three models: 2 FF, GK and KM models. The calibration was kept constant with the purpose of comparison.

The main conclusion is that the 2 FF Model impulse response functions closely follow the KM Model, suggesting that results are mostly driven by the collateral constraint part of the model, as already suggested above.

Nonetheless, in the 2 FF Model, the magnitude of the impact of the shock is less pronounced, with the IRF being plotted in between the GK and the KM Models impulse response functions for all the variables, except for investment and output.

The plotting of the impulse response functions for the three models suggests that considering different sources of financial frictions in a same setup may partially offset each other. This may be observed in the behaviour of bank loans, which drop is not as pronounced in the 2 FF Model as in the other two (although it follows KM Model bank loans impulse responses very closely).

This leads to a smaller fall in investment and it contributes to a faster recovery in output (although the drop in output on impact is steeper than in the GK Model). Brzoza-Brzezina et al. (2011) find that a model featuring only a collateral constraint produces reaction functions with the deepest impact occurring in the first quarter of the shock. Nevertheless, they note that this behaviour seems inconsistent with VAR evidence on monetary transmission, where the reactions are usually hump-shaped. In addition, Brzoza-Brzezina et al. (2011) conclude that, under a KM type of framework, shocks exercise a strong response on the price of capital, as we observe in our two financial frictions model. Again, this feature may be inconsistent with empirical evidence and is also reflected into excessive fluctuations in the rate of return on capital.
5.4 Preliminary insights on the interaction of macro-prudential and monetary policies

In the previous sections, we simulated the dynamics of the model under a productivity and a monetary policy shocks, assuming a constant loan-to-value ratio (i.e. in our model \(m\) represents the loan-to-value ratio and is a parameter equal to 0.35). Since we are ultimately interested in understanding the effectiveness of time-varying LTV ratios as a macroprudential tool (which are still to be introduced in the model), in this section we seek to get some insights regarding the monetary transmission mechanism in the case of a less stringent regulatory requirement for this ratio.

As aforementioned, we introduce a collateral constraint, in which the parameter \(m\) represents a loan-to-value ratio. This ratio can be thought of as a legal or regulatory constraint on banks. Since we will introduce time-varying LTV ratios in a later stage of this project, this exercise gives us a flavour of how it can impact on the monetary shock propagation. With this purpose, we depart from our baseline calibration and we re-run the simulation procedure assuming the same parameters’ values, except for \(m\), which is calibrated to capture a less stringent regulatory stance.
Recall that the collateral constraint is given by

\[ R_{l,t} L_t \leq m E_t [\Pi_{t+1} Q_{t+1} (1 - \delta) K_t] \]  

(5.77)

Therefore, the LTV or \( m \) is then determined by the total amount of lending divided by the expected value of the collateral at time \( t \):

\[ m = \frac{R_{l,t} L_t}{E_t [\Pi_{t+1} Q_{t+1} (1 - \delta) K_t]} \]  

(5.78)

By assuming a low LTV ratio we thereby impose a tighter collateral constraint on the entrepreneurs’ side of the model. It means that entrepreneurs can borrow less given a fixed expected amount of physical capital. We consider two regimes for the LTV ratio: a stricter regime (Regime 1), in which we assume a low value of 0.35 (our baseline scenario) and an alternative and more flexible regime (Regime 2), in which we assume a high value of 0.89, as in Iacoviello (2005). The comparison of the dynamics of the model after a monetary policy tightening under very distinct LTV ratios is presented in Figure 5.8:

Figure 5.8: Monetary Policy Shock under a low and a high LTV ratio.

A positive monetary policy shock in the context of a tighter (low) LTV ratio (Regime 1) causes a smaller fall in output, driven by a less drastic fall in entrepreneurs’ consumption. In Regime 2, in turn, the transmission mechanism of a monetary policy shock is
considerably amplified when a less strict loan-to-value ratio is required. Results suggest that, *ceteris paribus*, the sensitivity of borrowing to changes in the value of the collateral increases when the collateral constraint is relaxed. Calza et al. (2013) have similar findings.

Therefore, the propagation dynamics of monetary policy under different LTV ratios suggest that a tighter LTV ratio dampens the credit cycle and decreases volatility in the economy, outcomes that are in line with the macroprudential policy ultimate goals of financial and macroeconomic stability. In terms of monetary policy implications, the amplification effects associated to less stringent regulatory requirements must be taken into account by monetary policymakers when assessing the implications of monetary policy changes.

In the context of a monetary union such as the euro area, this result is even more important. While the monetary policy is common to all the Member States that belong to the euro area, some macroprudential instruments are of the exclusive responsibility of the national macroprudential authorities. This is precisely the case of the loan-to-value ratios and other instruments that aim at mitigating the systemic risk that may arise from asset price bubbles (such as loan-to-income and debt-service-to-income ratios). Under this peculiar institutional and regulatory set-up, it is possible to observe divergent national macroprudential policies targeting the real estate sector (more or less strict LTV ratios), which may hamper the effectiveness of monetary policymaker efforts to stabilize prices within the euro area.

### 5.5 Conclusions

The introduction of a macroprudential oversight of the financial system raises very interesting questions to researchers and economic policy makers. The institutional and regulatory setup in the euro area are particularly challenging, since it combines centralized monetary and macroprudential policy powers at the ECB, but, at the same time, discretion is allowed to national supervisory authorities in certain domains of macroprudential policy, such as in countereviling real estate bubbles. Given that macroprudential tools available to the ECB and those available to national authorities are imperfect substitutes, how should the ECB as a monetary authority respond in the case national authorities refrain from leaning against the bubble, e.g. because they do not fully internalize the associated financial stability risks, which may partly spill over to other
countries? And how should the ECB as a macroprudential authority react, acknowledging that its incomplete macroprudential policy toolkit may be not as effective as the one under the national authorities guard?

To the extent such risks complicate the ECB’s task to maintain price stability, there may be monetary policy rationale to respond to them. But, in this simplified example, it would have to choose between policy-controlled interest rates or counter-cyclical capital buffers, both of which could only partly mitigate the risks. The question is which tool would be best suited, in this second-best scenario, to counteract the price stability implications of the bubble.

The DSGE framework with a banking sector constrained by two sources of financial frictions was developed in this chapter as a first step to answer some of the current concerns of euro area policy makers. Three main conclusions stand out from our simulations. First, when merging two sources of credit frictions in an otherwise standard New Keynesian framework, the collateral constraint type of credit friction is dominant over the incentive constraint proposed by Gertler and Karadi (2011). Against this background, the net worth channel of the banking sector from the Gertler and Karadi (2011) model is not so relevant and, as a consequence, the model’s large effect on the economy also vanishes under a technology and monetary type of shocks. This is a robust property of our framework, since it holds for different calibration scenarios and alternative monetary policy rules.

Second, the inclusion of a collateral constraint, that can be seen as a prudent bank behaviour, enhances banks’ resilience to shocks. This ability is improved when a more stringent LTV ratio is considered. These outcomes offer some insight in terms of the benefits of introducing time-varying loan-to-value ratios as a macroprudential tool. Finally, less stricter regulatory requirements for the loan-to-value ratio amplify the propagation mechanism of monetary policy shocks.

As previously stated, the embeddedness in this two financial frictions model of macroprudential tools, such as countercyclical capital requirements and time-varying loan-to-value ratios, will be work for future research. Once this task is completed, we will be focusing our analysis on the assessment of how effective macroprudential policy is in counteracting the effects of shocks in the business cycle, assuming a perfect control of both instruments and considering two scenarios: one including a monetary policy response and the other abstracting from monetary policy.
5.6 Appendix A - Equilibrium conditions

5.6.1 Households

The equilibrium of households sector is given by 7 equations:

\[ \Lambda_t = \Lambda(C_t, h_t) = \frac{((C_t - \chi C_{t-1} / (1 + Stochg_t))(1-\rho)(1-h_t)^{\rho(1-\sigma_c)} - 1}{1 - \sigma_c} \]

(5.79)

\[ \Lambda_{C,t} = (1-\rho)(C_t - \chi C_{t-1} / (1 + Stochg_t))(1-\rho)(1-\sigma_c)^{-1}(1-h_t)^{\rho(1-\sigma_c)} \]

(5.80)

\[ R_{t+1}^{ext} = \frac{R_{t+1}}{\Pi_t} \]

(5.81)

\[ \Lambda_{C,t} = \beta_t (1 + Stochg_t)^{\rho(1-\sigma_c)^{-1}} E_t \left[ R_{t+1}^{ext} \Lambda_{C,t+1} \right] \]

(5.82)

\[ W_t = \frac{\phi(C_t - \chi C_{t-1} / (1 + Stochg_t))(1-\rho)(1-\sigma_c)^{-1}(1-h_t)^{\rho(1-\sigma_c)} - 1}{\Lambda_{C,t}} \]

(5.83)

\[ \beta_t = \beta \]

(5.84)

\[ \rho_t = \rho \]

(5.85)

5.6.2 Goods Producers

Equilibrium of Goods Producers is given by 3 equations:

\[ Y_t^W = F(A_t, h_t, K_t) = (A_t h_t)^{\alpha}(K_{t-1}/(1 + Stochg_t))^{(1-\alpha)} / \Delta_t \]

(5.86)

\[ Y_t = (1-c)Y_t^W \]

(5.87)

\[ \frac{P_t^W}{P_t} F_{h,t} = \frac{P_t^W}{P_t} \alpha Y_t^W = \frac{W_t}{P_t} \]

(5.88)

5.6.3 Capital Producers

Equilibrium of capital producers is given by 7 equations:
\[ K_t = \frac{(1 - \delta)K_{t-1}}{1 + Stoch_g_t} + (1 - \phi_x(X_t - (1 + Stoch_g_t))^2)I_t)\psi_{t+1} \]  
\[ X_t = \frac{I_t}{I_{t-1}}(1 + Stoch_g_t) \]  
\[ D_{t,t} = \beta \frac{\Lambda_{E,t}}{\Lambda_{C,t}}(1 + Stoch_g_t)^{(1-\rho)(1-\sigma_e)-1} \]  
\[ 1 = Q_t (1 - \phi_x(X_t - (1 + Stoch_g_t))^2 - 2X_t\phi_x(X_t - (1 + Stoch_g_t)) + Z_1(t) \]  
\[ Z_{1,t} = E_{t-1} \left[ D_{t,t}Q_t2\phi_x(X_t - (1 + Stoch_g_t))X_t^2 \right] \]  
\[ Z_{2,t} = (1 - \alpha) \frac{P_t}{P_t} \frac{Y^W}{K_{t-1}/(1 + Stoch_g_t)} + (1 - \delta)Q_t \]  
\[ R_{k,t} = \psi_t(Z_{2,t}/Q_{t-1}) \]  

### 5.6.4 Entrepreneurs

Equilibrium for entrepreneurs is given by 12 equations:

\[ DDE_{t,t+1} = \beta \frac{\Lambda_{E,t+1}}{\Lambda_{C,t}}(1 + Stoch_g_{t+1})^{-\sigma_E} \]  
\[ 1 = E_t \left[ DDE_{t,t+1}R_{t,t+1}^{ex} + \frac{\Theta_{E,t}R_{t,t}}{\Lambda_{C,t}} \right] \]  
\[ 1 = E_t \left[ DDE_{t,t+1}R_{k,t+1}^{ex} + \frac{\Theta_{E,t}mE_t\Pi_{t+1}Q_{t+1}(1 - \delta)}{\Lambda_{C,t}Q_t} \right] \]  
\[ \phi_{E,t} = \frac{Q_tK_t}{Q_tK_t - L_t} \]  
\[ R_{t,t}L_t = mE_t[\Pi_{t+1}Q_{t+1}(1 - \delta)K_t] \]  
\[ C_{E,t} + Q_tK_t + R_{t,t}^{ex}L_{t-1}/(1 + Stoch_g_t) = R_{k,t}Q_t(K_t - (1 + Stoch_g_t) + T_{E,t} + L_t \]  
\[ \Lambda_{E,t}^E = (C_{E,t} - \chi_E C_{E,t-1}/(1 + Stoch_g_t))^{(1-\sigma_E)} \left( \frac{1}{1 - \sigma_E} \right) \]  
\[ \Lambda_{C,t}^E = (C_{E,t} - \chi_E C_{E,t-1}/(1 + Stoch_g_t))^{-\sigma_E} \]  
\[ R_{t,t}^{ex} = \frac{R_{t,t-1}}{\Pi_t} \]  
\[ \beta_{E,t} = \beta_E \]  
\[ T_{E,t} = T_{E} \]
5.6.5 Banking Sector

The equilibrium of the banking sector is given by 9 equations:

\[
\phi_{B,t} = \frac{\mu_{n,t}}{\Theta_{B,t} - \mu_{L,t}} \tag{5.107}
\]

\[
L_t = \phi_{B,t} N_t \tag{5.108}
\]

\[
N_t = (\sigma_B + \xi_{B,t}) R_{t+1}^e L_{t+1} / (1 + Stoch_{t+1}) - \sigma_B R_t^e D_{t-1} / (1 + Stoch_t) \tag{5.109}
\]

\[
D_t = L_t - N_t \tag{5.110}
\]

\[
\mu_{n,t} = E_t [DD_{t,t+1} + 1 + \Omega_{t+1} + 1 + R_{t+1}^e] \tag{5.111}
\]

\[
\mu_{L,t} = E_t [DD_{t,t+1} + 1 + (R_{t+1}^e - R_t^e)] \tag{5.112}
\]

\[
\Omega_t = 1 - \sigma_B + \sigma_B (\mu_{n,t} + \phi_{B,t} \mu_{L,t}) \tag{5.113}
\]

\[
\Theta_{B,t} = \Theta_B \tag{5.114}
\]

\[
\xi_{B,t} = \xi_B \tag{5.115}
\]

5.6.6 Retail Sector

Retail sector is standard and comprises 6 equations:

\[
H_t - \xi \beta E_t \left[ \bar{\Pi}_{t+1}^{\xi-1} H_{t+1} (1 + Stoch_{t+1})^{(1-\rho)(1-\sigma_e)} \right] = Y_t \Lambda_{C,t} \tag{5.116}
\]

\[
J_t - \xi \beta E_t \left[ \bar{\Pi}_{t+1}^{\xi} J_{t+1} (1 + Stoch_{t+1})^{(1-\rho)(1-\sigma_e)} \right] = \left( \frac{1}{1 - (\frac{1}{\xi})} \right) MC_t Y_t \Lambda_{C,t} \tag{5.117}
\]

\[
\bar{\Pi}_t \equiv \frac{\Pi_t}{\Pi_{t-1}} \tag{5.118}
\]

\[
1 = \xi \Pi_t^{\xi-1} + (1 - \xi) \left( \frac{J_t}{H_t} \right)^{1-\xi} \tag{5.119}
\]

\[
MC_t = \frac{P_t^W}{P_t} \tag{5.120}
\]

\[
\Delta_t = \xi \bar{\Pi}_t^{\xi} \Delta_{t-1} + (1 - \xi) \left( \frac{J_t}{H_t} \right)^{-\xi} \tag{5.121}
\]

191
5.6.7 Closing the Model

The resource constraint and the government balanced budget close the model, plus the Monetary Policy Rule:

\[ Y_t = C_t + C_{E,t} + G_t + I_t \]  

\[ G = h_t tax_t \frac{W_t}{P_t} \]  

\[ \log \left( \frac{R_{n,t}}{R_n} \right) = \alpha_r \log \left( \frac{R_{n,t-1}}{R_n} \right) + (1 - \alpha_R) \left( \Theta_{\Pi} \log (\Pi_t / \Pi) + \Theta_Y \log (Y_t / Y) \right) + \text{epsMPS} \]  

5.6.8 Shocks

The shocks are 6: monetary policy, government spending, technology, trend, mark-up and capital quality shocks, respectively:

\[ \log(\text{MPS}) = g_{\text{MPS}} \log(\text{MPS}_{t-1}) + \text{epsMPS} \]  

\[ \log(G_t) - \log(G) = g_G (\log G_{t-1} - \log G) - \text{epsG} \]  

\[ \log(A_t) - \log(A) = g_A (\log A_{t-1} - \log A) - \text{epsA} \]  

\[ \log(1 + \text{Stoch}_t) = \log(1 + g) + \text{epsAtrend} \]  

\[ \log(\text{MS}_t) = g_{\text{MS}} \log(\text{MS}_{t-1}) + \text{epsMS} \]
5.7 Appendix B - Steady State

5.7.1 Households

\[ \Lambda = \frac{((C - \chi C/(1 + g))(1 - \rho)(1 - h)^\rho)^{1 - \sigma_c} - 1}{1 - \sigma_c} \]
\[ \Lambda_C = \frac{((1 - \rho)(C - \chi C/(1 + g))(1 - \rho)(1 - h)^\rho - 1)/(1 - \sigma_C)}{1 - \sigma_c} \]
\[ R_n = R^{ex} \Pi \]
\[ R^{ex} = \frac{(1 + g)^{(1-\rho)(\sigma_c-1)+1}}{\beta} \]
\[ C = \frac{[W/P(1 - \rho)(1 - h)]}{(\rho(1 - \chi/(1 + g))} \]
\[ \beta = \beta \]
\[ \rho = \rho \]

5.7.2 Goods Producers

\[ Y^W = (Ah)^\alpha (K/(1 + g))^{(1-\alpha)}/\Delta \]
\[ Y = (1 - c)Y^W \]
\[ \frac{P^W}{P} = \frac{\alpha Y^W}{h} = W/P \]

5.7.3 Capital Producers

\[ X = 1 + g \]
\[ I = \left( \frac{\delta + g}{1 + g} \right) K \]
\[ DD = \beta(1 + g)^{(1-\rho)(1-\sigma_c)-1} \]
\[ Q = 1 \]
\[ Z_1 = 2DDQ\phi_x(X - 1 - g)X^2 \]
\[ Z_2 = (1 - \alpha) \frac{P^W}{P} \frac{Y^W}{K/(1 + g)} + (1 - \delta)Q \]
\[ R_k = Z_2/Q \]
5.7.4 Entrepreneurs

\[ DDE = \beta_E (1 + g)^{-\sigma_E} \]
\[ \Theta_E = (1 - DDER^e) \frac{\Lambda_E}{R_i} \]
\[ R_k = \frac{1 - \Theta_E m \Pi (1 - \delta) / \Lambda_E^{C,E}}{DDE} \]
\[ \phi_E = \frac{QK}{QK - L} \]
\[ L = m \Pi Q (1 - \delta) K / R_t \]
\[ C_E = R_k Q K / (1 + g) + T_E + L - Q K - R_i^{ex} L / (1 + g) \]
\[ \Lambda_E = ((C_E - \chi_E C_E / (1 + g))^{(1 - \sigma_E) / (1 - \sigma_E)} \]
\[ \Lambda_{C,E} = (C_E - \chi_E C_E / (1 + g))^{-\sigma_E} \]
\[ R_i^{ex} = R_i / \Pi \]

5.7.5 Banking Sector

\[ \phi_B = \frac{\mu_n}{\Theta_B - \mu_L} \]
\[ N = L / \phi_B \]
\[ N = ((\sigma_B + \xi_B) R_i^{ex} - \sigma_B R^{ex}) L / (1 + g) / [1 - \sigma_B R^{ex} / (1 + g)] \]
\[ D = L - N \]
\[ \mu_n = \Omega \]
\[ \mu_L = DD \Omega (R_i^{ex} - R^{ex}) \]
\[ \Omega = 1 - \sigma_B + \sigma_B \phi_B \Theta_B \]
\[ \Theta_B = \Theta_B \]
\[ \xi_B = \xi_B \]
5.7.6 Retail Sector

\[ H = \frac{Y \Lambda_C}{1 - \xi \beta \Pi (\zeta^{-1}) (1 + g)^{(1-\rho)(1-\sigma_C)}} \]
\[ J = \frac{(1 - 1/\xi) Y \Lambda_C \cdot MC}{1 - \beta \xi \Pi \zeta (1 + g)^{(1-\rho)(1-\sigma_C)}} \]
\[ MC = \frac{(1 - 1/\xi) \left[ 1 - \xi \beta \Pi \zeta (1 + g)^{(1-\rho)(1-\sigma_C)} \right]}{1 - \xi \beta \Pi (\zeta^{-1}) (1 + g)^{(1-\rho)(1-\sigma_C)}} \left( \frac{1 - \xi \Pi (\zeta^{-1})}{1 - \xi} \right)^{1/(1-\zeta)} \]
\[ \bar{\Pi} \equiv \frac{\Pi}{\Pi^\gamma} \]
\[ P^W/P = MC \]
\[ \Delta = \left( \frac{1 - \xi}{1 - \xi \bar{\Pi} \zeta} \right) \left( \frac{1 - \xi \bar{\Pi} (\zeta^{-1})}{1 - \xi} \right)^{1/(1-\zeta)} \]

At the steady state, \( MS = 1 \).

5.7.7 Closing the Model

\[ Y = C + C_E + I + G \]
\[ tax = G/(h \frac{W}{P}) \]

At the steady state, we also make use of the following relationship:

\[ G = g_y Y \]

where we assume \( g_y = 0.2 \).
Chapter 6

Concluding Remarks

The selection of the topics for the research conducted within the scope of this thesis was motivated by the extensive and widespread reforms in the institutional settings of monetary policy and banking regulation, implemented as a response to the large economic breakdown caused by the financial crisis of 2008. The financial crisis challenged not only the way by which economic policy had been conducted in the past, but also questioned the theoretical underpinnings of monetary policy and banking regulation.

As an example of the high policy interest of the research questions investigated in this thesis, the Bank of England (2015), in its discussion paper introducing “One Bank Research Agenda”, has identified these themes as key research fields that need deeper knowledge and understanding, or, has Bank of England puts it, “require(s) frontier research”. In particular, the Bank of England (2015) research questions to which this thesis aims at contributing are:

- “How should monetary policy, macroprudential policy and microprudential policy be co-ordinated?”
- “Do we need to revisit the monetary policy framework in light of the financial crisis?”
- “How should we design an appropriate macroprudential policy framework?”

The survey finds that there is a common view that central banks should have an explicit financial stability mandate, by playing a role in macroprudential policy, but the micro-prudential dimension of banking regulation and supervision should be assigned to an
independent authority. This view is raised upon the stronger similarities between monetary and macroprudential policies and, as such, the assignment of a financial stability mandate to central banks would maximise the synergies arising from the interaction of the two policies (Smets, 2014). Nonetheless, the survey also highlights the need for empirical and theoretical evidence, which is still scarce, suggesting that this view is not yet informed by empirical and theoretical analysis, but mostly by personal opinions of researchers and policymakers. Theoretical microeconomic approaches on this topic show that the analysis of the banking supervisors’ incentives should be carefully considered in the design of optimal supervisory institutional setups. This literature would benefit from an extension to assess the implications of incorporating its interplay with monetary policy. Macroeconomic models in which the interplay of monetary policy and banking regulation is investigated are also scant and mainly focused on Basel I and Basel II capital regulation frameworks, although recent years have been very fruitful on producing research on this field.

The study presented in chapter 3 assesses the conflicting goals of price and banking stability. Acknowledging that central banks in charge of banking regulation may be less aggressive in their inflation mandate, in cases in which tight monetary policy conditions could have a negative effect on the stability of the banking system, it has been argued that banking supervisory powers should be assigned to an independent authority to avoid inflation bias. The paper investigates, from an empirical standpoint, whether central banks’ combined mandates lead to an inflation bias problem, using panel data for 25 industrialised countries from 1975 to 2012. Both static and dynamic panel data models are employed. Findings show that, once we control for relevant policy and institutional factors, there is no evidence of an inflationary bias arising from institutional frameworks in which central banks have banking supervisory mandates. Our estimation results, which are backed up by several robustness tests, suggest that there are other institutional pillars of the monetary and financial supervisory architecture, such as deposit insurance schemes and inflation targeting mandates of central banks, that contribute in a significant manner to keeping inflation rates low. From a policy standpoint, empirically we do not find an inflation bias standing out from institutional arrangements in which central banks combine monetary policy tasks with supervisory responsibilities. Still, without further research on the relevance of other arguments against the combination of tasks, such as reputation risks or organisational costs, we cannot argue that such an institutional setup would be superior to one in which banking supervision is assigned to an independent authority.
The role of monetary policy in promoting financial stability, its interaction with macro-prudential regulation and how these policies can contribute to improve social welfare is investigated in Chapter 4. We find that a 'leaning against the financial imbalances' monetary policy rule would perform better in terms of maximizing welfare than a standard, conventional monetary policy rule in this type of framework. However, rules responding to credit spreads and asset prices would come at a cost of higher inflation volatility.

In the case of scenarios encompassing a macroprudential policy approach, our findings from optimization exercises are interesting from a policy perspective. They not only confirm the countercyclical nature of macroprudential tools, but more importantly they show that the deployment of macroprudential regulation together with standard monetary policy improves welfare, regardless of the target selected in the analysis and, to some extent, of the type of policy mandate under assessment (separate or unified). The welfare maximization is achieved, though, under a partially unified mandate featuring a macroprudential rule that reacts simultaneously to credit and credit spreads. Inflation stabilization, on the other hand, is better accomplished in a separate mandate, comprising a standard Taylor rule feeding back on inflation and output gaps, and a macroprudential rule responding to credit and spreads. Next steps of this project involves the estimation of the model using Bayesian techniques.

The last chapter presents preliminary work on the investigation of the transmission mechanisms of different macroprudential policy instruments and their interactions with monetary policy-controlled interest rates, under a New Keynesian model with two types of financial frictions. We extend a New Keynesian model with a banking sector incorporating an incentive constraint between households and banks to include a second friction, which arises from a collateral constraint on the entrepreneurs’ optimization problem. This setup provides a first step to analyze how monetary policy would differ depending on whether it has access to the full or only parts of the macroprudential toolkit - a question that is particularly relevant in the emerging institutional landscape of the euro area where the central bank will lack some important macroprudential instruments.

Three main preliminary findings stand out from our simulations. First, when merging two sources of credit frictions in an otherwise standard New Keynesian framework, the collateral constraint type of credit friction is dominant over the incentive constraint. Second, the inclusion of a collateral constraint enhances banks’ resilience to shocks. This ability is improved when a more stringent loan-to-value (LTV) ratio is considered. These outcomes offer some insight in terms of the benefits of introducing time-varying LTV ratios as a macroprudential tool. Finally, less stricter regulatory requirements for the
loan-to-value ratio amplify the propagation mechanism of monetary policy shocks. Future work on the model encompasses the embeddedness of macroprudential instruments, such as countercyclical capital requirements and time-varying loan-to-value ratios.

The extension of the model to encompass tools that address specific types of macroprudential risks is needed to assess the challenges emerging from the new institutional landscape in the euro area: upon inception of the Single Supervisory Mechanism (SSM), the European Central Bank (ECB) is granted certain tools to address macroprudential risks, but its toolkit remains incomplete: for example, the ECB is authorized to raise countercyclical capital buffers on euro area banks, whereas loan-to-value ratios remain at the discretion of national authorities in euro area countries. A real-estate bubble might be best addressed by raising loan-to-value ratios, thus putting the onus of action on national authorities, but they may not fully internalize the associated financial stability risks, and refrain from act against the bubble. Such risks may complicate the ECB’s task to maintain price stability and there may be monetary policy rationale to respond to them. What would be then the best suited tool, in this second-best scenario, to counteract the price stability implications of the bubble, in such an institutional arrangement?

Our findings must be interpreted carefully, since DSGE models with typical solution techniques based on log-linearization do not allow for the non-linear dynamics that usually characterize boom-bust episodes. As an example, bank default is an important aspect of bust events which is difficult to model in this type of frameworks. Recent research work has been undertaken to overcome this limitation of DSGE models, such as Clerc et al. [2015], in which bank, households and firms default are incorporated in a otherwise standard real business cycle model. Still, despite the absence of nonlinearities in these models, the importance for monetary policy to ‘lean against the wind’ and for considering macroprudential policy as an ancillary tool to deal with financial imbalances is entirely confirmed by simply granting a non-negligible role to financial intermediation provided by the banking system.

Contributions of this thesis for macroeconomic policy making are several. Empirically, we do not find evidence for the ‘conflict of interest’ thesis in developed countries, suggesting that institutional arrangements assigning a central bank role in banking supervision are insulated from a tendency to deviate from the inflation target. Moreover, results also show that monetary policy rules reacting to price developments and financial imbalances are welfare optimizing, although they imply higher inflation volatility. The introduction of macroprudential policy improves welfare, even in the case in which we consider a separate institutional regime. Nonetheless, findings also suggest that macroprudential
instruments may impact on the way monetary policy shocks propagate in the economy. Research work in this field is fundamental, not only to identify the situations in which macroprudential policies may act as a complement to monetary policy, but mainly the cases in which they may enter into conflict. As an example, research is needed on the implications of a very accommodative monetary policy stance on the banking and insurance companies’ business models, on the build-up of housing price bubbles and other risks to financial stability. The way each policy affects the transmission mechanism of the other policy should thereby be investigated more extensively. The understanding of these interactions is key to the optimal design of institutional setups of monetary policy and macroprudential regulation, taking into consideration that there are currently multiple institutional frameworks of macroprudential policy around the world. In Europe, for example, macroprudential policy institutional arrangements differ significantly from country to country - the most common framework is characterised by the central bank being the macroprudential authority (i.e. Portugal, United Kingdom, Finland or Spain), but there are jurisdictions that have opted by assigning the macroprudential policy powers to committees, that can have different compositions from country to country (varying, for example, in the degree of intervention in the decision making process of the Ministry of Finance). Adding a layer of complexity to the institutional landscape in Europe, the European Central Bank has also macroprudential responsibilities, which provides it with the capacity to top up measures taken by national authorities in some cases. As such, there is a need to establish better cooperation mechanisms between monetary and macroprudential authorities, at the national and European levels.

Other future research avenues related to these issues may assess the optimal level of bank capital requirements and its decomposition into micro and macroprudential components. The pace of implementation of stricter capital requirements, also considering its impact on the monetary policy transmission channels, is also a very challenging topic that claims for further investigation. Should supervisory authorities request financial institutions to comply with higher capital buffers gradually (for instance, allowing them to build the capital ratio over a period of 3-4 years) or quickly (in one year, at most). What are the implications of a faster or slower build up of capital buffers for credit, probability of default and economic activity? This question leads to another relevant issue: How to measure and quantify the costs and benefits of such distinct approaches?

The effectiveness of cyclical and structural macroprudential policy instruments is yet to be proven; some macroprudential instruments are imperfect substitutes (for instance, countercyclical capital requirements and the leverage ratio, both of them promote delever
aging) and may work better in some circumstances than others. The development of frameworks accounting for endogenous bank default and systemic banking crisis would be a very important step to assess the effectiveness of macroprudential tools. The small impact on welfare of introducing macroprudential policy in a framework that already accounts for monetary policy could be related to the absence of such features in the models.

The impact of the banking system structure on the transmission channel of monetary policy also requires further empirical research. It is still not clear whether the propagation of monetary policy is smoother in more or less concentrated banking systems.
Bibliography


