THE EVOLUTION AND EFFECTIVENESS OF MACROPRUDENTIAL POLICY

A study of its objectives and effects on the financial sector, specifically focusing on the differences between advanced countries and emerging market economies.

A thesis submitted for the degree of Doctor of Philosophy

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ABSTRACT

This thesis investigates the evolution of macroprudential policy, its objectives and effects on the financial sector with emphasis on the differences between advanced countries and emerging market economies. Firstly, we examine the effectiveness of macroprudential policy in reducing the build-up of financial imbalances in the wider economy. We focus on the aggregate credit-to-GDP gap, which besides being recommended to trigger the Basel III countercyclical buffer, is also widely seen as a key indicator of financial imbalances and a predictor of financial crises. This approach has not been done elsewhere. We find a number of tools to be effective including loan-to-value and debt-to-income ratio regulations, notably when the credit gap is positive. Secondly, we extend the research to look at the cross-border spill over effects of macroprudential policies, which can help in the understanding of the interconnectedness of financial markets via international banks' claims (lending activities). We consider this of particular relevance for understanding the concept of financial stability given the rapid spread of the 2007-2008 financial crisis to international markets. Our approach is unique because the panel vector autoregressive approach has not been used so far to investigate potential macroprudential instruments spill over effects between countries. Our results show some macroprudential measures spillovers, notably in emerging market economies, but the impact is negligible in term of affecting a country's financial stability or the build-up of financial imbalances. Thirdly, we study the costs that are incurred when macroprudential policy are employed in the financial sector as well as the relationship with monetary policy. We contend that although the aim of macroprudential policy is to prevent or limit financial instability across the broad financial system, the currently suggested macroprudential regulations target the banking sector narrowly. This can be seen as an added cost to banks which in turn can affect banks' profitability and hence their ability to lend and potential economic growth. There are very few micro data studies of macroprudential policy and no previous studies on the impact on banks' profitability. Our findings suggest that although macroprudential instruments can achieve its objective of preventing the build-up of financial system imbalances, as measured by the credit-to-GDP gap, yet it has significant and negative effects on banks' profitability. Also, we found that there is positive/ negative interaction between macroprudential and monetary policies.

Keywords: Macroprudential Policy, Credit-to-GDP Gap, Financial Crisis, Financial Stability, Cross-border, Banking, Banks' Profitability.

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To

my wife, Ezra

and

children, Dionne and William

DECLARATION

The following papers have been issued as working papers or for comments.

Chapter 3 – The Effectiveness of Macroprudential Policy

Davis, E.P, Karim, D. and D. Noel (2017), "*Macroprudential policy and Financial Imbalances*", Brunel University London Economics and Finance Working Paper No. 17-22.

Noel, D. (2018), "*Could macroprudential indicators have helped predict a financial crisis in Jamaica? A case study of the Credit-to-GDP gap.*" A paper presented at the Caribbean Economic Research Team, 50th Annual Monetary Studies Conference, hosted by the Central Bank of Barbados, Bridgetown.

Chapter 4 – Financial Stability and Macroprudential Policy: Are there cross-border effects?

Davis, E.P, Karim, D. and D. Noel (2019), "Financial Stability and Macroprudential Policy: Cross Border Effects", Working Paper issued for comments.

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ABBREVIATIONS

ADV	Advanced Countries
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
BoE	Bank of England
CGFS	Committee on the Global Financial System
ECB	European Central Bank
EME	Emerging Market Economies
EMU	European Monetary Union
EU	European Union
ESRB	European Systemic Risk Board
EWI	Early Warning Indicators
FDIC	Federal Deposit Insurance Corporation (US)
FSAP	Financial Sector Assessment Program
FSB	Financial Stability Board
GATS	General Agreement on Trade and Services
GATT	General Agreement on Trade and Tariffs
GMM	Generalized Method of Moments
GMPI	Global Macroprudential Policy Instruments
IBRN	International Banking Research Network
ILO	International Labour Organisation
IMF	International Monetary Fund
MAPP	Macroprudential Policy Instruments
MP	Macroprudential Policy
OECD	Organisation for Economic Co-operation and Development
PVAR	Panel Vector Autoregressive
UK	United Kingdom
US	United States
WB	The World Bank
WTO	World Trade Organization

CHAPTER 1:

Introduction and Overview

1.1. Research motivation

The potential risk of the U.S. subprime mortgage market was discussed in many Financial Stability Reports prior to the 2007-2008 financial crisis, such as the International Monetary Fund (IMF), the Bank of England (BoE), European Central Bank (ECB), etc., (see the survey by Davis and Karim (2008b)), and the initial opinion was that the risk has been contained to certain portions of the subprime market and was not likely to pose a serious systemic threat (see BIS (2008)). Davis and Karim (2008b) noted that IMF Global Financial Stability Report for April 2007 suggested that there is a 'strong foundation for global financial stability and any spill over financial effects of the U.S. subprime market could be contained.

At the time, the paradox was that many countries had a macroprudential surveillance programme, which should have given warning (early warning indicators (EWI)) of an impending financial instability (Čihák (2006), Čihák et al (2012)). The BIS[1] has analysed and monitored such early warning indicators of domestic banking distress and these indicators, e.g. the credit-to-GDP gap, capture financial overheating and signal potential banking distress over medium-term horizons. However, Davis and Karim (2008b) noted that none of the main surveillance reports identified the weaknesses in the subprime market and special purpose vehicles as a systemic threat nor did they foresee the collapse of the interbank market. They suggested that even if the pending financial instability was identified, macroprudential surveillance came with no recommended policy tools to deal with the build-up of financial sector imbalances or the risk of a financial crisis. A possible exception is the Spanish dynamic provisioning tool (see Jiménez et al (2012)).

[1] See BIS website, https://www.bis.org/publ/qtrpdf/early warning indicators.htm.

Therefore, in the aftermath of the 2007-2008 global financial crisis, the consensus among regulators, policymakers and researchers was that there needs to be a shift in focus on how the financial system is regulated and monitored. Many observers argued that systemic risk was insufficiently understood and financial regulation focused excessively on preventing individual financial institution failure (microprudential policy) (Hanson et al (2011)).

Yet, it is important to note that, this does not mean that microprudential policy and the macroprudential surveillance programme are ineffective and have become insignificant in the regulatory framework. What the 2007-2008 global financial crisis has shown is that there were shortcomings in the existing regulatory framework and that microprudential policy, the surveillance programme (financial stability) and other macroeconomic policies needed to be supplemented with a more comprehensive policy that looks at the welfare of the entire financial system. Regulators and policy makers needed to adopt a holistic approach to financial system regulations and monitoring, as the stability of the entire financial system is important for a country's economic performance. Crockett (2000)[2] suggested that there needed to be a marrying of two aspects of prudential regulation (microprudential and macroprudential dimensions) in order to build on past achievements in the pursuit of financial stability.

Accordingly, the 2007-2008 global financial crisis led to the introduction of several new regulatory policies in the financial sector with the intended goals of 1) strengthening existing supervisory policy especially microprudential policy[3]; and 2) introducing macroprudential policy as the focal policy for looking at systemic risks, both in the time and cross-sectional dimensions (we discussed this further in **Chapter 2**), as distinct from microprudential policy which looks at risks from an individual bank perspective.

Lim et al (2011) noted, following the 2007-2008 financial crisis, using data from 49 countries (the first IMF survey (2010)[4]), that the use of macroprudential instruments

[2] Andrew Crockett, General Manager of the Bank for International Settlements (1994-2003).
[3] Basel III: International regulatory framework for banks saw the introduction of new banking standards for capital and liquidity requirements, disclosure and risk management and governance, etc. See BIS website, http://www.bis.org/bcbs/basel3.htm.
[4] IMF (2010), "Financial Stability and Macroprudential Policy Survey: A Stock Taking", December. The survey was sent to 63 countries and the European Central Bank (ECB), including all countries in the G-20 and those subjects to mandatory Financial Sector Assessment Programs (FSAPs).

was growing and countries have introduced them with the objective of reducing systemic risk either over time or across institutions and markets. Also, they suggested that, over time, instruments used were associated with reducing procyclicality in the credit markets and leverage. It should be noted that these instruments were commonly used in emerging market countries prior to the 2007-2008 financial crisis, normally as part of an IMF/World Bank restructuring programme as a result of the country experiencing an economic and financial crisis.

Further, Cerutti et al (2015a), a few years later, (the second IMF survey[5]) provided evidence of the rapid growth in the development of macroprudential policy framework and usage of macroprudential instruments in over 119 counties. They noted that usage is generally aimed at dampening credit demand, notably in household credit. Examples of macroprudential instruments used are time-varying/dynamic loan-loss provisioning (DP), loan-to-value ratio (LTV), debt-to-income ratio (DTI), limits on foreign currency loans (FC) and concentration limits (CONC), etc.

However, the nature of macroprudential policy to date as reflected in many countries' policy framework is that it commonly affects mainly the domestic banking and household sectors (via lending and house prices). In line with this, most research studies of the effectiveness of macroprudential policy tend to focus on the effects on domestic operating deposit-taking-institutions (DTIs), which are typically commercial banks. Nevertheless, a large number of macroprudential tools have been proposed and there is no clear agreement on which tool should play a primary role in macroprudential regulation, e.g. countercyclical capital requirement (CTC), cap on loan to value ratio (LTVCAP), debt-to-income ratio (DTI), etc. For emerging markets, some central banks have applied reserve requirement and have set specific requirements as well as capital controls as part of their macroprudential regulation framework. Although capital controls are not macroprudential tools, they do have a macroprudential effect. We would expect that macroprudential regulation would be tailored to each country or region circumstances and "*one size does not fit all*".

[5] Analysis from the IMF Global Macro-Prudential Policy Instruments (GMPI) survey (2013-2014). The IMF surveys the central banks/national authorities of 125 member countries and the Central Bank of West African States (BCEAO) and respondents provided responses to more than 100 detailed questions on about 17 key macro-prudential policy tools.

Furthermore, as with any new regulatory framework, there are costs associated with its implementation, although it has been argued that economic benefits far outweigh the costs (see Davis et al (2018), Barrell et al (2009), etc.). Popov and Smets (2012) argued that the goal of financial regulation must be to reduce systemic risk without eliminating the financial sector's contribution to long-term economic growth. The policymaker's objective becomes one of distinguishing 'good' from 'bad' booms, and of reducing the contribution of financial markets to "tail risk" without eliminating their contribution to growth. Popov and Smets (2012) recommended that macroprudential tools should be employed forcefully during costly booms driven by excessive debt and characterised by no fundamental contribution to long-term growth, while reacting more cautiously during low-cost booms driven by equity finance. Yet, the question remains of how effective macroprudential regulation is in a national financial system and what is the potential cost for the financial sector.

1.2. Thesis objectives

In this context, the main objective of this thesis is to contribute to the growing body of empirical research on macroprudential policy, its objectives, effectiveness and the potential costs to the financial sector and economic activities, with a particular emphasis on looking at the differences between advanced countries and emerging market economies. First, we seek to assess the concept of macroprudential policy and explore the growth of it over the years, especially considering the period since the 2007-2008 global financial crisis when adoption has become more general. We review the background history of macroprudential policy, the development of macroprudential policy as a financial sector regulatory tool as well as its suggested operation, structure and benefits. We highlight inter alia that the adoption of a macroprudential approach implicitly corrects the error in thinking, especially prior to the 2007-2008 global financial crisis, that only inflation mattered and not assets prices – against the background of the Great Moderation (see Hulseman and Detmeister (2017)).

Second, we provide empirical evidence on the effectiveness of macroprudential policy and its instruments in reducing the build-up of financial imbalances in the wider economy. Much of the research literature such as Carreras et al (2018), Cerutti et al (2017), Akinci and Olmstead-Rumsey (2015), Claessens et al (2014), Dell'Ariccia et

al (2012) has focused on analysing the effect of macroprudential instruments on credit growth and house prices and the mitigation of the build-up of imbalances in the housing market. Yet, we contend it is as or more appropriate to examine the effectiveness of macroprudential policy and its instruments in reducing the build-up of imbalances in the credit market using the credit-to-GDP gap. Besides being recommended to trigger the Basel III countercyclical buffer, it is also widely seen as a key indicator of financial imbalances and predictor of financial crises. Also, the credit-to-GDP gap uses a broader definition of credit, including commercial property lending and non-bank debt financing, etc., which is generally ignored in existing research but which have been crucial in the build-up to many past financial crises (Davis (1995)).

Third, we highlight a gap in the literature, where the focus tends to be on the domestic financial market, and with limited emphasis on the interconnectedness of international financial markets and how domestic policies can spill over into other countries. Thus, an important issue is the extent to which macroprudential measures generate spill over effects between countries and whether this can affect financial stability positively or negatively or there is no effect. Avdijev et al (2017) indicated that when a country enacts prudential policy, three types of effects may occur, firstly, domestically owned banks' activities in the same country such as credit expansion are affected (see Lim et al (2011) and Cerutti et al (2017)). Secondly, foreign banks may change their lending to the country that enacted the policy (see Aiyar et al (2014a and b). Thirdly, similar to foreign banks, domestic-owned banks may alter their foreign lending to the rest of the world (see Damar and Mordel (2017) and Auer et al (2017)). The last two effects are international in nature and these are the international transmission effects between countries.

We contend that by analysing the potential spill over effects of macroprudential policies, this will help in the understanding of the interconnectedness of financial markets via international banks' claims (lending activities). We consider this of particular relevance for understanding the concepts of financial stability in light of the rapid spread of the 2007-2008 financial crisis to international markets. Additionally, it is important to understand the potential impact prudential measures could have on international banks' lending and their ability to avoid any costs associated with the implementation of these instruments.

Finally, another objective of the thesis is to look at the costs incurred when new regulations are placed on the banking sector, as in this case of macroprudential policy. Van den Heuvel (2008) and Tchana (2012) suggested that although capital requirements limit moral hazard on the part of banks and hence are beneficial for financial stability, they are costly since they reduce the ability of banks to lend, and thus can hamper economic growth. However, Barrell et al (2009) noted that the cost of tighter regulation is small in the long run and if the costs of crises are potentially high, then tighter regulation would be appropriate, as the benefit of reduced probability of crisis outweighs the cost of the loss of economic output. Equally, Davis et al (2018) suggested that if macroprudential measures had been introduced prior to the subprime crisis, this might have reduced the incidence of the crisis and improved macroeconomic performance.

We again contend that there is a gap in the literature on effects of macroprudential policy. The focus is on the benefit of limiting financial sector disruptions, and notably the effects on aggregate credit and house prices. In contrast, there is limited emphasis on the effects on banks as measured by the impact on their profitability, structure and activities, etc. Also, there is limited research using micro banking data in analysing the use of macroprudential policy (for an exception, see Claessens et al (2014) which focused on asset growth).

1.3. Research method and data

The empirical analysis in this thesis is based on various research techniques, with a combination of statistical description, different economic models and econometric tests. Various traditional financial system, banking sector and economic terms as well as theories on financial stability and regulations and macroprudential policy have been applied throughout the thesis in the understanding of the effectiveness of macroprudential policy, the cross-border spill over effects between countries and the effects on banks' profitability.

Micro- and macro- panel econometric techniques such as Generalized Method of Moments (GMM) method, Panel-vector Autoregressive (PVAR) analysis and Ordinary Least Squares (OLS) model are used to explore the different research questions.

These methods have been employed in the research literature to address similar research questions. The empirical results, tables and figures are prepared using Microsoft Word and Excel, EViews and STATA.

The periods of analysis in the thesis for **Chapters 3** and **5** are divided over three periods, the full sample period 2000-2013, the pre-crisis period 2000-2006, and the post-crisis period 2007-2013. In **Chapter 4**, the period of analysis is the full sample period 2000-2014, the pre-crisis period 2000-2006, and the post-crisis period 2007-2014. We selected these periods as they reflect the sample period of the macroprudential policy instruments datasets (see Cerutti et al (2015a) and Cerutti et al in IBRN (2017)) while contrasting the results prior and after the financial crisis is important for testing the effects of macroprudential policy under different economic and financial conditions.

The datasets used in the thesis are considered to be comprehensive and of high statistical quality and standards, produced by organisations such as the International Monetary Fund (IMF), the World Bank (WB), the Bank for International Settlements (BIS), the International Labour Organisation (ILO), the European Union (EU) and various countries, central banks and national statistical agencies. The main bank-specific data are sourced from Fitch Connect (Fitch Solutions) database, which provides annual financial information for banks in many countries around the world.

The two macroprudential policy instruments datasets used in the thesis are produced using information from the IMF Global Macroprudential Policy Instruments (GMPI) survey (2013-2014) and central banks reports (see Cerutti et al (2015a) and Cerutti et al IBRN (2017)). The dataset on the credit-to-GDP gap is produced by the BIS[6], which was first released in September 2016 as time-series quarterly data covering 43 developed and developing countries and one economic region, the Euro currency area, starting at the earliest in 1961. In our model testing, the Euro area is excluded from the panel analysis as many individual countries in the Euro area are already included in the data.

[6] See BIS website, https://www.bis.org/statistics/credit-to-GDP gap.htm.

Another important dataset produced by the BIS that is used in the thesis is the International Banking Statistics (IBS). The IBS track internationally active banks' foreign positions and provides a comprehensive picture of total cross-border banks claims. The data are organised in two datasets – locational and consolidated banking statistics. The locational banking statistics were introduced in 1964 to monitor the development of international deposit, more so, the Eurocurrency markets. The consolidated banking statistics developed in response to the expansion of international banking activity in the Caribbean and other offshore financial centres in the 1970s. Both datasets are collected under the auspices of the Committee on the Global Financial System (CGFS).

1.4. Thesis structure

The organisation of the thesis is as follows.

1.4.1. Chapter 2: Literature Review

Chapter 2 reviews the evolution of macroprudential policy, its objective and the regulatory framework (structure). We commence the chapter with a review of the background history of the development of the concept of macroprudential policy and the changing macroeconomic environment and headwinds faced by many countries, which account for the growth of macroprudential policy as a financial system regulatory policy tool. Secondly, we discuss the growth of macroprudential policy and its instruments since the 2007-2008 financial crisis. We review the theoretical rationale for the importance of macroprudential policy in the context of financial crises and their attendant economic costs and benefits. We look at the development of macroprudential policy framework and what should be some of the key objectives and features of an effective framework. Most of the information in this section will reference the policy guidance of the IMF-FSB-BIS (2016) and to some extent the ESRB (2014a) which has been prepared specifically in light of the global financial crisis. Secondly, we explore the concept of financial stability and its meaning, including the underlying financial stability, definitions, concepts and key principles of financial stability. Thirdly, we provide a review of the agency and organisational structure that is responsible for reporting on financial stability (instability) in a country's financial system. In this

context, we highlight that the definitions of financial stability (instability), which typically focus on the domestic financial system and often do not include reference to international financial markets or the role of international banks specifically. Finally, we review the theory and empirical studies of macroprudential policy and the overall benefit to the financial sector.

1.4.2. Chapter 3: The Effectiveness of Macroprudential Policy

In Chapter 3, we start to look at the effectiveness of macroprudential policy and its instruments in reducing the build-up of financial system imbalances as measured by the credit-to-GDP gap. Firstly, we highlight the rather narrow focus of macroprudential policy in research literature in analysing the financial system imbalances, which is credit growth and house prices. Secondly, we review the credit-to-GDP gap and the prominent role given to it in Basel III as a signalling tool (early warning indicator (EWI)) for policymakers in identifying looming build-ups of imbalances in the financial market and in setting the countercyclical capital buffers. We also point out the wider scope of credit that it captures over what is used in most empirical tests of macroprudential instruments. We go on to discuss empirical research on the credit-to-GDP gap and early warning indicators (EWIs). Thirdly, we present our empirical analysis and results of the effectiveness of the macroprudential instruments in reducing the credit-to-GDP gap, which is to our knowledge the first such test in the literature. This measure is highly relevant since it incorporates a broader definition of credit and captures credit in sectors, e.g. commercial property and non-bank debt financing, which are generally ignored in existing research but which have been highly relevant for past crises. Our results show that a number of tools to be effective including loan-to-value and debt-to-income ratio regulations, notably when the credit gap is positive, which is consistent with the research literature.

1.4.3. Chapter 4: Financial Stability and Macroprudential Policy: Are there cross-border effects?

In this chapter, we look at the interconnectedness of international financial markets and assess whether domestic macroprudential policies can spill over into other countries. We believe this is a further gap in the literature, where the focus tends to

be on the domestic financial market, and with limited emphasis on the interconnectedness of international financial markets. Firstly, we look at the interconnectedness of global financial markets, the growth of international banking and the role international banks play in the transmission of credit and other financial services between countries. Secondly, we explore the role of international banking in financial stability issues. In the final section of the chapter, we examine how international banks' claims impact total domestic lending (measured by the domestic credit-to-GDP ratio), banks' regulatory capital ratio (a measure of banks' strength and stability) and economic activities. Then we look at the spill over effects of macroprudential policy between countries and what potential effects these policies can have across borders. Our results show some spill over effects of prudential measures, notably in emerging market economies, but overall, we consider that the impact is negligible in term of affecting a country's financial stability or the build-up of financial imbalances.

1.4.4. Chapter 5: Macroprudential Policy, Banks' Profitability and Monetary Policy

The purpose of this chapter is, firstly, to present empirical research on the potential effects of macroprudential policies on banks' profitability and activities which will also help in the understanding of how banks react to macroprudential regulations and thus the "transmission process". Secondly, we look at the relationship between macroprudential policy and monetary policy using a banks' profitability model and a net interest margin (NIM) model. Despite the increased trend toward bank disintermediation, the financial crisis of 2007-2008 underlines just how important the banking sector is to the financial system and the economy. Firstly, we look at the role of banks in the financial system and the research literature on the factors affecting banks' profitability. Secondly, we look how banks are regulated (financial system regulatory and supervisory framework) and the impact regulations have on banks' costs and lending activities. Thirdly, we present an empirical analysis of the impact macroprudential policy has had on banks' profitability (return on average assets (ROAA) and return on average equity (ROAE) as well as the relationship with monetary policy using the net interest margin profitability model (NIM). We contend that although the aim of macroprudential policy is to prevent or limit financial instability

across the broad financial system, the currently-suggested macroprudential tools and new regulations target the banking sector narrowly, which can be seen as an added cost to banks which in turn can affect banks' profitability and hence their ability to lend. Our findings suggest that although macroprudential instruments can achieve its objective of preventing the build-up of financial system imbalances, yet it has significant and negative effects on banks' profitability, which can reduce the ability of banks to lend, and thus hamper economic growth. Also, we found that there is positive/ negative interaction between macroprudential and monetary policies.

1.4.5. Chapter 6: Conclusion and Policy Implications

In chapter 6, we summarise the main empirical findings of the thesis and discusses what are the policy implications of the research. We conclude the chapter by suggesting some areas for future research that may rewarding for macroprudential policy researchers and financial sector professionals.

CHAPTER 2:

Literature Review

2.1. Introduction

In this chapter we outline the existing theoretical and empirical literature in relation to macroprudential policy, which is key background for the rest of the thesis. More specifically, **Section 2.2** presents the background history of macroprudential policy. **Section 2.3** looks at the development of macroprudential policy as a financial sector regulatory tool as well as its suggested operational structure and benefits. **Section 2.4** explores the concept of financial stability and its meaning, including the underlying financial stability definitions, concepts and key principles of financial stability. In **Section 2.5** we review the theoretical and empirical literature of macroprudential policy. Finally, **Section 2.6**, we conclude.

2.2. Background history of the development of the concept of macroprudential policy

Before laying the groundwork for developing the concept of macroprudential policy, we review the macroeconomic environment of the 1970s. Clement (2010) noted that it is difficult to pinpoint the exact time the term macroprudential was used yet it is important to discuss the 1970s macroeconomic environment in order to comprehend the background history of the term “macroprudential”. Where did it all start? As such this section looks at the chronological history of macroprudential policy starting from 1970s up to the 2007-2008 financial crisis.

2.2.1. The history of the term "macroprudential" policy

I. The 1970s macroeconomic environment and the genesis of the concept of "macroprudential"

The 1970s was characterised as a period of great economic challenges and changes in the financial landscape after a long period when no major financial crises had taken place since the end of World War II. The Bretton Woods system of managed exchange rates came to an end and many major world currencies started to float from 1973.[7] Inflation and unemployment were rising and the first oil shock in 1973 added to the economic slowdown in many countries as well as rapid inflation.

The financial sector had already witnessed the growth of the euro-markets and international capital markets in the 1960s and early 1970s largely following regulatory restrictions in the US, discussed in more detail later.[8] In the United Kingdom (UK), the removal of credit controls on all banks – the Competition and Credit Control (CCC) reform (1971-1973)[9], sharply increased competition in the banking sector. This led to a rapid increase in lending, a stock market and property boom. But, by the middle of the 1970s, many developed countries were fighting rapid inflation by rising interest rates to reduce demand and tightening fiscal policy. In the UK, the push to control inflation led to a sharp fall in share and property values and the reimposition of credit controls on all banks. This in turn weakened the balance sheet of secondary banks and led to the UK secondary banking crisis in 1973 (see Davis (1995)).

[7] The system dissolved between 1968 and 1973. In August 1971, U.S. President Richard Nixon announced the "temporary" suspension of the dollar's convertibility into gold. While the dollar had struggled throughout most of the 1960s within the parity established at Bretton Woods, this crisis marked the breakdown of the system. An attempt to revive the fixed exchange rates failed, and by March 1973 the major currencies began to float against each other. See IMF website, https://www.imf.org/external/about/histend.htm.

[8] Some factors that contributed to the growth of this market are the following, the imposition of maximum rates of interest in the US (Regulation Q), US withholding taxes regime, listing and disclosure regulation requirements, etc. as well as the growth of multi-national financial institutions.

[9] See the Bank of England website, https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/1971/competition-and-credit-control-text-of-a-consultatice-document-issued-on-14-may-1971.

After the collapse of Bretton Woods, many banks incurred large foreign currency losses and the collapse of Herstatt Bank[10] (1974) had two major consequences, 1) the effects on international banks through the international interbank market and 2) the action of regulators, which had international supervisory and regulatory implications (Mourlon-Druol (2015)). The Herstatt collapse had a cross border effect on the settlement of foreign exchange positions, which severely affected several international banks especially United States (US) based banks. The German supervisory institutions closed the bank due to insolvency before the clearing of several foreign exchange transactions. The same year, Franklin National Bank of New York also closed its doors after incurring large foreign exchange losses (Davis (1995)).

In response to the financial turmoil and other disruptions in the international financial markets as discussed in the above paragraph, the central bank governors of the G10[11] countries established a Committee on Banking Regulations and Supervisory Practices (the predecessor of the Basel Committee on Banking Supervision (BCBS)) at the end of 1974.[12] The Committee was designed as a forum for regular cooperation between its member countries on banking supervisory matters. Its aim is to enhance financial stability by improving supervisory know how and the quality of banking supervision worldwide as well as to serve as a forum for regular cooperation between its member countries on banking supervisory matters.[13] There were concerns about the stability of international financial markets and the threats it can pose to the world economy.

Prior to the BCBS, the Committee on the Global Financial System (CGFS), formerly known as the Euro-currency Standing Committee (ECSC), was established in 1971 with a mandate to monitor international banking markets, as mentioned grew rapidly

[10] Herstatt Bank (Bankhaus I.D. Herstatt K.G.a.A.) was a privately owned bank in the German city of Cologne and was a significant participant in the foreign exchange market. It went bankrupt on 26 June 1974 and led to the formulation of the Basel Committee on Banking Supervision (BCBS).
[11] Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden United Kingdom, and the United States. See BIS website, https://www.bis.org/list/g10publications/.
[12] The Basel Committee - initially named the Committee of Banking Regulations and Supervisory Practices - was established by the central bank Governors of the Group of Ten countries at the end of 1974 in the aftermath of serious disturbances in international currency and banking markets (notably the failure of Bankhaus Herstatt in West Germany). See BIS website, https://www.bis.org/bcbs/history.htm.
[13] There was a focus on three key areas for banking supervisors - liquidity, solvency and foreign exchange positions. The focus on banks' capital came in the 1980s. Report on the supervision of banks' foreign establishments – Concordat (1975). See BIS website, https://www.bis.org/publ/bcbs00a.pdf.

in the 1960s. The initial focus of the ECSC/ CGFS was on the monetary policy implications of the rapid growth of offshore deposit and lending markets, but attention increasingly shifted to financial stability questions and to broader issues related to structural change in the financial system, which will be discussed throughout the thesis. Reflecting this change in focus, the G10 Governors decided on 8th February 1999 to rename the Committee and to revise its mandate. As of January 2010, the Chairman of the CGFS reports to the Global Economy Meeting, which comprises a group of 31 central bank Governors as members.[14]

By the end of the 1970s and with the second major oil shock, a link between prudential regulation and macroeconomic issues were being discussed concerning the implications of rising oil prices for banks international lending and the stability of the international financial system. As global banks, spurred on by US deregulation in the 1960s (Houpt (1999)), saw an opening for international expansion and profit opportunity from international banking, lending the surplus profits from oil producing countries. W. P. Cooke, Associate Director of the Bank of England and chairman of the BCBC, in 1979 highlighted the issues of micro-economic problems merging into macro-economic problems which will have consequences for banking regulation where microprudential problems can lead to macroprudential issues, which can affect the entire financial system (Clement (2010), Maes (2010)).

Further in late 1979, a working group chaired by Alexandre Lamfalussy, at the time, the BIS Economic Adviser and Chairman of the ECSC, examined the use of prudential measures as one of several alternative ways to constrain international bank lending, and a contrast between microprudential and macroprudential measures was highlighted (see Clement 2010)). Specifically, it was noted that microprudential measures are primarily concerned with sound banking practice and the protection of depositors at the level of the individual bank. However, there may be a need to have prudential measures with a wider perspective, which consider problems that affect the market as a whole. Five groups of (micro-) prudential measures to constrain the growth of international bank lending were suggested. These are control of banks' foreign exchange exposure, control of banks' country risk exposure, capital ratios,

[14] See BIS website, http://www.bis.org/cgfs.

controls on maturity transformation, and controlling the “entry” of new market participants.

As summarised in Maes (2010), the Lamfalussy working group paper emphasised three elements of prudential supervision for the growth of banks’ international lending, 1) there is a need for effective supervision of the international banking system, 2) the reduction of inequalities in competitive conditions between domestic and international banking, and 3) the monitoring of international banking developments.

II. The 1980s Latin American debt crisis and financial innovation

Through the 1970s and into the early 1980s, inflation remained one of the major problems facing many developed countries. Also, financial crises continued to generate financial instability in financial markets. Of particular interest in the early 1980s was the Latin American Debt crisis which had a major impact on many global banks, especially in the US and on the economic performance of Latin American countries during the decade.

The Latin American Debt crisis had its origin in the 1970s as the two large oil price shocks created current account deficits in many Latin American countries. In order to finance these deficits, Latin America countries turned to the international banking market and borrowed from oil-exporting countries, who had large current account surpluses (Sim (2013)). The intermediaries for these syndicated loans were mainly US money-centre banks, as international banking grew very quickly in the 1970s and their primary goals were market expansion and profitability. Latin American borrowing in US dollars from US commercial banks and other creditors increased dramatically and by 1982, the debt level reached US$327 billion (estimated as 55% of Latin American countries total GDP, see Bertola and Ocampo (2012)) and these loans carried relatively low floating interest rates (FDIC (1997)).

There was a change in monetary policy in the US and Europe towards disinflation that was led by US tightening which starting in October 1979, with the fed funds rate peaking at 17.6% in April 1980. Across the developed world priority was given to lowering inflation, which led to the increase in interest rates in many advanced

countries.[15] Nominal interest rates rose globally and Latin American countries soon found it difficult to service their debts. In August 1982, Mexico indicated that it could no longer meet interest payments and by the end of 1982, approximately 40 nations were in arrears in their interest payments. A year later 27 nations including the four major Latin American countries of Mexico, Brazil, Venezuela, and Argentina were in negotiations to restructure their existing loans (FDIC (1987)), which resulted in major losses for banks.

At the same time, the issue of international banking financial innovation was attracting the attention of G10 countries central banks governors such as the US, Canada, France, Germany, Japan and the UK, etc. A Study Group (Cross Report) was set up to examine the issue (see BIS (1986)). The purposes of the Study Group were to improve central-bank knowledge of these (innovative) instruments such as derivative products (currency and interests swaps, options, etc.) and note issuance facility (NIFs), and their markets as the situation existed in the second half of 1985, and to provide a foundation for considering their implications for the stability and functioning of international financial institutions and markets, for monetary policy, for banks' financial reporting and the statistical reporting of international financial developments.

The Cross Report highlighted the change in the process of international financial intermediation as a result of financial innovation and the decline of comparative advantage of large international banks to international securities markets as a channel for credit intermediation. There was 1) a trend towards securitisation (growth of the securities market for lending activity), 2) increasing used of off-balance-sheet items (derivatives instruments), and 3) the global integration of financial markets. This new development had important consequences for the functioning of the banking and financial systems, which led to greater risk taking by financial institutions to compensate for the loss of high-quality borrowers. Furthermore, the report saw that financial innovation may heighten financial vulnerabilities in many ways and may contribute to systemic vulnerabilities. This would then require authorities to consider substantial adjustments to regulation and other policies, including addressing issues

[15] Paul A. Volcker, chairman of the Board of Governors of the Federal Reserve System (1979–1987) focused on reducing inflation as his main goal in his first term. See US Federal Reserve website, https://www.federalreservehistory.org/people/paul_a_volcker.

relating to macroprudential policy that is, the safety and soundness of the broader financial system and the payments mechanism.

The Cross Report raised several issues for macroprudential policy (supervision). The Report suggested in order to deal with the concerns of financial innovation and the macroeconomic consequences of financial system fragility, firstly, supervisors will have to overcome the problem of knowing who is conducting these transactions. Some of these transactions were being completed by subsidiaries and branches of banks in other countries. Therefore, "consolidated" supervisors of the parent banks will have to take account of these transactions wherever they take place.

Secondly, the report highlighted a blurring of the line between banks and securities houses for these innovative transactions. Banks are becoming less important in financial intermediation and questions arose who is responsible for supervising the securities houses, which are becoming increasingly important part of the financial structure. Macroprudential policy would need to overcome this issue and there need to be a clear supervisory framework on who is responsible for supervising these securities houses. Additionally, the Cross Report saw an opportunity for international cooperation and co-ordination between supervisory agencies in different countries as the interconnectedness of financial markets were growing.

In term of monetary policy and financial reporting and statistics, the Cross Report suggested that monetary policy is being influenced, in some countries (such as US, Japan and the UK) more than others by the effects of these innovative products, deregulation and structural changes. And the growth of off-balance sheet transactions and the unbundling of different types of risks (credit, liquidity, currency, etc.) rendered the analysis of financial statements more complex.

Subsequently, the vulnerabilities of financial innovation were emphasised in the stock market crash in 1987 (Black Monday). One of the reasons for the stock market crash was the extensive use of portfolio insurance and innovative products such as options

and derivatives which accelerated the crash (Carlson (2006)).[16] Also in the USA, the Savings and Loans (US thrifts) institutions crisis, which started in the early 1980s, due to interest rate mismatch and high risk lending resulted in the failure or insolvency of several thrift institutions, an example of the danger of deregulation and inadequate supervision. Other instances of financial fragility can be noted in several countries, such as in Canada, the Canadian Regional Banking Crisis (1985) where loans loss provisioning wiped out several banks' capital which resulted in banks failures and in Australia (1989), where loans losses saw several banks fail (Davis (1995)).

In response to these many international financial disruptions, banking regulation was strengthened with the introduction of the Basel I (Capital) Accord (1988)[17] by the Basel Committee on Banking Supervision (BCBS). The Basel I, at the time focused mainly on applying common minimum capital standards to the banking sector and addressed credit risk, which was the main risk faced by banks. The minimum capital ratio of capital to risk-weighted assets of 8% was the standard set by the BCBS and this was to be implemented by the end of 1992 for banks in G10 countries. Yet, many other countries (Non G10) also adopted or incorporated the Basel Accord into their regulatory framework. The Basel I Accord was further modified in the 1990s to address different aspects of banks risks (market and operational risks). Another two new versions of the Basel Accord (Basel II (2004), Basel III (2010)) were introduced to further address banks' fragility. The Basel Accords placed a lot of emphasis on microprudential policy (individual bank regulation), it was a bottom-up approach to banking regulation, as macroprudential policy was still in an embryonic stage of development.

[16] On October 19th, 1987, a chain reaction of market distress which started in Hong Kong sent global stock exchanges crashing.

[17] The onset of the Latin American debt crisis heightened the BCBS's concerns that the capital ratios of the main international banks were deteriorating at a time of growing international risks. Backed by the G10 Governors, Committee members resolved to halt the erosion of capital standards in their banking systems and to work towards greater convergence in the measurement of capital adequacy. This resulted in a broad consensus on a weighted approach to the measurement of risk, both on and off banks' balance sheets. See BIS website, http://www.bis.org/bcbs/history.htm#basel_i.

III. Headwinds in the early 1990s

At the end of the 1980s, the fear of rising inflation returned and the tightening of monetary policy (increases in interest rates) resulted in the end of the 1980s-economic boom (driven by rising credit and assets prices) and a recession in the early 1990s. Idiosyncratic shocks such as the collapse of the Soviet Union, the fall of the Berlin Wall and reunification of Germany, along with a spike in oil prices due to the Gulf War, as well as the decline in borrowing played a role in lower GDP growth (Davis (1995)). But financial deregulation in several countries (e.g. Scandinavian countries, Jamaica, etc.) in the late 1980s also resulted in excessive credit and asset prices boom in these countries that left them vulnerable to the global economic turbulence.

In the UK, the recession of 1991 was primarily caused by high interest rates, falling house prices and an overvalued exchange rate. In an attempt to reduce and control inflation, the UK joined the European Exchange Rate Mechanism (ERM) in 1990. In order to keep sterling within its ERM bands, high levels of interest rates needed to be maintained and this severely exacerbated the effects of the recession and by September of 1992 (Black Wednesday)[18], the UK exited the ERM (Bonefeld and Burnham (1996)). In the US, Walsh (1993) suggested that a decline in consumers' confidence, debt accumulations in the 1980s, the rise in oil prices due to the Iraq invasion of Kuwait (1991), and the rising interest rates by the US Federal Reserve in attempt to low inflation are cited as the causes of US recession between 1990 and 1991.

As detailed below, the early 1990s recession and financial deregulation in some countries led to several financial crises and these crises had major macroeconomic significance for those countries (see Demirguc-Kunt and Detragiache (1998)). Nevertheless, as the same authors stress, there are still many benefits to financial deregulation (liberalisation) and crisis risk is reduced when the institutional environment is strong. Hoggarth et al (2002) suggested that output losses during a financial crisis for a country can be large, roughly 15–20%, on average, of annual

[18] Wednesday 16th September 1992, the day the UK withdraw the pound sterling from the European Exchange Rate Mechanism.

GDP. Moreover, the losses can be even higher in developing countries. The following are examples of financial crises in the 1990s.

- The banking crises and economic slowdown in Scandinavian countries (1990-1991) due to financial deregulation and banks excessive credit lending which contributed to higher property prices (Sandel (2004)).
- In Japan, the collapse of the asset price bubble (1991-2003) rendered most of the banking sector insolvent and resulted in economic slowdown for more than 10 years (Horioka (2006)).
- The Latin America "tequila crisis" (1994) which started in Mexico with the devaluation of the Mexico peso (Musacchio (2012)).
- The Asian financial crisis (1997-1998), which was due to currency over devaluation and asset-liability currency mismatch by banks (Lindgren et al (1999)).

Late in the decade, due to the Asian financial crisis, the IMF stressed that effective bank supervision and financial system stability would only be achieved with both micro- and macro- prudential measures (Lindgren et al (1999)). As such, after the Asian financial crisis, a number of Asian countries started using macroprudential policy such as Hong Kong (1999), Singapore (2000), Thailand (2002), and China (2004). Nevertheless, the highlighted financial crises in the 1990s further underlined the danger of banking sector fragility and the need for macroprudential measures.

In 1999, as a policy response succeeding the Asian financial crisis, a more formal approach, the IMF[19] in conjunction with the World Bank developed the Financial Sector Assessment Program (FSAP) program, to formally assess a country's financial stability, its regulation framework and development.[20] A FSAP provides an in-depth examination of a country's financial sector and its regulation, however it does not

[19] Also, the IMF Monetary and Capital Markets Department produces the Global Financial Stability Report (GFSR), which provides an assessment of the global financial system and markets and addresses emerging market financing. See IMF website, http://www.imf.org/en/publications/gfsr.
[20] See IMF website, http://www.imf.org/external/np/fsap/fssa.aspx.

evaluate the health of individual financial institutions and cannot predict or prevent financial crises, though it identifies the main vulnerabilities that could trigger one.[21,22]

FSAP assessments[23] are the joint responsibility of the IMF and World Bank in developing economies and emerging markets and of the IMF alone in advanced economies. There are two main components of the FSAP programme, firstly the assessment of financial stability in a country's financial system, which is the responsibility of the IMF, and the second component, assesses financial system development in developing countries and emerging markets which is the responsibility of the World Bank. Although FSAP assesses a country's financial sector stability (instability), regulation and development, the program is voluntary and there is no requirement that countries must take part in the assessment. Also, the recommendations of the assessment are just advisory and it is up to the country to accept and implement the recommendation. Yet, the program gives the IMF/ World Bank more leverage in such cases for a country to adopt some of their recommendations. At the onset of the program in the 1999, macroprudential policy was not emphasized in assessment reports but since the 2007-2008 financial crisis, the FSAP reports include recommendations of a micro- and macro-prudential nature, tailored to country-specific circumstance.

With existence of the FSAP program[24], which give the IMF/ World Bank an additional source of information to identify potential financial sector fragility, many countries also developed a macroprudential surveillance program, defined as monitoring the conjunctural and structural trends in the financial markets as to give a warning of financial instability. This became a core activity for many central banks (Davis and Karim (2009)).

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[21] The IMF also collected Financial Soundness Indicators (FSIs) from the early 2000s. The FSIs were developed by the IMF with the aim of supporting analysis and assessing strengths and vulnerabilities of financial systems. See IMF website, https://www.imf.org/external/np/sta/fsi/eng/fsi.htm.

[22] As of September 2010, in response to the 2007/2008 financial crisis, FSAP becomes mandatory part of the Article IV Surveillance for members' country with systemically important financial sectors. See IMF website, https://www.imf.org/external/np/fsap/mandatoryfsap.htm.

[23] Since the launch in 1999, after the Asian crisis, 142 countries have completed the programme (many more than once). See IMF website, https://www.imf.org/external/np/fsap/faq/index.htm#q6.

[24] The IMF also conduct Article IV consultations with member countries once a year, which now include a focus on financial stability issues and not just macroeconomic developments. See IMF website, http://www.imf.org/external/ns/cs.aspx?id=51.

IV. Financial stability and macroprudential policy

Accordingly, by the early 2000s, there was a growing focus on financial stability by central banks and regulators, seen with the increase publication of financial stability reports, as the frequency of financial crises increased. Caprio and Klingebiel's (2003) crises chronologies suggested that 117 systemic banking crises (defined as much or all of bank capital being exhausted) had occurred in 93 countries since the mid-1970s.

Čihák (2006), who surveyed 47 countries financial stability reports, saw that by the mid-2000s many central banks and regulators had started to publish regular reports on financial stability with frequency either quarterly, semi-annually or yearly, which mainly focus on system-wide issues (macroprudential surveillance) rather than issues with individual institutions. The main reasons given for the increased focus on financial stability are the high cost of financial crisis (see Hoggarth et al (2002), Barrell et al (2008 and 2010)), the increase in frequency of financial crisis (see Caprio and Klingebiel (2003)) and the growth in the volume of financial transactions and complexity of these new financial instruments. Also, the growing interconnectedness of international financial markets was seen as an important reason for such surveillance. Čihák (2006) noted as well, that the emphasis on financial stability can be seen in the organisational structure of central banks, where new financial stability departments or divisions were being created. For example, Hong Kong started early with macroprudential policy and its institution arrangement was put in place in 2003 (see HKMA (2006)) but prior to this they used macroprudential instruments in 1999.

In this context, BIS General Manager, Andrew Crockett (2000) singled out two characteristics of the macroprudential approach to effective banks supervision and financial system stability. Firstly, macroprudential approach looks at the financial system as a whole with the objective of limiting the costs of financial distress in terms of output in the macroeconomy. This can be seen as limiting systemic risk in the wider financial system, which is explain further below. Secondly, macroprudential approach recognises the interconnectedness of financial institutions and the risk of correlated failures. In turn, the macroprudential approach had two dimensions, a time dimension, also known as the pro-cyclicality of the financial system, which focus on risks resulting from the fluctuation of financing activity over the business cycle, and a cross-sectional

dimension, where the emphasis is on the interconnections between financial institutions with a particular focus on systemically important financial institutions (SIFIs) (Borio (2003)). Systemically Important Financial Institutions (SIFIs) are financial institutions whose distress or disorderly failure, because of their size, complexity and systemic interconnectedness, would cause significant disruption to the wider financial system and economic activity.

Borio (2003) then outlined the terms and concepts of what is meant by a "macroprudential" perspective in the supervision and regulation of the financial system. He indicated that the objective of the macroprudential approach is to limit the risk of financial distress which could result in significant losses in terms of the real output for the economy, whereas microprudential approach is to limit the risk of episodes of financial distress at individual institutions, regardless of their impact on the overall economy. He indicated that macro- and micro- prudential perspectives differ in terms of their objectives as shown in Table 2.1.

Table 2.1: Summary analysis of macro vs. micro prudential perspectives

	Macroprudential	Microprudential
Proximate objective	limit financial system-wide distress	limit distress of individual institutions
Ultimate objective	avoid macroeconomic costs linked to financial instability	consumer (investor/depositor) protection
Characterisation of risk	"endogenous" (dependent on collective behaviour)	"exogenous" (independent of individual agents' behaviour)
Correlations and common exposures across institutions	Important	Irrelevant
Calibration of prudential controls	in terms of system-wide risk; top-down	in terms of risks of individual institutions; bottom-up

Source: Borio (2003)

As well, Borio (2003) argued why macroprudential perspective is useful in understanding financial instability, which is discussed later in this chapter. Firstly, he argued that macroprudential perspective include the basis for microprudential perspective due to the possible high costs of financial instability. Secondly, there is a

better balance between market and policy-induced discipline, as strengthening macroprudential can lead to better economic performance. Thirdly, microprudential perspectives is less likely to deliver a safe and sound financial system since the origin of financial crises with a large macroeconomic effect suggest that macroprudential perspective is important.

Similarly, the Bank of England (2009) argued that there is a role for macroprudential policy in the stable provision of financial intermediation services to the wider economy - payment services, credit intermediation and insurance against risk. Macroprudential policy should seek to avoid the type of boom and bust cycle in the supply of credit and liquidity and counterparty risk from individual financial institution as seen in the 2007-2008 financial crisis. See **Section 2.3.2** below for a taxonomy of macroprudential policy instruments.

Despite the benefits of macroprudential policy, in most countries it was not developed as a policy framework and incorporated in financial regulations prior to the 2007-2008 global financial crisis. The history of the term, as we summarised above, has shown that the macroprudential concept was discussed in different committees and forums and there was little interest in developing tools further prior to the crisis. Davis and Karim (2009) indicated that it was a "missing policy pillar" in the financial system regulatory framework. One can argue that the period of low unemployment rate, increasing asset prices, low interest rates, risk but steady GDP growth, low inflation (Goldilocks period) and delusion that financial crises are really just individual institutional crises led to excessive optimism about financial instability up to 2007. The 2007-2008 global financial crisis, however, changed the fortunes of macroprudential policy as discussed further below.

We now move on to **Section 2.3. The development of macroprudential policy**, where we look at the growth of macroprudential policy and its instruments since the 2007-2008 financial crisis.

2.3. The development of macroprudential policy

This section looks at the growth of macroprudential policy and its instruments since the 2007-2008 financial crisis. We review the theoretical rationale for the importance of macroprudential policy in the context of financial crises and their attendant economic costs and benefits. We look at the development of macroprudential policy framework and what should be some of the key objectives and features of an effective framework. Most of the information in this section will reference the policy guidance of the IMF-FSB-BIS (2016) and to some extent the ESRB (2014a) which were prepared specifically in light of the global financial crisis.

2.3.1. Macroprudential policy

In the literature, (such as Carreras et al (2018), Galati and Moessner (2013), Dell'Ariccia et al (2012), Lim et al (2011), Davis and Karim (2009), etc.), there are robust arguments for the use of macroprudential policy as an essential tool to forestall crises or at least offer a buffer to soften the impact of financial crises in the financial system. Yet, the literature on macroprudential policy is far from complete and continues to evolve, and also, there is no common agreement on the objectives of macroprudential policy. Many international organisations (IMF, FSB, and BIS, etc.), regional economic institutions (ECB, ESRB, etc.) and researchers have been advocating for countries' financial system regulators and policy makers to develop a macroprudential policy framework. This is because there are strong arguments for the use of it as an essential tool to avert systemic failure of the financial system, as one needs to consider the wellbeing of the entire financial system and not just focus on the welfare of each financial institution, that is not just "institution by institution" stability.

In addition, with the aim of encouraging countries to develop a macroprudential policy framework as part of their financial system reforms, the IMF-FSB-BIS has published guidelines on elements of an effective macroprudential policy and handbook (IMF-FSB-BIS (2016), IMF (2014)). The ESRB has also published its organising guidelines for European Union countries (ESRB (2014a)).

Countries have responded to these international agencies' advice and following the 2007-2008 global financial crisis, several countries have used macroprudential instruments to address financial system instability or prevent the build-up of imbalances in the financial system. Čihák et al (2012) and Jeanneau (2014) noted that after the 2007-2008 global financial crisis, there was a renewed policymakers' interest in improving the policy framework for financial stability driven by the new role of the central bank in macroprudential policy objectives and the coordination of responsibilities between the various supervisory agencies. Further below we will review the operational framework of macroprudential policy.

Lim et al (2011) noted from the first IMF survey (IMF (2010)) that two-thirds (34 or of 51) of respondents, had used various instruments for macroprudential objectives since 2008. Additionally, Cerutti et al (2015a), using the results of the second IMF survey a few years later (2013-2014), highlighted the growing use of macroprudential instruments in 119 countries. Both surveys show that element of macroprudential policy framework existed prior to the 2007-2008 global financial crisis in some advanced countries and more so, many emerging market economies. See **Appendix 2A.2** discussing the use of macroprudential policy instruments prior to the financial crisis. It is important to note that the use of macroprudential policy can vary substantially between countries as large number of macroprudential tools have been proposed and it is not a case where "one size fits all" (Darbar and Wu (2015)).

I. Definition and objectives of macroprudential policy

IMF-FSB-BIS (2016) defined macroprudential policy, in light of the financial crisis, as the use of primarily prudential tools to limit systemic risk. A key aspect of the definition is the concept of systemic risk, which is the widespread disruption of the provision of financial services that is caused by an impairment of all or parts of the financial system and this disruption can cause serious negative consequences for the real economy. Systemic risk is generally recognised as having two dimensions, either vulnerabilities during boom-bust financial cycles (time dimension) or vulnerabilities associated with the distribution of risk within the financial system due to the interconnectedness of financial institutions (cross-sectional or structural dimension).

IMF-FSB-BIS (2016) identify the following key objectives and scope of macroprudential policy. Firstly, macroprudential policy should increase the resilience of the financial system to deal with aggregate shocks, that is, help maintain the ability of the financial system to function effectively, even under adverse conditions. This involves the build-up of countercyclical buffers in periods of boom and releasing of these buffers in periods of economic downturn. The countercyclical buffers' aim is to ensure that the banking sector has enough capital to protect against potential future losses in a period of economic decline (see BIS (2010)).

A second objective of macroprudential policy is to contain the build-up of systemic vulnerabilities when there is an upswing in the business cycle (time dimension) and where there is a distortion in the feedback between asset prices and credit. There are times when during a boom, in the presence of imperfect information and a very competition environment, there are incentives for financial institutions to lower their risk standards and at the same time maintain unsustainable increases in leverage, debt stocks, and volatile funding. In the presence of such vulnerabilities, macroprudential policy seeks to increase the resilience of the financial system to asset price shocks by reducing the procyclical feedback between asset prices and credit.

Thirdly, macroprudential seek to control structural vulnerabilities within the financial system that arise through interlinkages, that is risk within the financial system due to the interconnectedness of financial institutions (cross-sectional or structural dimension). Financial institutions operate in an interconnected system where there is a potential for the failure of one institution to have a spill-over (contagion) effect on other entities and the macro-economy. Financial institutions can reduce contagion risk as a result of hedging and diversification strategies but they can't totally eliminate it due to the interconnection of the system that they can't control (De Nicolò et al (2012)). Contagion can be relatively strong among systemically important financial institution (SIFIs) operating in the financial system. Many national regulators and central banks have initiated research programmes to study the issue of interconnectedness especially among systemically important financial institution. Also, as seen with the rapid spread of the 2007-2008 financial crisis to international markets, there is a need to understand the interconnectedness of global financial

market, the linkages between international financial flows to/from an economy's financial system to the rest of the world.

2.3.2. Macroprudential policy instruments

As noted above, in the research literature (such as Lim et al (2011), Bennani et al (2014), Cerutti et al (2015a, 2017) and Carreras et al (2018)), a large number of macroprudential tools have been proposed to address financial system instability or prevent the build-up of imbalances in the financial system. In general, these instruments seek to address three types of probable imbalances – capital, assets and liquidity, many of which we shall test in **Chapters 3, 4,** and **5** empirical sections. Also, we discuss further the utilization of these instruments by a number of countries in **Appendix 2A.2** (prior to the 2007-2008 financial crisis).

Firstly, the aim of capital-related instruments is to encourage financial institutions to build up a capital buffer above the minimum requirement which can be drawn down during period of stress. Capital related instruments are for example, countercyclical/time-varying capital requirements, time-varying/ dynamic provisioning and the leverage ratio.

Secondly, there are assets-related instruments which in most cases aim to contain excessive credit growth in the financial sector and can target specific type of loans, a particular group of borrowers, a specific region or loans dominated in foreign currencies, etc. There is also focus on growth of financial institutions' assets other than loans. Credit related instruments are for example, loan-to-value (LTV) ratio, debt-to-income (DTI) ratio and concentration limits.

Thirdly, liquidity-related instruments' objective is to discourage financial institutions excess reliance on short-term funding, and these instruments are designed to ensure that financial institutions have the necessary liquidity buffer to deal with any short-term liquidity disruptions. Liquidity-related instruments are for example, reserve requirements, limits on foreign currency loans and limits on domestic currency loans.

Table 2.2 below shows the definition of the principal macroprudential instruments. Following the above, the table shows the instruments that address three types of probable imbalances – capital, assets and liquidity. We cover all these types of instruments in our research in this thesis but find asset-type instruments are particularly effective. As noted by Darbar and Wu (2015), each country will have to choose the ones that is most appropriate for their financial system.

Table 2.2: Description of macroprudential instruments

Instruments	Abbreviation	Definition
Capital		
Time-Varying/Dynamic Loan-Loss Provisioning	DP	Requires banks to hold more loan-loss provisions during upturns.
General Countercyclical Capital Buffer/Requirement	CTC	Requires banks to hold more capital during upturns.
Sectoral capital requirements	SCR	Additional capital requirements on exposures to specific sectors that pose a risk to the system as a whole.
Sectoral risk weights	SRW	Additional risk weights on exposures to specific sectors that pose a risk to the system as a whole.
Capital Surcharges on SIFIs	SIFI	Requires Systemically Important Financial Institutions to hold a higher capital level than other financial institutions.
Leverage Ratio	LEV	Limits banks from exceeding a fixed minimum leverage ratio.
Systemic risk buffer	SYRB	Requires banks to hold additional capital that can be used to prevent and mitigate long term non-cyclical macroprudential or systemic risks not covered by the capital requirements regulation.
Assets		
Loan-to-Value Ratio	LTV	Constrains highly levered mortgage down payments

		by enforcing or encouraging a limit or by determining regulatory risk weights.
Debt-to-Income Ratio	DTI	Constrains household indebtedness by enforcing or encouraging a limit.
Limits on Interbank Exposures	INTER	Limits the fraction of liabilities held by the banking sector or by individual banks.
Concentration Limits	CONC	Limits the fraction of assets held by a limited number of borrowers.
Levy/Tax on Financial Institutions	TAX	Tax on revenues of financial institutions.
Loan-to-Value Ratio Caps	LTVCAP	Restricts to LTV used as a strictly enforced cap on new loans, as opposed to a supervisory guideline or merely a determinant of risk weights.
Liquidity		
Limits on Foreign Currency Loans	FC	Reduces vulnerability to foreign-currency risks.
Reserve Requirement Ratios	RR	Limits credit growth; can also be targeted to limit foreign-currency credit growth.
Limits on Domestic Currency Loans	CG	Limits credit growth directly.
FX and/or Countercyclical Reserve Requirements	RRREV	Restricts to RR which i) imposes a wedge on foreign currency deposits or ii) is adjusted countercyclically
Systemic liquidity surcharge	SYLS	Requires banks to hold additional market-liquid assets to cover systemic liquidity difficulties that can arise in the financial system.
Liquidity coverage ratio	LCR	Requires banks to hold enough market-liquid assets to cover their assumed net cash outflows over a 30-day stress period.

Net stable funding ratio (NSFR)	NSFR	Requires banks to finance long-term less liquid assets with long-term stable liabilities on a constant basis.

Source: Lim et al (2011), Bennani et al (2014), Cerutti et al (2015a), Carreras et al (2018).

2.3.3. Taxonomy of macroprudential policy

As suggested above, Crockett (2000) and Borio (2003) indicated that a macroprudential approach to regulation has two dimensions, a time dimension, also known as the pro-cyclicality of the financial system, which focus on risks resulting from the fluctuation in the business cycle, and a cross-sectional dimension, where the emphasis is on the interconnections between financial institutions with a particular focus on systemically important financial institutions. Table 2.3 below shows a taxonomy of the macroprudential instruments in the time and cross-sectional dimensions.

Table 2.3: Summary analysis of the macroprudential instruments in the time and cross-sectional dimensions

Type of instruments	Time dimension	Cross-sectional dimension
Capital	• Time-Varying/Dynamic Loan-Loss Provisioning • General Countercyclical Capital Buffer/Requirement • Sectoral capital requirements • Sectoral risk weights	• Capital Surcharges on SIFIs • Leverage Ratio • Systemic risk buffer
Assets (credits)	• Loan-to-Value Ratio • Debt-to-Income Ratio • Loan-to-Value Ratio Caps	• Limits on Interbank Exposures • Concentration Limits • Levy/Tax on Financial Institutions
Liquidity	• Limits on Foreign Currency Loans • Limits on Domestic Currency Loans • FX and/or Countercyclical Reserve Requirements	• Reserve Requirement Ratios • Systemic liquidity surcharge • Liquidity coverage ratio (LCR) • Net stable funding ratio (NSFR)

Source: Adapted from Bennani et al (2014), Carreras et al (2018).

Table 2.3 above shows that there are instruments that target the time (procyclicality) and cross-sectional dimensions. These instruments can target capital, assets (credits) and liquidity as shown in the table.

A second taxonomy considers phases of the cycle. Claessens et al (2013) suggested that some instruments are aimed at dampening risks arising from the expansionary phase of the business cycle and others look at risks arising from the interconnectedness of financial institution, that is, contagion between systemic institutions. Table 2.4 shows the macroprudential instruments toolkit outlining the instruments use at different phase of the business cycle, that is the expansionary and contractionary phases (time dimension) and the interconnectedness of financial institutions (cross-sectional dimension).

Table 2.4: The macroprudential instruments toolkit

	Restrictions related to borrower, instrument, or activity	Restrictions on financial sector balance sheet (assets liabilities)	Buffer based policy	Other	
				Taxes, levies	Other (including institutional infrastructure)
Expansionary phase	Time varying caps/limits/ rules: - DTI, LTI, LTV - margins, haircuts - lending to sectors - credit crunch	Time varying caps/limits: mismatches (FX, interest rate) and RRs	CCR, LEV, DP	Levy/ tax on specific assets and/or liabilities	- Accounting (e.g. varying rules on mark to market) - Changes to compensation, market discipline, governance
Contractionary phase: fire-sales, credit crunch	Adjustment to specific loan-loss prov., margins or haircuts (e.g. through the	Liquidity limits (NSFR; LCR)	CCR, DP	Levy/ tax (e.g. non-core liabilities	- Standardized products - OTC vs. on exchange - Safety net (Central Bank/

	cycle dynamic)				Treasury liquidity, fiscal support)
Contagion, or shock propagation from SIFIs or networks	Varying restrictions on asset composition, activities (e.g. Volcker, Vickers)	Institutions specific limits on (bilateral) financial exposures, other balance sheet measures	CS linked to sys. Risk.	Levy/ tax varying outside factors - size network	- Institution infrastructure (e.g. CCPs) - Resolution (e.g. living wills) - Varying information disclosure

	Enhancing resilience
	Dampening the cycle
	Dispelling gestation of the cycle

Source: Claessens et al (2013). DTI – Debt to Income, LTI – Loan to Income, RR – Reserve Requirements, CCR is countercyclical capital requirement, CS – Capital Surcharges, LEV - Leverage, NSFR – Net Stable Funding Ratio, LCR – Liquidity Core Ratio.

Table 2.5: Externalities and macroprudential policies

Externalities due to:	Can be addresses by:			
	Capital Requirements (Surcharges)	Liquidity Requirements	Restrictions on activities, assets or liabilities	Taxation
Strategic complementarities	X		X	
Fire sale	X	X		X
Interconnectedness	X		X	X

Source: De Nicolò et al (2012)

A third taxonomy looks at market failures and the use of macroprudential policy to correct externalities that lead to systemic risk. Table 2.5 above show the externalities map with the macroprudential instruments. The instruments in the table may affect more than one externality especially capital requirements. De Nicolò et al (2012) classified three type of externalities that can lead to systemic risk, these are externalities related to strategic complementarities, fire sales and interconnectedness. They noted that strategic complementarities arise from the strategic interaction of banks (and other financial institutions) and cause the build-up of vulnerabilities during the expansionary phase of a financial cycle. Fire sales arise from a generalized sell-

off of financial assets causing a decline in asset prices and a deterioration of the balance sheets of intermediaries, especially during the contractionary phase of a financial cycle. Interconnectedness caused by the propagation of shocks from systemic institutions or through financial networks.

2.3.4. Rationale for macroprudential policy as a policy tool

I. Financial stability

A main area of focus for macroprudential policy is that it should contribute to financial system stability or, as some researchers would see it, provide a tool to identify and prevent periods of financial instability (systemic risks). The 2007-2008 global financial crisis showed clearly that there is a need for macroprudential policy. However, it is critical to note that macroprudential policy is not the only desirable policy for financial system stability, rather it works in coordination with other policy instruments such as microprudential, monetary and macroeconomic policies to maintain financial system stability and even competition policy (Crockett (2000), Borio et al, (2007), and BoE (2009), etc.).

As discussed above, many researchers have attempted to define financial stability, yet there is no single and widely acceptable definition of financial stability. Additionally, some researchers prefer to define financial instability or systemic risk (such as Davis (1995, 2001), Chant (2003), and Allen and Wood (2006)). Gadanecz and Jayaram (2008) indicated that financial stability is difficult to define and measure given the interdependence and the complex interactions of different elements of the financial system among themselves and with the real economy. It is even more difficult to measure when one includes the international market interaction with the domestic economy. Largely, any attempt to define financial stability or instability requires taking a broad view of the financial system and the role its play in the performance of the economy. The concept of financial stability will be developed further in **Section 2.4** below.

II. Complement to other policies

There are considerable debates on the interaction of macroprudential policy with a range of other policies such as monetary policy, fiscal and structural policy, microprudential policy, competition policy and even crisis management and resolution policy if financial crisis occurs.

a) Monetary policy

Constâncio (2015)[25] argued that macroprudential policy is essential in any economy as the business and financial cycles are not synchronised while monetary policy simultaneously affects all sectors of the economy and can therefore be an ineffective tool to cope with specific imbalances in the financial sector. Independently addressing financial stability concerns, macroprudential policy provides monetary policy with additional room for manoeuvre to better focus on ensuring price stability.

N'Diaye (2009) saw that countercyclical prudential policy can help reduce output fluctuations and lessen the risk of financial instability, which can allow monetary authorities to achieve the same output and inflation objectives but with smaller adjustments in interest rates. In some instance, there could be a supporting role of macroprudential policy to monetary policy. He used a standard multi-country macroeconomic model for monetary policy analysis for the period. The macro side, model includes an IS curve, a Phillips curve, an Okun's law relationship, a monetary rule, a yield curve, a modified uncovered interest parity, a labour income relationship, and several identities. On the financial side, the model includes the 6 macro side model, tailored to three sectors: corporate, households, and banks. The model is set up to accommodate up to 4 economies.

Further, Beau et al (2012), using a DSGE model incorporating financial frictions, heterogeneous agents and housing, analysed the interactions between monetary and macroprudential policies and the circumstances under which such interactions call for

[25] Vítor Constâncio, Vice-President of the European Central Bank (ECB), Financial stability risks, monetary policy and the need for macro-prudential policy, Warwick Economics Summit, February 2015.

their coordinated implementation. They saw that conflicts between both policies were rather limited, on average, over the business cycle during the period under review 1985 to 2010. These conflicts depend on the nature of the shocks impacting the economy.

However, Agur and Demertzis (2015), using a bank-based model (profitability and leverage), looked at the interaction between monetary and macroprudential policies. They noted that bank-based models highlight the various types of channels through which monetary policy affects the financial sector such as through the incentives of banks to monitor, the screening of borrowers by banks, the skewness of bank returns, the impact on information asymmetries, the incentives of bank loan officers or asset managers whose incentives deviate from profit maximization, the impact on nominal contracts between banks and creditors that cannot be made state-contingent, and moral hazard when policy rates are used as a bailout mechanism. They saw that with the presence of macroprudential policy, there is at times a partial offsetting of monetary policy (expansionary interest rate policy) and at the same time, monetary policy can affect financial stability (e.g. Latin debt crisis and loose monetary policy in the 2000s cited above).

Researchers have presented arguments showing where both policies can co-exist as well as work in conflict to each other. In these conflicting cases, policy makers may have to determine which policy is more effective in achieving the financial and economic objective of policy makers at the time. Yet, there is a strong appetite by policy makers for the development and incorporation of macroprudential policy in the regulatory framework. Additionally, there may be cases where both monetary and macroprudential policies may have to be suppressed to allow fiscal policy to be more effective in a declining economy. Fiscal policy may be the most effective policy in an economic downturn, which would bring us to the debate of having both policies accommodating fiscal policy, yet political consideration of the government should not undermine financial stability for political gains as the cost of financial sector failure can be very high. We will develop the concept of macroprudential policy and its relationship with monetary policy further in the thesis, see **Chapter 5**.

b) Fiscal and structural policies

The build-up of financial imbalances and systemic risk can be a result of macroeconomic imbalances and shocks. Inappropriate fiscal and structural policies can create biases that contribute to systemic risks. IMF (2013) noted that, firstly, corporate taxes can encourage the use of debt rather than equity financing, as interest paid is tax deductible. Thus, this could produce a debt crisis. For example, the European sovereign debt crisis which started in 2008, spread primarily to Greece, Iceland, Portugal, Italy, Ireland, and Spain in 2009. Secondly, households can be more vulnerable to shocks, if taxes provide generous relief for mortgage interest, which can lead to excesses credit growth. Taxes can also affect asset prices as a tax relief on asset returns can lead to excess asset price growth.

Generally, macroprudential policy makers have no control over fiscal and structural polices but they can help analyse the underlying macroeconomic risks and imbalances and raise concerns where appropriate action can be taken, if there is case of economic overexpansion by inappropriate fiscal policy. It is important to highlight once again that political consideration of the government, temptations for monetary policy to ease before elections, should not undermine financial stability for political gains as the cost of financial sector failure can be very high.

c) Microprudential policy

Micro- and macro- prudential policies should work very well together as both look at the supervision of the financial system from two difference aspects. Microprudential policy looks at the welfare and soundness of the financial system from a “bottom-up” approach, that is looking at the health and stability of the individual institutions that operate in the system. Macroprudential policy on the other hand adopts a “top-down” approach, where it looks at the overall welfare and soundness of the entire financial system. In wake of the 2007-2008 financial crisis, the BCBS has placed a strong emphasis of macroprudential perspective in supervision. Supervisory agencies of financial institutions are tasked with not just ensuring the financial safety and soundness of individual institutions but to also contribute to the stability of the financial

system as a whole (see **Section 2.4.2** below for a discussion on countries approach to financial stability analysis and operating framework).

However, Osiński et al (2013) suggested that conflict may arise between micro- and macro- prudential policies. This conflict can occur because of overlapping policy mandates and the way in which policies are applied. They saw this as happening especially at different point of the credit cycle, where in "good times" microprudential supervisors may agree that there is a build-up of countercyclical buffer although non-preforming loans are low and profits are high. Yet, in "bad times", conflicts may arise as macroprudential policy may call for a relaxation of regulatory requirements and the release of the buffer. But microprudential supervisors may seek to retain and tighten these requirements to protect the interest of depositors of individual banks and deposit insurance. They suggested in order to ease the potential tensions, microprudential and macroprudential authorities should establish a credible joint communication strategy to bolster investor confidence during turbulent periods and certain institutional mechanisms such as a coordination committee if the two policy mandates are held by different regulatory entities.

d) Competition policies

Although competition in the financial sector can result in higher efficiency in the sector, and stability implications of concentration are ambiguous, this could also contribute to systemic risk (Davis and Karim (2018)). This can lead to conflicts between competition agencies and macroprudential regulators especially when there is a concern about the build-up of systemic risk. Therefore, competition policy for the financial sector should include a macroprudential perspective of the financial sector. In addition, there should be information coordination and consultation between competition agencies and macroprudential regulators.

e) Crisis management and resolution policy

Crisis management and resolution policy can be seen as being complementary to macroprudential policy, and properly designed regimes can strengthen market discipline and reduce incentives to take excessive risks, thus mitigating the need for

macroprudential intervention. If there is appropriate macroprudential policy that is effective in reducing the risk then activation of crisis management and resolution policy would not be necessary. Crisis management and resolution policy requires close coordination among all financial sector authorities.

III. Cost of financial crises

The costs of financial distress can be substantial as such macroprudential policy has been seen as tool to help prevent costly financial crises. Hoggarth et al (2002) suggested that measuring the costs of financial crises is not in any way straightforward and most of the time there is a focus only on the fiscal cost of the crisis resolution. Resolution costs may not always be a perfect measure of the general costs of a crisis to the economy but rather it is a transfer cost. They noted that economic output losses during a financial crisis in developed countries are typically substantial and higher on average than those in emerging market economies. In addition, in emerging market economies, banking crises appear to be costly only when accompanied by a currency crisis. They measured cost by comparing actual output with its trend or potential. They assumed that output would have grown at some constant rate based on its past performance (i.e. to estimate the shortfall relative to past trend growth). They estimated the output trend or potential using a short (3 years and long (10 years) window. Hoggarth et al (2002) noted as well that it is not straightforward to define the beginning and end of a crisis in order to measure its cost which is important for the determine the overall cost of a crisis.

Furthermore, to understand the costs, there needs to be a clear understanding of the macro-financial linkages, that is the interaction between the financial sector and the domestic economy (Claessens and Kose (2013)). Costs should include an assessment for the damage incurred to different economic regions (Claessens et al (2012)). The 2007-2008 global financial crisis have highlighted the costs that can occur to the world economy due to the interconnectedness of global financial markets. Several researchers have studied the transmission of shocks from one country banks' balance sheets to lending activity in various economic regions (Cetorelli and Goldberg (2011), Popov and Udell (2012), etc.)

Likewise, the speed and way crisis resolution plans are implemented by authorities can impact the overall cost of the financial crisis on the economy. For example, in the US, during the 2007-2008 financial crisis, the Troubled Asset Relief Program (TARP)[26], which was designed to restore liquidity to the markets by using US$700 billion to buy up mortgage backed securities was quickly passed, yet the plan did not address the solvency of several financial institutions, as they were still exposed to insolvency. In the UK, the British government provided capital support and nationalised most of the banks in order for the financial system to remain solvent and reduce the level of uncertainty.

The IMF estimated that the 2007-2008 global financial crisis resulted in an estimated 2 per cent decline in world per capita GDP in 2009.[27] Furthermore, Claessens and Kose (2013) noted that the most notable effect on the world economy was the rationing of credit from banks and other financial institutions as there was an adverse reaction to taking on additional risks. Both advanced and emerging market economies experienced the phenomenon of "creditless recoveries", recoveries that occur in the absence of credit growth. Creditless recoveries are more common after banking crises and credit booms (Abiad et al (2013)). In addition, real output in the world economy declined as there was a fall in consumption, investment, industrial production, employment, etc. See **Appendix 2A.1** for a list of selected major financial instability and economic shocks and policy responses (from 1970).

2.3.5. Macroprudential policy: an operational framework

The acceptance of macroprudential policy and its instruments as part of a country's regulatory framework has been relatively swift in the years immediately after the 2007-2008 financial crisis. IMF-FSB-BIS (2016) noted that although emerging market economies had been using these instruments well before the global financial crisis, their broader use is more recent especially in advanced countries. It is suggested that

[26] TARP is the Troubled Asset Relief Program, created to implement programs to stabilize the financial system during the financial crisis of 2008. It was authorized by Congress through the Emergency Economic Stabilization Act of 2008 (EESA) and is overseen by the Office of Financial Stability at the United States Department of the Treasury. See United States Department of the Treasury website, https://www.treasury.gov/initiatives/financial-stability/Pages/default.aspx.
[27] IMF, World Economic Outlook, Rebalancing Growth, April 2010.

82 countries used macroprudential instruments prior to the 2007-2008 financial crisis. Most of the countries using these instruments were emerging and developing countries, that is 65 such countries, while 17 advanced countries had used macroprudential instruments (Lim et al (2010), Cerutti et al (2015a)). **See Appendix 2A.2** discussing the use of macroprudential policy instruments prior to the financial crisis**.**

In addition, the establishment of dedicated macroprudential policy frameworks has often been prompted by the crisis experience and the wide range of institutional arrangements and policies being adopted across countries suggests that there is no "one-size-fits-all" approach. The IMF-FSB-BIS and the ESRB, for its member countries, have published guidelines on elements of an effective macroprudential policy and the purpose of this section is to review and highlight of the key objectives and features of an effective framework, the requirements for operating a framework and the choice of instruments.

I. Key features of a macroprudential policy framework

In the development of macroprudential policy as a regulatory framework for the financial sector, the IMF-FSB-BIS and ESRB macroprudential policy guidelines have suggested that some of the key aspects of a macroprudential policy framework are the following.

a) Clear objectives and goal

There should be clear objectives and goals of macroprudential policy as such authorities need to develop the capacity to analyse risks (systemic), measures financial instability, identify the build-up of risks in the business cycle (time dimension) and through the interconnectedness within the financial sector. IMF-FSB-BIS (2016) noted that setting out clear objectives can enable policymakers to use their policy tools in the pursuit of financial stability and forms the basis for a framework to hold the designated authority accountable for achieving its objective, thereby reducing the risk of inaction.

b) Mandate and institutional arrangements

A strong institutional arrangement is important for macroprudential policy to operate effectively. There should be a responsible authority or committee that has the mandate to carry out the objectives of macroprudential policy. Yet, institutional arrangements need to suit country-specific circumstances and institutional backgrounds. The ESRB (2014a) noted that macroprudential policy requires complete independence from political pressures and an independent agency, such as the central bank or a financial authority, may therefore be appropriate for macroprudential policy rather than the ministry of finance. However, there is still a role for the government in the institutional arrangements of macroprudential policy as they have the legislative authority in passing laws and finance bailouts. Adequate arrangements for democratic accountability are always important.

IMF-FSB-BIS (2016) noted the following macroprudential policymaking models existing in various countries.

- **Model 1:** The macroprudential mandate is assigned to the central bank, with macroprudential decisions ultimately made by its Board (as in the Czech Republic).

- **Model 2:** The macroprudential mandate is assigned to a dedicated committee within the central bank structure (as in the U.K.).

- **Model 3:** The macroprudential mandate is assigned to a committee outside the central bank, with the central bank participating on the macroprudential committee (as in Mexico).

Some models also include independent external experts as voting members in the decision-making structure (France, UK), or in the form of an advisory committee to the main body (European Systemic Risk Board (ESRB)). Also, the macroprudential policy authority should have the necessary legislative powers to carry out its functions effectively, which can only be granted by the government, who has the legislative authority in passing laws.

These macroprudential policymaking models tend to reflect the financial supervisory framework existing in many countries such as sectoral, integrated twin peaks and two agency supervisory models. It is a situation where most countries integrated macroprudential policy as well as financial stability framework in the existing financial supervisory framework, thus minimising the need for legislative changes. We develop the financial supervisory framework further in **Chapter 5**.

c) Selection of a set of macroprudential instruments

Authorities need to select and assemble a set of macroprudential instruments that can be used to address systemic risk and other risks in the system (see Table 2.2 above). The selection of instruments should reflect the underlying sources of risk in the financial system. ESRB (2014a) noted the selection of instruments must account for possible cross-border spill over effects, both positive and negative, and unintended effects (e.g. “leakages”). We will investigate this further in **Chapter 4**.

d) Calibration of macroprudential instruments

The authorities need to calibrate the instruments in a manner that takes account of their likely benefits and costs, and clearly communicate the basis for policy judgments to the public and the markets.

The Bank of Slovenia (2015) identified the following core principles for the selection and calibration of instruments.

- **Effectiveness** in reducing or eliminating market failures and their contribution to the ultimate and intermediate objectives of the macroprudential policy.

- **Efficiency**. Capability of achieving ultimate and intermediate goals with minimum costs and minimum side-effects.

- **Proportionality**. The burden on individual institutions should be in line with their contribution to systemic risk.

- **Straightforwardness and simplicity** in the definition of the instrument, its requirements and external communication in order to achieve better understanding of instruments, their functioning and objectives.

- **Avoiding regulatory arbitrage** in both the definition and selection of the instrument.

- **Avoiding negative cross-border spill-overs**. Negative cross-border spill-overs will be considered in the process of the selection of the instrument and minimised.

e) Monitoring and Closing Regulatory Gaps

There should be a comprehensive framework for monitoring the risks in the system as it is important for operationalising macroprudential policy. Authorities should also have the ability to closing any regulatory gaps especially in the shadow banking sector, where macroprudential instruments are effective on banks but not in the shadow banking sector and securities markets, etc. We note that shadow banking is a term used to describe bank-like activities (mainly lending) that take place outside the traditional banking sector. It is now commonly referred to internationally as non-bank financial intermediation or market-based finance. Shadow bank lending has a similar function to traditional bank lending. However, it is not regulated in the same way as traditional bank lending.[28]

IMF-FSB-BIS (2016) noted that to assess the build-up of risks over time ("time dimension"), authorities should examine a number of areas, including: (1) economy-wide vulnerabilities from an excessive growth in total credit or asset prices; (2) sectoral vulnerabilities arising, for example, from growing credit to the household sector or from increasing exposures to the corporate sector; and (3) vulnerabilities from a build-up of maturity and foreign currency mismatches in the financial sector. In term of vulnerabilities related to the cross-sectional or structural dimension, authorities should

[28] See Central Bank of Ireland website, https://www.centralbank.ie/consumer-hub/explainers/what-is-shadow-banking.

monitor risks from linkages within and across key classes of intermediaries and market infrastructures, as well as the impact of the failure of any of these institutions on the system as a whole.

f) Evaluation and effectiveness

There should be a system where macroprudential policy action can be evaluated, as this is key for the recalibration or if additional measures are needed. Ex-post evaluation should seek to assess, (i) the extent to which measures have had the desired impact, the transmission mechanism; and (ii) effects on behaviour and the impacts on the risk that may have prompted the policy intervention.

g) Closing Data and Information Gaps

Data and information gaps can hinder the early detection of risks, increase uncertainty, impede the design and enforcement of macroprudential instruments and complicate the policing of the regulatory. This can also impede the effectiveness of macroprudential instruments. Authorities should close any gaps by improving on the collection and statistical and supervisory data.

We now move on to **Section 2.4. Financial stability theory** where we explore the concept of financial stability and its meaning. Macroprudential policy should contribute to financial system stability or provide a tool to identify and prevent periods of financial instability (systemic risks) as such we believe it is important to discuss the theory of financial stability in the thesis.

2.4. Financial stability theory

A main area of focus for macroprudential policy is that it should contribute to financial system stability or as some researchers would see it, provide a tool to identify and prevent periods of financial instability (systemic risks). Generally, we believe financial stability concepts are based on defining financial stability from a domestic perspective (in some aspect a closed economy) and there is a limited emphasis on defining financial stability which include international markets. National regulators tend to

define stability according to their needs and perspectives, in light of what they can mainly control and influence, that is the domestic financial system. Yet, any international systemic risks are normally taken into consideration in identifying potential threats to domestic financial stability.

In this context, the purpose of this section is to explore the concept of financial stability and its meaning. It explores the theory behind financial stability, definitions, concepts and key principles of financial stability. We provide a review of the agency and organisational structure that is responsible for reporting on financial stability (instability) in a country's financial system. Also, we explore the concept of financial stability and the role of international banking. None of the definitions of financial stability focus on the role of international banks specifically, yet in the literature links have been made between currency crisis, balance of payments problems, and banking crisis (see Kaminsky and Reinhart (1999)).

2.4.1. Theoretical review of the definition and key principles of financial stability

In the literature, there are two discernible schools of thought, i) researchers who prefer to define financial stability, and ii) researchers who attempt to define financial instability or systemic risk. Yet there is no single and widely acceptable definition of financial stability or instability. Moreover, any attempt to define financial stability or instability requires largely taking a broad view of the financial system in light of the role it plays in the performance of the economy, the experience from the 2007-2008 financial crisis and the role of macroprudential policy.

I. Definition of financial stability

Crockett (1996, 1997) suggested that financial stability refers to the smooth functioning of the financial institutions and markets that make up the financial system. He indicated that financial stability applies to, 1) key institutions and 2) markets that make up the financial system. Firstly, he indicated that stability requires that *key institutions in the financial system are stable, in that there is a high degree of confidence that they can continue to meet their contractual obligations without interruption or outside assistance*. Crockett (1997) indicated that stability in key financial institutions means

the absence of stress and possible failure that have the potential to cause measurable economic harm beyond a strictly limited group of customers and counterparties. He implies occasional failures of smaller institutions and losses at larger institutions are part of the normal functioning of the financial system and it should return to stability without outside assistance. However, Crockett (1997) failed to provide clarity on the definition or how to identify key institutions, *'too big to fail'*, that are important for financial stability. As well as the important of market infrastructure in the understanding of financial stability, yet his definition of financial stability accounts for interconnectedness of financial institutions and markets. The Financial Stability Board (FSB) has since identified a set of global systemically important financial institutions (G-SIFI) while country policy makers have determined additional domestic-SIFIs operating in their financial systems.

Secondly, *key markets are stable in that participants can confidently transact in them at prices that reflect fundamental forces and that do vary substantially over short periods when there have been no changes in fundamentals*. Crockett (1997) indicated that markets are stable when prices moves to reflect changes in fundamentals and there is the absence of large price movements that can cause economic damage. Large price movements in financial markets that are greater than what can be account for by fundamentals could be interpreted as possible financial instability or a crisis in the financial system. Price level stability is significant for financial stability, but it is also important for systemic risk. Yet, the focus of financial stability is on the domestic financial market and there is little mention of stability in international market.

Laker (1999) indicated that financial system stability should be defined in broad terms. He defined it *as the avoidance of the disruptions to the financial system that are likely to cause significant costs to real output*. In addition, he saw that disruptions might be caused by difficulties facing financial institutions or the disturbances in financial markets. Laker (1999) acknowledged that focusing on financial institutions failure in order to determine whether there is stability in the financial system is likely to be insufficient as in some circumstance, a failure of one or a few institutions might be part of normal market mechanism. It is a question of whether the failure is systemic or not.

Accordingly, Padoa-Schioppa (2002) defined financial stability *as a condition where the financial system is able to withstand shocks without giving way to cumulative processes which impairs the allocation of savings to investment opportunities and the processing of payments in the economy.* He saw that the concept of financial stability should refers to the preservation of the core economic functions of the financial system. The emphasis in the definition is on the ability of the financial system to absorb shocks or the resilience of it, so as to continue to carry out its core functions of resource allocation and the provision of an efficient payment system.

Foot (2003) suggested that monetary stability, the stability in the value of money, is an essential part of financial stability. He defined financial stability where there is, *i) monetary stability, ii) employment levels close to the economy's natural rate, iii) confidence in the operation of key financial institutions and markets in the economy, and iv) where there is no relative price movements if either real or financial assets within the economy that will undermine monetary stability and employment levels*. Similar to Crockett (1999), he provided no clarity on the definition or identification of key financial institutions as in some cases authorities prefer discretion. Nevertheless, Foot (2003) provided a close linkage between the real economy, monetary stability and confidence of financial institutions and markets operations. Large (2003) suggested that financial stability is about maintaining confidence in the financial system.

Schinasi (2004), also taking a broad view of the financial system, defined financial stability *as a financial system is in a range of stability whenever it is capable of facilitating (rather than impeding) the performance of an economy, and of dissipating financial imbalances that arise endogenously or as a result of significant adverse and unanticipated events.* He implies broadly that financial stability should be defined in terms of ability to facilitate and enhance economic performance with the efficient allocation of resources, manage risks, and absorb shocks, that is, maintain its ability to function efficiently in a period of disruption as self-corrective measures are made. Also, financial stability is considered a continuum rather than a static state, changeable over time and operating in a range as the economy grow. This suggests that financial systems operate within a corridor with stability and instability at opposite ends.

Allen (2014) combined the two approaches of defining financial stability and instability - where financial stability is not merely the absence of crisis but also the ability to absorb (rather than amplify) shocks. Allen (2014) defined *financial stability as a state of affairs wherein, i) financial institutions and markets are able to facilitate capital intermediation, risk management, and payment services in a way that enables sustainable economic growth; ii) there is no disruption to the ability of financial institutions or markets to operate that might cause harm to customers, counterparties or participants in the financial markets; and iii) financial institutions and market are able to withstand economic shocks or a chain of significant loses so that there is no disruptions to their functions.* The definition looks at the role and state of financial institutions and markets during periods of stability and the value added to broader economic prosperity. There is a focus on the functions and operation of institutions in the financial system and not necessary on the institution itself.

a) Definition of financial instability

As suggested above, there is a school of thought that define financial instability or systemic risk. The following are some definitions of financial instability or systemic risk from a few researchers.

- *Davis (2001) defined financial instability or systemic risk as a major collapse of the financial system, entailing inability to provide payments services or allocate credit to productive investment opportunities.*

- *Chant (2003) argues that that financial instability refers to conditions in financial markets that harm, or threaten to harm, an economy's performance through their impact on the working of the financial system.*

- *Ferguson (2003) proposed that financial instability can be characterized by three basic criteria, i) some important set of financial asset prices seem to have diverged sharply from fundamentals; ii) market functioning and credit availability, domestically and perhaps internationally, have been significantly*

distorted; iii) aggregate spending has deviates (or is likely to deviate significantly, either above or below, from the economy's ability to produce.

- *Haldane et al (2004) suggested that financial instability could be defined as any deviation from the optimal saving-investment plan of an economy deriving from imperfections in the financial sector.*

- *Allen and Wood (2006) defined financial instability as episodes in which a large number of parties, whether there are households, companies, or (individual) governments, experience financial crises which are not warranted by their previous behaviour, and where these crises collectively have seriously adverse macro-economic effects.*

- *IMF-BIS-FSB (2009) defined systemic risk as a risk of disruption to financial services that is, i) caused by an impairment of all or parts of the financial system and ii) has the potential to have serious negative consequences for the real economy.*

- *ECB (2009) described systemic risk as the risk that the provision of necessary financial products and services by the financial system will be impaired to a point where economic growth and welfare may be materially affected*.

II. Key principles of financial stability

Although, there is no single or widely acceptable definition of financial stability (instability), there is some common ground on the key principles concerning it (Davis (2001), Schinasi (2004), Allen and Wood (2006), etc.). Firstly, Laker (1999) and Schinasi (2004) noted that financial stability should be seen from a broad point of view, as it includes different aspects of the financial system infrastructure, encompassing the different aspects of the financial system infrastructure such as the payment system, institutions and markets. Yet there is some disagreement on the meaning of the word "broad". Allen and Wood (2006) have argued that some commentators have suggested that financial stability (instability) is related to institutions in the financial

system. However, they see this view as being too narrow and it should include non-financial institutions since episodes of non-financial institution instability could have a bearing on economic performance and function of the economy and stability of the financial system.

The second principle relates to the efficient allocation of resources. Researchers such as Davis (2001) and Padoa-Schioppa (2002) suggested that a role of financial stability is that it allows the financial system to efficiently allocate saving into productive investment opportunities as well as has a central role in the payment system infrastructure. Schinasi (2004) also implied that financial stability allows the financial system to adequately transforms and manage risks allowing for wealth accumulation and growth.

Thirdly, Fell and Schinasi (2005) saw that the concept of financial stability not only relates to the absence of financial crisis but recognises that instability often arise from unseen shocks, yet the financial system should be resilient to effectively deal with the threat before it develops into system-wide risks. Padoa-Schioppa (2002) and Allen (2014) noted that the financial system should be resilient and should be able to continue its core functions of resource allocation and the provision of an efficient payment system when there is an economic shock. Crockett (1997) noted that the financial system should be able to withstand the occasional failure and losses of financial institutions and return to stability without outside assistance.

Fourthly, Schinasi (2004) noted that the importance of financial stability in the context of the potential impact it may have on the performance of the economy and the financial intermediation process. Similarly, researchers such as Chant (2003), Allen (2014), etc. and IMF-BIS-FSB (2009) highlighted the importance of financial stability in the performance of the real economy and the cost of financial crises. The question becomes, what is the cost to the economy in the absence of financial stability, if there is a disruption to the efficient allocation of financial resources? The cost and impact of financial instability can be sizable and as indicated by the IMF, it is estimated that the 2007-2008 global financial crisis resulted in a 2 per cent decline in world per capita GDP in 2009 and it caused major disruption to the global financial market (see **Section 2.3.4**).

Lastly, Schinasi (2004) noted that financial stability is considered a continuum rather than a static state, changeable over time. This reflects the different possible combinations of measurable variables that can be used to model financial stability and how well the economy is performing. Allen and Wood (2006) said that financial stability should be measurable and observable so that those who are responsible for financial stability can know whether they are succeeding or failing. In addition, financial stability should not be strictly measured so as it is difficult to identify any changes as evidence of instability. There needs to be some flexibility in observation of financial stability in order to adapt to the changing financial structure and the grow of the economy.

Yet again, there is little emphasis on the role of international banking and cross-border activities in the understanding the key principles of financial stability as the focus is on the domestic financial system. Chinazzi et al (2013) noted that it is critical to understand financial-market interconnectedness to explain systemic risk, stability and economic dynamics. The 2007-2008 financial crisis revealed that the interconnectedness of international markets was poorly understood as such there was an appearance that domestic financial markets were stable, yet the downside risks from external markets were misrepresented. We discussed this further in **Chapter 4**.

2.4.2. Countries' approach to financial stability analysis and operating framework

As discussed above, **Section 2.2.1**, by the early 2000s, there was a growing focus on financial stability by central banks and regulators as the frequency of financial crises increased and after the 2007-2008 global financial crisis, there was a renewed policymakers' interest in improving the policy framework for financial stability. This renewed effort was driven by the new role given too many central banks in macroprudential policy and the coordination of responsibilities between the various supervisory agencies (see Čihák et al (2012), BIS (2011) and Jeanneau (2014).

BIS (2011), which is based on a Study Group[29], noted that similar to macroprudential policy framework (discussed above), it is also not a case where "one size fits all" for the design and implementation of a financial stability framework. Although, the Study Group was based on a very small pool of central banks (13), the report suggested that prior to the financial crisis of 2007-2008, central banks that were heavily involved in banking supervision were seen to be better suited to address broader financial stability issues (see Goodhart and Schoenmaker (1995) as well). They advised that central banks must be involved in the formulation and execution of financial stability policy if such policy is to be effective as their responsibilities in the framework need to be compatible with central banks' monetary policy responsibilities.

The Study group noted that since the 2007-2008 financial crisis, new financial stability governance and arrangements have been passed into law in some countries such as the United States with the Dodd-Frank and Consumer Protection Acts of 2010, the European Union created the European Supervisor Authorities (ESAs) and the European Systemic Risk Board (ESRB), and in the United Kingdom, the Bank of England was given banking supervision authority and the Financial Conduct Authority was created.

In Canada, the Department of Finance is responsible for financial stability and supported by federal agencies such as Bank of Canada, the Office of the Superintendent of Financial Institutions and Canada Deposit Insurance Corporation. In some emerging markets such as Argentina and Brazil, the role of the central bank was strengthened to include financial stability, in Mexico, the financial stability council was created to coordinate the roles of the Bank of Mexico, the Ministry of Finance and the other country's other principal regulatory agencies, and in the Philippines, central bank laws were amended to formalise and extend the financial stability functions of the central bank.

Although, countries have adopted different financial stability institutional arrangements and framework, which are based on their macroprudential policy framework, the Study

[29] A report by a Study Group chaired by Stefan Ingves, Governor, Sveriges Ribsbank, *Central Bank governance and financial stability*. May 2011. Thirteen (13) central banks participated in the study group, which looked that their roles and functions pre- and post- financial crisis of 2007/2008.

Group suggested that there are several issues to be considered in designing the governance of new financial stability responsibilities. Even though the Study Group focused on central banks, these issues can be applied to all agencies involve in a country's financial stability framework.

Firstly, the role and responsibilities should be explicitly stated for all agencies and it is seen by the public to have such a responsibility. Secondly, all agencies should have access to the available data and information, has the authority to collect the necessary data and information, the analytical capacity to process and perform the mandate in the framework, as well as the suitable tools to foster financial stability. Thirdly, there must be a collective effort to maintain synergies and avoid conflict in the assignment of functions between agencies in the financial stability framework and at the same time deal with any possible trade off or fall out of any conflict with monetary policy. This include any possible financial and political risks arising from emergency actions undertaken. Fourthly, agencies must be taken the authority for decision making as part of their crisis management process. Finally, there should be a level of autonomy and accountability for the agencies in the financial stability framework.

IMF-FSB-BIS (2014, 2016) and ESRB (2014a) have suggested that setting out clear objectives can enable policymakers to use their policy tools including macroprudential tools, in the pursuit of financial stability, and forms the basis for a framework to hold the designated authority accountable for achieving its objective, thereby reducing the risk of inaction. Similarly, to macroprudential policy, countries approach to financial stability framework is influence by the financial supervisory framework that exist in the country such as sectoral, integrated twin peaks and two agency supervisory models. Once again, it is a situation where most countries integrated macroprudential policy as well as financial stability framework in the existing financial supervisory framework, thus minimising the need for legislative changes. We develop the financial supervisory framework further in **Chapter 5**.

Accordingly, Fell and Schinasi (2005) suggested that an effective financial stability framework requires three important standards. Firstly, there must be rigorous definitions and understanding of key concepts such as what is meant by the terms financial system, financial stability and instability, and systemic risks, etc. Secondly,

the framework's concepts and definitions must be measurable or assessment can be completed to determine the degree of financial stability or instability. González-Páramo (2007) noted the main objective of assessment is the early identification of risks and vulnerabilities that could threaten the financial system (see also Borio and Lowe (2002)). Also, Laker (1999) indicated that the many episodes of financial crises suggest that there is a wealth of indicators that can be used to identify possible financial fragility. Thirdly, the definitions, concepts and organising principles as well as the assessment tools of financial fragility must serve the purpose of ensuring consistency in the identification of sources of risks and vulnerabilities and in addition the design and implementation of polices aimed at revolving any potential financial fragility.

We now move on to **Section 2.5. Literature Overview of macroprudential policy**, where we discuss the theoretical and empirical literature of macroprudential policy. Overall, various aspect of the macroprudential policy literature will be discuss throughout the thesis in **Chapter 3, 4** and **5.**

2.5. Literature overview of macroprudential policy

In this section of the chapter, we review the theoretical literature of macroprudential policy with a brief discussion on the empirical analysis of the effectiveness of macroprudential policy. As well, we outline the critical issues and shortcomings that need to be addressed as macroprudential policy continues to develop.

2.5.1. Discussion of macroprudential policy

As with any financial crisis, the 2007-2008 financial crisis did not happen overnight, but as a precursor, imbalances built up over a period of time. Barrell and Davis (2008) saw that in the period leading up to the financial crisis, at least for more than five years, the world economy experienced an environment of low interest rates and a build-up of large investment surpluses especially in China and thus international liquidity which resulted in a rapid credit expansion and a growing risk appetite. In some aspect, we will argue that some of these imbalances and elevated risks did not go unnoticed as the regulatory frameworks were adjusted by regulators and policy makers to reflect

the changing risk environment. Yet, the focus of regulators and policymakers remained on microprudential policy (e.g. Basel Accords) as they considered that the stability of the financial system will continue to be depend on the health of individual financial institution. It should be notably mentioned that the concept of financial stability and macroprudential surveillance were slowing taking roots because of the Asian financial crisis (1997-1998) (see Davis (1999)).

We note that the 2007-2008 financial crisis did not only introduce macroprudential policy as financial sector regulatory policy, but other changes were made to microprudential policy as well. Basel III, which introduced the countercyclical capital buffers for the banking industry, provide a comprehensive set of reform measures, which aims to strengthen the regulation, supervision and risk management of the banking sector. These measures aim to:

- improve the banking sector's ability to absorb shocks arising from financial and economic stress, whatever the source.
- improve risk management and governance.
- strengthen banks' transparency and disclosures.

The reforms target:

- bank-level, or microprudential, regulation, which will help raise the resilience of individual banking institutions to periods of stress.
- macroprudential, system wide risks that can build up across the banking sector as well as the procyclical amplification of these risks over time.

Accordingly, one can then ask the question, why was macroprudential policy overlooked especially since macroprudential surveillance was well developed? Additionally, why did the 2007-2008 financial crisis change the fortunes of macroprudential policy? Firstly, to answer these questions, one must look at background of the concept of the term macroprudential. Although the term macroprudential (policy) perspectives to regulation was discussed in many committees and forums since 1979 (see above, **Section 2.2.1**), there was no clarity on what is meant by a “macroprudential” perspective in the supervision and regulation of the financial system. Only in the last 15 years, researchers (such as Crockett (2000)

and Borio (2003)) have provided a clearer idea of what is meant by macroprudential perspective in financial system supervision and regulation. Further, there were no recommended policy tools to use in period of financial crises.

Also, over the years prior to the 2007-2008 financial crisis, there was no clear agreement on what the objectives of macroprudential policy should be, and even today, there are still many debates by researchers and policy makers on this issue. However, several international agencies (such as IMF-FSB-BIS (2014, 2016), ESRB (2014a)), who have been encouraging countries to develop a macroprudential policy framework as part of their financial system reforms, have identified key objectives and scope of macroprudential policy. And these key objectives and scope can be used by countries as the starting point for the development of their macroprudential policy framework. Additionally, these international agencies have taken the lead in proposing key features of a macroprudential policy framework countries can adapt to their economic and financial situation. We noted that there is no pressure from these international agencies for countries to adopt the same framework, it is not a one size fits all, but countries need to use the framework that is appropriate to their situation.

Secondly, we saw that macroprudential policy is hindered by definition challenges and measurement. Much of the literature and concepts of macroprudential policy are still being developed and research in the area is slowly emerging as quality data become available (Galati and Moessner (2013)). Lim et al (2011) and Cerutti et al (2015a) have highlighted two IMF's surveys which provide information on the use of macroprudential instruments by member countries. The information from these surveys have been very useful to researchers, as well as the research in this thesis, to assess the objectives of macroprudential policy. However, to further develop macroprudential policy research literature, the information from these surveys needs to be updated as the information from these surveys are up to 2014.

Further, one of the key objectives of macroprudential policy is that it should contribute to financial system stability or a tool to identify and prevent periods of financial instability (systemic risks). But, similarly to macroprudential policy, there is no clarity in the definition of financial stability and measurement (see above, **Section 2.4**). As a result of there being no clear definition of financial stability and measurement,

assessing whether macroprudential policy is achieving its financial stability aim is a challenge.

Thirdly, as noted by Davis and Karim (2009), even if the pending 2007-2008 financial instability was identified, macroprudential surveillance (policy) came with no recommended policy tools to deal with the build-up of financial sector imbalances or a financial crisis. Čihák (2006), Čihák et al (2012) suggested that many countries had a macroprudential surveillance programme which should have given warning (early warning indicators (EWI)) of an impending financial instability. As we noted above, the BIS analysed and monitored early warning indicators of domestic banking distress. These indicators capture financial overheating and signal potential banking distress over medium-term horizons, e.g. credit-to-GDP gap, which is recommended by the BIS. The credit-to-GDP gap is widely seen as a key indicator of financial imbalances and predictor of financial crises (Borio (2003), Drehmann and Tsatsaronis (2014)). As such, it is recommended as an early warning indicator to trigger the Basel III countercyclical buffer. We discuss the credit-to-GDP gap further in **Chapter 3**.

Currently, several tools (see **Section 2.3.2** above) have been recommended, but although research has shown some tools are more effective than others against certain financial imbalances such as credit (as we will discuss further in **Chapter 3**), researchers and policy makers are still unsure on the strength and effectiveness of these tools in their financial system and especially in a period of financial crisis. Furthermore, advanced countries may worry about disintermediation of the policy, and in emerging market economies, they may be concerned about protecting the exchange rate (see Cerutti et al (2015a, 2017)). As such, Galati and Moessner (2014) suggested that one of the problems of the empirical research on macroprudential policy is how to measure the effectiveness of the policy tools on macroeconomic and financial variables, that is, which requires to assess the difference between correlation and causation.

Also, there is no actual/ recent financial crisis (history) where macroprudential policy and its tools have been deployed at a global level, thus making measurement of its effectiveness difficult. Furthermore, some of the macroprudential policy tools at have been proposed or being used were initially part of microprudential and monetary

policies objectives (such as loan-to-value ratio (LTV), debt service-to-income ratio (DSTI), concentration limits (CONC), dynamic provisioning (DP) and reserve requirements (RR), etc.) long before the 2007-2008 financial crisis (Galati and Moessner (2014)) especially in emerging market economies. In the literature, it has been highlighted that there is some "successful history" in the use of macroprudential tools, for example Hong Kong's utilisation of macroprudential tools (LTV, DSTI) in the 1990s to address risks in the property sector (Durbar and Wu (2015)) and in France in the 2000s (Dietsch and Welter-Nicol (2014)). As well, in Spain, an early adopter of macroprudential policy, dynamic provisioning helped smooth credit supply cycles and in bad times, preserve financial firms' ability to extent credit and their performance (Jiménez et al (2012)).

Finally, although organising guidelines (IMF-FSB-BIS (2016), IMF (2014), ESRB (2014a)) have been suggested and published, (see above, **Section 2.3.4**)**,** countries are slowly developing a macroprudential policy framework or in some cases, they are only adopting features of the policy in their regulatory framework that can implemented without the need for government legislative approval, mostly in emerging market economies. Nevertheless, regulators (central banks) in most cases, have created financial stability department to monitor and research financial stability issues in their financial system and have introduce some macroprudential tools.

In some countries, legislations are now in place (UK, USA, Euro area) to give effect to the macroprudential frameworks and governance structures (see Haldane (2013), Jenkins and Longworth (2015)), which outline the operating framework and coordination especially when multiple agencies have a macroprudential policy responsibility. In many other countries, these macroprudential legislations are not a priority in the government legislative agenda.

2.6. Chapter summary

Despite the benefits of macroprudential policy, the history of the term has shown that the macroprudential (policy) concept was discussed in different committees and forums and there was little interest in developing the policy further prior to the 2007-2008 global financial crisis. As we mentioned earlier, one can argue that the period of

low unemployment rate, increasing asset prices, low interest rates, risk but steady GDP growth, low inflation (Goldilocks period) and financial crises really being institutional crises led to excessive optimism about financial instability being less of a problem up to 2007.

The 2007-2008 global financial crisis changed the fortune of macroprudential policy as there is a rapid growth in the development of a macroprudential policy framework and the usage of macroprudential tools in many countries. There is some developing clarity in the scope and objectives of macroprudential policy, the benefits have been identified and debated. Although the literature and research are still developing, a number of countries' regulators have been given the legislative authority to formally develop a macroprudential policy framework and there is a rapid growth in the usage of macroprudential instruments in many countries.

A number of macroprudential tools have been proposed, yet there is no clear agreement on which tool should play a primary role in macroprudential policy, e.g. countercyclical capital requirement, leverage ratio, cap on loan to value ratio, reserve requirements, etc. Nevertheless, it is no longer a case of "one size fits all" and each country need to have the flexibility to develop the macroprudential policy framework including its tools that are most appropriate to their country's financial system requirements.

We believe the most important hurdle has been overcome, that is, many countries have "*bought into*" and accepted the concept, benefits and justification for macroprudential policy. This augurs well for future and the further development of macroprudential policy and it is becoming a key aspect of a country's regulatory framework and an acceptable policy tool.

2A. Appendix Chapter 2

2A.1. Selected major financial instability and economic shocks and policy responses from 1970

Appendix Table 2A.1 below highlights some of the major episodes of financial instability and economic shocks. The table outsides the main features of the financial instability, the policy responses and the estimated cost that was incurred.

Appendix Table 2A.1: Selected episodes of major financial instability and economic shocks from 1970

Date	Event	Country	Main feature	Policy response	Estimated direct costs
1970	Penn Central Bankruptcy	United States	Collapse of market liquidity and issuance of commercial paper because of Penn Central bankruptcy. (Commercial paper outstanding US$40 billion)	1. Elimination of exemptions for rail and motor carriers from the Federal securities laws. 2. Increased regulatory restrictions on dividend policy. 3. Extraterritorial application of the Federal securities laws. 4. Restrictions on interlocking directorates. 5. Insulation of commercial banking functions from bank trust departments. 6. Improved legislative and regulatory control over diversification of transportation companies.	US$750 million in aid from the Federal government.

1967-1973	Bretton Woods System	Advanced countries	Countries settled international balances in dollars, and US dollars were convertible to gold at a fixed exchange rate of $35 an ounce. The United States had the responsibility of keeping the price of gold fixed and had to adjust the supply of dollars to maintain confidence in future gold convertibility. The Bretton Woods system was in place until persistent US balance-of-payments deficits led to foreign-held dollars exceeding the US gold stock, implying that the United States could not fulfil its obligation to redeem dollars for gold at the official price. With inflation on the rise and a gold run looming, President Richard Nixon's team enacted a plan that ended dollar convertibility to gold and implemented wage and price controls, which soon brought an end to the Bretton Woods System.	Floatation of major currencies against each other.	
1973	OPEC first oil price shock	OPEC members (mainly middle east country)	Members of the Organization of Arab Petroleum Exporting Countries proclaimed an oil embargo, a decision to boycott America and punish the west in response to support for Israel in the Yom Kippur war against Egypt. Oil price shocks contributed to recession and higher inflation in many non-oil producing countries.	Led to a resurgence of interest in other forms of energy such as solar. Creation of the US Strategic Petroleum Reserve.	
1973	UK Secondary banking crisis of 1973–75	UK	Bank failures following loan losses and liquidity problem because of rising inflation, rising oil prices, a pay and prices freeze, strict credit limits and companies running desperately short of cash. Twenty-six financial firms needed financial support.	The Bank of England's regulatory powers over lenders were increased in the 1979 Banking Act to prevent a repeat of the crisis.	Life-support funds, up to £1,285 million from the Bank of England.

1974	Herstatt Bank	Germany	Cross border effect on the settlement of foreign exchange positions, which affected several international banks especially United States (US) based banks.	Establishment of the Basel Committee on Banking Supervision by the central bank Governors of the Group of Ten countries	Loss of US$620 million to the international banking sector
1978-1979	OPEC second oil price shock	Iran	The Iranian Revolution began in early 1978 and ended a year later and in conjunction, Iranian oil output declined by 4.8 million barrels per day (7 percent of world production at the time) by January 1979. Also, the Iranian disruption may have prompted a fear of further disruptions and spurred widespread speculative hoarding. Oil price shocks contributed to recession and higher inflation in many non-oil producing countries.	Led to a resurgence of interest in other forms of energy such as solar.	
1982 - 1989	Latin American and less-developed country debt crisis	Central and South American countries	The inability of several countries to service its outstanding debt to U.S. commercial banks and other creditors. Many countries felt into deep recession.	Brady Plan where countries undertake structural reforms of their economies, financial liberalisation, and to eliminate budget deficits in return for debt forgiveness. Also, regulatory forbearance was granted to the large banks with respect to the establishment of reserves against past-due LDC loans.	Financial firms forgave US$61 billion in loans.
1986 - 1995	Savings and loan crisis (S&L)	United States	Bank failures following loan losses as the rates they had to pay to attract deposits rose sharply, but the amount they earned on long-term fixed-rate mortgages didn't change. More than 1,400 savings and loan institutions and 1,300 banks failed.	In 1989, Congress passed the Financial Institutions Reform, Recovery and Enforcement Act of 1989 that instituted a number of reforms of the industry. The main S&L regulator (the Federal Home Loan Bank Board) was abolished, as was the bankrupt Federal Savings and Loan Insurance Corporation (FSLIC). In their place, Congress created the Office of Thrift Supervision and placed thrifts' insurance under the FDIC. In addition, the Resolution Trust Corporation (RTC) was established and funded to	US$180 billion or 3% of GDP.

				resolve the remaining troubled S&Ls.	
1987	Stock market crash	United States	Price volatility after shift in expectations, with high margin calls on market liquidity and market operation, program trading especially portfolio insurance impact, and uncertainty and herding behaviour	Regulators overhauled trade-clearing protocols to bring uniformity to all prominent market products and developed new rules, known as circuit breakers, allowing exchanges to temporarily halt trading in instances of exceptionally large price declines in some indexes. Federal Reserve provided liquidity to the financial system by conducting open market operations, aimed at supporting market confidence.	The Dow Jones Industrial Average (DJIA) dropped 22.6 percent in a single trading session.
1988 - 1993	Scandinavian banking crisis	Norway (1998-1992)	Bank failures following loan losses due to financial deregulation and banks excessive lending to the housing market.	In Norway, the three biggest banks were nationalized, eliminating private ownership completely. In Finland supported the banking system as the savings bank group was taken over by the government. The government of Sweden offered blanket insurance for claims on Swedish commercial banks, nationalized the two clearly insolvent banks, and set up asset management corporations to take over bad assets of the remaining commercial banks. Monetary policy was changed as he pegged exchange rate regime of the three countries were abolished.	In Norway, the gross fiscal cost of crisis resolution was 2 per cent of GDP.
		Finland (1990-1993)			Finish government gave a 7.1 billion FIM (€1.2 billion), initially zero-interest convertible loan to banks.
		Sweden (1991-1993)			Sweden spent 4 percent of its gross domestic product, or 65 billion kronor, the equivalent of US$11.7 billion.
1992	Japanese asset price bubble	Japan	Bank failures following loan losses; Japan experienced a rapid rise in asset prices, the overheating of economic activity, as well as an uncontrolled money supply and credit expansion prior to the financial crisis.	Bank of Japan review of how monetary policy is conducted, importance of conducting monetary policy in such a forward-looking manner. The development and understanding the risk profile of the economy in term of output gap, money supply and credit and assets prices, the behaviour of financial institutions and the interaction of risks.	The bursting of the Japanese asset price bubble contributed to, what is called the Lost Decade, a period of economic stagnation.

1992	European Currency Unit (ECU) Bond Market collapse	European Union	Collapse of market liquidity and issuance due to uncertainty created by Denmark and France "no" vote referenda concerning the Europe Economic and Monetary Union (EMU) led to heavy selling in the market in mid-1992.	European countries governments' commitment to provide liquidity to the markets, via their own issues and the desire to shift or retain ECU business in their own financial centres.	
1992-1993	European Exchange Rate Mechanism (ERM)	European Union (United Kingdom)	Price volatility after shift in expectations due to currency speculators. The ERM demanded that currencies stayed within a band set in relation to other currencies in the club. To maintain the currency values relative to each other, countries with the most valuable currencies had to sell their own and buy the weakest. This drove interest rates up the UK as the government struggled to control inflation.	The United Kingdom exited the program.	UK government lost an estimated £7 billion buying pounds.
1994	Mexican peso crisis (Tequila crisis)	Mexico	Liquidity crisis in the peso. The government responded to the liquidity crisis by devaluing the peso, thereby unleashing financial turmoil in the global currency market.	Floatation of the Mexican peso and fiscal discipline	Mexico GDP felt by 5%. Approximately US$60 billion in financial bailout, mainly from the US government.
1997-1998	Asian financial crisis	Asia	Currency and financial crisis in Thailand, soon spread to other Southeast Asian countries-including Malaysia, Indonesia and the Philippines. By the fall of 1997, the contagion extended its reach to South Korea, Hong Kong and China.	IMF loans with the conditions of fiscal discipline, banking and financial structure reform and capital flow control.	IMF bailout package of approximately US$80 billion.
1998	Russian default	Russia	Currency and debt crisis with the Russia devaluing of the ruble, defaulting on his domestic debt and declared a moratorium on repayment of foreign debt.	Russia bounced very quickly mainly due to rising oil prices.	
1998	Long-Term Capital Management L.P. (LTCM)	United States	Debt and liquidity crisis because of high-risk arbitrage trading strategies.	Creation of a supervisory board to oversee operation and regulatory requirements.	Federal Reserve Bank of New York organized a bailout of US$3.625 billion.

2001-2002	Argentina debt crisis	Argentina	Debt and currency crisis due to fiscal indiscipline, overvalued currency and large-scale foreign currency borrowing.	Fiscal and structural reform, with the devaluation of the peso.	IMF bailout package of approximately US$40 billion.
2007-2010	Subprime banking crisis	United States	Asset prices boom and collapse (real estate market).	Lenders were asked to rework payments and other terms on troubled mortgages or to refinance "underwater" mortgages (loans exceeding the market value of homes) rather than aggressively seek foreclosure. Congress passed the temporary tax credits for homebuyers that increased housing demand and eased the fall of house prices in 2009 and 2010. As well as, Congress greatly increased the maximum size of mortgages that FHA would insure. The Federal Reserve lowered short-term interest rates to nearly 0 percent by early 2009, took additional steps to lower longer-term interest rates and stimulate economic activity.	TARP and other bailout programs cost an estimated US$1 trillion.
2007-2008	Global financial crisis	Mostly advanced countries	Financial institutions liquidity and credit crunch crisis because of the subprime banking crisis.	The Dodd–Frank Act to promote financial stability in the United States Basel III capital and liquidity standards were adopted by countries around the world. Macroprudential policy.	About 2% fall in the world GDP.
2008–2010	Irish banking crisis	Ireland	Banking insolvency following loan losses.	Government guarantee of Irish domestic banks under the Credit Institutions (Financial Support) Act 2008. Passage of the Credit Institutions (Eligible Liabilities Guarantee) Scheme 2009. Nationalisation of Anglo-Irish Bank.	Government bailout of €64 billion.
2008–2011	Icelandic financial crisis	Iceland	Banking bankruptcy and debt crisis.	Iceland nationalized its three largest banks.	US$4.6 billion IMF and Scandinavian countries bail out.

2009	European sovereign debt crisis	Greece, Portugal, Ireland, Spain and Cyprus	Debt crisis because of high risks borrowing and lending, fiscal indiscipline and large trade imbalances.	Economic structural and fiscal reform.	Estimated bail out to date is US$544 billon.

Source: Davis (1998) and author's extension

2A.2. Utilisation of macroprudential policy instruments prior to the 2007-2008 global financial crisis

Following the 2007-2008 global financial crisis, several countries have used macroprudential policy and its instruments to address financial system instability or prevent the build-up of imbalances in the financial system. However, two surveys by the IMF, (Lim et al (2011) and Cerutti et al (2015a), have shown that some element of macroprudential policy framework existed prior to the 2007-2008 global financial crisis in some advanced economics and more so, many emerging market economies. The IMF surveys provided information on the use of macro-prudential policy from 2000 but some countries used macro-prudential policy much earlier (see, for example, Kuttner and Shim 2016). The purpose of this case study is to highlight the use of macroprudential policy prior to the global financial crisis.

I. Early adopters of macroprudential policy instruments

The concept of macroprudential policy existed since the 1970s and despite the benefits of macroprudential policy, it was not developed as a policy framework and incorporated in financial regulations prior to the 2007-2008 global financial crisis in most countries. Furthermore, many international agencies did not advance the development of macroprudential policy prior to the crisis as the focus of regulators and policy makers were on microprudential policy (e.g. Basel Accords) as they saw that the stability of the financial system will continue to be depend on the health of individual financial institution.

Nonetheless, the IMF surveys have shown they were early users of macroprudential policy instruments prior to the 2007-2008 global financial crisis in several countries. As an example, Spain introduced countercyclical dynamic provisioning in 2000. The concept of dynamic provisioning is to build up countercyclical loan loss reserve in good

times and then using it to cover losses as they arise in bad times. It is suggested that dynamic provisioning can greatly smooth provisioning costs over the cycle and thus insulate banks' profits and losses (Wezel et al (2012)).

Subsequently, time varying/ dynamic provisioning requirements were adopted in Uruguay, Colombia, Peru, and Bolivia. Meanwhile, countries like Mexico and Chile switched to provisioning based on expected loan loss, which is broadly in line with the Basel II principles. Expected loss provisioning requires a specific provision on newly originated loan that reflects expected loss over the life of the loan. This brings the benefit of explicitly incorporating individual borrower characteristics that drive loan performance. That is, each loan carries an individual specific provision from the outset based on the borrower's characteristics, even though no loan impairment has occurred as yet. Similarly, Brazil has used a formula to smooth capital requirements for interest rate risk in times of extreme volatility, China introduced a countercyclical capital requirement similar to the countercyclical buffer under Basel III, and India has made countercyclical adjustments in risk weights and in provisioning (Wezel et al (2012)). This shows that countries are tailoring the design and calibration of the instruments to suit their specific circumstances.

Also, in emerging market economies, Lim et al (2011) suggested that macroprudential instruments were part of a broader macroprudential stability framework which was developed after many of these economies experienced financial crises in the 1990s. Therefore, elements of macroprudential instruments were used to address systemic risk after these crises. Also, Claessens et al (2014) noted emerging markets have had much greater experience with macroprudential policy due to the more volatile business and financial cycles. There is greater cyclicality due to their larger exposure to international capital market flows, commodity prices shocks, etc. They noted that emerging countries use macroprudential policies more frequently, especially foreign exchange policies, suggesting the dual objective of stabilising the country's foreign exchange market, in contrast to advanced countries, which typically use borrower-based policies which specifically target consumer lending and credits for the real estate market.

In the 1990s, the financial crises in emerging market were primarily due to combination of unsustainable current account deficits, excessive short-term debts and weak domestic banks. The International Monetary Fund (IMF) responded with substantial packages of financial support and with the imposition of wide-ranging requirements of domestic economic reforms (Feldstein (2003)). Of significance were the Mexican (1994) and Asian financial crises (1997-1998), which has contagion effects in many Latin America and Asia countries, where unhedged currency, fixed exchange rate system and interest rate exposures played a central role in theses crises. Another factor in these crises was the weakness in the regulatory framework for the financial systems in these countries. Claessens et al (2014) noted that emerging countries mostly used macroprudential instruments such as loan-to-value ratio (LTV), debt-to-income ratio (DTI), foreign currency loan limits (FC) and reserve requirements (RR). In many emerging and lower income developing countries, reserve requirements are also use as a monetary policy instrument, and as such there may be some difficulty in interpreting the effectiveness of this prudential instrument (see Izquerido et al (2013)).

II. Countries with macroprudential policy prior to the 2007-2008 global financial crisis

As detailed in Lim et al (2011), the first IMF survey (2010) identified 10 instruments that have been frequently used to achieve macroprudential objectives, that is to limit the risk of widespread disruptions to the financial system. Cerutti et al (2015a) expanded on the list of instruments and the number of countries using macroprudential policy and they saw that these instruments seek to address three types of probable imbalances - credit, liquidity and capital. This is also discussed in **Section 2.3.2** above.

Appendix Tables 2A.2 and 2A.3 below show the credit related instruments which aim is to contain excessive credit growth in the financial sector and can target specific type of loans, a particular group of borrowers, a specific region or loans dominated in foreign currencies, etc.

Appendix Table 2A.2: Advanced countries used of credit related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments				
Advanced countries	Year	Caps on foreign currency lending	Caps on loan-to-value (LTV) ratio	Lending ceiling	Caps on the debt-to-income (DTI) ratio	Loan-to-deposits ratio
Austria	2003	✓				
Belgium	2000					
Cyprus	2003		✓			
Hong Kong	1999		✓	✓		
Iceland	2001	✓				
Italy	2000		✓			
Singapore	2000		✓			
Slovakia	2000		✓			
South Korea	2002		✓		✓	✓
Spain	2000		✓			
United States	2000		✓			

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017).

Appendix Table 2A.3: Emerging market economies use of credit related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments – Credit				
Emerging market economies	Year	Caps on foreign currency lending	Caps on loan-to-value (LTV) ratio	Lending ceiling	Caps on the debt-to-income (DTI) ratio	Loan-to-deposits ratio
Algeria	2000					
Argentina	2000	✓	✓			
Bahamas	2000		✓		✓	
Bangladesh	2004		✓			
Bulgaria	2004		✓			
Chile	2000		✓			
China	2004		✓			
Colombia	1999	✓	✓			
Costa Rica	2005		✓			
Croatia	2003		✓	✓	✓	
Curacao	2000		✓			
Haiti	2000	✓				
India	2000		✓			
Jordan	2000	✓				
Malaysia	1995		✓	✓		
Moldova	2000	✓				
Morocco	2000	✓				
Pakistan	2000	✓	✓			
Paraguay	2000	✓				
Poland	2000	✓			✓	

Romania	2000	✓	✓		✓	
Serbia	2004	✓			✓	
Thailand	2002		✓		✓	
Ukraine	2001	✓				

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017).

Secondly, Appendix Tables 2A.4 and 2A.5 show the liquidity related instruments, which objective is to discourage financial institutions excess reliance on short-term funding and these instruments are designed to ensure that financial institutions have the necessary liquidity buffer to deal with any short-term liquidity disruptions.

Appendix Table 2A.4: Advanced countries used of liquidity related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments - Liquidity				
Advanced countries	Year	Limits on currency/ maturity mismatch	Reserve requirements	Limits on net open currency positions (NOP)	Liquidity limits/ requirement	Limits on Interbank Exposures
Australia	2000				✓	
France	2000				✓	
Italy	2000				✓	
Singapore	2000		✓			
South Korea	2002		✓			
United States	2000		✓		✓	

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017).

Appendix Table 2A.5: Emerging market economies used of liquidity related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments - Liquidity				
Emerging market economies/ Developing countries	Year	Limits on currency/ maturity mismatch	Reserve requirements	Limits on net open currency positions (NOP)	Liquidity limits/ requirement	Limits on Interbank Exposures
Argentina	2000		✓			✓
Armenia	2000		✓			✓
Azerbaijan	2005		✓			
Bahamas	2005					✓
Bahrain	2000		✓			
Belarus	2000		✓			
Bosnia and Herzegovina	2000		✓			
Brazil	2004	✓	✓			

Bulgaria	2004		✓			
Brunei	2000		✓			
Bulgaria	2005		✓			
Burundi	2000		✓			
Cambodia	2000		✓			
Colombia	1999		✓	✓		✓
Costa Rica	2000					✓
Croatia	2000		✓		✓	
Curacao	2000		✓			
Dem. Rep. Congo	2003					✓
El Salvador	2001		✓			
Fiji	2000		✓			
Georgia	2000		✓			
India	2004		✓	✓		
Kazakhstan	2000		✓			
Kosovo	2001		✓			
Kyrgyz Republic	2003					✓
Lebanon	1997		✓	✓		
Lao PDR	2000					✓
Macedonia	2000		✓			
Malaysia	1995		✓			
Mexico	1997	✓			✓	
Moldova	2000		✓			
Mongolia	2000		✓			
Morocco	2000					✓
Mozambique	2000		✓			
Nepal	2000		✓			
Pakistan	2000		✓			✓
Paraguay	2000					✓
Peru	2000		✓	✓		✓
Philippines	2000		✓			
Poland	2006		✓			
Romania	2000		✓			✓
Serbia	2004		✓	✓		
Solomon Islands	2000		✓			
Sri Lanka	2000		✓			
Sudan	2000		✓			
Thailand	2002			✓		
The Gambia	2000		✓			
Trinidad and Tobago	2000					✓
Tonga	2000		✓			
Uganda	2004					✓
Ukraine	2001		✓			✓
United Arab Emirates	2000		✓			✓
Uruguay	1990s		✓	✓	✓	

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017).

Thirdly, the aim of capital related instruments, which are shown in Appendix Tables 2A.6 and 2A.7, is to encourage financial institutions to build up a capital buffer above the minimum requirement which can be drawn down during period of stress.

Appendix Table 2A.6: Advanced countries used of capital related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments – Capital							
Adv. countries	Year	New risk weights for loans and non-performing loans, etc.	Time-varying/ dynamic provisio ning	General Counter cyclical Capital Buffer/ Req.	Capital req.	Increase provisioning for general/ households' loans	Restrictions on profit distribution	Levy/ Tax on FIs	Leverage Ratio
Belgium	2000							✓	✓
Canada	2000								✓
Ireland	2003	✓							
Norway	1998	✓							
Portugal	1999			✓	✓				
Spain	2000	✓	✓						
United States	2000								✓

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017). Adv – Advanced countries, Reg. – requirement. IMF WEO country classification (April 2017).

Appendix Table 2A.7: Emerging market economies used of capital related instruments prior to the 2007-2008 financial crisis

		Macroprudential Policy Instruments – Capital							
EME and DEV	Year	New risk weights for loans and non-performing loans, etc.	Time-varying/ dynamic provisio ning	General Counter cyclical Capital Buffer/ Req.	Capital req.	Increase provisioning for general/ households' loans	Restrictions on profit distribution	Levy/ Tax on FIs	Leverage Ratio
Bahrain	2000								✓
Bangladesh	2000							✓	
Brazil	2005		✓						
Bulgaria	2004				✓	✓			
Burundi	2000		✓						
Chile	2000								
China	2003		✓						
Colombia	2007		✓						
Croatia	2003		✓						
Croatia	2002								
Ecuador	2001							✓	✓
Georgia	2002			✓					
Ghana	2000							✓	

India	2004	✓				✓			
Jamaica	2004							✓	✓
Kyrgyz Republic	2004		✓						✓
Malaysia	2005	✓							
Nepal	2000		✓						
Pakistan	2002							✓	
Paraguay	2000								✓
Peru	2001		✓						
Philippines	2002							✓	
Poland	2006	✓					✓		
Romania	2000					✓			
Saudi Arabia	2000								✓
Serbia	2002				✓				
St. Kitts and Nevis	2000								✓
Tajikistan	2000		✓						
Thailand	2002	✓							
Trinidad and Tobago	2000							✓	
Uruguay	2001	✓	✓						
Zambia	2000								✓

Sources: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017). EME – Emerging Market Economies, DEV – Developing countries, Reg. – requirement.

III. Overall use of macroprudential instruments prior to the 2007-2008 financial crisis

In the table below (**Appendix Table 2A.8**), 82 countries used macroprudential instruments prior to the 2007-2008 financial crisis. Most of the countries using these instruments were emerging and developing countries, that is 65 such countries, while 17 advanced countries had used macroprudential instruments. Most of the countries, that is 59 countries, have used some form of liquidity related instruments, with reserve requirements (RR) being used by most countries. As suggested previously, in many emerging and low developing countries reserve requirements are also used as a monetary policy instrument. Capital related instruments were used in 39 countries, as several different instruments were employed. Credit related instruments were used by 35 countries, with loan-to-value ratios (LTV) being employed the most.

Appendix Table 2A.8: Overall use of macroprudential instruments prior to the 2007-2008 financial crisis

Type of Instrument	Total countries	Emerging and developing countries	Advanced countries
Credit related instruments			
Caps on foreign currency lending	14	12	2
Caps on loan-to-value (LTV) ratio	23	15	8
Lending ceiling	3	2	1
Caps on the debt-to-income (DTI) ratio	7	6	1
Loan-to-deposits ratio	1	0	1
Subtotal by classification	***35***	***24***	***11***
Liquidity related instruments			
Limits on currency mismatch	2	2	0
Reserve requirements	44	41	3
Limits on net open currency positions (NOP)	7	7	0
Liquidity limits/ requirement	3	3	0
Limits on Interbank Exposures	21	17	4
Limits on maturity mismatch	2	2	0
Subtotal by classification	***59***	***53***	***6***
Capital related instruments			
New risk weights for loans and non-performing loans, etc.	8	5	3
Time-varying/ dynamic provisioning	11	10	1
General Countercyclical Capital Buffer/Requirement	1	1	0
Increase capital requirement	3	2	1
Increase provisioning for general/ households' loans	4	3	1
Restrictions on profit distribution	2	2	0
Levy/Tax on Financial Institutions	10	8	2
Leverage Ratio	12	9	3
Subtotal by classification	***39***	***32***	***7***
Total by country classification	**82**	**65**	**17**

Source: Lim et al (2011), Cerutti et al (2015a) and author's extension. IMF WEO country classification (April 2017), ADV is advanced country, EME is emerging market economy.

We now move on to **Chapter 3: The Effectiveness of Macroprudential Policy**, where we present our empirical results testing the effectiveness of macroprudential

policy and its instruments in reducing the build-up of imbalances in the credit market using the BIS' credit-to-GDP gap as a measure of systemic risk.

CHAPTER 3

The Effectiveness of Macroprudential Policy

3.1. Introduction

In the aftermath of the 2007-2008 global financial crisis, the growing consensus of regulators, policymakers and researchers was that there needs to be a shift in focus on how the financial system is regulated and monitored. This was because the systemic risk was insufficiently understood and financial regulation focused excessively on preventing individual financial institution failure (microprudential policy) (Hanson et al (2011)). In light of this, policymakers sought not to only focus on improving microprudential policy but introduce macroprudential policy, which would strengthen the regulation, supervision and risk management of the banking sector.

The main underlying purpose of macroprudential policy is the use of primarily prudential tools to limit systemic risk, which is the widespread disruption of the provision of financial services that is caused by an impairment of all or parts of the financial system and this disruption can cause serious negative consequences for the real economy (IMF-FSB-BIS (2016). However, the literature on macroprudential is far from complete and continues to evolve, and also, there is no common agreement on the objectives of macroprudential policy.

As such, the purpose of this chapter is to assess the effectiveness of macroprudential policy in reducing imbalances in the financial sector. We will focus on the credit-to-GDP gap which is considered to be a good predictor of instability (e.g. by the BIS) as well as having a recommended link to the Basel III countercyclical buffer (CCB). Borio and Lowe (2002a and b) of the BIS indicated that a combination of sustained rapid growth in credit and asset prices can indicate an impending financial crisis, and contended that the gap between the total non-financial private sector credit-to-GDP ratio and its trend (the credit-to-GDP gap) is a key indicator of financial imbalances and system wide risk. These results were underpinned by an assessment of

performance of the credit-to-GDP gap over the subprime crisis in Borio and Drehmann (2009).

IMF-FSB-BIS (2016) noted that macroprudential policy should, 1) increase the resilience of the financial system to deal with aggregate shocks, that is help maintain the ability of the financials system to function effectively even under adverse conditions, 2) contain the build-up of systemic vulnerabilities when there is an upswing in the business cycle (time dimension) and where there is a distortion in the feedback between asset prices and credit, and 3) seek to control structural vulnerabilities within the financial system that arise through interlinkages, that is risk within the financial system due to the interconnectedness of financial institutions (cross-sectional or structural dimension). See **Chapter 2** for further discussion on macroprudential policy.

Many international agencies and researchers support the view that countries should adopt and develop a macroprudential regulatory framework for their financial sector. As such, Lim et al (2011) and Cerutti et al (2015a) noted that following the 2007-2008 financial crisis many countries have used macroprudential instruments, with the objective of reducing systemic risk either over time or across institutions and markets. They established that the usage of the instruments is generally aimed at dampening credit demand, notably in household credit. Examples of macroprudential instruments used are time-varying/dynamic loan-loss provisioning (DP); loan-to-value ratio (LTV); debt-to-income ratio (DTI); limits on foreign currency loans (FC); reserve requirement ratios (RR) and concentration limits (CONC).

As the usage of macroprudential instruments continue to grow, the effectiveness of these instruments is being analysed. In the last few years since the publication of the first IMF survey (2010) (Lim et al (2011)), there have been many empirical studies on the use and effectiveness of macroprudential policy and its instruments, such as, Carreas et al (2018), Akinci and Olmstead-Rumsey (2015), Cerutti et al (2015a), Claessens et al (2014), Dell'Ariccia et al (2012), etc., with many of these studies focusing on analysing the effect of macroprudential instruments on credit growth and house prices at a macroeconomic level and the mitigation of the build-up of imbalances in this market. There are few micro level studies (see Claessens et al (2014)).

In this chapter of the thesis, we will review and assess the effectiveness of macroprudential policy in reducing imbalances in the financial sector. We will focus on the credit-to-GDP gap, as Basel III has given it a prominent role as a signalling agent (early warning indicator (EWI)) for policymakers in identifying looming build-up of imbalances in the financial market and in setting the countercyclical capital buffers.

The rest of the chapter is structured as follow. Firstly, **Section 3.2. Empirical studies on the effectiveness of macroprudential instruments** provide an overview of the focus of macroprudential policy and summarises some of the existing empirical research on macroprudential policy effectiveness. Secondly, **Section 3.3. BIS' credit-to-GDP gap** reviews the research literature of the gap and discuss the empirical analysis of the effectiveness of the gap in identifying periods of potential financial sector instability and the build-up of imbalances. **Section 3.4. Empirical analysis of the effectiveness of macroprudential policy** provides a quantitative assessment of the effectiveness of macroprudential policy in reducing imbalances in the financial sector as measured by the credit-to-GDP gap. The empirical analysis looks at, 1) the effectiveness of macroprudential policy instruments in reducing the credit-to-GDP Gap and 2) determines which instrument(s) would be more effective as per the structure of the country's economy. Dynamic panel regression is conducted on 43 countries, of which 27 are advanced countries and 16 emerging market economies, using quarterly data from IMF, World Bank, OECD, and the BIS. **Section 3.5. Robustness checks** provide a check on the model results. Finally, **Section 3.6. Chapter Summary**, we conclude.

3.2. Empirical studies on the effectiveness of macroprudential instruments

Before reviewing the empirical research on the effectiveness of macroprudential instruments, firstly, we look at the focus of macroprudential policy, the area of the financial sector where there is potential for the build-up of financial sector imbalances, that is, the credit market and the housing sector. Then, we review some of the existing empirical research on macroprudential policy effectiveness.

3.2.1. The focus of macroprudential policy

In the last 10 years since the introduction of macroprudential policy as a regulatory policy, there have been many empirical studies on the use and effectiveness of macroprudential policy and its instruments, such as, Carreas et al (2018), Akinci and Olmstead-Rumsey (2015), Cerutti et al (2015a, 2017), Claessens et al (2014), Dell'Ariccia et al (2012), etc., with many of these studies focusing on analysing the effect of macroprudential instruments on credit growth and house prices and the mitigation of the build-up of imbalances in the housing market, the area of the financial sector, mostly the banking sector, where there is the most potential for systemic risk to develop. In hindsight, the study of the effectiveness of macroprudential policy follows many countries' policy framework, where there is a narrow focus of the policy on the banking sector and housing market in many advanced countries and emerging market economies.

That said, the focus of the policy and research on the housing and credit markets related and the banking sector is not surprising. Concerning credit and asset prices, Borio and Lowe (2002) suggested that although it is difficult to predict financial instability before it happens, there are some circumstances where it is appropriate for policymakers to respond to certain imbalances. They saw that historically a combination of sustained rapid growth in credit and asset prices can indicate an impending financial crisis. Also, while low and stable inflation can promote financial stability, it can increase the likelihood of a surge in credit and asset prices growth rather than the demand for goods and services. As regards the banking sector, Caprio and Klingebiel's (2003) crises chronologies suggested that 117 systemic banking crises (defined as much or all of bank capital being exhausted) had occurred in 93 countries since the mid-1970s (see Laeven and Valencia (2018) as well).

Further, with the introduction of the countercyclical capital buffer in the Basel III Accord framework (2010), policymakers have been further focusing on the bank credit markets. Basel III has placed a prominent role on the credit-to-GDP gap (see BIS (2010)) to act as a signalling guide (early warning indicator (EWI)) for policymakers in setting the countercyclical capital buffers (see BIS (2011)). We will discuss this further in the chapter **Section 3.3** below**.**

3.2.2. Some empirical research on the effectiveness of macroprudential instruments

The empirical literature on the effectiveness of macroprudential policy and its instruments are still preliminary and in its developmental stage as countries formulate and implement their macroprudential policy framework. Also, there are limited data sets that can be used to conduct empirical analysis. Carreras et al (2018) suggested there are three publicly available datasets for research, one from the BIS and two from the IMF (see Kuttner and Shim(2016), Cerutti et al (2015a, 2017) used in this Chapter and Chapter 5, and Cerutti et al in IBRN (2017), used in Chapter 4). Yet, there are several studies that have mostly focus on the area of the financial sector where there is considered to be the most potential for systemic risk to develop, that is the credit and housing markets and the banking sector.

In looking at cross-country analysis, Lim et al (2011), using the first IMF survey (2010) database, suggested that macroprudential instruments have an impact on the procyclicality of credit and leverage. Using a system generalized method of moments model (SGMM), ten instruments were tested to see their effects on the procyclicality of credit and leverage, the impact on four measure of systemic risk, credit growth, systemic liquidity, leverage and capital flows. The ten instruments were caps on the LTV, caps on the DTI, caps on foreign currency lending, ceilings on credit or credit growth, reserve requirements, countercyclical/time-varying capital requirements, time-varying/dynamic provisioning, restrictions on profit distribution, limits on net open currency positions (NOP) and limits on maturity mismatch. They argued that procyclicality in the business cycle is captured by analysing the correlation between growth in credit and leverage with the growth in the GDP. They suggested that this specification has the advantage of showing the effect of the instruments in both the expansionary and recessionary phases of the financial and business cycles. The regression analysis used data from 49 countries for the period 2002 – 2010.

Building on the work of Lim et al (2011), Cerutti et al (2015a, 2017), using the second IMF survey database (2013-2014) which covered 119 countries over the period 2000 – 2013, describes the usage of macroprudential instruments and its effect on the credit and housing markets. The survey covers 18 different instruments but the focus was

on 12 specific instruments (see Table 3.2 and related discussion below). Using a panel generalized method of moments (GMM), they tested the impact of the instruments on real credit growth or real house prices credit growth in a number of countries. They saw that the macroprudential index (MPI), summing all the different types of instruments used over the period, is correlated with lower credit growth especially in emerging markets. Cerutti et al (2017) concluded that emerging markets use macroprudential policies more frequently than advanced countries. Emerging markets focus on foreign exchange policies, suggesting the dual objective of stabilising the country foreign exchange market. Advanced countries use more borrower-based policies which specifically target consumer spending and the real estate market. Also, there is a weaker effect in more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy.

Continuing on the topic of testing a macroprudential index, Akinci and Olmstead-Rumsey (2015) of the U.S. Federal Reserve System, developed several macroprudential indexes for 57 advanced and emerging countries covering the period 2001 to 2013 to use in a dynamic panel data model (GMM) to investigate the effectiveness of macroprudential policy in restraining the growth in credit and asset prices, measured by real domestic bank credit. They focus on the domestic banks' housing credit growth and house prices as they suggested that in the literature these variables are often linked to boom-bust in the financial cycle. Their empirical study concluded that macroprudential policies have been used more actively since the 2007-2008 global financial crisis in both advanced and emerging market economies. They saw that tightening macroprudential actions outweighed the easing actions and these policies targeting specific credit growth in certain sectors are more effective than on average credit growth and house prices inflation in the countries in the study.

Carreras et al (2018) analysed the transmission of macroprudential policies and its effectiveness in reducing asset prices, credit growth and financial instability. The focus of the study was up to 19 OECD countries during the period 2000-2014 using the three datasets from the IMF and BIS. They estimated panel error correction models for house prices and households sector credit, before testing the additional impact of macroprudential policies. They focused on the OECD countries which allow for the greater access to a wider range of control variables whose omission could bias the

results. They highlighted that some policies are shown to be more effective than others in the 19 OECD countries. These include, in particular, taxes on financial institutions, general capital requirements and strict loan-to-value ratio limits. Limits on foreign currency lending, debt-to-income ratio limits, limits on interbank exposures and concentration limits are also shown to be effective in some estimates.

Crowe et al (2011) and Dell'Ariccia et al (2012) looked at the use of policies that will mitigate general booms and bust cycles in the real estate and credit markets respectively. Firstly, Crowe et al (2011) found that macroprudential measures appear to be the most effective policy to achieve the objective of curbing real estate prices and leverage because of their ability to attack the problem directly and the added benefit of increasing the resilience of the banking system. They concluded that policies such as LTV limits have a better chance to curb a boom and the narrower the focus of such a policy, the better the effectiveness and performance of macroprudential policy.

Dell'Ariccia et al (2012) conducted analysis on credit (total credit to the private non-financial sector) booms and busts with the aim of assessing the effectiveness of macroprudential measures in reducing the risk of a crisis or at least limiting its consequences. They identify a credit boom episode by analysing the country's credit-to-GDP ratio and classify an episode as a boom if either of the following two conditions is satisfied, (i) the deviation from trend is greater than 1.5 times its standard deviation and the annual growth rate of the credit-to-GDP ratio exceeds 10 percent; or (ii) the annual growth rate of the credit-to-GDP ratio exceeds 20 percent. They argued that credit booms are often a result of financial reform and periods of strong economic growth. Booms tend to be more frequent in fixed exchange rate regimes with weak banking supervision. Yet not all booms are bad or end up in a financial crisis and it is difficult to tell a good boom from a bad one that ends up in a crisis. They found that macroprudential instruments have proven to be effective in containing booms and more often in limiting the consequences of busts. Yet, there are some trade-offs which entail costs and distortions in the macro economy if these instruments are not carefully design, coordinated with other policies and with close supervision to ensure the efficacy of the instruments.

In one of the only micro-level studies, Claessens et al (2014) conducted analysis on the use of macroprudential policy to reduce banking systems vulnerabilities. They assessed the effectiveness of macroprudential policies in 48 countries, 1,650 banks in 23 advanced countries and 1,170 banks in 25 emerging markets and some 18,000 observations. They grouped the macroprudential policies according to whether they are borrower specific (caps on debt-to-income (DTI) and loan-to-value (LTV) ratios), specific to banks' assets or liabilities (limits on credit growth (CG), foreign currency credit growth (FC) and reserve requirements (RR)), and policies that encourage counter-cyclical buffers (counter-cyclical capital (CTC), dynamic provisioning (DP) and profits distribution restrictions (PRD)). There was a final group of miscellaneous policies (which have some overlap with the three groups). The miscellaneous instruments are countercyclical provisioning, countercyclical capital, restrictions on profit distribution and restrictions on treatment of profits in regulatory capital. The Claessens et al (2014) grouping was similar to Cerutti et al (2015a, 2017).

Using panel, GMM regressions and relating these policies to changes in individual banks' assets, Claessens et al (2014) found that policies aimed at borrowers are effective in (indirectly) reducing the build-up of banking system vulnerabilities. They suggested that measures aimed at banks' assets and liabilities are also very effective. Countercyclical buffers as a group show less promise, yet these measures are recently introduced as such they have not be used regularly. The group of miscellaneous policies is also very effective. Also, when distinctions were made between upswings and downswings in the overall credit cycle in the countries, all the measures except buffer-based policies directly help reduce asset growth during upswings. And policies aimed at banks' asset and liabilities and miscellaneous measures again are very significant. During a contractionary period, the borrower-based measures help reduce asset growth to a lesser degree. They stop declines in bank asset growth in contractionary periods. Measures aimed at banks' asset and liabilities side and the miscellaneous measures also have positive impact in contractionary periods and measures aimed at building banks' buffers are not productive in downswings.

There are also case studies which often focused on specific risks or markets segments. Jiménez et al (2012) saw that in Spain, countercyclical capital buffers such as dynamic provisioning help smooth credit supply cycles and in bad times, preserve

financial firms' ability to extent credit and their performance. They noted that their results are consistent with the concept that dynamic provisioning generates countercyclical bank capital buffers, mitigates bank procyclicality in credit supply, and in turn generates net positive real effects at the firm-level. The buffers contract credit availability (volume and cost) in good times but expand it in bad times. Dynamic provisions are forward-looking provisions and before any credit loss is individually identified on a specific loan, there is a buffer build-up of bank own funds from retained profits in good times that can be used in bad times to cover the realized losses.

In a regional empirical study, Bruno et al (2015) provided a comparative assessment of the effectiveness of macroprudential policies in 12 Asia-Pacific economies, using comprehensive databases of domestic macroprudential policies and capital flow management (CFM) policies. They considered both macroprudential policies that have a domestic credit focus, such as loan to value (LTV) and debt service to income (DTI) caps, as well as CFM policies that address the spill-over of financial conditions through banking sector and bond market capital flows. The data sets include 152 distinct CFM measures on banking and bond inflows and 177 domestic macroprudential measures taken by 12 Asia-Pacific economies for the period 2004-2013. Bruno et al (2015) concluded that banking sector CFM polices and bond market CFM policies are effective in slowing down banking and bond inflows, respectively. However, macroprudential policy is not introduced in a vacuum and it is a complement with other policies such as monetary policy.

In Latin America, Gambacorta and Murcia (2017)[30], using confidential bank-loan (credit registry) data for five countries (Argentina, Brazil, Colombia, Mexico and Peru) in the region, firstly saw that macroprudential tools, such as reserve and deposits requirements regimes (Brazil, Colombia) and foreign currency net global position, to limit currency mismatches (Argentina), used to dampen the credit cycles (reduce credit growth) were effective, even in the short-term (within three months). The effects of capital-based tools such as dynamic provisioning (Colombia, Mexico, Peru) and

[30] The paper produced as part of the BIS Consultative Council for the Americas (CCA) research project on "The impact of macroprudential policies: an empirical analysis using credit registry data" implemented by a Working Group of the CCA Consultative Group of Directors of Financial Stability (CGDFS).

capital buffer and profit reinvestment (Argentina), are less rapid, taking up to a year. Secondly, macroprudential policy acts as a complement to monetary policy, and is more effective if both policies are used for the same objective of dampening credit cycles. They noted that due to the high confidentiality of the credit register data, it was not possible to pool country-level data, instead regression models were used for each country and then compare the results. The regression models follow that of Jimenez et al (2012).

Finally, Vandenbussche et al (2012) analysed the relation between macroprudential policies and house price inflation in Central, Eastern, and South-eastern European countries, using panel error correction estimation data techniques. Several countries in the region used macroprudential policies actively in response to credit and housing boom and bust cycles in the late 1990s and early 2000s. They saw that capital ratio requirements and non-standard liquidity measures (marginal reserve ratio on foreign funding or linked to credit growth) reduce house price inflation.

From the empirical literature, there is no focus on the non-bank sector credit, debt securities or non-housing credit (commercial lending) but these forms of lending are included in the calculation of the credit-to-GDP gap.

We now move on to **Section 3.3. BIS' credit-to-GDP gap** where we review the theoretical and empirical literature of the gap.

3.3. BIS' credit-to-GDP gap

Unlike the existing literature which assesses macroprudential policy impact on credit growth and rising house prices, the focus of our empirical analysis is the BIS' credit-to-GDP gap and our empirical analysis will explore the effect of macroprudential instruments on the credit-to-GDP gap. However, before pursing that question, in this section of the chapter we review the research literature on the BIS' credit-to-GDP gap and discuss the empirical analysis of the effectiveness the gap in identifying periods of potential financial sector instability and the build-up of imbalances.

3.3.1. Definition and calculation of the BIS' credit-to-GDP gap

The credit-to-GDP gap (Gap_t) is defined as the difference between the credit-to-GDP ratio (c_t/y_t) and its long-term trend (t_t) (see BIS (2010), (2016)). The gap is calculated as follows.

$$Gap_t = (c_t/y_t) - t_t \qquad (3.1)$$

In the determinant of the credit-to-GDP ratio, GDP is domestic GDP and credit is a broad measure of credit to the private, non-financial sector in the period, that is, it captures all sources of debt funds (including debt securities) for the private non-financial sector as well as funds raised abroad. This is the sum of credit to households and non-financial corporate sectors (see Dembiermont et al (2013)). As such it would be less vulnerable to distortion by disintermediation and innovation than the narrower measures such as bank credit (Detken et al 2014). Both variables, GDP and credit are in nominal terms and on a quarterly frequency. The ratio is calculated as follows.

$$\text{Credit-to-GDP ratio}_t = \text{credit}_t / \text{GDP}_t * 100\% \qquad (3.2)$$

The trend is derived from using the Hodrick-Prescott (HP) filter (see Hodrick and Prescott (1997)). The HP filter is a mathematical tool used in macroeconomics to establish the trend of a variable over time. The HP filter is based on assumptions that the credit-to-GDP ratio: (c_t/y_t) can be decomposed into two components: the trend (t_t) and the cycle (c_t), which means $y_t = t_t + c_t$.

By using the Hodrick and Prescott (1997) technique, the BIS proposed that obtaining the trend involves solving the following optimisation problem:

$$\min_{\{g_t\}_{t=1}^{T}} \Sigma_{t=1}^{T} = \left(\frac{c_t}{y_t} - t_t\right) + \lambda \Sigma_{t=1}^{T} (t_{t+1} - 2t_t + 2t_{t-1})^2 \qquad (3.3)$$

where λ (lambda) is the smoothing parameter. The first term in the loss function penalises the variance of the cyclical component, while the second imposes a penalty

on the lack of smoothness in the trend. Hence, the solution to the problem is a trade-off between the smoothness of the trend and how well it fits the original series.

There are three technical features that are important when calculating the BIS' credit-to-GDP gap. Firstly, the trend (t_t) is calculated by means of a one-sided (backward-looking) filter. This means, the filter is run recursively for each period over an expanding sample. This is done to capture data constraints in day-to-day policymaking. Secondly, a larger smoothing parameter λ (lambda) is employed. The parameter equals 400,000. It is assumed that the credit cycles are on average is about four times longer than standard business cycles. Thirdly, the BIS credit-to-GDP gap required 10 years of data as the starting point for estimating the trend can have a measurement impact on the gap if there is a smaller data time series.

The credit-to-GDP ratio is then compared to its long-term trend. If the credit-to-GDP ratio is significantly above its trend (that is there is a large positive gap) then this is an indication that credit may have grown to excessive levels relative to GDP, implying financial imbalances, which in BIS' research (we discuss further below) often foreshadows a crisis. A negative gap suggests that credit growth has not grown in line with GDP growth and there is excess capacity in credit expansion. The lower and upper threshold of the gap as prescribed by the BCBS is 2 and 10 percentage points deviation from its trend (see BCBS (2010b)). Yet each country will have to determine what is their acceptable level for the credit-to-GDP (positive) gap, that is the critical threshold for triggering the countercyclical buffer. See **Section 3.4.1** and **Appendix 3A.1** for the credit-to-GDP gap discussions for specific countries.[31]

3.3.2. BIS empirical research on the credit-to-GDP gap

I. Early warning indicators

As mentioned previously, the 2007-2008 financial crisis did not happen suddenly, but as a precursor, imbalances built up over a period of time. The same can be said of

[31] The BIS credit-to-GDP gap data for selected countries are available on their website. See https://www.bis.org/statistics/c_gaps.htm.

the many financial and banking crises that have taken place throughout history (see Laeven and Valencia (2013)). Bordo (2000) noted that the frequency of financial crises has increased since 1973, the end of the Bretton Woods period (1945 to 1971).

Early econometric work on banking crisis determinants such as Hardy and Pasarbasioglou (1998) analysed lagged determinants of financial crises for 38 countries 1980-97 using logit estimation; relevant variables included GDP growth; boom-bust cycles of inflation, credit expansion and capital inflows; rising real interest rates and an increasing incremental capital output ratio; declining bank deposits; a sharp fall in the real exchange rate, declining imports and an adverse terms-of trade-shock. Davis and Karim (2008a) highlighted that the literature was divided between signal extraction methods that generate single (possibly composite) early warning variables and multivariate logit methods. They suggested that logit is the most appropriate approach for global early warning systems (EWS) and signal extraction for country specific EWS.

Further, using the available background information on the many banking crises, Borio and Lowe (2002) highlighted some features of banking crises that can be used in developing forward looking EWIs. Firstly, they noted that banking crises tend to arise primarily from deteriorating economic conditions, particularly declines in asset quality. Secondly, banking crises with significant economic costs in terms of overall output often arises from exposure of several institutions to common risks (factors) such as real estate and equity. Thirdly, vulnerabilities or imbalances tend to build up over time, reflecting the macro-financial linkages between the financial sector and the real domestic economy (see Caprio, Jr. (2011). Finally, although it is difficult to predict financial instability before it happens, it is possible to detect the build-up of financial imbalances using credit-to-GDP as discussed below.

Yet, Davis and Karim (2008a) noted that the practical use of early warning systems (EWSs) (indicators) by policy makers are limited but due to the changing nature of banking risks, as more economies liberalise and develop their financial systems, and with the growth of financial innovation, the use of EWSs are still very important for informing policies aimed at preventing crises. They noted as well, an effective EWS, which highlight growing risks of a banking crisis, could facilitate policy action that could

help head off a potential crisis or limit its effects (costs). But for the EWS to be effective, Davis and Karim (2008a) suggested that it is essential that the EWS gives advance warning as policy actions take time to be effective.

II. Empirical tests of credit-to-GDP as an early warning indicator

In the initial empirical test of credit-to-GDP gap as an early warning indicator, Borio and Lowe (2002 a and b) attempted to determine whether the build-up of vulnerabilities can be spotted in time to take preventive action. They saw that sustained rapid credit growth combined with large swings in asset prices appear to increase the probability of an episode of financial instability. In addition, while low and stable inflation promotes financial stability, it also increases the likelihood that excess demand pressures show up first in credit aggregates and asset prices, rather than in goods and services prices. As such focusing on the growth in asset prices can be a good early warning indicator for determining the build-up of imbalances in the financial sector.

Borio and Lowe (2002b) suggested that a small set of variables should be sufficient to capture the build-up of vulnerabilities as focusing on few variables can improve the reliability of indicators. Thus, they consider three core variables (indicators) that could capture information on the behaviour of credit, asset prices and the exchange rate, which should contain useful information about the development of financial imbalances. The three variables were (1) credit-to-GDP; (2) equity prices (deflated by the price level); and (3) the real effective exchange rate. They indicated that in order to determine the build-up of imbalances or a boom, they employed a measure that look at the derivation of the variables (level) from its trend. The trend is estimated using a Hodrick-Prescott (1997) filter. Therefore, the expectation is that if the credit-to-GDP gap, real equity prices and/or the real effective exchange rate move "sufficiently above" their trend (i.e. exceed some critical threshold), then financial imbalances are emerging, signalling the risk of subsequent financial distress. They noted that good early warning indicators have two important properties. These properties are, (1) the indicator should predict a high percentage of crises that do occur; and (2) the indicator should have a low false negative, meaning the indicator should not signal a crisis that does not materialise. Tests were also performed on four different combinations of the variables, (1) credit and asset prices; (2) credit and the

exchange rate; (3) credit and either asset prices or the exchange rate; and (4) credit and asset prices and the exchange rate.

Borio and Lowe (2002b) concluded that their test results were promising as the credit and exchange rate gaps tended on average to rise one period (year) before and to peak in the crisis year, respectively. But the equity price gap is consistently positive until the crisis year yet peaks well before a crisis. They indicated that the composite indicators performed well also. Their empirical tests included 40 crises spread over 27 of the 34 countries, with 16 such episodes occurring in industrial countries and 24 in emerging market economies.

In an update to their earlier work, Drehmann et al (2011) analysed the use of the credit-to-GDP gap in 36 countries from 1960 onwards using a criterion of the noise to signal ratio. They suggested that across countries and crisis episodes, the variable exhibits very good signalling properties, as rapid credit growth lifts the gap as early as three or four years prior to the crisis. In addition, the gap typically generates very low "noise," that is not producing many false warning signals that crises are imminent. The credit-to-GDP gap, however, is not a reliable coincident indicator of systemic stress in the banking sector, credit spreads may be better.

Subsequently, Drehmann and Juselius (2014) conducted empirical research on 10 indicators for 26 economies, covering quarterly time series starting in 1980, using criteria derived from the receiver operating characteristic (ROC) curve, (the ROC curve is a mapping of the false positive rate (Type II errors) to the true positive rate (the complement of Type I errors). The 10 indicators were, debt service ratio (DSR), credit growth, credit-to-GDP gap, non-core deposit ratio, credit growth, property price gap, property price growth, equity price gap, equity price growth, GDP growth and history. They saw the area under the curve (AUC) as a summary measure, credit-to-GDP gap performed well over long horizons and the Debt Service Ratio is better in the shorter horizons.

Detken et al (2014) of the ESRB also found favourable results for the indicator properties of the credit-to-GDP gap in the European Union countries. They found that in univariate signalling, the gap is the best single leading indicator for systemic banking

crises associated with excessive credit growth. Meanwhile, multivariate analysis showed that when the gap is combined with other variables (such as debt service to income, the current account/GDP and real equity price growth) in a multivariate signalling approach, a discrete choice model or a decision tree, the overall signalling performance improves.

In recent related work, Grintzalis et al (2017) present estimates of finance-adjusted output gaps which incorporate the information on the domestic and global credit cycles for a sample of emerging market economies (EMEs), with a state-space representation of an HP filter augmented with a measure of the credit gap to estimate finance-adjusted output gaps. They measure the domestic and global credit gaps as the deviation of private-sector real credit growth and net capital flows to EMEs from long-term trends, using the asymmetric Band-Pass filter. They find financial cycle information is associated with cyclical movements in output.

III. Critics of the credit-to-GDP gap

In light of the positive and encouraging empirical results, Basel III recommends using the credit-to-GDP gap as a guide for setting the countercyclical capital buffer. Yet, it has faced criticism in context of its role as a warning indicator in the countercyclical capital buffer framework and the identification of costly credit boom or banking crisis. Borgy et al (2014) of the Banque de France, for example, mentioned in their study of asset-price booms and banking crises, that existing macroprudential regulations may have given too strong a role to the credit-to-GDP gap as in their analysis it does not perform particularly well in the identification of costly asset-price booms or systemic banking crises relative to other indicators such as real interest rates and the real stock price.

Barrell et al (2010a) in a logit analysis of precursors to banking crises in OECD countries, found that house prices were key indicators, along with aggregate banking sector leverage and liquidity. Subsequent work found the current account/GDP ratio (Barrell et al 2010b) and a measure of off-balance-sheet activity (Karim et al 2013) to be also relevant. However, in all their estimations they did not find measures related to credit growth to be significant once a simplification search had taken place.

Repullo and Saurina (2011) argued that the credit-to-GDP gap could exacerbate the inherent procyclicality of risk-sensitive bank capital regulation. GDP growth is seen as a better indicator for these purposes. In addition, as the credit-to-GDP gap corresponds to the deviation from a filtered trend, its real-time use depends mostly on the reliability of the end-of-sample estimates of credit and GDP. Some authors argue that subsequent revisions of macroeconomic statistics could be as large as the gap itself (Edge and Meisenzahl, 2011), which can raise concerns about the robustness of the credit-to-GDP gap if used as the sole indicator for CCB implementation.

Giese et al (2014) of the Bank of England, in looking that the performance of the credit-to-GDP gap in the UK, saw that it provided timely signals for policy tightening in past episodes of banking system distress. Yet, they are still cautious on performance of the gap in the future and they suggested complementary indicators such as household debt-to-income ratios, leverage ratio, etc. Similarly, Bennani et al (2014) saw that credit-to-GDP gap as well as real credit growth variables perform well in signalling a boom early in the case of France but other indicators such as measures of property prices, of private sector debt sustainability or of bank balance sheets could also usefully complement the credit-to-GDP gap. As with the case of macroprudential policy, it is not a case of "one size fits all" and no single indicator can be used to identify asset-price booms and banking crises. As Bank of England (2014) suggested it is therefore important to complement the credit-to-GDP gap measure with other indicators, a point acknowledged in the Basel III Accord guidance and in EU legislation.

As a response, Drehmann and Tsatsaronis (2014) of the BIS identified three areas of criticism of the credit-to-GDP gap. These areas are (i) the credit gap is not a good measure for setting the buffer because it can lead to decisions that conflict with the countercyclical capital buffer objective; (ii) the credit gap is not the best early warning indicator for banking crises, especially in the case of emerging market economies; and (iii) the credit gap has measurement problems. They acknowledged there are relevant measurement issues with the credit-to-GDP gap, particularly the starting point for the calculation and how to deal with structural breaks in the data series. Yet they suggested that the data should be properly adjusted to deal with structural breaks and the gap should be develop using at least ten years of data. Additionally, in their

research, they saw that the credit-to-GDP gap performs better in providing policymakers with reliable signals about when to raise the buffer but this does not mean that the credit-to-GDP gap should solely be used, notably during a bust when more rapid release of buffers may be required.

Indeed, Detken et al (2014) suggested that multivariate analysis of other variables when combined with the credit-to-GDP gap, can reduce the false alarms and improve on the signalling performance of the credit-to-GDP gap. Yet, judgement may have to play an even greater role, as empirical results are less robust and that complementary market-based indicators (such as overnight swaps or covered bond spreads, etc.) are found to display the best performance of coincident or near-crisis indicators to be used to signal that the CCB should be reduced or released.

We now move on to **Section 3.4. Empirical analysis for testing the effectiveness of macroprudential policy** which provide a quantitative assessment of the effectiveness of macroprudential policy in reducing imbalances in the financial sector as measured by the credit-to-GDP gap.

3.4. Empirical analysis for testing the effectiveness of macroprudential policy

This section of the chapter looks at the empirical analysis for testing the effect of macroprudential policy on the credit-to-GDP gap. However, before presenting our empirical results, we will, firstly outline the key datasets used in the analysis. Secondly, we discuss the model specifications and methodology.

3.4.1. Datasets for modelling the impact of macroprudential policy

Our data modelling used two key datasets, one from the BIS for the credit-to-GDP gap (denoted CGDPGAP) and the other, the IMF GMPI survey data on macroprudential instruments (where macroprudential instruments are denoted MAPP) (Cerutti et al (2015a)).

I. BIS' credit-to-GDP gap data

In September 2016, the BIS released time-series quarterly data on the credit-to-GDP gap covering 43 countries and one economic region, the Euro area, starting at the earliest in 1961. In our model testing, the Euro area is excluded from the panel analysis as many individual countries in the Euro area are already included in the data. There are 27 advanced countries and 16 emerging market economies in the BIS' credit-to-GDP gap dataset. The following Table 3.1 shows the list of countries in the panel analysis and the sample period of their credit-to-GDP gap.

Table 3.1: List of countries included in the empirical analysis

Country	ISO Code	Credit-to-GDP Gap[1]	IMF category
Argentina	ARG	2000q1	EME
Australia	AUS	2000q1	ADV
Austria	AUT	2000q1	ADV
Belgium	BEL	2000q1	ADV
Brazil	BRA	2005q1	EME
Canada	CAN	2000q1	ADV
Switzerland	CHE	2000q1	ADV
Chile	CHL	2000q1	EME
China (People's Republic of)	CHN	2000q1	EME
Colombia	COL	2006q4	EME
Czech Republic	CZE	2003q1	ADV
Denmark	DEN	2000q1	ADV
Germany	DEU	2000q1	ADV
Spain	ESP	2000q1	ADV
Finland	FIN	2000q1	ADV
France	FRA	2000q1	ADV
United Kingdom	GBR	2000q1	ADV
Greece	GRC	2000q1	ADV
Hong Kong SAR	HKG	2000q1	ADV
Hungary	HUN	2000q1	EME
Indonesia	IDN	2000q1	EME
India	IND	2000q1	EME
Ireland	IRL	2000q1	ADV
Israel	ISR	2001q1	ADV
Italy	ITA	2000q1	ADV
Japan	JPN	2000q1	ADV
Korea	KOR	2000q1	ADV
Luxembourg	LUX	2012q1	ADV
Mexico	MEX	2000q1	EME
Malaysia	MYS	2000q1	EME
Netherlands	NLD	2000q1	ADV

Norway	NOR	2000q1	ADV
New Zealand	NZL	2000q1	ADV
Poland	POL	2002q1	EME
Portugal	PRT	2000q1	ADV
Russia	RUS	2005q1	EME
Saudi Arabia	SAU	2003q1	EME
Singapore	SGP	2000q1	ADV
Sweden	SWE	2000q1	ADV
Thailand	THA	2000q1	EME
Turkey	TUR	2000q1	EME
United States	USA	2000q1	ADV
South Africa	ZAF	2000q1	EME

Source: BIS credit-to-GDP gap statistics (Version: March 2017). IMF WEO country classification (April 2017), ADV - advanced country, EME - emerging market economy. [1] Sample beginning period.

Appendix 3A.1 shows the credit-to-GDP gap for a number of countries. **Appendix Figures 3A.1 to 3A.5** show the credit-to-GDP gaps for a number of advanced countries and emerging market economies in Europe, Asia, the Americas and Southern hemisphere. A positive credit-to-GDP gap indicates that credit growth relative to GDP growth may have reached excessive levels in relation to its trend, implying financial imbalances and in BIS' research often foreshadows a crisis. A negative gap suggests that credit has not grown in line with GDP growth and there is excess capacity in credit markets (see **Section 3.3** above for discussion on the credit-to-GDP gap).

Of particular interest (**Appendix Figure 3A.1**), Germany has been reporting a negative gap since 2003Q4, suggesting that there is excess capacity in credit expansion. In France, there was a continuous rise in the (positive) gap from 2003Q4 until the effects of the global financial crisis in 2007-2008 started to take a hold in 2009Q4, whereas the gap trended downward but remained positive. Italy experienced a greater fall in their gap, moving from positive to negative, after the financial crisis, which was also influenced by the European Sovereign Debt Crisis (see Lane (2012)). In Spain and Ireland, the gaps were excessively high in the quarters leading up to the financial crisis. Spain's gap reached a high of 40 percent and Ireland peaked at 88 percent on account of a housing sector credit boom (see Norris and Byrne (2015)). In 2015q1, the Irish data was affected by a change in the reporting of financial institutions. Institutions' off-balance sheet items are being captured in the data from the on, and as a result there was a large jump in the Ireland's gap in the quarter. In the UK, the

gap had been relatively stable leading up to the crisis. The chart shows that all three countries' gap fell after the financial crisis (**Appendix Figure 3A.2**).

In the South American countries, the gap in Argentina had been mostly negative after their sovereign debt crisis which started in 2001 (see Hornbeck (2013)). The gap in Chile started to fall at the same time as Argentina's sovereign debt crisis, which suggest they could have been negatively affected by the crisis. Brazil's gap, which is available from 2004q4, shows a gradual increase and then a decease later in the sample period (**Appendix Figure 3A.3**). In the US, the starting point for the 2007-2008 global financial crisis, shows the steady rise in the gap before a declining as the crisis took hold. Canada reported a decline in their gap on account of the financial crisis but the gap stayed positive post-crisis period and has since returned to the pre-crisis level. Mexico recorded a gradual increase in their gap over the sample period (**Appendix Figure 3A.4**).

In the southern countries of Australia, New Zealand and South Africa (**Appendix Figure 3A.5**), the gaps increased relatively in the same pattern and fell when the financial crisis started to take hold. New Zealand experienced the largest decline in the post-crisis period. In Asia (**Appendix Figure 3A.6**), China and Singapore have recorded strong positive gaps since the 2007-2008 financial crisis, with Japan being relative stable.

Overall, most of the countries experienced a fall in their credit-to-GDP gap as a result of the 2007-2008 global financial crisis after a period of continuous growth between 2000 to 2006. In addition, a country's credit-to-GDP gap tends to fall after a country experienced a crisis, such as in the case with Argentina in 2001.

II. Macroprudential instruments dataset

The IMF dataset on macroprudential instruments (which we denote MAPP) covers 119 countries for the period 2000 to 2013. The data are from the IMF's Global Macroprudential Policy Instruments (GMPI) survey. There are 12 macroprudential survey instruments and 2 additional derived instruments and 3 groups summary instruments in the publicly available dataset. This macroprudential database is used

as it is one of the most comprehensive databases on the actual usage of macroprudential instruments by countries over the sample period 2000-2013, which is publicly available.[32] Furthermore, it is based on survey data collected from official reporting agencies to the IMF such as central banks and financial sector regulatory authorities.

An alternative is the International Banking Research Network (IBRN) dataset on macroprudential instruments, which covers sixty-four (64) countries for the period 2000 to 2014 (see Cerutti et al IBRN (2017)).[33] We will discuss IBRN further in **Chapter 4**. This dataset is quarterly frequency, the same frequency of the credit-to-GDP gap but it is not used in this chapter since it omits some categories of macroprudential instruments included in the IMF macroprudential dataset such as debt-to-income ratio (DTI), taxes, dynamic loan-Loss provisioning (DP), etc. as discussed in Cerutti et al IBRN (2017). In addition, for comparison to the research literature, the IMF macroprudential dataset provides a more comprehensive list of macroprudential instruments.

This IMF macroprudential dataset is also used in **Chapter 5**, with the IBRN macroprudential dataset being used in **Chapter 4**. We are testing a subset of the instruments listed in **Chapter 2**. For a discussion on the description and taxonomy of the macroprudential instruments see **Chapter 2**. Table 3.2 below shows the instruments in the IMF macroprudential dataset.

Table 3.2: Description of macroprudential instruments dataset

Instrument	**Abbreviation**
Survey Instruments	
Loan-to-Value Ratio	LTV
Debt-to-Income Ratio	DTI
Time-Varying/Dynamic Loan-Loss Provisioning	DP
General Countercyclical Capital Buffer/Requirement	CTC
Leverage Ratio	LEV
Capital Surcharges on SIFIs	SIFI

[32] The data can be downloaded and available in Excel on the IMF website at: www.imf.org/external/pubs/ft/wp/2015/Data/wp1561.zip.
[33] The data can be downloaded and available in Excel on the IBRN web page at: https://www.newyorkfed.org/medialibrary/media/ibrn/prudential_ind_3.xlxs. The data is also described in Cerutti et al (2016).

Limits on Interbank Exposures	INTER
Concentration Limits	CONC
Limits on Foreign Currency Loans	FC
Reserve Requirement Ratios	RR
Limits on Domestic Currency Loans	CG
Levy/Tax on Financial Institutions	TAX
Derived Instruments	
Loan-to-Value Ratio Caps	LTVCAP
FX and/or Countercyclical Reserve Requirements	RREV
Groups of Instruments	
Total macroprudential instruments	MPI
Macroprudential instruments focused on the borrower	MPIB
Macroprudential instruments focused on the financial institution	MPIF

Source: Cerutti et al (2015a) (Version February 24th, 2015). Notes: each variable is a dummy that takes on two values: 0 for no policy and 1 for policy in effect. The database covers a sample from 2000 to 2013 with annual data. The groups instruments are the aggregate of the survey instruments.

Table 3.3 below shows the usage of the macroprudential instruments by the 43 countries in the panel data. The data is compiled by first use and not by instances. The table shows countries employ various macroprudential instruments and from the survey, the ones being used the most are LTV, CONC, INTER and DTI (Cerutti et al (2015a)).

Table 3.3: Summary statistics on the usage of macroprudential instruments

Instrument	Abbreviation	Total	ADV countries	EME
Survey Instruments				
Loan-to-Value Ratio	LTV	25	13	12
Debt-to-Income Ratio	DTI	14	7	7
Time-Varying/Dynamic Loan-Loss Provisioning	DP	3	1	2
General Countercyclical Capital Buffer/Requirement	CTC	1	1	0
Leverage Ratio	LEV	8	4	4
Capital Surcharges on SIFIs	SIFI	4	3	1
Limits on Interbank Exposures	INTER	14	9	5
Concentration Limits	CONC	24	13	11
Limits on Foreign Currency Loans	FC	8	2	6
Reserve Requirement Ratios	RR	6	2	4

Limits on Domestic Currency Loans	CG	2	0	2
Levy/Tax on Financial Institutions	TAX	12	7	5
Derived Instruments				
Loan-to-Value Ratio Caps	LTVCAP	17	9	8
FX and/or Countercyclical Reserve Requirements	RRREV	3	0	3
Total by country classification		**43**	**27**	**16**

Source: Cerutti et al (2015a) (Version February 24th, 2015). IMF WEO country classification (April 2017) and author's extension. IMF WEO country classification (April 2017). ADV is advanced country, EME is emerging market economies.

Additionally, Table 3.4 shows the usage of the macroprudential instruments by the 43 countries in the IMF dataset over the sample periods, pre-crisis 2000-2006 and post-crisis 2007-2013. The table shows countries employ various macroprudential instruments and from the survey, preceding the 2007-2008 financial crisis, emerging market economies used macroprudential instruments the most and have a longer history in using some of these instruments (see **Appendix 2A.2** as well). Also, the table shows that since the crisis, advanced countries have increased the use of these instruments.

Table 3.4: Summary statistics on the usage of macroprudential instruments over the sample periods, pre-crisis 2000-2006 and post- crisis 2007-2013

Instruments	**ADV (27)**		**EME (16)**	
	2000-2006	2007-2013	2000-2006	2007-2013
Loan-to-Value Ratio (LTV)	6	13	6	12
Loan-to-Value Ratio Caps (LTVCAP)	4	10	5	8
Debt-to-Income Ratio (DTI)	2	7	4	7
Time-Varying/Dynamic Loan-Loss Provisioning (DP)	1	1	1	3
General Countercyclical Capital Buffer/Requirement (CTC)	0	1	0	0
Leverage Ratio (LEV)	2	4	2	4
Capital Surcharges on SIFIs (SIFI)	0	3	2	1

Limits on Interbank Exposures (INTER)	5	9	4	5
Concentration Limits (CONC)	12	13	11	11
Limits on Foreign Currency Loans (FC)	0	2	2	6
Reserve Requirement Ratios (RR)	2	2	3	5
FX and/or Countercyclical Reserve Requirements (RRREV)	0	0	2	3
Limits on Domestic Currency Loans (CG)	0	0	2	3
Levy/Tax on Financial Institutions (TAX)	1	7	3	5

Source: Cerutti et al (2015a) (Version February 24th, 2015). IMF WEO country classification (April 2017) and author's extension. ADV - advanced country, EME - emerging market economies.

Due to the coverage of the IMF dataset, the period for the analysis will be from 2000q1 to 2013q4 and the IMF GMPI survey data is converted from yearly to quarterly data frequency. The measures were coded from the beginning of the year they are actually in place and subsequently all quarters after that starting year until the period they were discontinued. Quarterly data for the measures is the most appropriate approach since we are testing the macroprudential policies' effectiveness against the lowering of the credit-to-GDP gap, which is a quarterly measure, it is appropriate to have a quarterly frequency for the measures. Please see **Chapter 2** for a discussion on the taxonomy of the macroprudential instruments.

Our main focus is on macroprudential instruments that are expected to have a negative and significant effect on the credit-to-GDP gap especially when it is positive over the sample period. We expect that macroprudential measures which target banks assets (credit activities) as defined in Section 2.3.2 above will have the greater effect on reducing the credit-to-GDP gap since the gap is a credit measure. Accordingly, we expect that debt-to-income ratio (DTI), loans-to-value measures (LTV and LTVCAP) and concentration limits (CONC), etc., should have a greater effect on the credit-to-GDP gap. This is also supported by empirical research by Lim et al (2011), Dell'Ariccia et al (2012), Jiménez et al (2012), Vandenbussche et al (2012), Akinci and Olmstead-Rumsey (2015), Kuttner and Shim (2016), Cerutti et al (2017), Carreras et al (2018) using macro data. They found various macroprudential instruments to be effective in reducing the financial system imbalances (credit and house price growth). Similarly,

Claessens et al (2014) using bank-by-bank data found that policies aimed at borrowers are effective in (indirectly) reducing the build-up of banking system vulnerabilities. They suggested that measures aimed at banks' assets and liabilities are also very effective.

3.4.2. Model specification

I. Baseline model

The starting point for our empirical analysis is the work of Cerutti et al (2015a, 2017) as noted above, who look at how the macroprudential index and its various sub-indexes relate to the growth in countries' credit and house prices. Also, relevant is the work of Akinci and Olmstead-Rumsey (2015), who as notes using quarterly data, investigated macroprudential policies' effects on total bank credit, housing credit and house prices using their own calculated macroprudential index. We note that both used a GMM specification (Arellano and Bond 1991) which they considered most appropriate to deal with the lagged dependent variable and country fixed effects. Lags of the tools should mitigate potential endogeneity.

The specification we used in our analysis extends from the work of Cerutti et al (2015a, 2017) and the literature where firstly, we are using the credit-to-GDP gap (CGDPGAP) as our dependent variable, instead of the underlying credit and house prices series. This will identify which macroprudential instrument (MAPP) will have an effect in reducing the build-up of imbalances in the credit market using the credit-to-GDP gap. Secondly, by using the credit-to-GDP gap as the dependent variable this will provide policy makers with a list of macroprudential instruments are most effective in reducing the gap, if there is a need to respond to a credit market imbalance.

The empirical reduced-form regression model used in the analysis is as follows:

$$CGDPGAP_{i,t} = \alpha CGDPGAP_{i,t-1} + ßBCRISIS_{i,t-1} + ÞX_{i,t-1} + Ų_i + \varepsilon_{it} \qquad (3.4)$$

where *i* denotes the countries, t indicates time period. The dependent variable, $CGDPGAP_{i,t}$ denotes the quarterly credit-to-GDP gap. The lagged credit-to-GDP gap

variable ($CGDPGAP_{i,t-1}$) included in the model is expected to have a positive effect on future credit-to-GDP gap values. In terms of control variables (see Table 3.5 below) BCRISIS variable is a vector capturing the presence of a banking crisis during the period a country experienced a banking crisis as defined by Laeven and Valencia (2018). This is included because credit activities are normally affected during a crisis (see **Chapter 2, Section 2.3.4**). It is a dummy variable and it is coded in the quarter the crisis starts until the period it was over. Additional macroeconomic control variables denoted by $X_{c,t}$, are the unemployment rate (UNEMPLRATE), the real GDP growth rate (REALGDPRATE), the inflation rate (INFLATRATE) and the monetary authority bank rate (BANKRATE). Finally, similar to Cerutti (2015a, 2017), we include cross-section fixed effects to allow for country specific conditions which are invariant over time, which should allow for economic and financial development, the relative mix of bank and market-based intermediation, financial structure in terms of institutional concentration, and various other institutional characteristics. This is represented by the variable μ_i. The error term is ε_{it}.

We did consider other possible control variables such as fiscal policy, confidence variables and monetary growth. However we do not consider fiscal policy to be a first-choice control variable since its link to credit is not evident (other recent papers in the field such as Kuttner and Shin (2016), Carreras et al (2018), Cerutti et al (2017) and Akinci and Olmstead Rumsey (2018) did not include it). Meanwhile, there is a subjective bias if using confidence variables to capture economic activities while generally, monetary growth is likely to be very highly correlated with credit growth.

Among the control variables, we expect that real GDP growth rate will have a negative effect (inverse relationship) on the credit-to-GDP gap since GDP is the denominator in the credit-to-GDP ratio formula (see **Section 3.3** above). Similarly, we expected that if central bank rate increases, this should have a negative effect on credit expansion and on the credit-to-GDP gap. The banking crisis dummy variable is expected to have a negative effect on the credit-to-GDP gap since in a crisis, banking credit activities are affected more than GDP, yet the strength of the effect would depend on how long the crisis lasts and the response of the fiscal and monetary authorities to the crisis (once again see **Chapter 2, Section 2.3.4**). We expect that a rise in unemployment rate should have a negative effect on credit expansion relative

to GDP and the credit-to-GDP gap. The effect of inflation on the credit-to-GDP gap is expected to positive or negative depending on which part of the credit-to-GDP ratio formula is affected more by inflation. The nominator (credit) and denominator (GDP) in the credit-to-GDP ratio formula are in nominal terms. On balance since credit is usually by definition fixed in nominal terms while prices of goods and services comprising GDP would usually rise with inflation, we would expect a negative effect.

The data for the control variables are collected from the IMF' International Financial Statistics, the OECD database and International Labour Organisation (ILO). The control variables will be tested for significance. In this we follow Cerutti et al (2017) but include unemployment and inflation as additional controls.

Table 3.5: Control variables data source

Variable	**Source**
Banking crisis dummy (BCRISIS)	Laeven and Valencia (2018)
Central bank rate (BANKRATE)	IMF International Financial Statistics and Bank for International Settlement
Real GDP growth rate (REALGDPRATE)	IMF International Financial Statistics
Unemployment rate (UNEMPLRATE)	IMF International Financial Statistics and International Labour Organisation
Inflation rate (INFLATRATE)	IMF International Financial Statistics

Notes: For some countries, data for certain variables were collected from their central bank and/or national statistical agency. In addition, some data were derived by the author.

II. Descriptive statistics of the model variables

Table 3.6 and 3.7 show below some descriptive statistics of the variables in the model for all countries, advanced countries and emerging market economies over the period 2000q1 to 2013q4. Table 3.6 shows that for the sample countries, the credit-to-GDP ratio is above its long-term trend as the mean is not zero. Yet, there is large variation in the credit-to-GDP gap ranging from -51 percent to 81.10 percent and a standard deviation of 15.17 percent. The maximum value of 88.10 percent is Ireland (see **Appendix 3A.1**), where their gap peak in the first quarter of 2010 before declining as Ireland experienced the effects of the global financial crisis and subsequent an economic recession. The minimum value of -51 percent is Thailand (2001q4), which

shows the slowdown in credit growth most likely due to the after-effects of the Asian financial crisis (1997-1998).

Table 3.6: Descriptive statistics of the variables in the model for the period 2000q1-2013q4 (all countries)

	Credit-to-GDP Gap	Central bank rate	Real GDP growth rate	Unemployment rate	Inflation rate
Mean	2.94	4.42	2.85	7.23	3.56
Median	3.60	3.25	2.86	6.11	2.60
Maximum	88.10	82.46	18.86	30.40	70.32
Minimum	-51.00	0.00	-16.34	0.47	-6.11
Standard Deviation	15.17	5.87	3.69	4.57	5.00
Observations	2,255	2,303	2,357	2,408	2,408
Number of countries	43	43	43	43	43

Note: The values are in per cent except for the observations and the number of countries, which is a number. The data are quarterly values. The variables are in level. ADV – Advanced countries, EME – Emerging market economies.

The central bank rate has a minimum value of zero, supporting the fact that during the financial crisis many advanced countries lowered their rate to virtually zero to increase economic activity and reduce the impact of the subsequent economic recession. Argentina recorded the highest central bank rate of 82.46 per cent in 2001 as the country experienced a debt and financial crisis. Real GDP growth is mainly influenced by the strength of the Asian countries such as China, Singapore, Thailand, India and the Middle East country of Saudi Arabia. Singapore reported the largest real GDP growth of 18.86% in 2010Q2 and with Argentina recording a decline of -16.34% in 2002Q1, which is around the same time of their sovereign debt and financial crisis which started in 2001 (see Hornbeck (2013)).

Further, Table 3.6 shows that the mean unemployment rate is 7.23 percent with the maximum rate of 30.40 percent, which is reported in South Africa. During the period, South Africa reported very high unemployment rates, averaging 25.26 per cent. Thailand reported the lowest unemployment of 0.47 and their average during the period was 1.67 percent. The low employment rate is the result of high economic

growth as well as the benefits from the economic expansion in neighbouring countries in Asia as indicated above. Turkey reported the highest inflation rate of 70.32 per cent on account of political instability and a financial crisis in 2001, which is in line with the high central bank rate which was used to control inflation. In Ireland inflation rate fell to -6.11 per cent as result of the financial crisis.

Table 3.7 below that the credit-to-GDP gap is higher in advanced countries, suggesting the higher rate of credit growth relative to GDP in these countries, while GDP growth is higher in emerging market economies. This highlights the relationship between credit growth (demand side) in advanced countries and economic growth in emerging market economies (supply side). Intuitively, it follows that with higher economic growth in emerging markets, the central bank rate is also higher as there is a need to control higher inflation and cool the overheating economy in emerging markets. However, the unemployment rate is higher in emerging markets than in advanced countries, which could suggest excess labour capacity although emerging markets experienced an economic boom during the period.

Table 3.7: Descriptive statistics of the variables in the model for advanced countries and emerging market economies for the period 2000q1-2013q4

	Credit-to-GDP Gap		Central bank rate		Real GDP growth rate		Unemployment rate		Inflation rate	
	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME
Mean	5.42	-1.43	2.65	8.39	2.00	4.50	6.69	8.49	2.07	6.20
Median	5.10	1.30	2.50	6.50	2.15	4.84	5.90	7.22	2.12	4.73
Maximum	88.10	39.90	9.90	82.46	18.86	16.24	27.80	30.40	7.47	70.32
Minimum	-41.10	-51.00	0.00	0.25	-10.73	-16.34	1.67	0.47	-6.11	-3.29
Standard Deviation	15.41	13.62	1.89	8.13	3.16	3.92	3.51	5.88	1.54	7.18
Observations	1,447	804	1,512	896	1,512	896	1,512	896	1,512	896
Number of countries	27	16	27	16	27	16	27	16	27	16

Note: The values are in percent except for the observations and the number of countries, which is a number. The data are quarterly values. The variables are in level. ADV – Advanced countries, EME – Emerging market economies.

It is important to mention that some of the large maximum and minimum values for the model variables are the result of political and financial crises in a number of countries (e.g. Argentina, Turkey, Greece, Ireland, Russia, Spain, etc.) and these values can be seen as outliers during the period. Note however that we have not chosen to winsorise the data, in line with studies such as Carreras et al (2018).

III. Correlation matrix for the variables in the model

Table 3.8 below shows that for all countries, none of the variables are highly correlated except for the central bank rate and inflation, which are high positively correlated (Pearson's correlation coefficient) (see Hinkle et al (2003)).[34]

Table 3.8: Correlation matrix for the variables in the model for the period 2000q1-2013q4 (all countries)

	Credit-to-GDP Gap	Central bank rate	Real GDP growth rate	Unemployment rate	Inflation rate
Credit-to-GDP Gap	1.00				
Central bank rate	-0.02	1.00			
Real GDP growth rate	-0.20	0.09	1.00		
Unemployment rate	0.12	0.13	-0.20	1.00	
Inflation rate	-0.00	0.76	0.08	0.10	1.00

Note: The variables are in level.

The high positive correlation between the central bank rate and the inflation rate is because a number of countries such as Argentina, Russia and Turkey, etc., which at some point experienced a political and financial crisis, reported higher central bank and inflation rates during the period. Also as noted above, emerging market economies were experiencing higher economic growth than advanced countries as such interest rates were used to dampened economic growth and higher inflation

[34] The rule of thumb for interpreting the size of a correlation coefficient is the following: 0.90 to 1.00 (-0.90 to –1.00) very high positive (negative) correlation; 0.70 to 0.90 (-0.70 to -0.90) high positive (negative) correlation; 0.50 to 0.70 (-0.50 to -0.70) moderate positive (negative) correlation; 0.30 to 0.50 (-0.30 to -0.50) low positive (negative) correlation; 0.00 to 0.30 (0.00 to -0.30) little if any correlation.

growth rate. As expected, we found there is a low negative correlation between the central bank rate, GDP growth rate and credit-to-GDP gap. The correlation between credit/GDP gap and inflation is virtually zero, the relationship is -0.003. However, there is a positive correlation between the credit-to-GDP gap and the unemployment rate but there is a negative correlation between unemployment rate and GDP growth. There is a positive correlation between inflation and economic growth.

Once again, in Table 3.9 below, none of the variables are highly correlated except for the central bank rate and inflation, which is high positively correlated in emerging markets (0.75). As discussed above, this is due to the higher reported central bank and inflation rates in emerging markets.

Table 3.9: Correlation matrix for the variables in the model for the period 2000q1-2013q4 (advanced countries and emerging market economies)

	Credit-to-GDP Gap		Central bank rate		Real GDP growth rate		Unemployment rate		Inflation rate	
	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME
Credit-to-GDP Gap	1.00	1.00								
Central bank rate	0.08	0.12	1.00	1.00						
Real GDP growth rate	-0.16	-0.10	0.31	-0.18	1.00	1.00				
Unemployment rate	0.12	0.22	-0.22	0.15	-0.34	-0.21	1.00	1.00		
Inflation rate	0.18	0.08	0.28	0.75	0.14	-0.11	-0.09	0.09	1.00	1.00

Note: The variables are in level. ADV – advanced countries, EME – emerging market economies.

IV. Unit Root Tests

An important issue is how to enter variables into the model. We would prefer to have stationary variables for the regression, in line with the existing literature. A set of results for panel unit root tests is given in Table 3.10 below. We see that over 2000q1-2013q4, all the control variables are stationary both according to the Levin-Lin-Chu test (2002) (which assumes a common unit root process for all countries) and the Im-

Pesaran-Shin test (2003) (which allows for individual unit root processes between countries).

Table 3.10: Summary statistics of the unit root tests 2000q1-2013q4

Variable	Levin-Lin-Chu	Im-Pesaran-Shin
BANKRATE	-4.88 (0.00)	-4.1 (0.00)
REALGDPRATE	-4.3 (0.00)	-12.7 (0.00)
UNEMPLRATE	-3.42 (0.00)	-5.04 (0.00)
INFLATRATE	-3.90 (0.00)	-11.88 (0.00)
CGDPGAP	2.3 (0.98)	4.6 (1.0)
CGDPGAP (WITH TREND)	-3.03 (0.00)	2.25 (0.99)
CGDPGAP (NO CONSTANT)	-5.81 (0.00)	n/a
DIFFERENCE OF CGDPGAP	-22.1 (0.00)	-23.7 (0.00)
CGDPGAP FULL SAMPLE FROM 1951	-1.21 (0.11)	-2.81 (0.00)
CGDPGAP SAMPLE FROM 1970Q1	-1.22 (0.11)	-2.74 (0.00)
CGDPGAP SAMPLE FROM 1980Q1	-1.74 (0.04)	-2.39 (0.01)
CGDPGAP SAMPLE FROM 1990Q1	-0.14 (0.44)	-0.12 (0.45)

Note: P-value in parentheses

The outstanding issue is how to deal with the credit-GDP gap. The logic of a Hodrick Prescott filter is that the difference between the variable and its trend tends to be stationary. This is borne out in practice by the longer runs of data shown in the table, where the full dataset and the data from 1970 and 1980 onwards are stationary. On the other hand, the data from 1990 and 2000 onwards fail the stationarity tests, unless the variable is first differenced. We considered that the a priori considerations and the results from the longer term still justified the inclusion of the level of the credit gap as if it were stationary. Accordingly, we have it as a level and lagged level in the chosen specification. In **Section 3.5** we show an alternative GMM-difference estimate with the first difference of the gap as a robustness check.

3.4.3. Estimation methodology

Similar, to Cerutti et al (2017) and Akinci and Olmstead-Rumsey (2015), we undertook a dynamic panel data regression using the Generalized Method of Moments (GMM) method (Arellano and Bond (1991)) in differences using quarterly data from 43 countries. The period sample begins in 2000q1 and ends in 2013q4. Instruments were lagged levels of the independent variables and two further lags of the dependent

variable. In each case, the insignificant variables were eliminated. Including lagged levels of the variables are consistent with the literature as well as it should help with addressing endogeneity concerns.

Notably, we decided to estimate the baseline model using difference[35] GMM (Arellano and Bond (1991)) instead of Ordinary Least Squares, in line with the literature, such as Davis et al (2019), Cerutti et al (2017) and Akinci and Olmstead-Rumsey (2015) and Claessens et al (2014). Also, an OLS specification could lead to biased results due to the presence of lagged dependent variable and country fixed effects. Therefore, as noted above we used GMM method as our primary modelling technique. OLS estimation with country fixed effects will be used as one of the robustness checks.

The baseline model was estimated over three periods, full sample 2000q1-2013q4, pre-crisis 2000q1-2006q4, post-crisis 2007q1-2013q4 as well as by country classifications, all countries, advanced countries and emerging market economies. This was done to understand the effectiveness of macroprudential instruments in different periods, especially before the 2007-2008 financial crisis. The country classifications models give an idea of which macroprudential instruments are more effectiveness based on the economic structure of a country not least since that emerging market economies has been using macroprudential instruments longer than advanced countries (Cerutti et al (2017)).

3.4.4. Main regression results of the effectiveness of the macroprudential policy (all countries)

I. Baseline equation regression results (all countries)

The baseline models were tested for goodness of fit using the Sargan test (J-Statistics). The J-Statistics results indicate that the null hypothesis of over-identifying restrictions is not rejected and there is first-order autocorrelation but no second order autocorrelation in line with the expectation for GMM (see the Arellano-Bond (AB) test

[35] Furthermore, we wish to retain comparability with the existing literature such as Akinci and Olmstead-Rumsey (2018) and Cerutti et al (2017) which has used standard difference-GMM rather than system-GMM.

for autocorrelation, AR1 and AR2). The initial estimates for the all countries baseline models are shown in the following Table 3.11.

Table 3.11: Summary results of the baseline equation (all countries)

Instruments	**Our expected relation (+/-)**	**Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4**	**Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4**	**Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4**
CGDPGAP(-1)	+	0.94*** (41.01)	0.93*** (24.50)	0.90*** (46.52)
BCRISIS(-1)	-	-2.20*** (-20.65)	-0.85* (-1.65)	-1.06 (-1.49)
UNEMPLRATE(-1)	-	-1.01*** (-38.65)	-0.28*** (-4.85)	-1.46*** (-29.26)
INFLATRATE(-1)	+/-	-0.19*** (-9.66)	-0.18*** (-4.35)	-0.48*** (-6.90)
REALGDPRATE(-1)	-	-0.22*** (-7.55)	-0.29*** (-5.59)	-1.31*** (-11.96)
BANKRATE(-1)	-	0.13*** (9.54)	0.14*** (7.39)	0.36* (2.58)
Observations		2,167	986	1,181
Sargan (J-Statistic) (p-value)		0.42	0.42	0.30
Arellano-Bond AR(1) p-value		0.00	0.00	0.00
Arellano-Bond AR(2) p-value		0.49	0.34	0.14
Periods included		54	26	28
Cross sections included		43	41	43

Notes: The coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. The Sargan tests' null hypothesis of over-identifying restrictions are not rejected. Arellano-Bond (AB) test for AR(1) in first differences are rejected, but not for the AR(2) test. *** significant at 1%, ** significant at 5%, * significant at 10%.

The baseline model coefficients signs are correct and expected except for the short-term monetary policy interest rate (BANKRATE) as a higher cost of credit should reduce credit expansion and the bank crisis (BCRISIS) variable in the period 2007-2013. One would expect the BANKRATE sign to be negative and inversely related to the CGDPGAP variable. However, many advanced countries lowered their monetary policy rate to almost zero percent in the period 2007 to 2013 in order to reduce the effect of the financial crisis and looming economic recession, thus creating a high liquidity environment to encourage credit and economic growth. This may have resulted in a positive relationship with the CGDPGAP variable. In addition, BANKRATE is not the only measure of monetary policy in some countries especially

in emerging markets; other monetary policy tools have been employed, such as reserve requirements, which are not captured in the model (see Cerutti et al (2017) as well).

The result for the bank crisis (BCRISIS) variable, that it is insignificant, for the period 2007-2013 is surprising but we argue that, as a result of the financial crisis many advanced countries employed expansionary monetary and fiscal policies for an extended period of time to dampen the negative effects of the crisis, which has a positive effect on the gap. It could also be a case of reverse causality. Also, as noted above, the significance and the strength of the effect of a crisis would depend on how long the crisis lasts and the response of the fiscal and monetary authorities to the crisis (see **Chapter 2: Section 2.3.4**). However, it remains strongly significant over the full sample period.

The negative coefficients on unemployment and the GDP growth rate are expected and consistent between periods. As noted above (see **Section 3.3**), since GDP is the denominator in the credit-to-GDP ratio, one should expect GDP growth rate to be inversely related to the gap. Also, a rise in the unemployment rate should have a negative effect on credit expansion and the credit-to-GDP gap. Finally, the rate of inflation has a negative and significant effect on the credit-to-GDP gap. This suggests that inflation is having a greater impact on GDP (denominator) than credit (numerator) in the credit-to-GDP ratio. As indicated above, both the nominator and denominator values are in nominal terms but we expect credit to be fixed in nominal terms while nominal GDP typically rises in line with inflation.

II. Estimated results of the effectiveness of the macroprudential instruments (all countries)

The macroprudential instruments were tested one by one using the baseline models equation 3.4 (all countries). The baseline models were transformed to include a vector of macroprudential instruments as shown below.

$$CGDPGAP_{i,t} = \alpha CGDPGAP_{i,t-1} + ßBCRISIS_{i,t-1} + ÞX_{i,t-1} + \theta MAPP_{i,t-1} + Ų_i + \varepsilon_{it} \quad (3.5)$$

The variable denoted by MAPP is the vector of macroprudential policy instruments, which is a zero-one variable with zero for policy off and one for policy on. It thus captures the macroprudential effect on the credit-to-GDP gap from the beginning of the year they are actually in place and subsequently all quarters after that starting year until the period it is discontinued.

Table 3.12 below outline the results for each tool. The instruments are tested over three periods as indicated above, 2000q1-2013q4, 2000q1-2006q4 (pre-crisis) and 2007q1-2013q4 (crisis period). Blanks show estimates that generated a near-singular matrix.

a) Results for the period 2000q1-2013q4

Overall in the period 2000-2013, the model results suggest that debt-to-income (DTI), concentration limits (CONC) and the loan-to-value ratios (LTV and LTVCAP) are the most effective macroprudential instruments, being statistically significant at all significance levels and negatively related to the credit-to-GDP gap. DTI, LTV and LTVCAP has a direct effect on people's ability to borrow, as they are determined by one's income level, debt outstanding and the value of the property, thus having a strong effect on credit growth and the gap. Concentration limits (CONC) affects financial firms' ability to lend to specific sectors, reducing their exposure to these sectors.

Table 3.12: Macroprudential instruments results using the baseline equation (all countries)

Macroprudential instruments	**Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4**	**Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4**	**Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4**
Loan-to-Value Ratio (LTV(-1))	-2.91*** (-3.80)	1.84 (1.62)	-4.25*** (-3.55)
Debt-to-Income Ratio (DTI(-1))	-9.70*** (-5.65)	-5.39* (-1.90)	-2.30 (-1.00)
Capital Surcharges on SIFIs (SIFI(-1))	------	------	-1.69 (-0.96)

General Countercyclical Capital Buffer/Requirement (CTC(-1))	------	------	5.34 (1.11)
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-21.14** (-2.16)	36.00** (2.48)	-3.77 (-0.39)
Leverage Ratio (LEV(-1))	-24.93 (-1.23)	------	-9.05*** (-2.63)
Limits on Interbank Exposures (INTER(-1))	-4.47 (-0.91)	26.24** (2.16)	1.67 (0.41)
Concentration Limits (CONC(-1))	-5.59*** (-3.30)	-1.63 (-0.84)	-5.62 (-0.48)
Limits on Domestic Currency Loans (CG(-1))	-30.46 (-1.55)	------	5.44 (0.34)
Levy/Tax on Financial Institutions (TAX(-1))	-3.04 (0.54)	------	5.43*** (2.60)
Reserve Requirement Ratios (RR(-1))	-9.62 (-0.62)	28.06 (1.37)	15.73 (0.99)
Limits on Foreign Currency Loans (FC(-1))	-3.41 (-1.03)	5.88*** (2.88)	9.78*** (3.30)
Loan-to-value ratio caps (LTVCAP(-1))	-3.27*** (-4.38)	0.09 (0.09)	-4.13** (-2.28)
FX and/or Countercyclical Reserve Requirements (RREV(-1))	-8.47 (-0.59)	-18.10*** (-2.65)	23.34 (1.17)
Total macroprudential instruments (MPI(-1))	-1.47*** (-2.75)	1.53*** (2.73)	-0.77* (-1.88)
Macroprudential instruments focused on the borrower (MPIB(-1))	-2.45*** (-2.85)	-1.13 (-1.27)	-1.94** (-1.99)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-1.83*** (-3.64)	4.92*** (4.25)	-0.55 (-1.05)

Note: For macroprudential instruments definitions please see Table 3.2. for specification see Table 3.8. The instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

Dynamic provisioning (DP) is also statistically significant. This result is expected as DP is a countercyclical capital buffers tool, which help smooth credit supply cycles and in bad times, preserve financial firms' ability to extent credit and their performance. DP contracts credit availability (volume and cost) in good times but expand it in bad times. The result is consistent with Jiménez et al (2012) as they noted that dynamic provisioning generates countercyclical bank capital buffers, mitigates bank procyclicality in credit supply, and in turn generates net positive real effects at the firm-level.

The overall MPI, the general borrowers-based MPIB and financial institutions-based MPIF measures are negative and statistically significant in the period 2000q1-2013q4, which suggest that macroprudential policies generally have a significant effect on credit-to-GDP gap. This result is consistent with Cerutti et al (2017), where they suggested that macroprudential policies having a significant mitigating effects on credit growth.

It is noted that the reserve requirements variables (RR and RRREV) are negative but statistically insignificant despite their use as a macroprudential instrument, notably in many emerging markets. The difficulty in getting "right results", that is negative and significant, for reserve requirements may link to their many roles such as an instrument of monetary policy and of macroprudential policy. Reserve requirements set the minimum amount of reserves banks are required to hold and as such they are sometimes used as a tool in monetary policy by influencing banks' lending, interest rates as well as for controlling inflation. Also, in some emerging market economies, it has been used to support the foreign currency reserve and foreign exchange rate via reserve requirements on foreign currency deposits. See for example Izquerido et al (2013) on related issues in Latin America. In this context, the macroprudential instrument database does not capture and measure for what purpose reserve requirements were used by countries in the model, therefore interpreting the results for this tool could be challenging.

A number of additional instruments were negative but insignificant in the period 2000-2013, such as limits on domestics and foreign currency loans (CG and FC), the leverage ratio (LEV), levy/tax on financial institutions (TAX) and limits on interbank deposits (INTER). This could be due to the uptick in the usage of these instruments because of the 2007-2008 financial crisis (see Table 3.4 above). There is some promise in these instruments, but they have not been used regularly as in the case of LTV, CONC and DTI to form a proper conclusion to be drawn on these instruments. We note in this context the Bank of England (2014) view that the credit-to-GDP gap ratio should be complemented with other early warning indicators such as the Debt to Income ratio (i.e. as an indicator as well as being targeted by a tool), leverage ratio, loans to deposits ratio, spreads on new lending, etc.

b) Pre-crisis (2000q1-2006q4) and post-crisis (2007q1-2013q4) periods results

In the pre-crisis period (2000q1-2006q4), the results suggest that debt-to-income ratio (DTI) and FX and/or countercyclical reserve requirements (RRREV) are statistically significant and have a negative impact on the credit-to-GDP gap. A number of other macroprudential instruments are statistically significant as well such as time-varying/ dynamic loan-loss provisioning (DP), limits on interbank exposures (INTER) and foreign currency loans (FC) but their signs are positive, which in turn generates net positive real effects on the gap. The positive sign in the pre-crisis period is not surprising as many advanced countries were experiencing an asset price boom, which allowed many individuals to borrow excessively against their property and financial institutions build-up excessive on- and off-balance sheet leverage in the financial system (BCBS (2014)). Barrell and Davis (2008) suggested that in the period leading up to the financial crisis, the world economy experienced an environment of low interest rates and with a build-up of large investment surpluses especially in China, which contributed to the rapid credit and asset prices expansion and consequently rising leverage.

In term of the summary indexes, total macroprudential instruments (MPI) and MPIF, financial-institution-based are statistically significant but the signs are positive. The MPIB, borrowers-based index is statistically insignificant but its sign is negative. This suggests that in a period of rapid credit and asset prices expansion, strong economy growth, financial institutions are able to pass on the financial costs associated with macroprudential instruments to the public or absorb the costs in their profits. In **Chapter 5**, we will look at the impact on banks' profitability.

In the post-crisis period (2007q1-2013q4), macroprudential instruments that target borrowers such as the loan-to-value ratios (LTV and LTVCAP) were negatively and statistically significant as well as the MPIB index. Although, one of the aims of quantitative easing, expansionary monetary and fiscal policies was to stimulate credit growth and lending, yet on the other hand, we contend that there was concerns about high risks borrowers accessing "cheap" credit and countries used macroprudential instruments to target these borrowers. Therefore, we expected that macroprudential instruments targeting borrowers will be significant.

As noted, an underlying cause of the 2007-2008 financial crisis was the build-up of excessive on- and off- balance sheet leverage in the financial system. There has been a great deal of focus on banks' leverage ratio by the BCBS (see Davis et al 2019a and b). In the model results for the period 2007-2013, the leverage instrument (LEV) is negatively and statistically significant, which reduces banks' ability to borrow to finance credit growth and lending. Other instruments, concentration limits (CONC), time-varying/ dynamic loan-loss provisioning (DP), debt-to-income ratio (DTI) and capital surcharges on SIFIs (SIFI) have a negative effect on the gap but they are all statistically insignificant.

III. Advanced countries and emerging market economies results of the effectiveness of the macroprudential instruments

a) Baseline models for advanced countries and emerging market economies

The focus of the modelling results for advanced countries (ADV) and emerging market economies (EME) will mainly be 2007q1-2013q4 and some reference will be to the 2000q1-2006q4 period for EME.[36] Similar to the all countries models, the baseline models were tested for goodness of fit using the Sargan test (J-Statistics) and the test results indicate that the null hypothesis of over-identifying restrictions is not rejected. Please see **Appendix 3A.2** for the baseline models results for advanced countries and emerging market economies.

For both ADV and EME, the baseline model coefficients signs are correct and as expected except for the short-term monetary policy interest rate (BANKRATE) and the bank crisis (BCRISIS) variables. This follows from the points made for the All countries model results, where the lowering of monetary policy rate to almost zero percent in advanced countries in the period 2007q1 to 2013q4 as well as quantitative easing, creating a high liquidity environment, to encourage credit growth, resulted in a positive relationship with the CGDPGAP variable. In addition, for EME, the BANKRATE is not

[36] For the period 2000-2013, the baseline models for both group of countries, and for the period 2000-2006 for advanced countries, the results are inconclusive as some of the independents variables are statistically insignificant and I was unable to use these models to test the effectiveness of the macro-prudential instruments for these periods.

the only measure of monetary policy in some countries especially in emerging markets and other monetary policy instruments have been employed such as reserve requirements, which are not captured in the model.

The bank crisis (BCRISIS) variable is statistically significant for EME but insignificant for ADV. The same argument can be made for ADV as with the All countries model results, where, as a result of the financial crisis many advanced countries employ expansionary monetary and fiscal policies for an extended period of time to dampen the negative effects of the crisis, which has a positive effect on the gap, could be a case of reverse causality. Finally, the negative coefficients and inverse relationship between unemployment, inflation and GDP growth rate and the gap are expected. However, it should be noted that inflation is on the "border" for significant testing at 90% for EME. We will accept the result that inflation is insignificant for EME.

For EME in the period 2000q1-2006q4, the banking crisis (BCRISIS) variable is not included in the baseline model since banking crises were limited to a few quarters for two countries (Argentina and Indonesia) in the data and the BCRISIS variable result was highly insignificant. All the other coefficients results were consistent, negative and inversely related to the credit-to-GDP gap.

IV. Macroprudential instruments results (advanced countries (ADV) and emerging market economies (EME))

For the period 2007q1-2013q4 for both ADV and EME, many of the macroprudential instruments and summary indexes are negative but they are statistically insignificant. Please see **Appendix 3A.2** for macroprudential results. It seems that macroprudential instruments were designed to work in a period of relative financial stability or assist in the preventing financial instability and has limited effect during an actual financial crisis, as other policies objectives are given priority. This is an area where further research is warranted and as indicated we will look at it further in the thesis, **Chapter 5** where we look at the interaction between macroprudential and monetary policies.
Finally, for EME in the period 2000q1-2006q4, loan-to-value ratio caps (LTVCAP) and MPIB, borrower-based instruments are negatively and statistically significant during this period. For ADV countries, loan-to-value ratio caps (LTVCAP) is statistically

significant but positive. There are other instruments that are negative but statistically insignificant, which could suggest that in a period of rapid credit and asset prices expansion, strong economy growth, financial institutions are able to pass on the financial costs associated with these macroprudential instruments to the public or absorb the costs in their profits.

V. Macroprudential instruments results for a positive and negative credit-to-GDP gap (all countries) for the period 2000q1-2013q4

As a further test, Table 3.13 reports results where the credit gap is either positive or negative, hence testing whether macroprudential policy could be more effective in boom periods (when the gap is positive). As noted by Lang and Welz (2017), and as shown in the **Appendix 3A.1**, gaps were often highly negative for prolonged periods in the wake of crises. Of course, countries are also more likely to apply macroprudential policies in boom periods, but the non-zero coefficients in the second column conform that policies have also been applied in times of negative gaps.

Table 3.13: Macroprudential instruments results for a positive and negative credit-to-GDP gap using the baseline model (all countries)

Macroprudential instruments	Positive Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4	Negative Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4
Loan-to-Value Ratio (LTV(-1))	-	3.23*** (28.6)
Debt-to-Income Ratio (DTI(-1))	-8.75*** (12.3)	-0.28 (0.3)
Capital Surcharges on SIFIs (SIFI(-1))	-1.82 (0.7)	1.83 (1.5)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	1.89 (0.5)	-
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-	3.86 (1.5)
Leverage Ratio (LEV(-1))	-	2.04 (0.5)
Limits on Interbank Exposures (INTER(-1))	-28.7*** (20.0)	-0.06 (0.1)
Concentration Limits (CONC(-1))	-9.84*** (4.3)	-

Limits on Domestic Currency Loans (CG(-1))	1.19 (1.2)	-
Levy/Tax on Financial Institutions (TAX(-1))	-10.46*** (5.7)	2.13* (1.7)
Reserve Requirement Ratios (RR(-1))	-2.68 (1.6)	-
Limits on Foreign Currency Loans (FC(-1))	2.55*** (5.6)	5.29** (2.3)
Loan-to-value ratio caps (LTVCAP(-1))	-	2.97 (24.5)
FX and/or Countercyclical Reserve Requirements (RRREV(-1))	-2.34 (1.4)	-
Total macroprudential instruments (MPI(-1))	-	1.09*** (15.5)
Macroprudential instruments focused on the borrower (MPIB(-1))	-4.75*** (14.7)	1.4*** (7.8)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-1.18*** (4.6)	1.35*** (3.3)

Notes: For macroprudential instruments definitions please see Table 3.2, for specification see Table 3.8. The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%

In general, the results confirm that policy is more effective in reducing gaps during periods of positive gaps. DTI, INTER, CONC and TAX are highly significant for positive gaps and not for the negative gaps, this also carries over to the summary variables MPIB and MPIF. For LTV, TAX and LTV_CAP there are positive effects when gaps are negative. FC is positive for the both positive and negative gaps. MPI, MPIB and MPIF are all positive for the negative gaps. Overall, these results are consistent with the conclusion of Cerutti et al (2017) noted above, that policies are effective but especially in the upturn.

VI. Summary table of results for the effectiveness of the macroprudential policy instruments

We summarise the work in this chapter and compare results for the work with other research using the same IMF dataset of macroprudential instruments and time period in Table 3.14 below.

Table 3.14: Summary results of the effect of macroprudential instruments

Variable	All 00-13	All 00-06	All 07-13	EME 00-06	ADV 00-06	Memo: Carreras et al (2018)[a]	Memo: Cerutti et al (2017)[b]
LTV	-***		-***			-***	
DTI	-***	-*			-**		-**
FC		+***	+***	+**			-*
TAX			+***			-***	
INTER		+**				-***	-**
CONC	-***						-*
LTVCAP	-***		-**	-*	+*		-*
SIFI							
DP	-**	+**					-***
CTC							
LEV			-***				
CG							
RR							
RRREV		-***					-*
MPI	-***	+***	-*			-***	-***
MPIB	-***		-**	-***			-**
MPIF	-***	+***		+***		-***	-***

Notes: For macroprudential instruments definitions please see Table 3.2 above. Signs of significant variables are shown where *** significant at 1%, ** significant at 5% * significant at 10%. IMF WEO country classification (April 2017), ADV - advanced countries, EME - emerging market economies. [a] OECD countries, real household credit growth, [b] All countries, credit growth

It is noteworthy that the tools that we find most consistently effective in reducing the credit-to-GDP gap are the housing-market focused tools, the loan-to-value ratios (LTV and LTVCAP) and the debt-to-income ratio (DTI). There is a significant result for dynamic provisioning (DP) in the full sample, where the effect is negative. There is also a post-crisis result for leverage policies.

It is also of interest to compare our results with those of two other extensive studies using the same dataset of macroprudential instruments estimated over the same time period, namely Carreras et al (2018) and Cerutti et al (2017). As noted above the Carreras et al paper used as a target variable the growth rate of real household credit, while the Cerutti et al work focused on the growth of real credit or real house prices credit growth in the country, although they noted that effects were greater for household credit. The former paper was for advanced countries only, the latter for a much wider range of both advanced and emerging/developing countries. They both featured a banking crisis dummy to avoid crediting the crisis effect to the tools. It can

be seen that the results for these papers were similar to ours regarding the effectiveness of macroprudential instruments, with both highlighting interbank limits and LTV or LTVCAP. The Carreras et al paper also found effectiveness for taxes on financial institutions, while the Cerutti et al paper also found effectiveness for DTI, foreign currency lending limits and dynamic provisioning in limiting credit growth.

Two differences between the dependent variable for our study and these studies are that we include (following the BIS) total non-financial credit in the dependent variable deflated by GDP and assessed relative to trend credit/GDP. The tools that most influence the credit gap (LTV and DTI) may influence non-financial private sector credit growth largely via their influence on household sector credit (except to the extent entrepreneurs raise funds for their companies by borrowing on their home equity).

3.5. Robustness checks

We ran three robustness checks on the estimates above. First, we reran the basic GMM equations with the difference of the credit gap as a dependent and lagged dependent variable. This accordingly takes the view that stationarity over the data period is required, in the light of the tests in Table 3.10 showing that the variable is not stationary over the period 2000q1-2013q4. Second, in line with Akinci and Olmstead-Rumsey (2015) and Kuttner and Shim (2016), we estimated the specification by Panel OLS with fixed effects as an alternative to GMM. One estimate used cross section fixed effects only, the other also added time series fixed effects.[37] The results of the estimations are shown in Table 3.15.

Table 3.15: All countries variant baseline models 2000q1 to 2013q4

	GMM with difference of CGDPGAP	Panel OLS with cross-section fixed effects	Panel OLS with cross-section and time series fixed effects
Dependent	DCGDGAP	CGDPGAP	CGDPGAP
CONSTANT		2.512*** (10.4)	2.184*** (8.4)
CGDPGAP(-1)		0.981*** (190.6)	0.983*** (184.7)

[37] The OLS model with time-fixed effects only did not yield any useful results when testing the macroprudential tools, so as such it was not included.

DCGDPGAP(-1)	0.103*** (18.5)		
BCRISIS(-1)	-5.991*** (6.5)	-0.777*** (4.4)	-0.763*** (3.6)
UNEMPLRATE(-1)	-0.962*** (20.9)	-0.284*** (10.3)	-0.237*** (8.3)
INFLATRATE(-1)	-0.154** (9.1)	-0.0877*** (5.0)	-0.095*** (5.4)
REALGDPRATE(-1)		-0.0803*** (4.3)	-0.058* (2.5)
BANKRATE(-1)	0.046*** (2.9)	0.054** (3.3)	0.048* (2.7)
R-squared	n/a	97.51	97.66
R-squared adj.	n/a	97.45	97.55
Sargan (J-Statistic) (p-value)	0.43	n/a	n/a
Arellano-Bond AR(1) p-value	0.00	n/a	n/a
Arellano-Bond AR(2) p-value	0.60	n/a	n/a
F-statistic	n/a	1,764.82	865.39
Prob(F-statistic)	n/a	0.00	0.00
Periods included	53	55	55
Cross sections	43	43	43
Observations	2,124	2,210	2,210

Notes: The coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. The Sargan tests' null hypothesis of over-identifying restrictions are not rejected. Arellano-Bond (AB) test for AR(1) in first differences are rejected, but not for the AR(2) test. *** significant at 1%, ** 5% and * 10%.

For the GMM with difference of the gap, the growth rate of GDP is not significant so is omitted. Other variables are as in the earlier levels-based estimation, including the positive sign for the interest rate variable. Sargan's J is again satisfactory and there is first-order autocorrelation but no second order autocorrelation in line with the expectation for GMM (Arellano-Bond (AB) test for autocorrelation, AR1 and AR2). The two panel OLS estimates used all the variables from Table 3.8, as the growth rate of GDP is also significant, and again had a positive and significant interest rate effect. The results of the Hausman test suggested that fixed effects model is appropriate for the OLS models (Hausman test, X^2: 80.20, p-value: 0.00).

Table 3.16 shows the results for the different macroprudential instruments using these estimates. It can be seen that in each case the outcome for LTV and DTI is quite consistently favourable, and accordingly the summary variable MPIB is also

significant. In the GMM specification with the difference of the gap as dependent variable, LTVCAP, DTI, the instruments for interbank exposure limits (INTER) and FX and/or countercyclical reserve requirements (RRREV) are significant and negative although LTV per se is not significant and FC has the wrong sign and is significant. Accordingly, the summary variable MPIB, borrower-based index, is also significant. As regards the fixed effects specifications there is consistent significance for LTV, DTI and MPIB with the correct sign, while DP, LEV and MPIF have the wrong (positive) sign. We may conclude that the main results for the macroprudential tools are robust to these alternative specifications.

Table 3.16: Macroprudential instruments results for variant equations (all countries, 2000q1-2013q4)

Macroprudential instruments	GMM with difference of CGDPGAP	Panel OLS with cross-section fixed effects	Panel OLS with cross-section and time series fixed effects
Loan-to-Value Ratio (LTV (-1))	-2.17 (0.8)	-0.47** (2.3)	-0.43** (2.0)
Debt-to-Income Ratio (DTI(-1))	-3.48* (1.7)	-0.5* (1.9)	-0.49* (1.8)
Capital Surcharges on SIFIs (SIFI(-1))	-	0.074 (1.1)	0.33 (0.6)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	-	-1.09 (0.8)	-0.858 (0.6)
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-5.08 (0.2)	1.07* (1.9)	1.02* (1.8)
Leverage Ratio (LEV(-1))	2.86 (0.2)	0.85* (1.9)	1.06** (2.3)
Limits on Interbank Exposures (INTER(-1))	-9.63*** (3.2)	0.22 (0.7)	0.35 (1.1)
Concentration Limits (CONC(-1))	1.22 (0.8)	0.46 (1.2)	0.20 (0.5)
Limits on Domestic Currency Loans (CG(-1))	-	0.83 (1.0)	0.87 (1.1)
Levy/Tax on Financial Institutions (TAX(-1))	-2.64 (0.4)	0.25 (0.9)	0.47 (1.6)
Reserve Requirement Ratios (RR(-1))	-12.6 (1.2)	0.92 (1.3)	0.90 (1.3)
Limits on Foreign Currency Loans (FC(-1))	1.91*** (5.9)	-0.16 (0.5)	-0.05 (0.2)
Loan-to-value ratio caps (LTVCAP(-1))	-5.49** (2.7)	-0.35 (1.4)	-0.27 (1.1)

FX and/or Countercyclical Reserve Requirements (RRREV(-1))	-20.8** (2.2)	0.92 (1.3)	0.90 (1.3)
Total macroprudential instruments (MPI(-1))	-0.92 (1.6)	0.02 (0.3)	0.07 (0.9)
Macroprudential instruments focused on the borrower (MPIB(-1))	-2.87*** (3.2)	-0.28* (1.9)	-0.26* (1.7)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-0.91 (1.3)	0.17* (1.7)	0.25** (2.3)

Notes: For macroprudential instruments definitions please see Table 3.2. The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

3.6. Chapter summary

Research has shown macroprudential policy and its instruments are effective in reducing the built up of imbalances in the financial system. Further, using a different measure of imbalances, our empirical analysis has shown that the macroprudential instruments are effective in reducing financial system imbalances as identified by the credit-to-GDP gap. The analysis suggests that the impact of macroprudential policy on the credit gap is most apparent for housing market related instruments, or instruments targeting borrowers, such as loan-to-value (LTV) and debt-to-income (DTI) ratios, which is comparable with other empirical analysis using the same dataset of instruments for growth of credit to the non-financial sector (Cerutti et al (2017)) globally, and for a narrower measure, namely household credit growth (Carreras et al (2018)) in advanced countries.

In this context, it is important to mention that the nature of macroprudential policy to date is that it commonly affects mainly the banks and the household sector. The policy may not be effective if the imbalances are in the non-bank financial institutions' lending, debt securities markets or shadow banking sector as well as in the corporate sector especially commercial property. Similarly, with the recently-introduced counter cyclical buffer, the application of it applies to banks, although there may be situations where the factors driving growth in the gap, which is recommended to prompt rises in the countercyclical buffer (CCB), might not be bank credit or household sector related (e.g. non-bank financial institutions credit or bond issue). This shows the need for

careful analysis of causes of a rising gap and the ratio should be complemented with other early warning indicators (Bank of England (2014), Drehmann and Tsatsaronis (2014)).

Clearly, a wide measure of credit deflated by GDP and its trend such as in the “gaps” is in principle less likely to be less impacted by typical macroprudential policies, since corporate sector credit is usually not impacted by loan-to-value (LTV) and debt-to-income (DTI) measures, for example, while even the countercyclical buffer (CCB) does not affect credit by non-bank financial institutions or market credit (unless assets are held on or off banks’ balance sheets). Also, the application of macroprudential policy may be complicated by the presence of multiple regulators in advanced countries. These points may apply less to emerging market economies whose domestic financial system is typically bank based, and regulatory structures simpler, but their capital flows require alternative macroprudential measures (such as reserve requirements) and our current work does not suggest a strong impact of these policies on the credit gap per se.

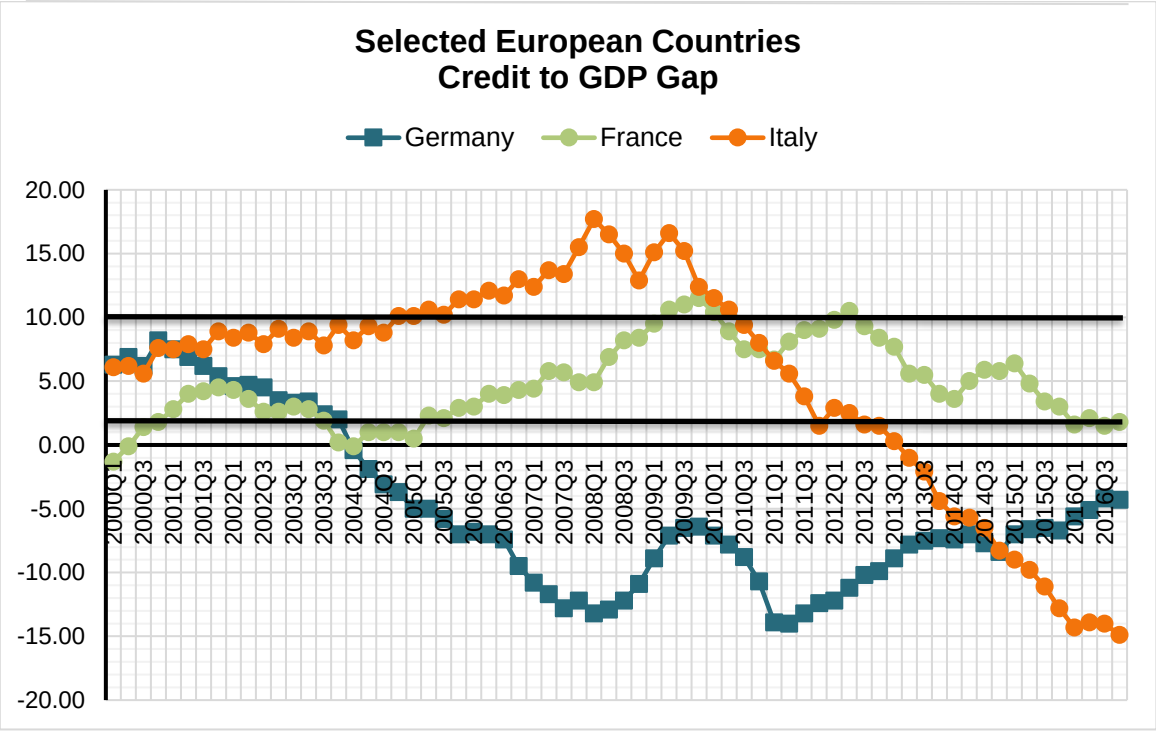
Finally, what useful further research could include individual country analysis (see Noel (2018)) and macro regional analysis of the credit-to-GDP and the effectiveness of macroprudential policy. Such work might underline the importance for each country of tailoring the design and calibration of macroprudential policy and its instruments to suit their specific circumstances.

3A. Appendix Chapter 3

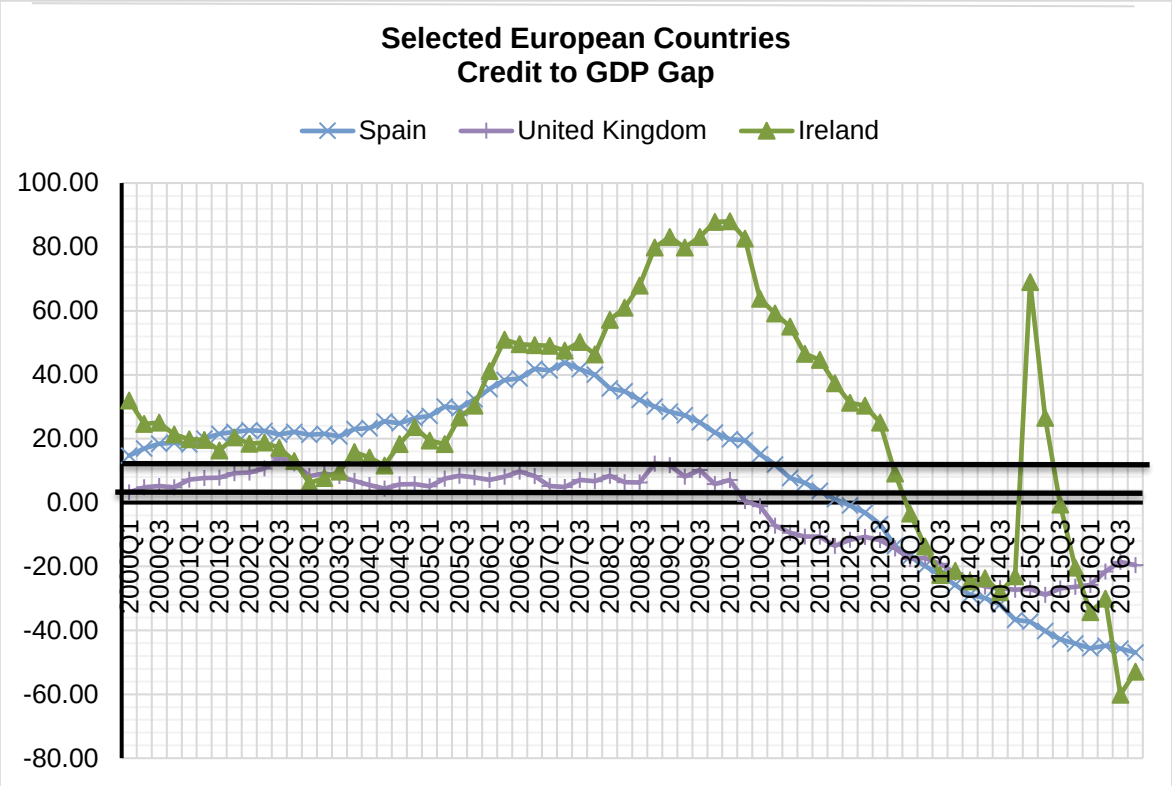
3A.1. Credit-to-GDP gap figures

The following Appendix Figures (3A.1 to 3A.5) show the credit-to-GDP gaps for a number of advanced countries and emerging market economies in Europe, Asia, the Americas and Southern hemisphere. The solid lines show the BCBS percentage threshold of 2 and 10 percent that should trigger an early warning to policymakers about the potential build-up of financial sector imbalances and may warrant policymakers making a policy decision to reduce the imbalance. The charts are prepared using the BIS' credit-to-GDP gap data (version March 2017).

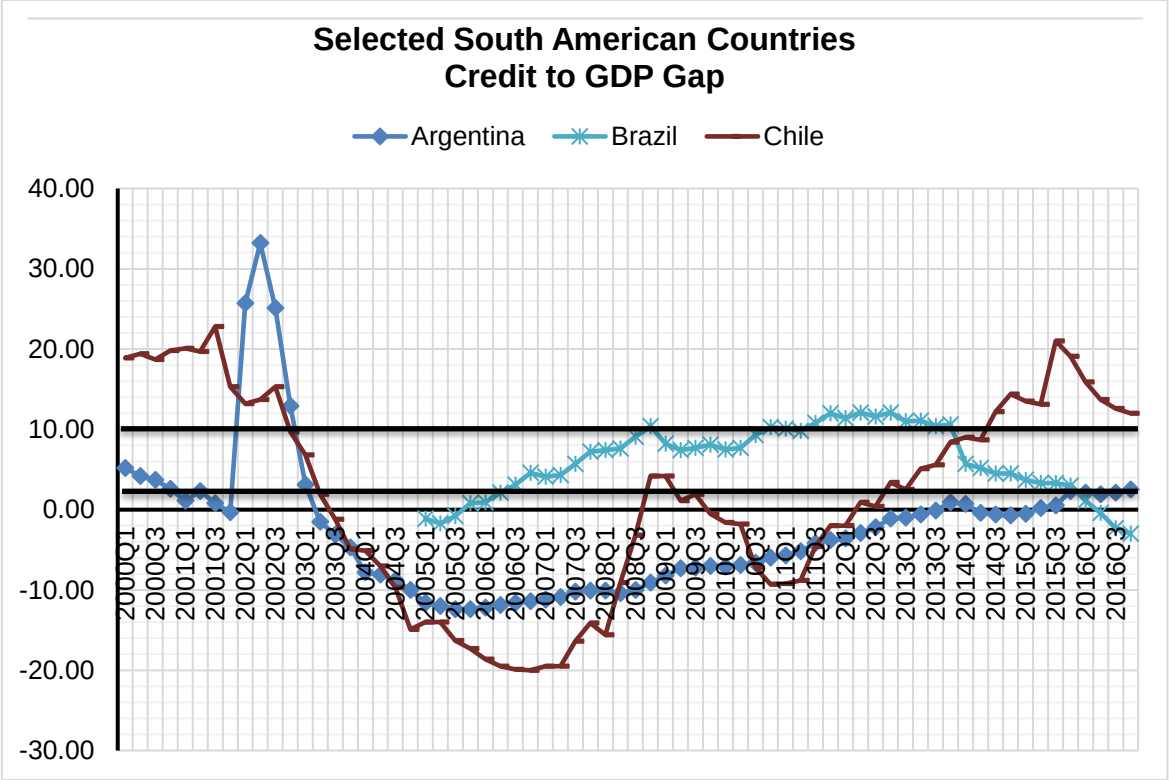
Appendix Figure 3A.1: Credit-to-GDP gaps for selected European countries (1)



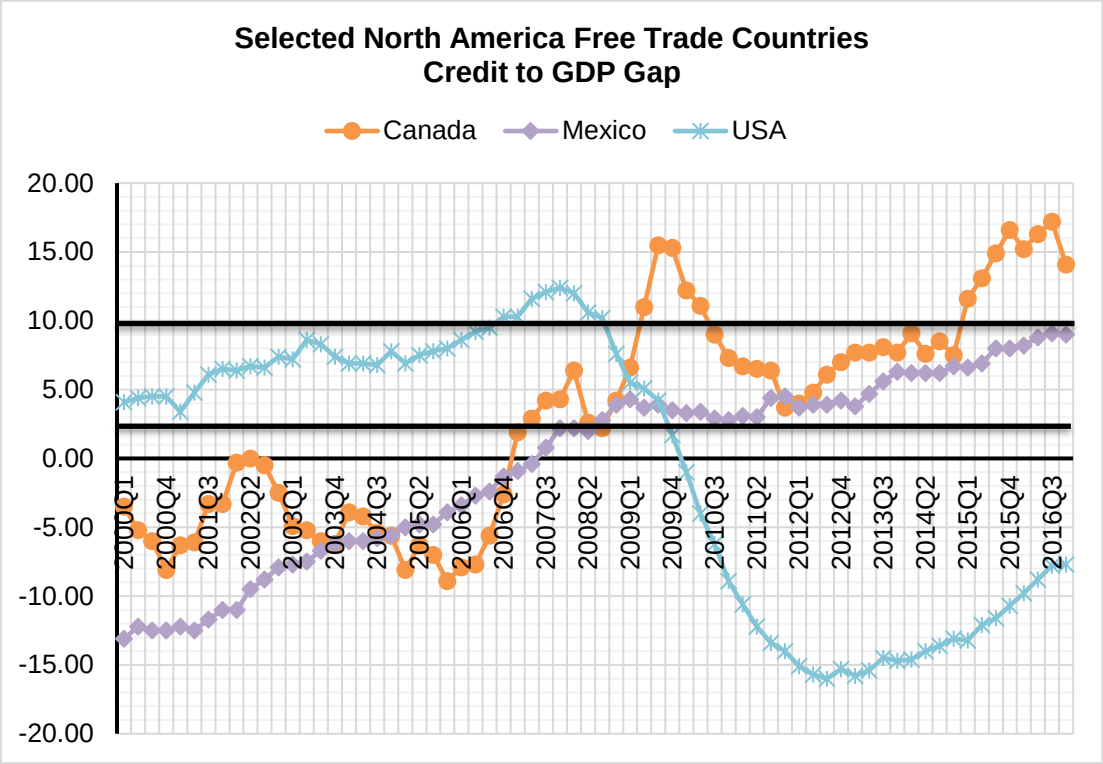
Appendix Figure 3A.2: Credit-to-GDP gaps for selected European countries (2)



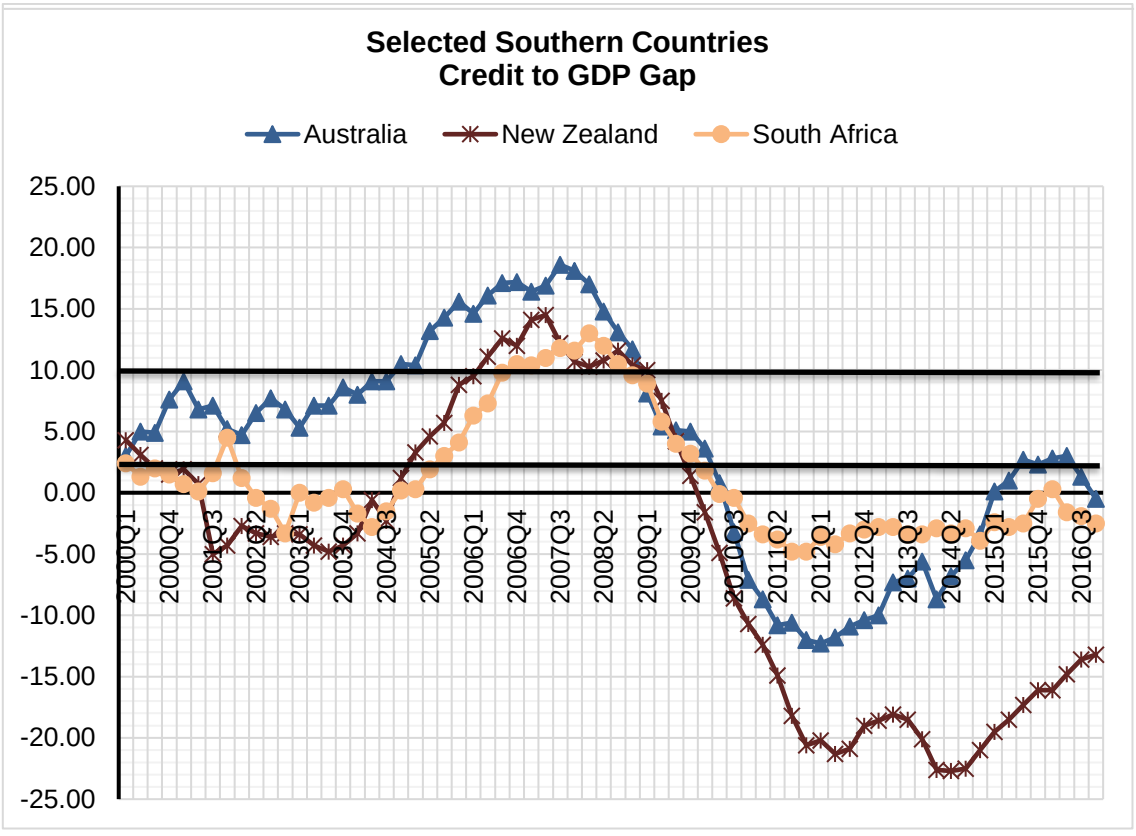
Appendix Figure 3A.3: Credit-to-GDP gaps for selected South American countries



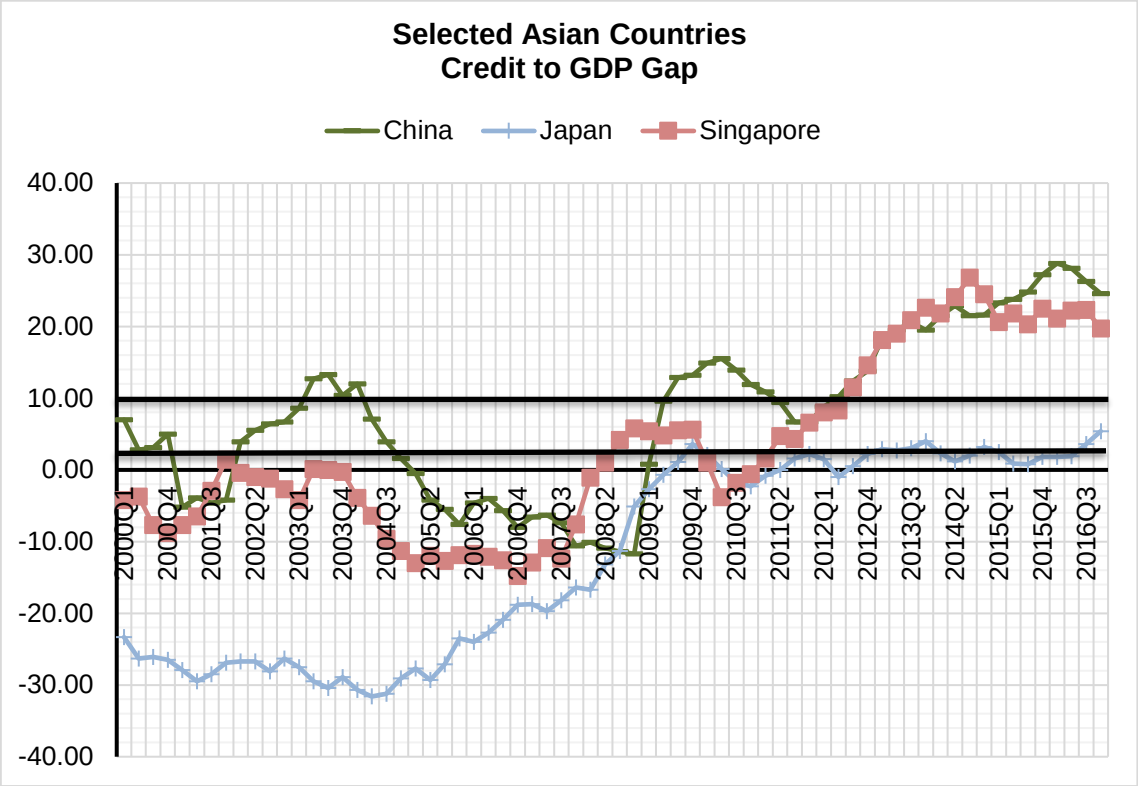
Appendix Figure 3A.4: Credit-to-GDP gaps for North America Free Trade countries



Appendix Figure 3A.5: Credit-to-GDP gaps for selected Southern countries



Appendix Figure 3A.6: Credit-to-GDP gaps for selected Asian countries



3A.2. Model estimation and macroprudential results for advanced countries and emerging market economies

Appendix Table 3A.1: Advanced countries baseline equation regression results

Variables	Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4 (estimated coefficient)	Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4 (estimated coefficient)	Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4 (estimated coefficient)
CGDPGAP(-1)	0.90*** (54.14)	0.86*** (33.9)	0.85*** (37.86)
BCRISIS(-1)	-1.35 (-1.19)	------	1.87*** (3.30)
UNEMPLRATE(-2)	-1.03*** (-4.87)	-0.23 (-1.48)	-1.64*** (-14.91)
INFLATRATE(-2)	0.03 (0.17)	0.25 (2.38)	-0.64*** (-7.37)
REALGDPRATE(-1)	-0.15* (-1.93)	-0.25*** (-4.47)	-0.16*** (-5.77)
BANKRATE(-1)	-0.05 (-0.39)	0.27 (2.41)	0.30* (1.73)

Observations	1,395	661	734
Sargan (J-Statistic) (p-value)	0.52	0.40	0.46
Arellano-Bond AR(1) p-value	0.00	0.00	0.00
Arellano-Bond AR(2) p-value	0.13	0.32	0.11
Periods included	54	26	28
Cross sections included	27	26	27

Notes: The coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. The Sargan tests' null hypothesis of over-identifying restrictions are not rejected. Arellano-Bond (AB) test for AR(1) in first differences are rejected, but not for the AR(2) test. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 3A.2: Advanced countries macroprudential instruments results

Macroprudential instruments	**Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4 (estimated coefficient)**	**Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4 (estimated coefficient)**
Loan-to-Value Ratio (LTV(-1))	8.26 (1.25)	-0.92 (-0.38)
Debt-to-Income Ratio (DTI(-1))	-5.98** (-2.37)	------
Capital Surcharges on SIFIs (SIFI(-1))	------	-2.33 (-1.17)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	------	------
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	------	------
Leverage Ratio (LEV(-1))	------	-13.63 (-1.29)
Limits on Interbank Exposures (INTER(-1))	------	3.88 (1.26)
Concentration Limits (CONC(-1))	-5.61 (-0.91)	-6.99 (0.64)
Limits on Domestic Currency Loans (CG(-1))	------	------
Levy/Tax on Financial Institutions (TAX(-1))	------	1.53 (0.47)
Reserve Requirement Ratios (RR(-1))	------	------
Limits on Foreign Currency Loans (FC(-1))	------	26.07 (1.06)
Loan-to-value ratio caps (LTVCAP(-1))	8.21* (1.72)	-0.68 (-0.22)

FX and/or Countercyclical Reserve Requirements (RRREV(-1))	------	------
Total macroprudential instruments (MPI(-1))	-1.87 (-1.30)	-0.73 (-0.78)
Macroprudential instruments focused on the borrower (MPIB(-1))	-1.31 (-0.87)	-0.12 (-0.06)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-1.04 (-0.25)	-0.30 (-0.46)

Notes: For macroprudential instruments definitions please see Table 3.2, for specification see Appendix Table 3.14. The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 3A.3: Emerging market economies baseline equation regression results

Variables	**Credit-to-GDP gap (CGDPGAP) 2000q1-2013q4 (estimated coefficient)**	**Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4 (estimated coefficient)**	**Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4 (estimated coefficient)**
CGDPGAP(-1)	1.07*** (10.31)	0.94*** (20.28)	0.91*** (14.84)
BCRISIS(-1)	-4.72*** (-2.90)	------	-7.39*** (-5.21)
UNEMPLRATE(-2)	-0.80* (-2.58)	0.25** (-2.01)	-0.48* (-1.88)
INFLATRATE(-2)	-0.06 (-0.37)	-0.21*** (-4.63)	-0.24 (-1.61)
REALGDPRATE(-1)	-0.22 (-0.96)	-0.22*** (-3.80)	-0.44*** (-2.62)
BANKRATE(-1)	0.17** (2.14)	0.13*** (5.28)	0.19 (0.51)
Observations	772	325	447
Sargan (J-Statistic) (p-value)	0.44	0.33	0.37
Arellano-Bond AR(1) p-value	0.00	0.00	0.08
Arellano-Bond AR(2) p-value	0.41	0.74	0.56
Periods included	54	26	28
Cross sections included	16	15	16

Notes: The coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. The Sargan tests' null hypothesis of over-identifying restrictions are not rejected. Arellano-Bond (AB) test for AR(1) in first differences are rejected at 10%, but not for the AR(2) test. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 3A.4: Emerging market economies macroprudential instruments results

Macroprudential instruments	Credit-to-GDP gap (CGDPGAP) 2000q1-2006q4 (estimated coefficient)	Credit-to-GDP gap (CGDPGAP) 2007q1-2013q4 (estimated coefficient)
Loan-to-Value Ratio (LTV(-1))	-0.88 (-1.30)	0.40 (0.10)
Debt-to-Income Ratio (DTI(-1))	------	1.53 (0.73)
Capital Surcharges on SIFIs (SIFI(-1))	------	------
General Countercyclical Capital Buffer/Requirement (CTC(-1))	------	------
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	6.68 (1.43)	-0.13 (0.01)
Leverage Ratio (LEV(-1))	------	------
Limits on Interbank Exposures (INTER(-1))	------	13.00 (0.98)
Concentration Limits (CONC(-1))	10.74 (1.24)	------
Limits on Domestic Currency Loans (CG(-1))	------	-1.63 (-0.18)
Levy/Tax on Financial Institutions (TAX(-1))	------	1.48 (0.43)
Reserve Requirement Ratios (RR(-1))	-20.8 (-0.57)	0.54 (0.06)
Limits on Foreign Currency Loans (FC(-1))	4.15** (2.14)	-18.19 (-0.91)
Loan-to-value ratio caps (LTVCAP(-1))	-1.36* (-1.93)	1.28 (0.35)
FX and/or Countercyclical Reserve Requirements (RRREV(-1))	-20.81 (0.57)	-0.15 (-0.02)
Total macroprudential instruments (MPI(-1))	1.56 (0.82)	0.06 (0.09)
Macroprudential instruments focused on the borrower (MPIB(-1))	-2.05*** (-2.76)	1.04 (0.76)
Macroprudential instruments focused on the financial institution (MPIF(-1))	5.37*** (4.24)	-0.33 (-0.23)

Notes: For macroprudential instruments definitions please see Table 3.2, for specification see Appendix Table 3.16. The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

We now move on to **Chapter 4: Financial Stability and Macroprudential Policy: Are there cross-border effects?** where we investigate whether and to what extent is

there any spill over effects of macroprudential instruments between countries using international banks' claims (lending activities).

CHAPTER 4:

Financial Stability and Macroprudential Policy: Are there cross-border effects?

4.1. Introduction

The increase in the usage of macroprudential policy in the wake of the 2007-2008 financial crisis has had a particular focus in that it commonly affects mainly the domestic banking and household sectors. The growth in use of such policies has fuelled many studies on the effectiveness of macroprudential policy and the rationale is to focus on the area of the financial sector where there is the most potential for systemic risk to develop, that is the credit and housing markets and the banking sector. Accordingly, reflecting on the aim of the policy itself, most of these studies have specifically focused on the effectiveness of macroprudential policy on credit and housing markets, notably via domestic operating deposit-taking-institutions (DTIs), which are mostly commercial banks (see **Chapter 3**). However, such an approach to the effect of macroprudential policy may be incomplete.

Avdijev et al (2017) indicated that when a country enacts prudential policy, three types of effects may occur, firstly, domestically-owned banks' activities in the same country such as credit expansion are affected (see Lim et al (2011), Cerutti et al (2017), etc.). Secondly, foreign banks may change their lending to the country that enacted the policy (see Aiyar et al (2014a and b, etc.). Thirdly, similar to foreign banks, domestic-owned banks may alter their foreign lending to the rest of the world (see Damar and Mordel (2017), Auer et al (2017), etc.). The last two effects are international in nature and these are the international transmission effects between countries.

Despite these insights, as far as we are aware, there is limited emphasis on the interconnectedness of international financial markets and how domestic macroprudential policies can spill over into other countries. In this the empirical literature reflects the bias of the theoretical literature on banking crises (as opposed to currency crises) which often disregard cross-border flows, or even assume a closed economy. And as noted in Chapter 2, most definitions of financial stability do not

include reference to international markets or international banks. Hence, an important issue is the extent to which macroprudential measures generate spill over effects between countries and whether this can affect financial stability positively or negatively or whether there are no significant cross-border effects on financial stability.

We suggest that we may find no effects in regions where there is a common macroprudential policy framework or financial stability policy such as in the European Monetary Union (EMU) or if there is a close alignment of policies between countries, that is countries change their policies simultaneously. Alternatively, the effects may be more significant in small open economies where policy is not coordinated in this manner, as in the case of the Asian crisis of 1997-1998, and indeed in respect of flows from Northern to Southern EMU countries in the 2000s. This may be the case more generally in emerging market economies, which have a longer history of using these macroprudential polices.

In this context, the purpose of this chapter is to present empirical research of potential cross-border spill over effects of macroprudential policies which will also help in the understanding of the interconnectedness of financial markets via international banks' claims (lending activities). It is important to understand the potential impact prudential measures could have on international banks' lending as well as their ability to avoid any costs associated with the implementation of these instruments. The Cross Report (see **Chapter 2** for a discussion of the report) saw an opportunity for international cooperation and co-ordination between supervisory agencies in different countries as the interconnectedness of financial markets were growing. As such, close cooperation between countries with regards to financial regulations can help in limiting financial instability.

Additionally, the question arises whether the spill over effects of macroprudential policy between countries can lead to financial instability or the build-up of imbalances in the receiving country, that is, in the country that has not employed any prudential measures. We consider this of particular relevance for understanding the concepts of financial stability due to the rapid spread of the 2007-2008 financial crisis to international markets (see **Chapter 2** for a discussion of financial stability concepts). Kaminsky and Reinhart (2000) suggested that in analysing the many crises in the

1990s, most researchers focused on the subject of contagion and not on the transmission channels in which these disturbances are transmitted. As such, for example, if the transmission channel of credit between countries are disrupted, the question arises whether there is the potential for financial crisis or instability to develop in the receiving country, for instance a sudden stops crisis or a currency crisis, etc. This can be seen in the European Economic and Monetary Union (EMU) where cross-border flows into southern Europe, especially Greece in 2000s, later resulted in a debt crisis (see Ari (2014)).

Further, a main area of focus for macroprudential policy framework is that it should contribute to assessment of financial system stability and as some researchers suggested, such as Borio and Lowe (2002 a and b, 2007), Davis and Karim (2008a), Giese et al (2014) etc., provide indicators to identify and prevent periods of financial instability (systemic risks). We believe that understanding the interconnectedness of financial institutions should not only apply to the domestic financial markets but should include international financial markets (institutions)[38] as a result of the growth of international banking over the last four decades and globalization, the opening up of trade and financial links between countries. Yet, most macroprudential policy analysis and theory focus on the domestic financial sector. Crockett (2000) suggested that macroprudential approach to effective banks supervision and financial system stability should recognise the interconnectedness of financial institutions and the risk of correlated failures, such as systemically important financial institutions.

In this context, by estimating a panel-vector autoregressive (PVAR) model and using the BIS International Banking Statistics and the International Banking Research Network (IBRN)[39] Macroprudential Prudential Instruments database, we will analyse the potential spill over effects of macroprudential policies. The remainder of the chapter is structured as follow. Firstly, **Section 4.2. Financial markets**

[38] Davis (1995) suggested that the issue of international financial markets and crises is an old one as the seen from financial crises back to the 1970s as well as the Asian financial crisis (1997-1999), the Argentinian debt crisis (2001-2003), etc.

[39] It was established in 2012 by Austrian, German, U.S., and U.K. researchers who saw a need for joint analysis of key questions, such as the role of cross-border banking in the transmission of financial shocks. The group has expanded to include economists and analysts from a broad group of central banks, as well as the Bank for International Settlements (BIS) and the International Monetary Fund (IMF). See International Banking Research Network webpage, https://www.newyorkfed.org/ibrn/about.

interconnectedness and the transmission channel of credit looks at the growth of international banking and the role it plays in the transmission of credit, the interconnectedness of global financial markets and financial stability. Secondly, **Section 4.3. Financial stability and the role of international banks,** we review the role of international banking in financial stability issues. Thirdly, **Section 4.4. Empirical analysis of the spill over effects of macroprudential policies via international banks claims**, we present empirical results which will focus on the following issues; firstly, how the international banks' claims impact total domestic lending (measurement credit-to-GDP ratio), banks' regulatory capital ratio (a measure of banks' strength and stability) and economic activity. Intuitively, in order to assess the spill over effects of macroprudential policy, it is important to establish whether there is a relationship between international banks' claims and the domestic economy. Secondly, we then look at the spill over effects of macroprudential policies between countries and what potential effects these policies can have across borders. Panel-vector autoregressive (PVAR) analysis will be conducted on 43 countries, using quarterly data from the IMF, OECD, and the BIS. Fourthly, **Section 4.5. Robustness checks** provide a check on the model results. Finally, **Section 4.6. Chapter Summary**, we conclude.

4.2. Financial markets interconnectedness and the transmission channel of credit

The purpose of this section is to look at the interconnectedness of global financial markets and financial stability, the growth of international banks and the role they play in the transmission of credit and other financial services between countries.

4.2.1. Financial markets interconnectedness

As mentioned above, Kaminsky and Reinhart (2000) noted that with many crises in the 1990s (see **Chapter 2: Appendix 2A.1** for a list of crises from 1970), there tended to be a focus on the contagion effects and not on understanding the transmission channels in which these disturbances are transmitted. Furthermore, they noted that there is the challenge for researchers to explain why some financial crises have a significant international impact and others don't. They suggested that understanding

both the trade and financial sector links between countries are both important for analysis of the transmission channel of crises as they found that in all studies the trade linkages play an important role in the propagation of shocks and this could explain why some contagion tend to be regional rather than global. Contagion can be defined as the spread of market changes or disturbances from one regional market to others. Contagion occurs both globally and domestically and have become more prominent in the global economy and within certain geographic regions, e.g. European Union, Asia and Latin America, since financial markets and economies have become more correlated and integrated with each other.

In the literature since the 2007-2008 global financial crisis, there is a growing focus on understanding the macro-financial linkages between the financial sector and the real (domestic) economy (see Caprio Jr. (2011), Claessens and Kose (2013), etc.). Caprio Jr. (2011) noted that research on macro-financial linkages was very limited prior to the 2007-2008 financial crisis and from 2007 it has been increased significantly. Chinazzi et al (2013) noted that it is critical to understand financial-market interconnectedness to explain systemic risk, stability and economic dynamics. However, with the rapid spread of the 2007-2008 financial crisis to international markets, we contend that macro-financial linkages should include the need to understand the interconnectedness of global financial markets, the linkages between international financial flows to/ from an economy's financial system to the rest of the world. Thus, in order to understand the interconnectedness of global financial markets, we contend a discussion of the following is warranted, 1) Financial liberalisation, and 2) The role and growth of international banking.

I. Financial liberalisation and interconnectedness

Financial liberalisation became one of the most important financial reform policies in both advanced countries, emerging market economies and lower income countries in the 1980s and 1990s. Pill and Pradhan (1997) suggested that financial liberalisation involves the abolition of explicit controls on the pricing and allocation of credit as well as an end to direct government involvement in the credit allocation process of commercial banks. Financial liberalisation may also involve the abolition of controls on international capital (account) movements and in some cases, foreign exchange

rate control and foreign bank entry. Yet, government policies continue to play a central role in determining how the financial sector performs in a liberalised financial system via structural and prudential regulations.

In this respect, financial liberalisation can be interpreted as a policy where market forces are allowed to have a greater role in determining financial-market activities. This implies that interest rates are liberalised and there is the removal of other price controls, amounting to the reduction in the implicit taxation of financial intermediation. In some cases, interest rates liberalisation is accompanied with exchange rate and capital account liberalisation. There may be the privatisation of state-owned intermediaries and reduction of administrative credit directives by government agencies, removal of restrictions on the admission of new entrants into the financial sector and legal protection for cartelized financial markets. Finally, there may be the reductions in line-of-business restrictions on financial intermediaries, which necessitates prudential supervision (Caprio and Honohan (1999)).

Capital account liberalisation implies the removal of control on the outflows and inflows of capital, that is, the freedom from prohibitions on transactions in the capital and financial accounts of the balance of payments (see Eichengreen and Mussa (1998)). In many countries, capital account controls were introduced in order to protect the exchange rate, to stabilise the financial sector or alleviate severe balance of payment problems. Foreign exchange rates liberalisation is tightly coupled with capital account liberalisation. As such, demand and supply in the capital markets directly affect the foreign exchange rates. However, in many cases the monetary authority still indirectly controls the exchange rate, muting the degree of coupling between these two economic variables by use of interest rates, reserve requirements, etc. For example, Prasad and Rajan (2008) suggested that in emerging market economies (EME), as a result of capital inflows, emerging markets build-up foreign exchange reserves in attempt to prevent large exchange rate appreciation by intervening in the foreign exchange market.

The reasons for financial liberalisation varied from country to country. Accordingly, Caprio and Honohan (1999) suggested that in many emerging market economies the major reasons for the movement to a market-oriented financial system can be looked

at from the following viewpoints. Firstly, the commitment made by many developing countries to the principles of the General Agreements on Trade in Services (GATS), which form part of the Uruguay Round[40] of trade negotiations, led many of these countries to be proactive in liberalising their respective financial sectors. The Uruguay Round of trade negotiations resulted in the creation of the World Trade Organization (WTO)[41] and an agreement updating the General Agreement on Trade and Tariffs (GATT) [42] in 1995. Prior to Uruguay Round of trade negotiations, GATT focused mainly on trade in goods, and not trade in services, only with the new GATT agreement in 1995 was there a greater push toward globalisation and financial liberalisation of markets. There is no universally acceptable definition of globalisation but it can be seen as the integration of economies, industries, markets, cultures and policymaking, etc., between countries.

A second influence is the economic policies of the lending agencies (International Monetary Fund (IMF) and the World Bank). Typically, liberalisation was one of the requirements of any structural adjustment package formulated by these bodies to assist in economic development and/or financial system stability following a financial or economic crisis. As such, financial liberalisation often takes place after the country experiences an economic crisis or the financial system is on the verge of collapse. Thirdly, the perceived benefits of financial liberalisation were extrapolated from the experiences of other countries experiencing rapid economic growth following such liberalisation.

Edey and Hviding (1994) suggested that in the Organisation for Economic Co-operation and Development (OECD)[43] advanced countries, the reasons for the shift to a market oriented financial system are mainly due to the shrinkage of the regulatory base, due to the various forms of regulatory avoidance by financial institutions (for

[40] This round of trade negotiations was launched in Punta del Este, Uruguay in September 1986 and lasted until 1994. See WTO website, https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact5_e.htm.
[41] The WTO is the only global international organization dealing with the rules of trade and services between nations. See WTO website, https://www.wto.org/english/thewto_e/thewto_e.htm.
[42] The original GATT agreement was signed on 30th October 1947 by 23 countries and provided the rules for much of the world trade between the period 1948 to 1994. See WTO website, https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact4_e.htm.
[43] The Organisation for Economic Co-operation and Development (OECD) was officially established on 30th September 1961 and currently has 35-member countries. See OECD website, http://www.oecd.org/about/history/.

example, the development of off-shore financial sectors, securities market growth and off-balance sheet methods of financing), as well as a more general tendency for banks and other regulated institutions to lose business to the less regulated parts of the financial sector. Indeed, as noted in **Chapter 2**, the Cross Report (1986) highlighted the loss of comparative advantage of large international banks to international securities markets as a channel for credit intermediation. This new development had important consequences for the functioning of the banking and financial systems, which led to greater risks taking by financial institutions. There was also financial innovation and rapid technological development, which progressively increased the ease with which regulations could be avoided. Inflationary problems and macroeconomic development in the 1970s resulted in the need for interest rate flexibility.

However, Demirguc-Kunt and Detragiache (1998) showed empirically that banking crises are more likely to occur in liberalised financial systems, not necessary immediately after liberalisation, but rather a few years after the liberalisation process begins. They noted that banking sector fragility is reduced when the institutional environment is strong, that is, regulations are properly adhered to by financial institutions, there is a low level of corruption and good prudential regulation. Nonetheless, they found financial liberalisation has positive effects on economic growth through financial development, even if it increases banking sector fragility. Similarly, to Demirguc-Kunt and Detragiache (1998), Bird and Rajan (2001) noted the role of financial liberalisation as a contributing factor to the East Asia financial crisis in 1997-1998, as well as Noel (2018) looking at the Jamaican's financial crisis 1996-1998, and Sandel (2004) on the Nordic Banking Crises in the early 1990s.

Gopalan (2015) suggested that there are different dimensions to financial liberalisation where, firstly, there is domestic financial liberalisation, which involves the relaxation of domestic credit and interest rates controls, limits on banking competition, etc. Secondly, there is international financial liberalisation, which encompasses both capital account liberalisation (as discussed above) and internationalisation of financial services and the banking sector. He defined internationalisation of financial services and the banking sector as the elimination of barriers to entry and discriminatory treatment of foreign competition as well as cross-border provision of banking services.

Gopalan (2015) further noted that a country opens its banking sector to foreign competition in two ways, firstly, allowing direct investments in the banking sector or foreign bank entry in the sector and secondly, permitting cross-border banking activities, includes lending and borrowing activities involving foreign banks. The role and growth of international banks are discussed further below.

II. The role and growth of international banking

International banking has expanded noticeably since the end of the Bretton Woods system of managed exchange rates in the 1970s and it plays an important role in the global economy. In a 2010 report by the Committee on the Global Financial System (CGFS (2010c)), international banking is defined as intermediation activity which involve the extension of credit (or financial services) by a bank headquartered in a particular country to residents[44] of another country. The CGFS report also noted, firstly, international banking has taken a significant role in the process of financial globalisation and integration of financial markets. Traditionally, international banking activity expanded largely in line with international trade and performed key functions for international non-financial firms. However, financial liberalisation, especially in emerging market economies as noted above, and the increased demand for financial services have accelerated financial integration and the growth of international banking activity beyond that of international trade.

Secondly, international banks play a vital role in the global economy and it is closely related to activities in international financial markets. International banks perform important functions in term of intermediation, the allocation of credit, and maintaining the resilience of the market infrastructure for the healthy functioning of the global financial system. And thirdly, technology development has spurred financial integration of international banks and paced the way for broader access to markets.

CGFS (2010c) indicated that the growth of international banking has gone through three phases. The first phase started in the second half of the 19th century with US

[44] This is a broad term which include individuals, companies and other financial institutions and it is based on the ultimate address of the resident.

banks underwriting securities being sold to European investors, for financing US railroads. In addition, with the expansion of trade and the signing of the GATT agreement in 1947, international banking activities grew largely in line with international trade and mainly between developed countries.

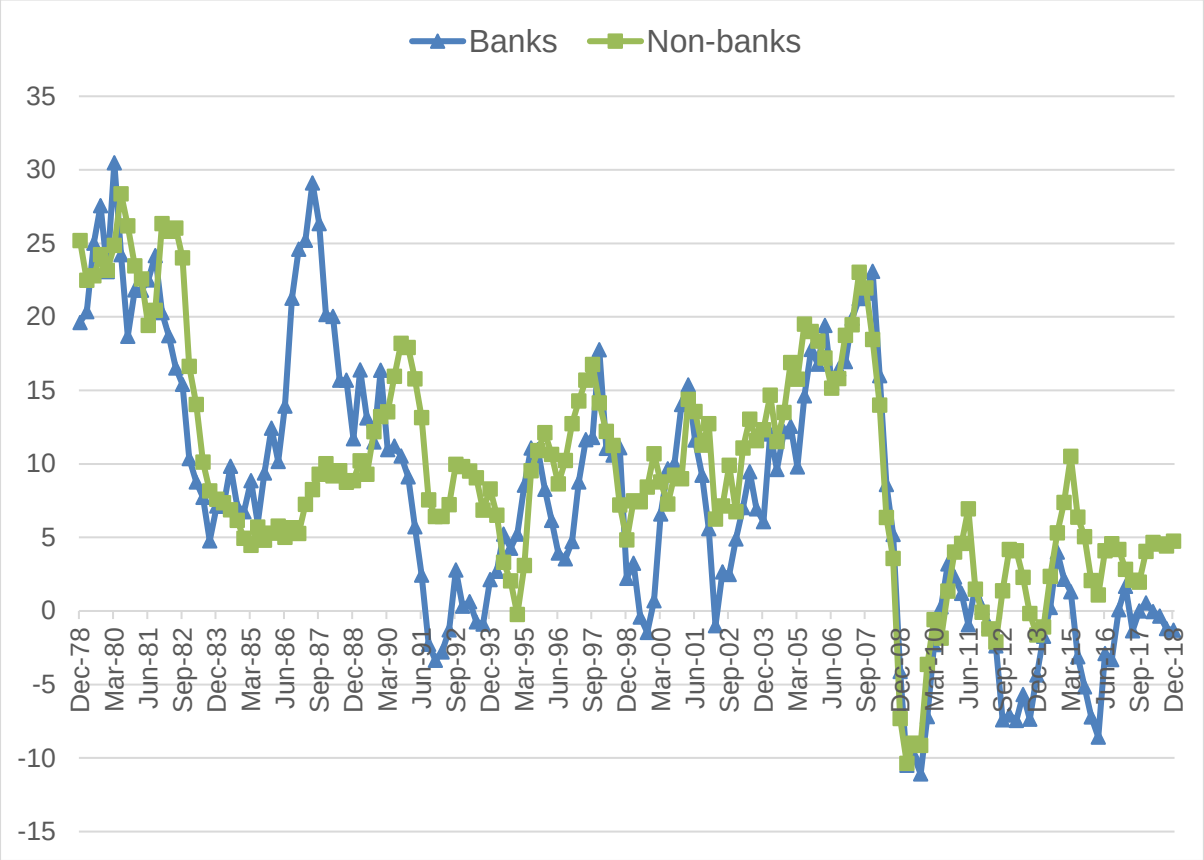
The second phase of international banking expansion began in the 1960s. Houpt (1999) noted for US banks, the 1960s and 1970s were years of rapid growth in international banking. Existing larger US global banks and money centre banks further expanded their networks and operations in foreign markets. Also, many smaller U.S regional institutions expanded their operation mainly in European cities but most of them sought only "shell branches"[45] in Caribbean offshore centres as a means to gain access to the Eurodollar markets. As such, international banking growth was reflected in the growth of the euro-markets and international capital markets in the 1960s and 1970s.[46]

In the UK, British banks already had a footprint in many countries especially Commonwealth countries, due to historical and political connections to the British Empire. In addition, many Commonwealth countries' legal systems are founded on English common law – a legacy of British colonialism. We contend that British banks were in a strong position to increase their foothold and banking activities when many Commonwealth countries adopted financial liberalisation policies in the 1980s and 1990s, which is the third phase in the growth of international banking.

The third phase started in the late 1980s with the liberalisation of many countries' financial systems, especially in emerging market economies related not least to the push toward globalisation with the new GATT agreement in 1995 as discussed above. Goldberg (2009) suggested as well that this period of expansion includes the dissolution of the Soviet Union, which led to bank entry by EU banks into central and Eastern Europe in the early 1990s.

[45] Shell branches are merely booking centres. Banks personnel do not conduct operations on site at these branches but rather book balances at these offices from other locations.
[46] Some factors that contributed to the growth of this market are the following, the imposition of maximum rates of interest in the US (Regulation Q), US withholding taxes regime, listing and disclosure regulation requirements, etc. as well as the growth of multi-national financial institutions.

Figure 4.1: Quarterly percentage change in international banks' cross-border claims (lending) by sector over the period 1978q4 to 2018q4



Source: BIS Locational Banking Statistics (2019)

Figure 4.1 shows the percentage change in cross-border claims (lending) by sector (banks/ non-banks) over the period 1978q4 to 2018q4. In the late 1970s, the average growth rate in international bank cross-border lending was between 20-30 per cent, it fell in the early 1980s due to the Latin America debt crisis. On account of deregulation and financial liberalisation there was a period of high growth from the mid-1980s until the slowdown in the world economy in the early 1990s. Also, during this period there was a diversion between banks and non-banks' lending. In the 1990s, the movement in the growth rates may be due to the increase in international trade and at the end of decade the Asian financial crisis. The early 2000s represented a period of high economy growth especially in China and other Asian countries before there was a large fall in cross-border as result of the 2007-2008 financial crisis.

Goldberg (2009) noted that the impetus and growth of international banking varies by player, by time and by country. Firstly, some episodes of the expansion of international

banking can be seen as an opportunity for parent banks to search out higher yield and diversification opportunities (for instance US banks in the 1960s and 1970s). And secondly, other episodes followed regulatory and political changes, which increased the opportunity for expanding banking services to new markets, either as cross-border transactions or through establishing branches and subsidiaries in these new markets. The expansion of international banking did not only involve the extension of financial services, cross-border lending, to new financial markets but it also included the acquisitions and ownership of foreign subsidiaries and branches. For example, in the UK in the 1980s, as the financial system became "market oriented" and the removal of restrictive trading practices[47] in the securities market, brought the traditional banking system and securities trading closer together. This led to an increasingly merging of functions between institutions which encourage a number of large UK banks and overseas retail banks to build-up a presence in London (see Bowen et al (1999)).

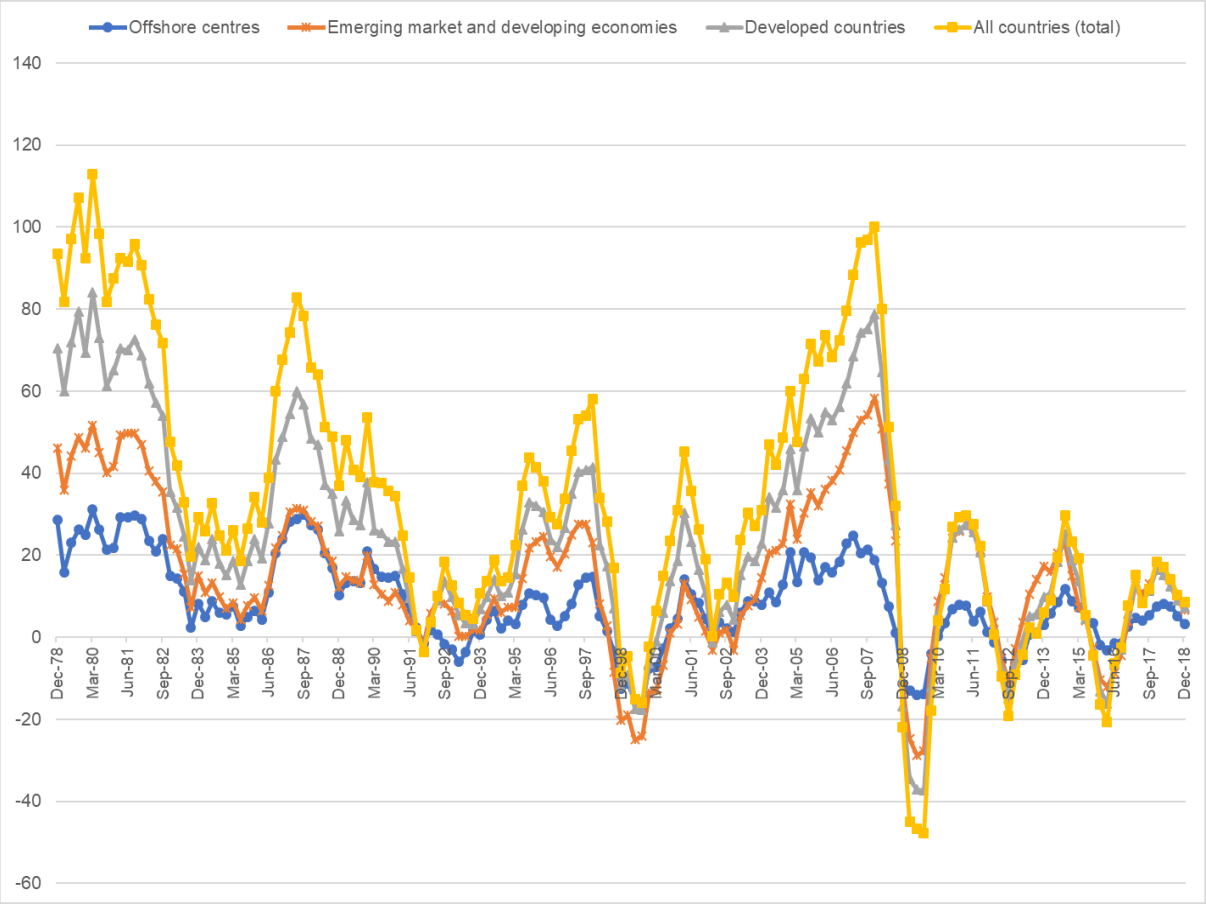
We agree that deregulation and financial liberalisation in many countries played an active role in the growth and development of international banking as new markets and opportunities were created for international banks to operate and grow. Further, the harmonisation of banking regulations such as Basel Capital Accord and accounting standards, in response to deteriorating international banks capital and growing international risks, provided an impetus for banks to expansion internationally. This led to the growth of large international banking groups such as UBS, JP Morgan, HSBC, etc., which are now considered to be global systemically important financial institution (G-SIFIs).[48] Finally, globalisation and the rapid growth in the demand for financial services from multinational corporations especially in quickly-growing emerging markets helped shape and influence the role of international banking and its contribution to economic growth and progress in many countries, resulting in the integration of global financial markets.

[47] Big Bang, on 27 October 1986, a series of reforms swept through the London Stock Exchange as there was the removal of restriction on membership, securities trading, etc., which allowed UK and overseas banks to grow in the financial system in the UK.

[48] See the Financial Stability Board (FSB) website, http://www.fsb.org/what-we-do/policy-development/systematically-important-financial-institutions-sifis/global-systemically-important-financial-institutions-g-sifis/.

Figure 4.2 shows the growth rate in cross-border by lending countries over the period 1978q4 to 2018q4. The changes in the growth rates are in line with the period of economic growth, deregulation and financial liberalisation and financial crises over the period as discussed above. Particular periods of interest are the fall in lending to emerging market and developing countries during the 1980s on account of the Latin America debt crisis, at the end of 1990s due to the Asian financial crisis and the early 2000s because of the Argentina debt crisis. All countries reported large fall in lending during the 2007-2008 financial crisis.

Figure 4.2: Quarterly percentage change in international banks' cross-border claims (credit) by country over the period 1978q4 to 2018q4



Source: BIS Locational Banking Statistics (2019)

We now move on to **Section 4.3. Financial stability and the role of international banks**, where we review the role of international banking in financial stability issues.

4.3. Financial stability and the role of international banks

There has been a resurgence of concerns over the role international banking and international financial integration played in the most recent financial crisis in 2007-2008. We suggest that prior to the 2007-2008 financial crisis, potential cross-border financial disturbances emanating and/ or spreading through the international banking channel were poorly understood. Most researchers focused on the subject of contagion and not on the transmission channels in which these disturbances are transmitted and the interconnectedness of financial markets (see Kaminsky and Reinhart (2000), Caprio Jr. (2011), Chinazzi et al (2013), etc.). Yet, episodes of financial crises with an international effect (e.g. debt and currency crises which we will develop further below) have been happening since the 1980s such as the Latin American Debt crisis in the early 1980's, Asia and Russia in 1997-1998 and Argentina in 2001-2002. The continue integration of financial markets clearly raises questions about financial instability arising from cross-border financial disturbances or domestic financial stability being disrupted by international disturbances transmitted through international bank lending.

As mentioned elsewhere in the thesis, the focus of macroprudential policy is mainly domestic markets (see **Chapter 3** and **Chapter 5** as well), with many of these studies focusing on analysing the effect of macroprudential instruments on credit growth and house prices and the mitigation of the build-up of imbalances in the housing market. However, Andrieş (2009) suggested the global financial environment enables the transmission of cross border crises and also that financial crises are mainly manifested at the level of financial institutions although it can happen in the non-financial institutions. In addition, financial crises have happened in all types of financial system, whether market-based or bank-based as well as in different degree of development of the financial system that is developed, market functional or emerging.

We believe that examining the role of international banks in the global financial landscape is important for the understanding of financial stability, as they can indeed amplify the international transmission of a financial shock, or weaken the stance of macroprudential policy in a boom by facilitating disintermediation, etc. Cerutti et al (2015a, 2017) suggested that there is a weaker effect of macroprudential policy in

more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy although they did not explicitly test for this.

IMF (2010) noted that with the rapid growth in globalization in the last few decades, the global financial system is highly concentrated and that global financial intermediation is carried out in predominantly by about 20 large financial centres such as London, New York, Hong Kong, etc., where many large international banks and other financial institutions such as insurance companies and securities houses operate. Financial markets have benefited from the financial globalization brought about by greater efficiency in intermediation, the pooling of risk and technology development, yet the IMF noted it has brought vulnerabilities to financial markets. In retrospect, the Cross Report (1986) highlighted the vulnerabilities to financial markets as a result of greater risk taking by financial institutions, due in turn to the loss of the comparative advantage of large international banks to international securities markets as well as to off-shore centres (e.g. Cayman Islands) due to financial market innovations and tax avoidance schemes. Also, the Report raised several issues for macroprudential policy (supervision) in order to deal with the concerns of financial innovation and the macroeconomic consequences of financial system fragility (see **Chapter 2** for a discussion of the report).

CGFS (2010c) noted that the growth of international banking has allowed economic agents to gain access to a broader range of financial services but it has affected the riskiness of individual banks and the financial system. Hence, international banks can have a major effect on the financial stability of a country's financial system. Firstly, CGFS (2010c) suggested that international expansion of banks can affect the risk profile and resilience of individual banks through risk diversification, competition and efficiency gains. But this need not necessarily enhance safety and soundness. Yet, diversification benefits may encourage banks to build riskier portfolios in order to realise higher yields and a more diversified bank does not necessarily means less risk. Competition can induce banks to exploit the risk-return paradigm and enter new markets, sometimes less regulated markets, as to maintain market share and profitability (The Cross Report (1986), Houpt (1999), Barrell and Davis (2008), etc.). Secondly, international banks have an influence on cross-border risk-sharing which could be beneficial for financial stability. Yet, the ability to manage the cross-border

risks during a financial crisis depends on whether foreign banks operating in a country alleviate or add to the country's financial sector disruption. Goldberg (2009) highlighted how international banks can enhance the international transmission of financial disturbances through their activities.

Goldberg (2009) suggested that the growth of global banks has the potential to alter the business cycle in a country and enhance the international transmission of financial disturbances through their activities. This may vary depending on whether the country is being served through cross-border flows or the funding source of the locally operating subsidiary or branch of the global banks in the host country. Notably, a banking business model based on cross-border flows or if the foreign bank subsidiary is more reliant on head office funding (foreign sources) than locally source funding, has the potential to amplify any potential international financial disturbance for the host country, such as a disruption to international liquidity market (the availability of cross-border liquidity). See Cetorelli and Goldberg (2010) and Polov and Udell (2012) for two empirical studies which explore the effect that the 2007-2008 financial crisis had on lending in emerging market economies in Europe, Asia and Latin America. This is will be discussed further below in **Section 4.4.1**.

Further Kaminsky and Reinhart (2000) indicated that financial linkages between countries can be caused of financial contagion even if bilateral and third-party trade links with the infected country are be weak. They noted the cases of Argentina following the Mexico Tequila crisis (1994-1995) and Indonesia after Thailand (Asian financial crisis 1997-1998). They suggested that one potential channel of transmission of financial crisis that has been ignored in the contagion literature is the role of common lenders, particularly commercial banks (cross-border international banks) such as in the case of U.S. banks extensive exposure to Latin America in the early 1980s (Latin America debt crisis) and the Japanese banks during the Asian financial crisis (1997-1998).

In addition, Kaminsky and Reinhart (1999) discussed the link between the causes of banking crises and balance of payments problems. They examined currency and banking problems for a number of industrial and developing countries such as the Scandinavian countries, Spain, Thailand, Philippines, Mexico, Brazil and Argentina,

etc. over the period 1970 to 1995. They that found, firstly, following financial liberalisation, which started in the 1980s, banking and currency crises become closely entwined. They suggested knowing that a banking crisis is underway helps predict a future currency crisis, as well, the collapse of the currency can deepen the banking crisis. Secondly, banking crisis is generally the immediate cause of a currency crisis. Thirdly, crises are preceded by a multitude of weak and deteriorating economic fundamentals. And fourthly, twin banking and currency crises tend to have severe effects on the economy.

Glick and Hutchison (2011) and Claessens and Kose (2013) saw that a currency crisis typically involves a speculative attack on the currency resulting in a devaluation (or sharp depreciation) or forcing the government to defend the currency, either by using their international reserves or sharply rising interest rates or imposing capital controls. They indicated that there are three generation of models to explain a currency crisis.

Firstly, there is the first-generation models (Krugman (1979) and Flood and Garber (1984)) which are specific to the 1980s, look at the sudden speculative attack on a fixed or pegged currency, when there is a balance of payment crisis and government budgetary deficit financed by central bank credit. The second-generation models look at the doubts about whether a government is willing to maintain its exchange rate peg and which could lead currency crisis (Obstfeld and Rogoff (1986)). The second-generation models are in part motivated by the European Monetary system in the period 1992-1993, where the UK pound came under attack. The third-generation models explore how rapid deterioration of balance sheets associated with fluctuations in assets prices, including exchange rates, can lead to a currency crisis. These models were largely motivated by the Asian crises in 1997-1998. The third-generation model papers show how balance sheet mismatch and over-borrowing by banks can lead to a currency crisis, such as Chang and Velasco (2000), McKinnon and Pill (1996), Krugman (1998), and Corsetti et al (1998). However, there is not always a clear linkage of these currency crisis papers to the literatures on financial crises and macroprudential policy summarised in **Chapters 2** and **3**, which as noted tends to have a domestic focus.

Claessens and Kose (2013) noted a debt crisis can take two forms, either a foreign debt crisis or a domestic public debt[49] crisis. A foreign debt crisis is when a country cannot service its foreign debt obligations (e.g. Latin American debt crisis 1980s and Argentina 2001). It can take the form of a sovereign or private (or both) debt crisis. A domestic public debt crisis is when a country does not honour its domestic fiscal obligations in real terms, either by defaulting explicitly, or inflating or debasing its currency or employing some form of financial repression. Debt crises with a cross border element are also likely to involve sudden stops (see Claessens and Kose (2013)), currency or banking crises (or various combinations), making it hard to identify the initial cause.

The role of international banks in the 2007-2008 financial crisis has been debated extensively and there is some common agreement that the interconnectedness of financial markets, with international banks as the transmission channel, contributed to the rapid spread of the crisis. In hindsight, the role and risks posed by international banks were not clearly understood. Regulators have since initiated research and assessment programs to study the transmission channels of financial crises and the issue of interconnectedness among the major financial institutions and markets especially systemically important financial institution (SIFIs) as well as global systemically important financial institution (G-SIFIs) operating in their financial system, which have since lead to the development of new regulations, Basel III and the enhanced role for the Financial Stability Board[50] in global financial markets stability.

Finally, as highlighted in the Cross Report (1986) there is an opportunity for international cooperation and co-ordination between supervisory agencies in different countries as the interconnectedness of financial markets and international banks were growing, as such close cooperation between countries can limit financial instability. Yet, the Report saw several issues for macroprudential policy (supervision). There should be a broader macroprudential approach to address the concerns of international banks' lending and activities and their overall effect on credit quality/

[49] Domestic debt can be reduced by inflation unless it is in a currency not under direct control of the local central bank, e.g. the European Union - Euro currency and the Organisation of Eastern Caribbean States - Eastern Caribbean dollar.
[50] See the Financial Stability Board website, http://www.fsb.org/about/.

volumes and the domestic financial sector, which we suggest has not always been the case.

We now move on to **Section 4.4. Empirical analysis of the spill over effects of macroprudential policies via international banks claims**, where we present empirical results, how the international banks' claims impact total domestic lending (measurement credit-to-GDP ratio), banks' regulatory capital ratio (a measure of banks' strength and stability) and economic activity. It then goes on to look at the spill over effects of macroprudential policies between countries and what potential effects these policies can have across borders.

4.4. Empirical analysis of the spill over effects of macroprudential policies using international banks claims

This section discusses our empirical analysis of the spill over effects of macroprudential policy via international bank claims, which add to the growing literature on financial stability and macroprudential policy. Limited research has been completed in this area so far in respect of macroprudential policy and we believe there is a gap in the literature, where the focus tends to be on the domestic financial market, and with limited emphasis on the interconnectedness of financial markets and how domestic macroprudential policies can spill over into other countries. As mentioned, due to data limitations as a result of confidentiality of micro-level banking data, the analysis will be done using country aggregate macro-level data. However, we believe this does not detract from the empirical analysis and results as we are capturing the effects on the entire financial sector rather than just a few large international banks, allowing for macroeconomic analysis not feasible with individual banks. Also, to our knowledge, the panel-vector autoregressive (PVAR) approach has not been used so far to investigate spill over effects of prudential instruments between countries.

In the ensuing sub-sections, we will first provide a brief overview of the limited existing empirical research on the cross-border spill over effects of macroprudential policy. Also, we will outline some papers where international banks claims (lending) were used to analyse the transmission of a financial shock.

Secondly, we discuss the datasets and set out the PVAR model for examining the spill over effects of macroprudential instruments via international banks claims. The BIS International Banking Statistics[51] (cross border claims) is one of the main datasets that has been used in recent research to assess the interconnectedness of financial markets, to develop financial global risk network maps[52] (see Cecchetti et al (2010)) and to analyse the transmission of financial crises between countries.

Thirdly, we present our empirical results which will focus on the following, firstly, how do international banks' claims impact total domestic lending (measured by the domestic credit-to-GDP ratio), banks' regulatory capital ratio (a measure of banks' strength and stability) and economic activity. As discussed above, intuitively, in order to assess the spill over effects of macroprudential policy, it is important to establish whether there is a relationship between international banks' claims and the domestic economy. Secondly, we then look at any potential spill over effects of macroprudential policy between countries via international banks' claims and what effects these policies can have across borders. Panel-vector autoregressive (PVAR) analysis is conducted on 43 countries, using quarterly data from the IMF, OECD, and the BIS.

4.4.1. Empirical studies on the spill over effects of macroprudential policy

The increase in the usage of macroprudential policy and its instruments in the wake of the 2007-2008 financial crisis has fuelled many studies on the effectiveness of macroprudential policy. Many of these studies have specifically focused on the effectiveness of macroprudential policy[53] in the area of the financial sector where there is the most potential for systemic risk to develop, that is the credit and housing markets and the banking sector, such as Lim et al (2011), Claessens et al (2014), Akinci and Olmstead-Rumsey (2015), Cerruti et al (2017), Carreras et al (2018), etc. (see **Chapter 3**).

[51] Prior to the 2007-2008 global financial crisis this dataset was used very little in research. See Cetorelli and Goldberg (2010), Kalemli-Ozcan et al (2013), etc. for more recent work using this dataset.
[52] These are matrices that track the bilateral (form-level) exposures of banks, non-bank financial institutions and other relevant market participants.
[53] It is important to note that fiscal policy and financial crisis effects should be taken into consideration when analysing the effectiveness of macro-prudential policy.

The bias in such studies reflects the nature of macroprudential policy to date which has focused mainly on the domestic banking and household sectors. Accordingly, limited research has been completed so far on the cross-border effects of macroprudential policy between countries, that is how the implementation of the policy in one country could have a cross-border effect in another country and vice versa. Not least, we contend that implementation of macroprudential policy in a country can create opportunities for regulatory arbitrage for banks. Indeed, Cerutti et al (2017) suggested there is a weaker effect in more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy. Moreover, Ostry et al (2012) suggested that there may be a need to consider macroprudential policy and capital inflows (controls) to enhance financial stability in face of the risks from large capital flows.

In one paper that does address the international aspect of macroprudential policy, Bruno et al (2015) provide a comparative assessment of the effectiveness of macro-prudential policies in 12 Asia-Pacific economies, using databases of both domestic macroprudential policies and capital flow management (CFM) policies over 2004-13, with 152 CFM measures on banking and bond inflows and 177 domestic macroprudential measures.[54] They employed panel regressions without country fixed effects because CFM indicators have little variation or are unchanged for some countries in the estimation. They found that banking sector CFM polices and bond market CFM policies are effective in slowing down banking and bond inflows, respectively and also there are spill over effects of these policies on the "other" type of inflows. Macroprudential policies tend to be introduced along with monetary tightening and are most successful when they complement monetary policy by reinforcing monetary tightening. The interaction between macroprudential and monetary policies is discussed further in **Chapter 5**.

[54] They classified macroprudential tools into asset-side tools (LTV Cap, Reserve Requirements, etc.), liability-side tools (Levy on non-core bank liabilities and foreign currency bank liabilities, etc.) and bank capital-oriented tools (Higher risk weights on foreign currency loans, Countercyclical buffer, etc.). The instruments were further classified into residency-based tools (so called capital controls), currency-based capital ow measures (also called FX-related prudential measures), and general prudential tools with domestic focus (possibly affecting capital flows indirectly).

I. International Banking Research Network

One of the most recent projects in the area of analysing the spill over effects of macroprudential policy was carried out by the International Banking Research Network (IBRN), which is a group of researchers from fifteen (15) central banks and two (2) international organisations. The IBRN looked at how banks' (international) lending responds to macroprudential policies implemented in home and foreign markets, the inward transmission of the policy changes to the domestic economy as well as the outward spillovers to foreign economies.[55]

Buch and Goldberg (2017), IBRN co-directors, outlined the group research methodology, database and the meta-analysis that generated key cross-country results. The research teams from 15 countries[56] examined the domestic effects on banks' lending[57] and banking activities and international spillovers of prudential instruments using confidential micro-banking data. The BIS and ECB provided cross-country perspectives. The research looked for evidence of international policy spillovers through two channels, i) *inward transmission* examines how foreign regulations affect domestic activities of domestic banks or foreign bank branches or subsidiaries located in the host country and ii) *outward transmission* to foreign economies addresses the effects of foreign policies on the foreign activities of a reporting country's global banks. All country research teams implemented the same baseline regression models for analysing inward and outward transmission. However, each country team addressed specific issues relating to their banking markets or banks' business models, such as capital requirements, etc.[58]

[55] A special issue of the International Journal of Central Banking (March 2017) was published looking at the International Banking Research Network (IBRN) research on the spill over effects of macroprudential policy.
[56] The countries were Canada, Chile, France, Germany, Hong Kong, Italy, Mexico, Netherlands, Poland, Portugal, South Korea, Switzerland, Turkey, the United Kingdom and the United States.
[57] They saw bank lending as the key transmission channel for analysing the spill over effects of macroprudential instruments and this was the dependent variable. Also, since they were interested in analysing the responses of lending to changes in prudential instruments, the baseline model uses (log) changes in loans (growth rate).
[58] Some specification included the credit-to-GDP gap data or domestic credit growth by country in order to test the prudential instruments effects over the credit cycle.

Buch and Goldberg (2017) noted that from a collective analysis of the results from all country research teams, the following are the three main findings. Firstly, macroprudential instrument[59] effects sometimes spill over across borders through bank lending. For instance, Damar and Mordel (2017), the Canadian research team, saw that Canadian banks adjust their international lending in response to macroprudential measures abroad. This effect is significant when capital requirements are tightened and weaker if banks lend mainly via affiliates. However, Hills et al (2017), the UK team, suggested that macroprudential actions taken abroad do not have significant spill over effects on bank lending in the U.K. The effects are more disaggregated sectoral effects, for example, when a foreign authority[60] tightens loan-to-value standards, U.K. affiliates of banks owned in that country expand their lending to U.K. households.

Secondly, the international spillovers vary across macroprudential instruments as discussed in IBRN (2017) (this will be discussed further below in **Section 4.4.2**) and are heterogeneous across banks, such as the effects of macroprudential measures differ across banks based on bank-specific factors like balance sheet conditions and business models as well as business and financial cycles. In Switzerland, Auer et al (2017) saw foreign macroprudential measures, particularly foreign capital regulations do have significant effects on domestic lending growth of banks based on their balance sheet characteristics such as liquidity positions. Similarly, in France, Bussiere et al (2017) indicated that banks' balance sheet characteristics are important for the cross-border transmission of domestic capital regulation.

The BIS (see Avdjiev et al (2017)) saw that the strength of macroprudential effects is affected by balance sheet characteristics, with better-capitalized banking systems and those with more liquid assets and less core deposit funding reacting more to policy

[59] The macro-prudential policy instruments used in this research project are the following: Sector specific capital buffer: real estate credit, Sector specific capital buffer: consumer credit, Sector specific capital buffer: other sectors, Capital requirements, Concentration limit, Interbank exposure limit, Loan-to-value ratio cap, Reserve requirements on foreign currency-denominated accounts and Reserve requirements on local currency-denominated accounts.

[60] In the European Union (EU), the European Central Bank (ECB) monitors developments in the banking sectors of the euro area and the EU as a whole to identify any vulnerabilities and check the resilience of the financial system and as such macroprudential policies implementation are coordinated with other central banks of the Eurosystem and the European System of Central Banks. See https://www.ecb.europa.eu/ecb/tasks/stability/html/index.en.html.

changes. They saw that these banks are able to increase their lending away from the domestic sector to international markets to avoid the effect of a domestic policy. This suggests that there is a weaker effect of macroprudential policy on these banks in their domestic market of operations. In addition, changes in macroprudential policy via loan-to-value limits and local currency reserve requirements have a significant impact on international bank lending. In Germany (see Ohis et al (2017)), business and financial cycles matter for lending decisions.

Thirdly, the international spillovers of macroprudential policy effects on loan growth rates have not been large on average as reported by the countries research teams. Buch and Goldberg (2017) suggested that it could be a case that the results underestimated the full effect of the policy and excluded the adjustments made through the entry and exit of entities in foreign markets and the impact of mergers and acquisitions. Also, the analysis covered a period in which relatively few countries implemented country-specific macroprudential policies, that is, during the period 2000-2014. That said, most studies found that there was a decline in domestic lending following a domestic regulatory tightening, with the domestic effects differing across banks, countries and instruments. This is in line with the existing literature regarding the effectiveness of macroprudential policy on domestic lending and the housing sector, see **Chapter 3** and our empirical results, which draw the same conclusion that macroprudential policy is effective in reducing financial system imbalances as measured by the credit-to-GDP gap.

Overall, Buch and Goldberg (2017) concluded that with the range of experiences with the spill over effects of macroprudential instruments between countries, there is not a one-size-fits-all pattern, and most prudential instruments have been associated with positive or negative spill over effects within or across the transmission channel. The effects are influenced by the characteristics and business model of the financial institutions. They noted that although most of the countries in the research project are advanced countries, they did not observe that the results are systematically different from the few participating emerging market countries.

II. Research based on international banks' lending

Reinhardt and Sowerbutts (2015) constructed a database of macroprudential instruments[61] and examined whether macroprudential regulations affect international banking flows. They categorised macroprudential instruments into three broad categories, i) capital regulation, ii) lending standards (loan-to-value (LTV), debt-to-income (DTI) ratios and underwriting standards) and iii) reserve requirements.[62] They suggested that each measure may have differing implications for banking flows. Using a panel regression of 37 countries, they found that domestic non-bank sectors increase aggregate borrowing from foreign banks after home authorities increase capital requirements. They saw no increase in borrowing from foreign banks after a tightening of lending standards and the results for reserve requirement are inconclusive.

There were also several studies that look at regulatory policy leakage from the perspective of a specific country and lending in the domestic economy. Aiyar et al (2014a), using evidence from the UK, examined the impact of banks' minimum capital requirements on cross-border bank loan supply (lending) in the UK from 1999 to 2006. They found that changes in banks' capital requirements have a negative and significant effect on cross-border lending, but countries with important banking relationships to the UK tend to be affected less. Also, Aiyar et al (2014b) found that regulated banks (UK-owned banks and resident foreign subsidiaries) reduce lending in response to tighter capital requirement but unregulated banks (resident foreign branches) increase lending in response to tighter capital requirements, suggesting competitive advantages.

Houston et al (2012), using the Barth et al (2004, 2006, 2008)[63] database which provides data and measures of bank regulatory and supervisory policies, in more than

[61] They constructed a macroprudential database using information from Lim et al (2011), Borio and Shim (2007), Kuttner and Shim (2013) and International Monetary Fund (2014) being the main sources. Further, they supplemented their data by collecting information from country regulators' websites and financial stability reports, and individual communication with relevant authorities.

[62] They asserted that reserve requirements are typically classified as monetary policy tools for controlling the supply of credit by banks but they contented reserve requirements are similar to liquidity requirements in terms of their economic effects and sometimes used for financial stability purposes and as such have macro-prudential consequences.

[63] The database was updated in 2013 to include 180 countries for the period 1999 – 2011.

100 countries, found in their regression analysis that cross-country differences in regulations have an effect on international banks' flows, where banks transferred funds to markets with less stringent regulation. They noted that regulatory arbitrage, where banks transfer funds between countries to limit their regulatory obligations tend to restrict domestic regulators' ability to limit banks risk-taking. They looked at data from primarily 26 OECD source countries (the source of funds) to 120 recipient countries (recipient of funds) for the period 1996 to 2008. Also, Bremus and Fratzscher (2015), using the updated Barth et al (2013) database and the BIS International Banking Statistics, which cover 15 reporting source countries and 46 recipient countries in a regression analysis, suggested that cross-border flows appear to be influenced by expansionary monetary policy and some flows are driven by regulatory policy where a higher degree of independence and power of the financial regulator in a country encourages cross-border bank lending.

Cetorelli and Goldberg (2010) suggested that global banks played a significant role in the transmission of the 2007-2008 global crisis to emerging market economies. They examined the relationships between adverse liquidity shocks in developed country banking systems and the effect it had on emerging markets in Europe, Asia and Latin America by isolating loan supply from loan demand effects using a difference-in-difference approach (see Khwaja and Mian (2008)). Their analysis looked at 17 source countries (the source of funds) and 94 destination countries (recipient of funds) from three emerging market regions: Latin America (30 countries), Emerging Asia (21 countries) and Emerging Europe (43 countries) over the period 2006 to 2009 using regression analysis. They found that loan supply in emerging markets was significantly affected through three channels, i) a contraction in direct, cross-border lending by foreign banks, ii) a contraction in local lending by foreign banks' affiliates in emerging markets and iii) a contraction in loan supply by domestic banks resulting from funding shock to their balance sheet induced by the decline in interbank, cross-border lending.

Similarly, Polov and Udell (2012), using survey data on over ten thousand loan applicants, found that firms' access to credit (cross-border lending) in 16 emerging European countries was affected by the financial conditions of their banks, particularly foreign owned banks. They found that over the period 2005 to 2008, different types

of financial shock, both positive and negative, on foreign banks as well as domestic banks had a significant impact on business lending to firms in emerging Europe countries.

Finally, Kalemli-Ozcan et al (2013) studies the effect of financial integration (through banks) on the international transmission of country-specific shocks. They examined the role of global banks in transmitting the 2007-2008 global crisis from the U.S. financial markets to the rest of developed world. Using quarterly BIS' Locational Banking Statistics data for 20 advanced countries between 1978 and 2009, they found that in periods without financial crises, increases in bilateral banking linkages are associated with more divergent output cycles and this relationship is weaker during financial turmoil periods. They suggested as well that countries with direct and indirect strong cross-border banking linkages with the U.S. and its main offshore financial centre, for instance Cayman Islands, experienced more synchronised business cycles with the U.S. during the 2007-2008 financial crisis. Similar findings were seen during financial crisis episodes in advanced economics such as the banking crisis in Scandinavian countries in the early 1990s.

4.4.2. Datasets for modelling the spill over effects of macroprudential policies via the credit channel

Our empirical modelling is using three key datasets, two from the BIS – International Banking Statistics (IBS) (cross-border claims) and Credit-to-GDP (CREDITGDP) ratio data and the third dataset, the IBRN Macroprudential Instruments database (Cerutti et al IBRN (2017)).[64]

I. BIS' international banking statistics dataset

In the literature, one of the key datasets for analysing issues such as financial markets interconnectedness, transmission channels for financial crises, and global risk network

[64] See special issue of the International Journal of Central Banking (IJCB) (March 2017) - Cerutti, E., Correa, R., Fiorentino, E. and E. Segalla, "Changes in Prudential Policy Instruments - A New Cross-Country Database."

maps, etc., is the BIS International Banking Statistics (IBS).[65] The IBS, which is publicly available in aggregate form, track internationally active banks' foreign positions and provides a comprehensive picture of total cross-border banks claims. The data are organised in two datasets – locational and consolidated banking statistics.[66]

The Locational banking statistics (LBS)[67] provide information about the currency composition of banks' balance sheets and the geographical breakdown of their counterparties. The LBS were first compiled in the 1960s but the first year of data availability for a country is 1977. They capture outstanding claims and liabilities of internationally active banks located in BIS forty-seven (47) reporting countries[68] against counterparties residing in other countries. The LBS are residence-based data and track the cross-border positions and the local positions in foreign currencies of banks located in a country. Banks record their positions on an unconsolidated basis, including intragroup positions between offices of the same banking group. The data are compiled following principles that are consistent with balance of payments statistics.

The Consolidated banking statistics (CBS) capture the worldwide consolidated positions of internationally active banking groups headquartered in BIS reporting countries. The CBS had their origins in the expansion of international banking activity in the Caribbean and other offshore centres in the 1970s but the first year of data availability for a country is 1983. The CBS track banks' worldwide consolidated gross claims and other exposures to individual countries and sectors, thus providing comparable base measures of national banking exposures to specific country risk. The data include the claims of reporting banks' foreign affiliates but exclude intragroup positions, similarly to the consolidation approach followed by banking supervisors. They detail the transfer of credit risk from the immediate counterparty to the country of ultimate risk (where the guarantor of a claim resides).

[65] See BIS website, https://www.bis.org/statistics/about_banking_stats.
[66] Both datasets are collected under the auspices of the Committee on Global Financial System (CGFS). See CCFS webpage, https://www.bis.org/cgfs.
[67] The LBS capture around 93% of all cross-border interbank business. See BIS Statistical Bulletin March 2018, https://www.bis.org/statistics/bulletin.
[68] See BIS website, https://www.bis.org/statistics/rep_countries.htm.

Both the LBS and CBS datasets are reported to the BIS at an aggregate (banking system) level rather than individual bank level, meaning these datasets do not report micro data, that is individual banks data. For our empirical analysis, we are using the quarterly Consolidated banking statistics from 2000q1 to 2014q4 (reflecting the coverage of the IBRN macroprudential instruments dataset outlined below), and the variable which captures total international banks' claims (CCBTC), that is cross border claims plus local claims in foreign currency plus local claims in local currency. CCBTC includes all instrument types.

II. BIS' domestic credit-to-GDP ratio

A key variable in our PVAR model is domestic credit and this is represented by the BIS' domestic credit-to-GDP ratio. The BIS has constructed credit series for forty three (43) countries, both advanced and emerging countries and one economic area, the Euro zone.[69] The domestic credit-to-GDP ratio represents lending by domestic bank and non-banking institutions credit to residents but excludes cross-border claims (funds raised abroad). The domestic credit ratio is thus different from the credit-to-GDP ratio used in the calculation of the credit-to-GDP gap (see **Chapter 3**) as the domestic credit ratio does not include cross-border claims (funds raised abroad).

Domestic credit represents credit as reported on the balance sheet of depository corporations that form the basis for the compilation of the monetary aggregates and their counterparts. The counterparts cover banks' claims on the private non-financial sector. The private non-financial sector includes non-financial corporations (both private-owned and public owned), households and non-profit institutions serving households as defined in the System of National Accounts 2008.[70] In terms of financial instruments, credit covers loans and debt securities. The series has quarterly frequency and capture the outstanding amount of credit at the end of the reference quarter. The credit series is divided by GDP, which is the four-quarter moving sum of

[69] See BIS website, https://www.bis.org/statistics/totcredit/credpriv_doc.pdf.
[70] This is the international statistical standard for the national accounts, adopted by the United Nations Statistical Commission (UNSC). See https://unstats.un.org/unsd/nationalaccount/sna2008.asp.

nominal GDP.[71] For our empirical analysis, we are using the quarterly data for the period 2000q1 to 2014q4.

We note one data issue, namely that there is no data or it would be difficult to remove local claims that may be included in international banks' claims, these are foreign bank subsidiaries or branches, operating domestically, credit that may be included in domestic credit as well as international banks' claims.[72] Hence there is a degree of overlap with the Consolidated Banking Statistics.

III. IBRN macroprudential instruments dataset

The IBRN dataset on macroprudential instruments covers sixty-four (64) countries for the period 2000 to 2014. This dataset was used by the International Banking Research Network (IBRN) research project teams on analysing the spill over effects of macroprudential policy as well as Carreras et al (2018), who analysed the transmission of macroprudential policies and its effectiveness in reducing asset prices and credit growth.

The macroprudential instruments data are aggregate information from primary sources such as central banks reports, and the IMF's Global Macroprudential Policy Instruments (GMPI) survey conducted by the IMF during 2013. There are five categories of macroprudential instruments in the database which are used to construct nine prudential tools indexes. The five categories are capital buffers, interbank exposure limits, concentration limits, loan-to-value (LTV) ratio limits and reserve requirements. Capital buffers and reserve requirements are divided in four and two sub-indexes respectively. The IBRN dataset omits some categories of macroprudential instruments included in the IMF macroprudential instruments dataset used in **Chapter 3** and **Chapter 5** such as the debt-to-income ratio (DTI), taxes, dynamic loan-Loss provisioning (DP), etc. as discussed in Cerutti et al (2015a, 2017).

[71] When historical data are insufficient to calculate the four-quarter moving sum nominal GDP, the annual data is converted to quarterly data using linear interpolation.
[72] The credit can be foreign or local currency loans issued by these foreign bank subsidiaries or branches.

The IBRN database captures quarterly changes for the nine prudential tools indexes that have been used by policymakers between 2000-2014. Also, it focuses on changes in the intensity in the usage of several widely used prudential instruments by cumulation of policy actions, considering both macroprudential and microprudential objectives. The indexes are coded with the change in a policy tool with a 1 or -1 entry, depending on whether the tool was tightened or loosened in a given quarter. The index equals 0 in those quarters when no changes occur. There is no recorded entry in the database for a given tool if policymakers cannot use that tool. Cerutti et al IBRN (2017) noted the advantage of this type of coding is that it can capture the intensity of a policy change while incorporating qualitative traits form the policy that cannot be measured by a unique numerical statistic.

We use the IBRN database in this chapter over the IMF macroprudential instruments dataset as it captures the changes in the intensity (positive/negative) of the macroprudential instruments, which allow us to analyse the shock of each instrument in the panel-VAR model. The five categories of macroprudential instruments and sub-indexes as well as the cumulative indexes are in the following table.

Table 4.1: IBRN macroprudential instruments dataset

Changes in prudential instruments	
Sector specific capital buffer – real estate credit (sscbres)	Change in sector specific capital buffer: real estate credit. Requires banks to finance a larger fraction of these exposures with capital.
Sector specific capital buffer: consumer credit (sscbcons)	Change in sector specific capital buffer: consumer credit Requires banks to finance a larger fraction of these exposures with capital.
Sector specific capital buffer: other sectors (sscboth)	Change in sector specific capital buffer: other sectors. Requires banks to finance a larger fraction of these exposures with capital.
Capital requirements (capreq)	Change in capital requirements. Implementation of Basel capital agreements.
Concentration limit (concrat)	Change in concentration limit. Limits banks' exposures to specific borrowers or sectors.
Interbank exposure limit (ibex)	Change in interbank exposure limit. Limits banks exposures to other banks.
Loan-to-value ratio cap (ltvcap)	Change in the loan-to-value ratio cap. Limits on loans to residential borrowers.
Reserve requirements on foreign currency (rrforeign)	Change in reserve requirements on foreign currency - denominated accounts.

Reserve requirements on local currency (rrlocal)	Change in reserve requirements on local currency - denominated accounts.
Aggregate indexes	
Sector-specific capital buffers (sscb)	Sum of changes in sector-specific capital buffers across the residential, consumer, and other sectors.
Sum of all country prudential instruments (pruC)	Country index by time t and country c, equal to 1 if the sum of the 9 instruments is >=1 and -1 if the sum of the instruments is <=-1, 0 otherwise.
Sum of all country prudential instruments (pruC2)	Country index by time t and country c, equal to 1 if the sum of the 9 instruments is >=1 and -1 if the sum of the instruments is <=-1, 0 otherwise. In this case, all individual instruments are adjusted to have maximum and minimum changes of 1 and -1.
Cumulative indexes (relative from 2000q1)[73]	
Cumulative change in sector specific capital buffer: real estate credit (cumsscbres)	
Cumulative change in sector specific capital buffer: consumer credit (cumsscbcons)	
Cumulative change in sector specific capital buffer: other sectors (cumsscboth)	
Cumulative change in capital requirements (cumcapreq)	
Cumulative change in concentration limit (cumconcrat)	
Cumulative change in interbank exposure limit (cumibex)	
Cumulative change in the loan-to-value cap (cumltvcap)	
Cumulative change in reserve requirements on foreign currency-denominated accounts (cumrrforeign)	
Cumulative change in reserve requirements on local currency-denominated accounts (cumrrlocal)	
Cumulative change in the aggregate sector-specific capital buffer instrument (cumsscb)	
Sum of the cumulative version of the 9 instruments by country c and time t (cumPruC)	
Sum of the cumulative version of the 9 instruments by country c and time t. In this case, all individual instruments are adjusted to have maximum and minimum changes of 1 and -1 (cumPruC2)	

Source: Cerutti et al (2017). The database covers a sample from 2000 to 2014 with quarterly data.

Our main focus is on prudential instruments that have a significant effect, either positive or negative, on international banks' cross-border activities as measured by international banks' claims. We expect that prudential measures which target banks' capital and liquidity positions will have the greater effect on international banks' claims as this will restrict banks' ability to move assets between countries. Additionally, in emerging markets, prudential measures that has a dual role of protecting the country

[73] The cumulative macroprudential instruments indexes form part of the testing in the panel VAR model but these indexes results were not much different from the individuals macroprudential instruments as such no results for these instruments will be discussed.

foreign reserves and currency exchange rate should have a spill over effect. We expect that capital requirements (CAPREQ), interbank exposure limit (IBEX) and reserve requirements – foreign currency (RRFOREIGN) and local currency (RRLOCAL), etc., should have a greater effect on international banks' claims. This supported by the research of IBRN (2017), Cerutti et al (2015a, 2017), Aiyar et al (2014 a and b), etc., (see **Section 4.4** above). As well, see **Chapter 2** for a presentation of a taxonomy of the macroprudential instruments.

IV. Banks' regulatory capital ratio

As a measure of banking strength and financial stability, the aggregate banking sector regulatory capital ratio is included in the model. Banks' capital ratios are a key part of banking regulation as helping to ensure robustness. The introduction of the Basel Accord, which established rules for banks' regulatory capital ratio, provides a means for varying capital requirements for limiting banks' fragility and financial sector vulnerabilities. There are other tools to measure banking sector fragility and financial sector vulnerabilities. In our model, banks regulatory capital ratio is used as a proxy for banking sector fragility and financial sector vulnerabilities. The measure of banks' regulatory capital ratio we used is the ratio of total regulatory capital to its assets held, weighted according to risk of those assets. The World Bank Global Financial Development Database (GFDD) (version July 2018) provides aggregate banking sector regulatory capital ratio (Čihák et al (2012), World Bank (2017)). This is GFDD series SI.05. The GFDD dataset frequency is annual but it was changed to quarterly data using linear interpolation.

V. Countries included in the panel analysis

Table 4.2. shows the countries that are included in the panel VAR with their respective prudential measures and international banks' claims. The dataset contains quarterly observations for 43 countries which includes 16 emerging market countries and 27 advanced countries which account for more than 90% of the global economy in terms of nominal GDP in 2014. These countries are the same used in **Chapter 3** since we are using BIS' domestic credit-to-GDP ratio, which is produced only for the countries listed in the table below.

Table 4.2: List of countries in the panel analysis

Country	ISO Code	IMF category
Argentina	ARG	EME
Australia	AUS	ADV
Austria	AUT	ADV
Belgium	BEL	ADV
Brazil	BRA	EME
Canada	CAN	ADV
Switzerland	CHE	ADV
Chile	CHL	EME
China (People's Republic of)	CHN	EME
Colombia	COL	EME
Czech Republic	CZE	ADV
Denmark	DEN	ADV
Germany	DEU	ADV
Spain	ESP	ADV
Finland	FIN	ADV
France	FRA	ADV
United Kingdom	GBR	ADV
Greece	GRC	ADV
Hong Kong SAR	HKG	ADV
Hungary	HUN	EME
Indonesia	IDN	EME
India	IND	EME
Ireland	IRL	ADV
Israel	ISR	ADV
Italy	ITA	ADV
Japan	JPN	ADV
Korea	KOR	ADV
Luxembourg	LUX	ADV
Mexico	MEX	EME
Malaysia	MYS	EME
Netherlands	NLD	ADV
Norway	NOR	ADV
New Zealand	NZL	ADV
Poland	POL	EME
Portugal	PRT	ADV
Russia	RUS	EME
Saudi Arabia	SAU	EME
Singapore	SGP	ADV
Sweden	SWE	ADV
Thailand	THA	EME
Turkey	TUR	EME
United States	USA	ADV
South Africa	ZAF	EME

Source: IMF WEO country classification (April 2017), ADV is advanced country, EME is emerging market economy.

4.4.3. Empirical analysis for testing the spill over effects of macroprudential policies via international banks' claims

I. Model specifications and estimation methodology

The starting point for the empirical analysis is the work of International Banking Research Network (IBRN) as mentioned above, who looked at how banks' (international) lending responds to macroprudential policies implemented in home and foreign markets by using OLS regression models for analysing inward and outward transmission of the impact. However, we differ in the modelling approach as we use panel-vector autoregressive (PVAR) analysis and country aggregate macro-level data to analyse the macroprudential measures' impact.

The main advantage of using a panel approach is that it increases the efficiency of the statistical inference, which would otherwise suffer from a small number of degrees of freedom when the VAR is estimated at the country level. Canova and Ciccarelli (2013) noted that panel VAR is built with the same logic as standard VAR yet by adding a cross-sectional dimension, they can be a useful tool to address policy related questions such as the transmission of shocks across borders. Panel VAR can better model the spill over effects from country to another since it can capture country level heterogeneity. Also, Carreras et al (2018) noted that a PVAR can overcome the difficulty of reduced form estimation such as OLS by capturing interaction of policy, real and financial sectors.

Before analysing the extent of spill over effects of macroprudential instruments between countries using international banks' claims (lending activities), we will assess the relationship between domestic credit and international banks' claims, that is, how one variable responds when there is a shock to the other variable and vice versa. Then, we will look at the spill over effects of macroprudential policies between countries and what potential effects these policies can have across borders. The macroprudential instruments will be tested one by one using the baseline PVAR model and the macroprudential instrument is adjudged to have a cross-border spill over effect if it has a significant effect on international banks' claims. Moreover, the macroprudential instruments are considered to have a domestic impact if domestic

credit is mainly affected. The cross-border spillovers and domestic effects can be categorised as being positive or negative.

The PVAR model is given by:

$$X_{i,t} = B(L)X_{it-1} + \varepsilon_{it} \qquad (4.1)$$

where $X_{i,t}$ is a vector of endogenous variable country *i*, B(L) is a matrix polynomial in lag operator, L, with country i = 1,….N (N = 43), t = T (T = 60), and ε_{it} is a vector of idiosyncratic errors.

In the baseline specification, the vector X includes the following variables:

- domestic credit to GDP ratio
- international banks' claims to GDP ratio[74]
- monetary policy interest rate
- the rate of real GDP growth
- the rate of inflation
- banks' regulatory capital ratio

The endogenous variables in the model are domestic credit and international banks' claims, while in addition, following Ciccarelli et al (2010) [75], we include real GDP growth, monetary policy interest rate, and the inflation rate. Banks' regulatory capital ratio is added as a measure of banking strength and financial stability. An exogenous bank crisis variable (BCRISIS) is included in the PVAR, capturing the presence of a banking crisis during the period a country experienced a banking crisis as defined by Laeven and Valencia (2018). It is a dummy variable and it is coded in the quarter the crisis starts until the period it was over.

The macroeconomic data included in the model capture the focus of macroprudential policy (see **Chapter 3**), that is, the area where financial imbalances are mostly to

[74] International banks' claims are divided by GDP to deflate the series.
[75] Using a standard VAR, they looked at the impact of the credit channels on GDP growth and inflation and how changes in monetary policy are transmitted through these channels in the Euro area and the US.

occur, the credit markets and the reason for using such policies as well as the variables that capture economic activities. We look at the impact of the credit (domestic and international lending) on GDP growth, inflation and changes in monetary policy interest rate, see Ciccarelli et al (2010). Table 4.3. shows the list of variables and the data source.

Table 4.3: List of variables and source

Variable	**Source**
Domestic Credit-to-GDP	Bank for International Settlements
International banks' claims to GDP	Bank for International Settlements
Monetary policy interest rate	IMF International Financial Statistics and Bank for International Settlements
Real GDP growth rate	IMF International Financial Statistics
Banks' regulatory capital ratio (capital to risk-weighted assets)	World Bank Global Financial Development Database (GFDD)
Inflation rate	IMF International Financial Statistics
Banking crisis dummy	Laeven and Valencia (2013)

Notes: For some countries, data for certain variables were collected from their central bank and/or national statistical agency. In addition, some data were derived by the author.

II. Descriptive statistics of the model variables

Table 4.4. shows some descriptive statistics of the variables in the model for the period 2000q1-2014q4 (all countries). Note that the data differ from the comparable data in **Chapter 3** as the period there ends in 2013q4. The mean for domestic credit is 81.288% of GDP but there is a large variation in the data as the standard deviation (StdDev) is 42.33%. Also, international banks claims are on average almost as large as domestic credit, but that this is affected by extreme observations from international financial centres (especially Luxembourg), the median for international claims is only half as high as for domestic credit. Argentina experienced deflation in 2014, where the inflation rate fell to -23.9 per cent which is an IMF estimate as there is no official rate but the 2014 values are seen as outliers in the data. In our sample, the average regulatory capital ratio for banking sectors is 14.14%, well above the 8% Basel minimum. See **Chapter 3** for further discussion of the macroeconomic variables.

Table 4.4: Descriptive statistics of the variables in the model for the period 2000q1 to 2014q4 (all countries)

	Monetary policy interest rate	Domestic credit-to-GDP	International Banks' claims-to-GDP	Real GDP growth rate	Banks' regulatory capital ratio	Inflation rate
Mean	4.63	81.28	79.87	2.97	14.14	3.48
Median	3.25	80.65	41.15	2.99	13.57	2.58
Maximum	82.46	229.30	1,371.69	18.85	30.90	70.33
Minimum	-0.25	8.40	3.35	-16.34	2.50	-23.90
StdDev	5.83	42.33	166.65	3.62	2.88	4.94
Observations	2,58	2,57	2,58	2,58	2,52	2,58
Number of countries	43	43	43	43	43	43

Note: The values are in percent except for the observations and the number of countries, which is a number. The data are quarterly values. The variables are in level (not log). StdDev is standard deviation. The variables are in level (not lagged).

Table 4.5 below shows that domestic credit market and international banks' claims are higher in advanced countries than in emerging market economies. Real GDP growth is higher in emerging market economies as indicated above as is inflation. Intuitively, it follows that with higher economic growth and inflation in emerging markets, the monetary policy interest rate may also need to be higher as there is a need to control higher inflation and cool the overheating economy in emerging markets (see **Chapter 3** as well). The average regulatory capital ratio for banking sectors is higher in emerging markets. Yet, it is important to note that some of the large maximum and minimum values for the model variables are the result of political and financial crises in a number of countries (e.g. Argentina, Turkey, Greece, Ireland, Russia, Spain, etc.) and these values can be seen as outliers during the period.

Table 4.5: Descriptive statistics of the variables in the model for the period 2000q1 to 2014q4 (advanced countries and emerging market economies)

	Monetary policy interest rate		Domestic credit-to-GDP		International Banks' claims		Real GDP growth rate		Banks' regulatory capital ratio		Inflation rate	
	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME
Mean	2.48	8.28	99.39	50.95	110.97	27.39	2.14	4.35	13.42	15.38	2.00	5.98
Median	2.00	6.45	93.40	40.45	56.36	19.87	2.32	4.63	12.85	14.97	2.00	4.66
Max	9.90	82.46	229.30	141.60	1,371.69	120.72	18.86	18.57	22.68	30.90	7.47	70.33
Min	-0.25	0.00	23.50	8.40	5.61	3.35	-10.73	-16.34	7.00	2.50	-6.11	-23.90
StdDev	1.87	8.02	35.41	35.00	203.44	20.62	3.19	3.88	2.46	3.12	1.55	7.19
Obs	1,620	960	1,608	960	1,620	960	1,620	960	1,589	934	1,620	960
NosCo	27	16	27	16	27	16	27	16	27	16	27	16

Note: The values are in percent except for the observations and the number of countries, which is a number. The data are quarterly values. The variables are in level (not log). StdDev – standard deviation, Obs – number of observations, NosCo – number of countries, ADV – advanced countries, EME – emerging market economies.

III. Correlation matrix for the variables in the model

Table 4.6 shows that for all countries, none of the variables are highly correlated except for the monetary policy interest rate, which is high positively correlated (Pearson's correlation coefficient) (see Hinkle et al (2003)).[76] See above and in **Chapter 3** for further discussion of the relationship between the macroeconomic variables. Domestic credit has a positive relationship with international banks' claims but a negative relationship with the rate of interest, inflation and real GDP growth. International banks' claims have a positive relationship to banks' regulatory capital.

[76] The rule of thumb for interpreting the size of a correlation coefficient is the following: 0.90 to 1.00 (-0.90 to –1.00) Very high positive (negative) correlation; 0.70 to 0.90 (-0.70 to -0.90) High positive (negative) correlation; 0.50 to 0.70 (-0.50 to -0.70) Moderate positive (negative) correlation; 0.30 to 0.50 (-0.30 to -0.50) Low positive (negative) correlation; 0.00 to 0.30 (0.00 to -0.30) Little if any correlation.

Table 4.6: Correlation matrix for the variables in the model for the period 2000q1-2014q4 (all countries)

	Monetary policy interest rate	Domestic credit-to-GDP	International Banks' claims-to-GDP	Real GDP growth rate	Banks' regulatory capital ratio	Inflation rate
Monetary policy interest rate	1.00					
Domestic credit-to-GDP	-0.44	1.00				
International Banks' claims-to-GDP	-0.14	0.18	1.00			
Real GDP growth rate	0.11	-0.17	-0.07	1.00		
Banks' regulatory capital ratio	0.20	-0.30	0.09	0.12	1.00	
Inflation rate	0.72	-0.38	-0.10	0.13	0.21	1.00

Note: The variables are in level.

Table 4.7: Correlation matrix for the variables in the model for the period 2000q1-2014q4 (advanced countries and emerging market economies)

	MPIR		DC		IBC		GDP		BCR		IR	
	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME	ADV	EME
MIR	1.00	1.00										
DC	-0.12	-0.36	1.00	1.00								
IBC	-0.06	-0.19	0.05	0.28	1.00	1.00						
GDP	0.29	-0.15	-0.13	0.16	0.02	-0.24	1.00	1.00				
BCR	-0.47	0.21	0.03	-0.39	0.28	-0.30	0.07	-0.03	1.00	1.00		
IR	0.32	0.69	-0.11	-0.31	0.03	-0.16	0.14	-0.02	-0.20	0.19	1.00	1.00

Note: The variables are in level. MPIR – monetary policy interest rate, DC - domestic credit-to-GDP, IBC – international banks' claims-to-GDP, GDP - real GDP growth rate, BCR - Banks' regulatory capital ratio, IR – inflation rate, ADV – advanced countries, EME – emerging market economies

Once again, in Table 4.7 above, none of the variables are highly correlated except for the monetary policy interest rate and inflation, which is high positively correlated in emerging markets. As suggested above, this could be due to the higher reported monetary policy interest rate and inflation rate in a number of countries such Argentina, Russia and Turkey, etc., which at some point experienced a political and financial crisis during the period. Also as noted above, emerging market economies

were experiencing higher economic growth than advanced countries, and as such interest rates were used to dampen economic growth and higher inflation growth rate.

IV. Estimation methodology

Following the literature (see Hristov et al (2012)), we estimated the PVAR with the real-GDP growth rate, international banks' claims-to-GDP, the inflation rate, domestic credit-to-GDP and regulatory capital are in logs, while the monetary policy interest rate is expressed in per cent. Woolridge (2006) noted that economic variables measured in monetary values are normally in log form while variables measured in units of time or interest rates are often left in levels. See for example the work of Carreras et al (2018). Similarly, variables that are ratios are often left in that form in empirical work e.g. the unemployment rate. Therefore, we adopted the modelling methodology of Hristov et al (2012), where they look at loan supply shocks during the financial crisis in the Euro area. Further, the variables are estimated in the model as endogenous variables except for the banking crisis, which is an exogenous variable. We control for country fixed and time effects by using dummy variables. The panel VAR is estimated quarterly for the period 2000q1 to 2014q4 using 43 countries (All Countries).

a) Unit Root Tests

An important issue is how to enter variables into the model. We would prefer to have stationary variables for the PVAR. A set of results for panel unit root tests is given in Table 4.8 below, where we see that over 2000q1-2014q4, all the variables are stationary except the log domestic credit variable according the Im-Pesaran-Shin (2003) test (which allows for individual unit root processes between countries).

Table 4.8: Summary statistics of the unit root tests 2000q1-2014q4

Log variable	Im-Pesaran-Shin
International banks' claims to GDP (LNCCBTCTOGDP)	-3.95 (0.00)
Monetary policy interest rate (BANKRATE)	-4.65 (0.00)
Log Banks' regulatory capital ratio (LNREGCAPRATIO)	-2.38 (0.00)
Log Inflation rate (LNINFLATRATE)	-3.90 (0.00)

Log Real GDP growth rate (LNREALGDPRATE)	-10.57 (0.00)
Log Domestic Credit-to-GDP (LNDOMCREDIT)	2.60 (0.99)
Difference of LNDOMCREDIT	-16.23 (0.00)

Note: P-value in parentheses

Ashley and Verbrugge (2009) suggested that modelling even in the presence of a non-stationary series is appropriate in the context of impulse response function that are robust and the misspecification danger from possible over differencing clearly outweighs the danger of spurious regression. Similarly, Fanchon and Wendel (1992) indicated that VAR models estimated with non-stationary series yield consistent parameter estimates especially when the non-stationary data is also cointegrated. Ludvigson (1998) notes that even in the case where some variables may be non-stationary, a VAR in levels will have standard asymptotic distributions. Therefore, we included the non-stationary LNDOMCREDIT in the PVAR model and a separate robustness test was completed using the variable in first differenced. Note that given we have stationary variables, a simple VAR is appropriate as opposed to a cointegrating vector-error-correction model as employed in Carreras et al (2018).

b) PVAR lagged order selection

We applied the Akaike information criterion (AIC) (1974) and the Schwarz information criterion (SIC) (1978) to determine the lag order of the PVAR models. The two criteria are very similar but arise from very different assumptions. The AIC is derived from information theory and it is designed to pick the model that produces a probability distribution with the smallest discrepancy from the true distribution, that is, it minimizes the loss of information. Similar to the AIC, the SIC is also based on information theory but it is set within a Bayesian model selection criterion (see Fabozzi et al (2014)).

Table 4.9 below shows the lag order results using the AIC and SIC. The results show that AIC recommends a lag order selection of 6 lags, while SIC reported a 2-lag order selection. In addition, the autoregressive (AR) roots polynomial results for both the AIC and SIC show that both order lag sections criteria satisfy the PVAR stability condition as all roots have modulus less than one and lie inside the unit circle.

Table 4.9: Lag-order selection statistics for Panel VAR (all Countries)

Endogenous variables (all in logs except monetary policy interest rate): Inflation rate, Monetary policy interest rate, Domestic credit, International banks' claims, Banks' regulatory capital ratio and Real GDP growth rate.		
Exogenous variables: Banking crisis dummy, Country dummy for fixed and time effects.		
Included observation: 1140		
Lag	AIC	SIC
0	12.636	12.689
1	-7.968	-7.755
2	-8.886	-8.515*
3	-8.953	-8.423
4	-8.980	-8.291
5	-9.118	-8.269
6	-9.275*	-8.267
7	-9.256	-8.089
8	-9.255	-7.929

* indicates lag order selected by the criterion. AIC: Akaike information criterion. SC: Schwarz information criterion.

In the research literature, Koehler and Murphree (1988), using 91 times series data from the Makridakis competition (1982), found that AIC procedure tends to overfit the data and choose higher order models for empirical analysis. They found that SIC is a better criterion to use. Similar results were found by Hannan (1982) and Geweke and Meese (1981). Moreover, Yang (2005) acknowledged that BIC is consistent in selecting the true model, yet, AIC may be better than BIC in case of multivariate regression analysis. However, Burnham and Anderson (2011) provided theoretical arguments in favour of AIC.

Intuitively, if the PVAR satisfies the stability condition at a lower lag, in this case at lag 2, all subsequent higher lags should all satisfy the stability condition as well. We will discuss the baseline PVAR model results mainly using the 2-lag order section criterion model. In discussion of the macroprudential results, we will first review the results from the 2-lag order section criterion model and then as a robustness checks, we will assess the results using the 6 lags order selection model before drawing a conclusion on the cross-border effects of macroprudential instruments.

Nevertheless, this will require further investigation and analysis of the estimation method and how cross countries effects are dealt with in the PVAR model for all

countries as when the PVAR is estimated for advanced countries and emerging market economies, both the AIC and SIC are indicating two lags. This could be a topic for future research.

c) Identification of structural shocks

The premise of the empirical analysis is to provide an analysis of the spill over effects of macroprudential policy, which will aid in the understanding of the interconnectedness of financial markets via international banks' claims (lending activities). The main focus of macroprudential policy to date is to prevent the build of imbalances in the credit market, mainly affecting domestic banking and household sectors. For the identification of the macroprudential policy shocks, we use the IBRN Macroprudential Instruments dataset as discussed above, which captures quarterly changes for the nine prudential tools indexes that have been used by policymakers between 2000 to 2014. For further information of the dataset, see IBRN Macroprudential Instruments dataset as discussed above for the description of macroprudential policy.

We follow common practice and identify shocks using recursive identification (through the Cholesky decomposition), with the variables ordered as follows, inflation, monetary policy rate, domestic credit, international banks' claims, bank regulatory capital ratio and real GDP growth. The logic of the chosen Cholesky ordering is to start with the response of monetary policy authority to inflation rate as price stability is recognised as the primary objective of monetary policy and a number of countries have adopted an inflation targeting framework (see Hammond (2012)). The assumption is that the best that monetary policy can do to support the long-term growth of the economy is to maintain price stability (see Jahan (2017)), such that when the inflation rate moves away from the target inflation rate, monetary policy rate is adjusted. This in turn affects the cost of credit (domestic credit), international banks' claims, bank regulatory capital ratio and then the GDP growth rate, where there is expected to be a lagged effect on GDP growth. We note that not all monetary authorities have an inflation targeting monetary policy regime, where the monetary authority has an explicit publicly announced target inflation rate for the medium term. However, in most countries price stability remains the primary objective of monetary policy which can also include other

goals such as economic growth and employment. Accordingly, we ordered the variables as discussed above using Cholesky decomposition.

4.4.4. Estimated results for analysing the relationship between domestic credit and international banks' claims

I. Impulse responses to domestic credit and international banks' claims for the period 2000q1-2014q4 (all countries, 2 lags PVAR model)

Before presenting the results analysing the spill over effects of macroprudential policies using international banks' claims (lending activities), we discuss the impulse responses and variance decomposition of the baseline PVAR model, looking at the relationship between domestic credit (DOMCREDIT), international banks' claims (CCBTCTOGDP), and the domestic economy.[77] As mentioned previously, in order to assess the spill over effects of macroprudential policy, it is important to establish whether there is a relationship between international banks' claims and the domestic economy.

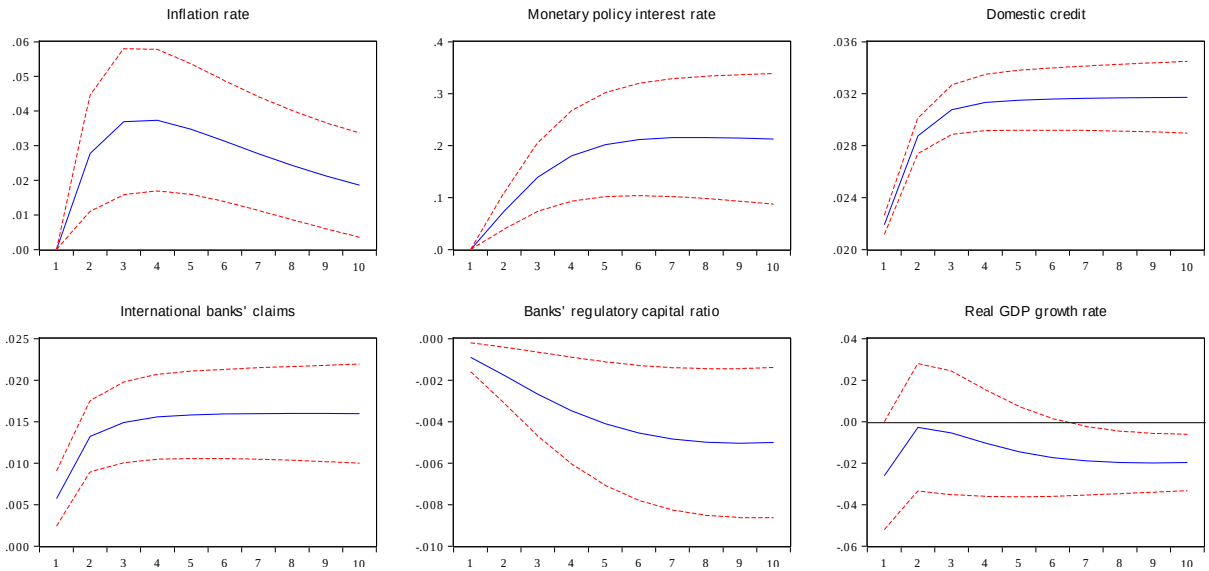
We assess the effects of domestic credit and international banks' claims on macroeconomic and banking variables – inflation rate, monetary policy interest rate, real GDP growth rate and banks' regulatory capital ratio over the period 2000q1 to 2014q4 since in the empirical literature, credit has been the focus of macroprudential policy and also a key early warning indicator. Impulse response functions were estimated from the six-variable panel vector autoregression model (PVAR), as discussed above.

The results for the impulse response functions to domestic credit and international banks' claims are presented in the following figures. In Figure 4.3 below, the effects of a one-standard-deviation shock to domestic credit has a positive and significant effect on the inflation rate, the monetary policy interest rate and international banks' claims. The positive impact on the inflation rate is about 0.04 point after 3 quarters,

[77] The results discussion is based on using the 2-lag order selection PVAR model. The results for the 6-lag order selection model is available from the author on request.

while the monetary policy interest rate rises to, up to 0.22 point after 8 quarters. Accordingly, credit growth is shown to accompany procyclical price pressures, and no doubt partly for this reason, monetary policy is shown to respond to domestic credit growth, also potentially complementing the effect of macroprudential policies.

Figure 4.3: Response of macroeconomic and banking variables to a shock to domestic credit for the period 2000q1-2014q4 (all countries, 2 lags PVAR model)



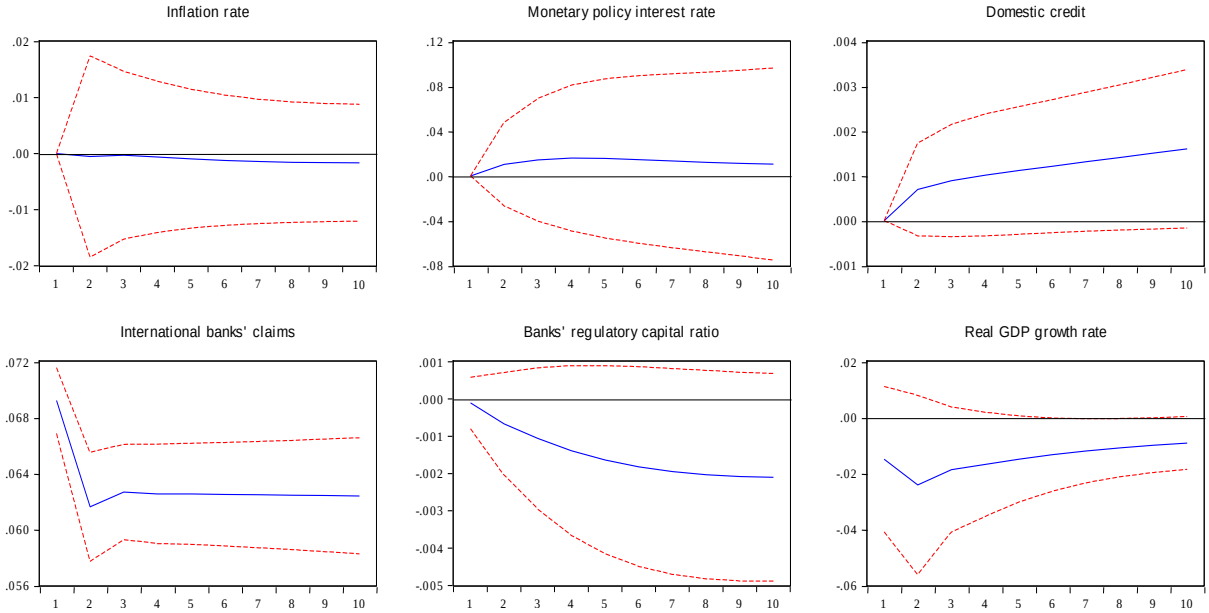
Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2000q1 to 2014q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

There is a positive and significant effect on international banks' claims up to the tenth quarter, increasing as much as 0.017 point, which shows the positive relationship between domestic credit and international banks' claims. Also, it suggests the ease in which domestic borrowers can access the international capital markets and substitute cheaper international credit for more costly domestic borrowing as domestic interest rates rise. Yet, it is critical to note that there is a partial overlap as discussed above, which may also partly explain the effect on international credit.[78] Meanwhile, there is a significant and negative effect of domestic credit on regulatory capital ratios,

[78] It would be difficult to remove domestic credit (local claims) that may be included in international banks' claims, these are foreign bank subsidiaries or branches, operating domestically, credit that may be included in domestic credit as well as international banks' claims. The credit can be foreign or local currency loans issued by these foreign bank subsidiaries or branches. The credit can be foreign or local currency loans issued by these foreign bank subsidiaries or branches.

which suggests lax regulation during at least part of the period (and inversely the tightening of Basel III during a period of subdued credit growth). Meanwhile, there is no continuous significant effect of GDP growth, although there is a negative effect on GDP growth from the sixth quarter.

Figure 4.4: Response of macroeconomic and banking variables to a shock to international banks' claims for the period 2000q1-2014q4 (all countries, 2 lags PVAR model)



Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2000q1 to 2014q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

The effects of one-standard-deviation shock on international banks' claims on the variables are shown in Figure 4.4 above. Overall, international banks' claims do not have a significant effect on the macroeconomic variables and banks' regulatory capital ratio, except for real GDP growth. There no continuous significant effect on real GDP growth but negative effects in the mid to longer term periods. This could reflect the fact that international lending is highly cyclical and may accordingly precede a downturn. This apart, the result suggests there is no significant spill over effect of international banking activities in the domestic economy. The lack of effect on domestic credit suggests that on average the domestic banking sector is not reliant on international markets for funds and is thus less likely to be affected by any potential international financial disturbance for the host country, such as a disruption to

international liquidity market (Goldberg (2009)). Further, this may suggest in advance that macroprudential policy has no spill over effects via international banks' claims. We will explore this further below.

In the term of pre-crisis (2000q1-2006q4) and post-crisis (2007q1-2014q4), the impact of a shock on domestic credit (see **Appendix Figures 4A.1 and 4A.2**) on the economic and banking variables is weaker in the post-crisis period which we suggest may be due to the financial crisis and subsequent recession especially in advanced countries. In the pre-crisis period, there is a positive and significant effect on inflation, the monetary policy interest rate, international banks' claims and economic growth. The domestic credit shock impacts on banks' regulatory capital ratio is negative and significant in the pre-crisis period, which could be due to Basel II new capital requirements and increasing competition. In the post-crisis period, there is positive and significant effect on monetary policy interest rate and international banks' claims. The effect on economic growth is significant and negative in the post-crisis period, while the effect on banking sectors' regulatory capital ratios is insignificant.

In term of international banks' claims (see **Appendix Figures 4A.3 and 4A4**), the effects of a shock to international banks' claims are only significant on banks' regulatory capital ratio in the pre-crisis period (2000q1-2006q4) and inflation rate in the post-crisis period (2007q1-2014q4). There is a negative and significant impact on banks' regulatory capital ratio in the pre-crisis (2000q1-2006q4) period, which could be the effect of the new regulatory capital requirement (Basel II Accord). In the post-crisis period (2007-2014), the impact of a shock on international banks' claims is stronger and significant on the rate of inflation than in the pre-crisis period (2000-2006), where the effect is positive. Once again, there is no significant relationship between international banks' claims and the domestic economy, further highlighting that there may be no spill over effects of macroprudential policy via international banks' claims.

Table 4.10 below shows the result summary of the effects of a shock to domestic credit and international banks' claims on the macroeconomic and banking variables (All countries). From the table, it seems in the current sample that international banks claims' do not really have a significant effect on the domestic economy except for

banks' capital, which suggest capital flows are affected by changes in international banks' claims.

Table 4.10: Summary statistics of the effects of a shock to domestic credit and international banks' claims on the macroeconomic and banking variables (all countries)

	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
Domestic credit						
2000q1-2014q4	+	+	+	+	-	-
2000q1-2006q4	+	+	+	+	-	+
2007q1-2014q4	o	+	+	+	o	-
International banks' claims						
2000q1-2014q4	o	o	o	+	o	-
2000q1-2006q4	o	o	o	+	-	o
2007q1-2014q4	+	o	o	+	o	o

Note: + positive and significant effect; - negative and significant effect; o insignificant effect. The frequency is quarterly.

II. Variance decomposition of credit and international banks' claims (all countries, 2 lags PVAR model)

In order to assess the importance of the domestic credit and international banks' claims shocks, we also present the variance decomposition analysis for up to 10 quarters, using the same Cholesky order (inflation, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate). The forecasted error variance decomposition shows the contribution of the variation of one variable that is explained by a shock (one standard deviation) in another variable, the effect over time. Tables 4.8 shows the percentage of variation of the variables that are explained by domestic credit and international banks' claims shocks over the period 2000q1-2014q4 (see **Appendix Table 4A.1**).

In Table 4.11 below, the forecasted error variance decomposition shows that the contribution of the unexpected domestic credit and international banks' claims shocks are rather unresponsive in the early periods but increase over time. These results are in line with the impulse response functions as a domestic credit shock tends to have stronger accumulated impact on the variables than an international banks' claims shock. As noted above with the impulse response functions, domestic credit has a strong impact on international banks' claims, which suggest the ease in which domestic borrowers can access the international market and substitute more costly domestic borrowing for cheaper international credit as domestic interest rates rise, as suggested by the increase in interest rate. See **Appendix Tables 4A.1, 4A.2 and 4A.3** for the forecasted error variance decomposition discussion for the periods (2000q1-2014q4, 2000q1-2006q4 and 2007q1-2014q4).

Table 4.11: Forecasted error variance decomposition of the variable explained by domestic credit and international banks' claims shocks for the period 2000q1-2014q4 (all countries, per cent)

Variable	Domestic credit			International banks' claims		
	Quarter			Quarter		
	1	5	10	1	5	10
Inflation rate	0.00	1.10	1.41	0.00	0.00	0.01
Monetary policy interest rate	0.00	1.06	1.44	0.00	0.00	0.00
Domestic credit	99.72	97.93	94.00	0.00	0.05	0.08
International banks' claims	0.86	4.59	5.36	99.65	94.01	91.11
Banks' regulatory capital	0.35	0.75	1.08	0.01	0.14	0.20
Real GDP growth rate	0.22	0.15	0.38	0.08	0.27	0.32

Note: Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate. The table shows the contribution effect domestic credit and international banks' claims have on the other variables. The total will not add up to 100%.

The forecasted error variance decomposition results provide further evidence that there may be no spill over effects of macroprudential policy via international banks' claims.

4.4.5. Estimated results for analysing the spill over effects of macroprudential policies using international banks' claims for the period (all countries, 2 lags PVAR model)

In analysing the spill over effects of macroprudential policies using international banks' claims channel, the macroprudential instruments were tested one by one using the baseline PVAR models (all countries). The cumulative macroprudential instruments indexes form part of the testing in the VAR model but these indexes results were not much different from the individual's macroprudential instruments that made up the cumulative indexes. Also, in some cases the PVAR model did not satisfy the stability condition that no AR root lies outside the unit circle, so the results for these instruments are not presented.[79]

Each macroprudential instrument was added as an endogenous variable, which allow for the measuring of the impact of a change in the instrument on the other variables in the model. This endogeneity suggests that macroprudential instruments are explained by the relationship to the other variables in the model. As discussed above, the nature of macroprudential policy to date is to prevent the build of imbalances in the credit market, mainly affecting domestic banking and household sectors. As such, the operation of macroprudential policy is based on responding to increasing credit demands (a positive credit shock). Therefore, the inclusion of domestic credit and international banks' claims (lending activities) in the model should suggest that the macroprudential instruments can be treated as endogenous variable in a model as the usage of these instruments are influenced by credit conditions.

As before, the impulse response functions were estimated using the baseline PVAR models (all countries) with the macroprudential instrument included and controlling for country fixed and time effects and financial crises during the period using the Cholesky decomposition. The variables are ordered as follows, the inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate and the macroprudential instrument. The logic of the ordering is as before, but we see macroprudential policy as responding to

[79] Results are available from the author on request.

procyclicality, and hence it comes after both types of credit and GDP growth. The assumption is also that the effect of such policies is likely to be lagged (as typically found in the literature). The ordering also assumes that monetary policy is a key part of the background to macroprudential policy decisions.

Similar to the research literature such as IBRN (2017), Cerutti et al (2017), Aiyar et al (2014 a and b), etc., the analysis focuses mainly on the macroprudential instruments that have a noteworthy effect on the international banks' claims (spill over effect) and domestic credit (domestic effect). A macroprudential instrument is adjudged to have a spill over effect if it has an effect on international banks' claims after analysing both the impulse response function and variance decomposition results. Moreover, the macroprudential instruments are considered to have a domestic impact if domestic credit is mainly affected. The cross-border spillovers and domestic effects can be categorised as being positive or negative.

As mentioned above, we expect that prudential measures which target banks' capital and liquidity positions will have the greater effect on international banks' claims as this will restrict banks' ability to move assets between countries. Additionally, in emerging markets, prudential measures that has a dual role of protecting the country foreign reserves and currency exchange rate should have a spill over effect. We expect that capital requirements (CAPREQ), interbank exposure limit (IBEX) and reserve requirements – foreign currency (RRFOREIGN) and local currency (RRLOCAL), etc., should have a greater effect on international banks' claims.

Yet, it is important to bear in mind some potential effects are not fully captured in the VAR models such as the underlying impact of quantitative easing, fiscal policies, asset prices etc. Also, it seems that macroprudential instruments were designed to work in a period of relative financial stability or assist in the prevention of financial instability and may have a more limited effect during an actual financial crisis, as other policy objectives were given priority. This is an area where further research is warranted and as indicated we will look at it in **Chapter 5** where we analyse the potential effects of macroprudential policies on banks' profitability and activities as well as we look at the relationship between macroprudential policy and monetary policy.

I. Summary results of the impulse responses functions and variance decomposition of the macroprudential instruments for the period 2000q1-2014q4 (all countries, 2 lags PVAR model)

Overall in the period 2000q1-2014q4[80], none of the macroprudential instruments including the aggregate indexes had any significant effects on international banks' claims. As mentioned above, we expected that prudential measures which target banks' capital and liquidity positions will have the greater effect on international banks' claims as this will restrict banks' ability to move assets between countries. Yet, the results do not show this and discussed in **Section 4.4.4**, the inability to establish a significant relationship between international banks' claims and the domestic economy, suggest in advance that there is no spill over effects of macroprudential policy via international banks' claims.

On balance, our empirical results show that individual macroprudential measures in one country will not generate significant spill over effects into another country. This result is in line with the general observation of the IBRN (2017), which suggested that macroprudential measures effects sometimes spill over across borders through bank lending but that it varies by country depending on factors such as the financial openness of the country's financial system, the business and financial cycle and the characteristics of banks' balance sheets. Yet, IBRN (2017) suggested that macroprudential policy effects on international banks loan growth are not very large. See Table 4.12 below for the summary results.

[80] The results for the pre-crisis (2000-2006) and post-crisis (2007-2014) periods are not presented as they don't change the analysis for full sample period 2000-2014. The results are available from the authors on request.

Table 4.12: Summary statistics of PVAR model (with 2 lagged order selection) variables to a shock to the macroprudential instruments for the period 2000q1-2014q4 (all countries)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	o	o	o	o	o	o
SSCBCONS	o	o	o	o	o	o
SSCBOTH	o	+	o	o	o	o
CAPREQ	na	na	na	na	na	na
CONCRAT	o	+	o	o	o	o
IBEX	na	na	na	na	na	na
LTVCAP	na	na	na	na	na	na
RRFOREIGN	o	o	+	o	o	o
RRLOCAL	o	+	o	o	o	o
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	o	+	o	o	o	o
PRUC2	o	+	o	o	o	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect, na – not applicable as the PVAR does satisfy the stability condition. See **Appendix 4A.4** for the impulse response functions figures.

Other significant results to highlight are from Table 4.12 above, where we find foreign currency reserve requirements ((RRFOREIGN) have a significant and positive effect in domestic credit growth. This may be attributed to a potential switch to domestic loans by banks when such requirements are imposed. It remains important to note these results for credit growth should not be taken in isolation, as there remains an impact of macroprudential policies on the other macroeconomic variables in the PVAR which is not captured in single equation studies. As suggested in the macroprudential policy literature, some macroprudential instruments may be more effective than others as well as affecting the macroeconomy differently (see **Chapter 3**).

Local currency reserve requirements (RRLOCAL) had a positive and significant effect on monetary policy, which suggest the dual role, as an instrument for macroprudential regulation and monetary policy especially in emerging market economies. The loan-

to-value ratio cap (LTVCAP) and interbank exposure limit (IBEX) when included in the model resulted in an unstable PVAR, where the PVAR does not satisfies the stability condition and at least one root lies outside of the unit circle of the AR polynomial. One possible reason for the unstable VAR is that some of these macroprudential instruments have not been used by a number of countries or only infrequently.

Local currency reserve requirements variables (RRLOCAL), concentration limits (CONCRAT) and sector specific capital buffer: other sectors (SSCBTH) have a positive effect on the monetary policy interest rate but the long-term effect for economic growth is insignificant, which suggest that the strong positive effect on the monetary policy interest rate, outweigh the benefit of the increase in domestic credit. Yet, we can ignore the dual role of reserve requirements as an instrument of monetary policy and of macroprudential policy notably in many emerging markets as such it may difficult to interpret the results for these instruments.

The aggregate indexes, PRUC and PRUC2 have a positive effect in the monetary policy interest rate. PRUC and PRUC2 are composite aggregate prudential indexes, derived information from the set of individual prudential instruments and the results accordingly do not indicate which combination of prudential instruments are causing the impact.

We conclude from the results that macroprudential policies applied to date tended to have a more domestic effect rather that an international, cross border effect.

II. Advanced countries versus emerging market economies summary results

We then investigated the differences in spill over effects of macroprudential policies[81] using international banks' claims between advanced countries and emerging market economies. We are interested to see if the results would be different based on the

[81] As noted above, the cumulative macroprudential instruments indexes form part of the testing in the panel VAR model for both advanced countries and emerging market economies but in some cases the index results were not much different from the individual macroprudential instruments or the VAR was unstable as such no results for these instruments will be discussed.

countries characteristics, advanced countries versus emerging market economies. In addition, Cerutti et al (2017) indicated that emerging markets use macroprudential policies more frequently than advanced countries and there tends to be a weaker effectiveness of macroprudential instruments in more developed and more financially open economies, suggesting some avoidance and/or disintermediation. Further, they suggested advanced countries use more borrower-based policies which specifically target the consumer spending and the real estate market while emerging markets focus on foreign exchange policies, suggesting the dual objective of stabilising the country foreign exchange market.

As such, the focus of the analysis for advanced countries will be borrower-based policies[82], such as sector specific capital buffers and capital requirements and the effect these macroprudential instruments has on the macroeconomic and banking variables. The period of analysis will be the 2007q1-2014q4 period since not many advanced countries used macroprudential instrument prior to the 2007-2008 financial crisis. For emerging market economies, the focus will be on the foreign exchange policies such as reserve requirements on currency (foreign and local), loan-to-value cap as these instruments have been used the most by countries in the sample.

The baseline PVAR model (2 lags) was used to analyse the spill over effects of macroprudential policies for twenty-seven advanced countries and sixteen emerging market economies.

a) Advanced countries analysis for the period 2007q1-2014q4

The impulse response functions for the macroprudential instruments[83] (see **Appendix Figure 4A.5**) show that none of the borrower-based policies measures or other macroprudential instruments, including the aggregate indexes had any significant

[82] The addition of some macroprudential instruments to the advanced countries baseline model resulted in an unstable VAR, where PVAR does not satisfies the stability condition and at least one root lies outside of the unit circle of the AR polynomial such as loan-to-value cap (ltvcap). One possible reason for the unable VAR is that some of these macroprudential instruments have not been used by a number of countries or infrequent.

[83] The impulse response functions and variance decomposition for the macroprudential instruments for the periods 2000q1-2014q4 and 2000q1-2006q4 are available from the author on request. The impulse responses suggest that most of the significant effects arise from the later period as there are very few significant impulse responses for the 2000q1-2006q4 period.

effects on international banks' claims, which suggest that there is no spill over effects between advanced countries over the period 2007q1-2014q4. This is in line with the all countries modelling results in Table 4.12.

Of interest for advanced countries, capital requirements (CAPREQ) have a negative effect on inflation and domestic credit, which for advanced countries has a negative and significant effect on economic growth. The reserve requirements variables, foreign currency (RRFOREIGN) had a positive effect on the monetary policy interest rate, yet local currency requirements (RRLOCAL) has a positive and significant on economic growth, which suggest that strong positive effect of domestic demands outweigh the effect of high interest rates. Please see Table 4.13 below for summary results.

Table 4.13: Summary results of the PVAR model (with 2 lagged order selection) variables to a shock to the macroprudential instruments for the period 2007q1-2014q4 (advanced countries)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	o	o	o	o	o	o
SSCBCONS	o	o	o	o	o	o
SSCBOTH	o	o	o	o	o	o
CAPREQ	-	o	-	o	o	-
CONCRAT	na	na	na	na	na	na
IBEX	na	na	na	na	na	na
LTVCAP	na	na	na	na	na	na
RRFOREIGN	o	+	o	o	o	o
RRLOCAL	o	o	o	o	o	+
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	o	o	o	o	o	o
PRUC2	o	o	o	o	o	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect, na – not applicable as the PVAR does satisfy the stability condition. See **Appendix 4A.5** for the impulse response functions graphs.

b) Emerging market economies analysis

Table 4.14 below shows the macroprudential policy summary results for merging market economies over the period 2007q1 to 2014q4.

Table 4.14: Summary statistics of PVAR model (with 2 lagged order selection) variables to a shock to the macroprudential instruments for the period 2007q1-2014q4 (emerging market economies)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	o	o	o	o	o	o
SSCBCONS	o	o	o	o	o	o
SSCBOTH	o	o	o	o	o	o
CAPREQ	o	o	o	o	o	o
CONCRAT	o	o	o	o	o	o
IBEX	o	o	o	o	o	o
LTVCAP	o	o	o	o	o	o
RRFOREIGN	o	o	+	o	o	+
RRLOCAL	o	+	o	+	o	o
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	o	+	o	o	-	o
PRUC2	o	+	o	o	-	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect. See **Appendix 4A.6** for the impulse response functions figures.

In emerging market economies for the period 2007q1-2014q4[84], the impulse response functions for the macroprudential instruments (see **Appendix 4A.6**) show that changes in local currency reserve requirements (RRLOCAL) had a significant and positive effect on international banks' claims. This suggests that there is some positive spill over effects in emerging markets. The purpose of reserve requirement is to have

[84] The impulse response functions and variance decomposition for the macroprudential instruments for the periods 2000q1-2014q4 and 2000q1-06q4 are available from the authors on request. The impulse responses suggest that most of the significant effects arise from the later period as there are very few significant impulse responses for the 2000q1-2006q4 period.

financial firms holding more cash, thus affecting their abilities to lend, etc. Hence in most cases the effect on domestic credit should be negative. Yet, there is no significant effects were detected on domestic credit, which suggest capital portfolio flows are attracted to higher returns in the domestic market on account of high interest rates (see Ahmed and Zlate (2014)). However, one needs to keep in mind the dual role of reserve requirements as an instrument of monetary policy and of macroprudential policy notably in many emerging markets. As such, there is some difficulty in interpreting this result for reserve requirements. Nevertheless, we did expect reserve requirements to have a significant effect on international banks' claims.

In addition, RRLOCAL effects on banks' regulatory capital is negative and significant, suggesting that banks offset the cost of reserve requirements with less capital, potentially offsetting the benefit to financial stability. As well, it can suggest competition by the banking sector to attract the capital portfolio flows. A similar negative effect on capital is found in the aggregate macroprudential measures PRUC and PRUC2. Foreign currency reserve requirements (RRFOREIGN) had a positive and significant effect on domestic credit and economic growth. Yet, there may be more a focus on managing the foreign exchange rate and not the domestic economy when there is a restriction on the inflow and outflow of capital (see Cerutti et al (2017)).

In the full sample period, 2000q1-2014q4, of interest is that in the longer-term loan-to-value cap (LTVCAP) has a negative and significant effect on domestic credit. See Table 4.15 below for the summary results. This instrument has a direct effect on people's ability to borrow, as they are determined by one's income level, debt outstanding and the value of the asset, thus having a strong effect on credit growth. As such, it has become one of the most common macroprudential instruments for reducing credit growth since the 2007-2008 financial crisis, as cited by studies such as Crowe et al (2011), Claessens et al (2014), Carreras et al (2018), Cerutti et al (2017). However, Jácome and Mitra (2015) suggested that although LTVCAP is effective in reducing loan-growth, it is not always the case in curbing house prices growth.

Table 4.15: Summary statistics of PVAR model (with 2 lagged order selection) variables to a shock to the macroprudential instruments for the period 2000q1-2014q4 (emerging market economies)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	o	o	o	o	o	o
SSCBCONS	o	o	o	o	o	-
SSCBOTH	o	o	o	o	o	o
CAPREQ	o	o	o	o	o	o
CONCRAT	o	+	o	o	o	o
IBEX	o	o	o	o	o	o
LTVCAP	o	o	-	o	o	o
RRFOREIGN	o	o	+	o	o	o
RRLOCAL	o	o	o	o	o	o
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	o	+	+	o	o	o
PRUC2	o	o	o	o	o	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect. See **Appendix 4A.6** for the impulse response functions figures.

4.5. Robustness checks

4.5.1. Lag order selection (all countries, 6 lags PVAR model)

As discussed above, the Akaike information criterion (AIC) and the Schwarz information criterion (SIC) determined two difference lag order selection of the PVAR models. AIC suggested 6-lags while SIC indicated 2 lags. Koehler and Murphree (1988) noted that AIC procedure tends to overfit the data and choose higher order models for empirical analysis and they suggested that SIC is a better criterion to use. Similarly, Yang (2005) acknowledged that BIC is consistent in selecting the true model. As such we robust check the 2 lagged order selection PVAR model estimates with the PVAR models with 6 lagged order selection and the macroprudential instruments test results can be seen in Table 4.16 below.

The results in Table 4.16 suggests that over the period 2000q1-2014q4, local currency reserve requirements (RRLOCAL) had a significant and negative effect on international banks' claims but it is insignificant on domestic credit. Also, RRLOCAL had a positive and significant effect on banks' regulatory capital. Similarly, in terms of the aggregate indexes, the sum of all of a country's prudential instruments (PRUC and PRUC2) have a negative and significant effect on international banks claims as well as a positive and significant effect on banks' regulatory capital. In comparison to the PVAR models with 2 lagged order section results, RRLOCAL and the aggregate indexes only had a significant and positive effect on the monetary policy interest rate and insignificant effects on international banks claims. Thus, the 6 lagged order selection model result is not in line with the 2 lags order selection model for all countries (see Table 4.12 above).

Table 4.16: Summary statistics of PVAR model (with 6 lagged order selection) variables to a shock to the macroprudential instruments for the period 2000q1-2014q4 (all countries)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	-	o	o	o	o	o
SSCBCONS	o	o	o	o	o	o
SSCBOTH	o	+	o	o	o	o
CAPREQ	na	na	na	na	na	na
CONCRAT	o	o	o	o	o	o
IBEX	o	o	o	o	o	o
LTVCAP	na	na	na	na	na	na
RRFOREIGN	o	o	+	o	o	o
RRLOCAL	o	+	o	-	+	o
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	o	+	o	-	+	o
PRUC2	o	+	o	-	+	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect, na – not applicable as the PVAR does satisfy the stability condition. See **Appendix 4A.7** for the impulse response functions graphs.

However, as we discussed above, we cannot ignore the dual role of reserve requirements as an instrument of monetary policy and of macroprudential policy notably in many emerging markets, and as such it may difficult to interpret the results for these instruments. On the balance of the empirical results in Tables 4.12 and 4.16, we show that most individual prudential measures in one country will not generate significant spill over effects into another country and the macroprudential instruments mostly affect the domestic financial sector and economy. This result is in line with the general observation of the IBRN (2017).

4.5.2. First differenced domestic credit (all countries, 2 lags PVAR model)

A second robustness check is the stationarity of the domestic credit variable. Table 4.17 shows the summary results when the domestic credit is first differenced and included in the model. In order to achieve a stable PVAR model, we made an adjustment to the baseline model as we included the log variant of the monetary policy interest rate. Once again, the results suggest that prudential measures in one country will not generate significant spill over effects into another country as none of the individual macroprudential instruments have any effect on international banks' claim, which is consistent with Table 4.12 all countries modelling results.

Of interest, capital requirements (CAPREQ) had a negative and significant effect on the rate of inflation, the interest rate, domestic credit and also GDP growth, which suggests domestic banks' lending was restricted with the new capital requirements, with wider macroeconomic effects.

Table 4.17: Summary statistics of PVAR model (with first differenced domestic credit and 2 lagged order section criterion) variables to a shock to the macroprudential instruments for the period 2000q1-2014q4 (all countries)

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	o	o	o	o	o	o
SSCBCONS	o	o	o	o	o	o
SSCBOTH	o	o	o	o	o	o
CAPREQ	-	-	-	o	o	-

CONCRAT	na	na	na	na	na	na
IBEX	na	na	na	na	na	na
LTVCAP	na	na	na	na	na	na
RRFOREIGN	o	o	+	o	o	o
RRLOCAL	+	+	o	o	o	o
Aggregate indexes						
SSCB	o	o	o	o	o	o
PRUC	+	o	o	o	o	o
PRUC2	+	o	o	o	o	o

Note: The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect, na – not applicable as the PVAR does satisfy the stability condition. See **Appendix 4A.8** for the impulse response functions graphs.

4.5.3. Omitting outlying countries as measured by the international banks' claims to GDP ratio (all countries, 2 lags PVAR model)

A third robustness check is omitting countries (outliers) with high international banks' claims to GDP ratio mean. Using the calculated standard deviation of 166.65 for the full sample, we assessed that Ireland (214.68), Hong Kong (200.64), Luxembourg (1,092.26) and Sweden (180.44) are outliers in the dataset as these countries means (in brackets) are more than one standard deviation from the full sample mean of 79.870 (see **Table 4.4** for summary of the descriptive statistics of the variables in the model). Apart from Sweden they are international financial centres and hence the inwards international claims that we study might be largely "entrepot" rather than directly affecting the domestic economy.

Table 4.18 below shows the results of the panel-VAR model with the omitted countries. In the table, the local currency reserve requirements (RRLOCAL) result had a positive and significant effect on international banks' claims, which is different from the results for all countries in Table 4.12 above but consistent with emerging markets results (see Table 4.14). This is could be due to the positive and significant effect RRLOCAL had on monetary policy interest rate. However, as we discussed above, once again we cannot ignore the dual role of reserve requirements as an instrument of monetary policy and of macroprudential policy as such it may difficult to interpret the results for

these instruments. In general, however, these results suggest that the main results of the Chapter are not affected by the inclusion of these outliers.

Table 4.18: Summary statistics of PVAR model (with omitted countries and 2 lagged order section criterion) variables to a shock to the macroprudential instruments for the period 2000q1-2014q4

Instruments	Inflation rate	Monetary policy interest rate	Domestic credit	International banks' claims	Banks' regulatory capital ratio	Real GDP growth rate
SSCBRES	+	o	o	o	o	-
SSCBCONS	o	o	o	o	o	-
SSCBOTH	o	+	o	o	o	o
CAPREQ	na	na	Na	na	na	na
CONCRAT	na	na	Na	na	na	na
IBEX	na	na	Na	na	na	na
LTVCAP	na	na	Na	na	na	na
RRFOREIGN	o	o	+	o	o	o
RRLOCAL	o	+	o	+	o	o
Aggregate indexes						
SSCB	o	o	o	o	o	-
PRUC	o	o	o	o	o	o
PRUC2	o	o	o	o	o	o

Note: Omitted countries are Ireland, Hong Kong, Luxembourg and Sweden. The results represent the initial impact of the macroprudential instrument shock on the variables over 10 quarters based on the impulse response functions. The shock is defined as a Cholesky one-standard deviation. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio, real GDP growth rate and the macroprudential instrument. + positive and significant effect; - negative and significant effect; o insignificant effect, na – not applicable as the PVAR does satisfy the stability condition. See **Appendix 4A.9** for the impulse response functions graphs.

In term of the macroeconomic variables, of interest is that sector specific capital buffer real estate (SSCBRES), consumer credit (SSCBCONS) and the aggregate index sector-specific capital buffers (SSCB) had a negative and significant effect on real GDP growth. Also, sector specific capital buffer real estate (SSCBRES) had a positive and significant effect on the rate of inflation.

4.6. Chapter summary

The purpose of the chapter is to present empirical research on potential cross-border spill over effects of macroprudential policies using a PVAR approach that has been

rarely employed in the literature on macroprudential policy. The empirical results suggest, in the sample period, 2000-2014, that macroprudential policy inwards cross-border spillovers are generally insignificant although there was a positive result in emerging market economies for local currency reserve requirements. Similar to the results of the IBRN, we consider the impact to be negligible in term of affecting financial stability. In addition, macroprudential instruments have a stronger effect on domestic credit and the macroeconomic variables. However, these results cannot be interpreted in isolation of the fact there is not a very long history of the usage of macroprudential policy, particularly in advanced countries and "time series" macroprudential policy was largely designed to operate in a period of upturn or absence of any financial disturbance.

One explanation for these results may be that inwards cross border lending is not always subject to domestic macroprudential policies, implying there is scope for disintermediation by cross border borrowing. However, a further notable point is that there are less significant effects for macroprudential instruments even for domestic credit than in most single equation panel tests (such as Cerutti et al (2017) and Carreras et al (2018)). As noted by Carreras et al (2018) a PVAR can overcome the difficulty of reduced form estimation such as OLS by capturing interaction of policy, real and financial sectors. Their PVECM had fewer significant policy effects on credit (although not on house prices) than single equation reduced form panels.

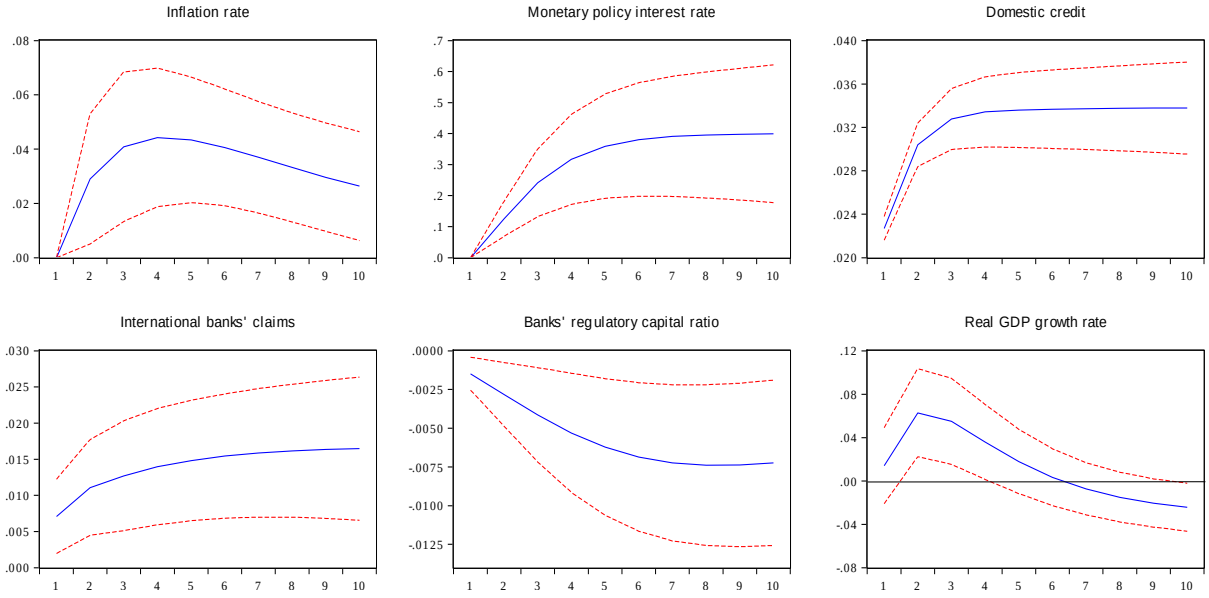
Further research can be undertaken to analyse the impact of a financial disturbance on the effectiveness of the macroprudential instruments. A good starting point could be how the 2007-2008 financial crisis affected the effectiveness of macroprudential instruments, particularly in emerging market economies since they have a longer history of using macroprudential instruments. Effects of macroprudential policy on outwards lending as well could be studied.

4A. Appendix Chapter 4

4A.1. Impulse responses to domestic credit and international banks' claims for the pre-crisis (2000-2006) and post-crisis (2007-2014) periods (all countries, 2 lags PVAR model)

Appendix Figure 4A.1 shows the response of macroeconomic and banking variables to a one-standard-deviation shock to domestic credit for the period 2000q1-2006q4. From the graph we see that there is a positive and significant effect to the rate of inflation, monetary policy interest rate and international banks' claims. GDP growth is positive in the short-term and the effect on banks' regulatory capital is negative and significant.

Appendix Figure 4A.1: Response of macroeconomic and banking variables to a shock to domestic credit for the period 2000q1-2006q4 (all countries, 2 lags PVAR model)

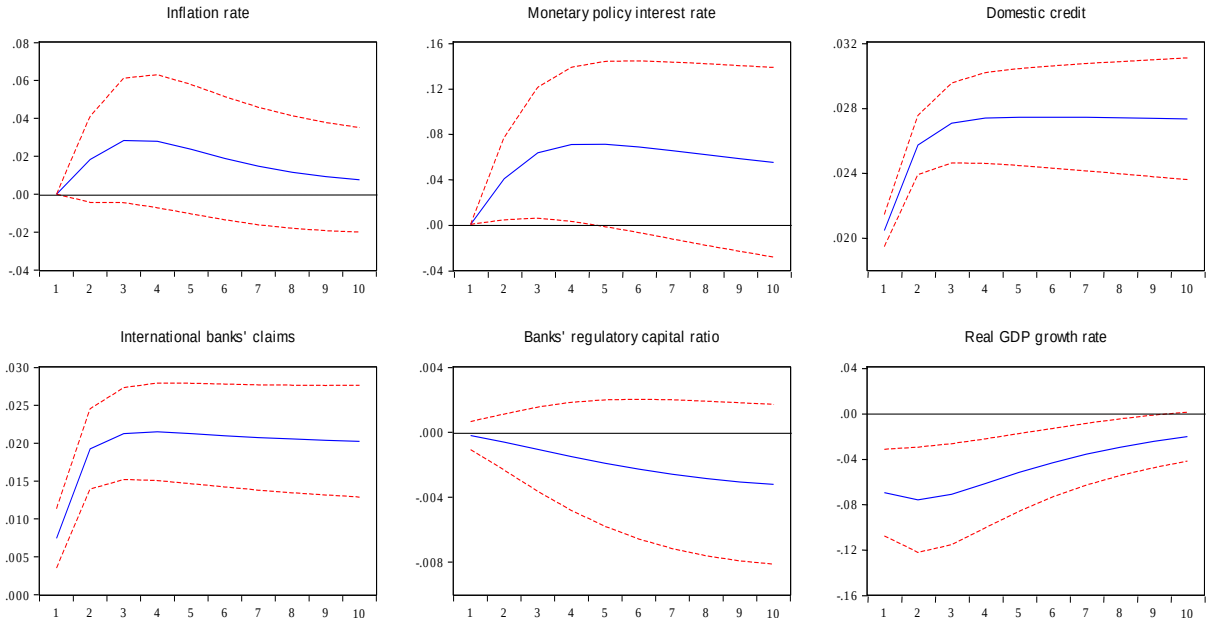


Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2000q1 to 2006q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

Appendix Figure 4A.2 below shows the response of macroeconomic and banking variables to a one-standard-deviation shock to domestic credit for the period 2007q1-2014q4. From the graph we see that there is a positive and significant effect to the

monetary policy and international banks' claims. The effect on economic growth is significant and negative in the post-crisis period, while the effect on the rate of inflation and banks' regulatory capital ratio are insignificant which may reflect tighten regulatory control over capital after the crisis.

Appendix Figure 4A.2: Response of macroeconomic and banking variables to a shock to domestic credit for the period 2007q1-2014q4 (all countries, 2 lags PVAR model)

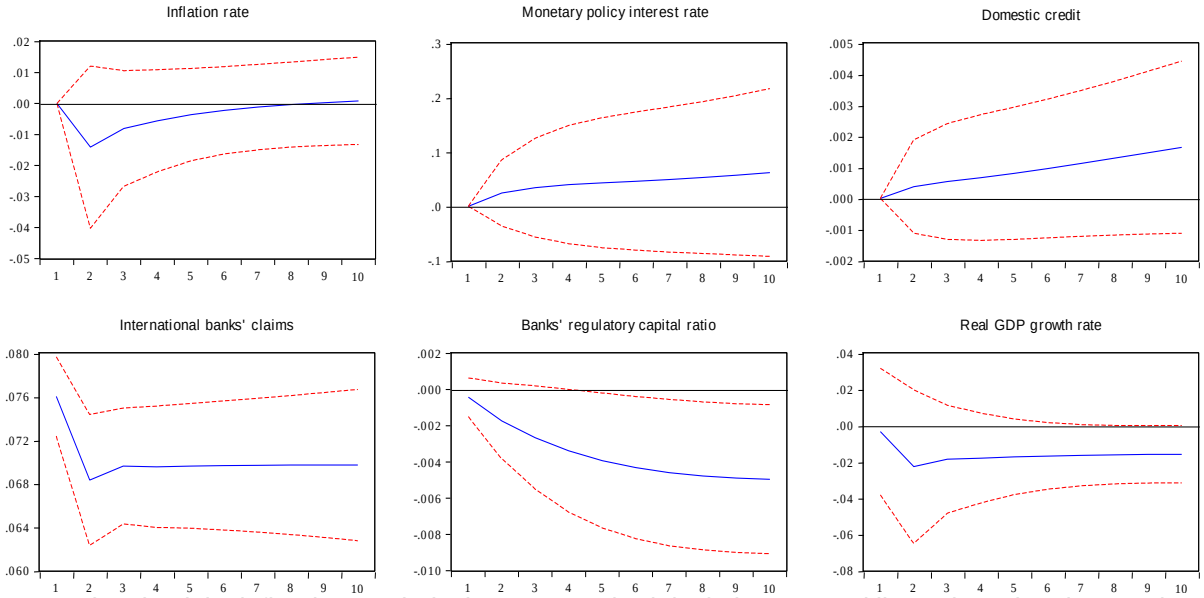


Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2007q1 to 2014q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

4A.2. Impulse responses to international banks' claims of the macroeconomic and banking variables for the pre-crisis (2000q1-2006q4) and post-crisis (2007q1-2014q4) periods (all countries, 2 lags PVAR model)

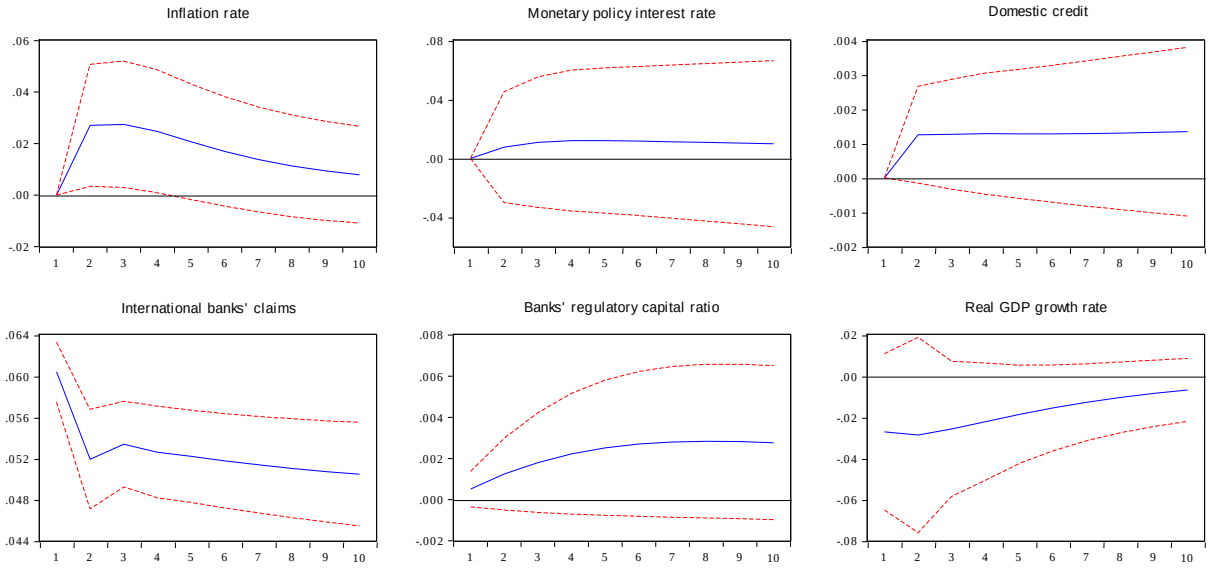
Appendix Figure 4A.3 below shows the response of macroeconomic and banking variables to a one-standard-deviation shock to international banks' claims credit for the period 2000q1-2006q4. From the graph we see that negative and significant effect to the banks' regulatory capital ratio. The effect on the rate of inflation, monetary policy interest rate, domestic credit and GDP growth is insignificant.

Appendix Figure 4A.3: Response of macroeconomic and banking variables to a shock to international banks' claims for the period 2000q1-2006q4 (all countries, 2 lags PVAR model)



Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2000q1 to 2006q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

Appendix Figure 4A.4: Response of macroeconomic and banking variables to a shock to international banks' claims for the period 2007q1-2014q4 (all countries, 2 lags PVAR model)



Note: The shock is defined as a Cholesky one-standard deviation. Dotted lines show the plus or minus two-standard error bands. The horizon period is measured in quarters and the sample spans from 2007q1 to 2014q4. Cholesky order is inflation rate, monetary policy interest rate, domestic credit, international banks' claims, banks' regulatory capital ratio and real GDP growth rate.

Appendix Figure 4A.4 above shows the response of macroeconomic and banking variables to a one-standard-deviation shock to international banks' claims credit for the period 2007q1-2014q4. From the graph we see that positive and significant effect to inflation rate. The effect on monetary policy interest rate, domestic credit, GDP growth and banks' regulatory capital ratio is insignificant.

4A.3. Forecasted error variance decomposition table for the period 2000q1-2014q4, 2000q1-2006q4 and 2007q1-2014q4 (all countries, 2 lags PVAR model)

I. Forecasted error variance decomposition table for the period 2000q1-2014q4

The forecasted error variance decomposition shows the contribution of the variation of one variable that is explained by a shock (one standard deviation) in another variable over a time period. In the Appendix Table 4A.1 below, the forecast horizon time period is 10 quarters. In the table, we can see shocks to banks' regulatory capital and GDP growth have about a 2 per cent impact on domestic credit, while inflation rate has 1 per cent impact. A shock to international banks' claims has a low impact on domestic credit. In term of international banks' claims, a shock to domestic credit has about a 5 per cent impact on international banks' claims, while banks' regulatory capital has a 2 per cent impact. A shock to monetary policy interest rate has between 8 to 10 per cent impact on the inflation rate and banks' regulatory capital respectively. GDP growth is mainly affected by a shock to the rate of inflation.

Appendix Table 4A.1: Forecasted error variance decomposition for the period 2000q1-2014q4 (all countries, 2 lags PVAR model, per cent)

		Forecasted Error Variance Decomposition of Inflation Rate:					
Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.377	100.000	0.000	0.000	0.000	0.000	0.000
2	0.515	98.835	0.392	0.319	0.002	0.072	0.379
3	0.597	96.788	1.138	0.663	0.003	0.206	1.200
4	0.652	94.307	2.126	0.925	0.004	0.357	2.279
5	0.691	91.647	3.295	1.108	0.005	0.495	3.450
6	0.721	88.965	4.601	1.232	0.006	0.602	4.593
7	0.744	86.362	6.006	1.315	0.006	0.676	5.634

8	0.762	83.896	7.477	1.367	0.007	0.719	6.533
9	0.778	81.594	8.985	1.398	0.008	0.738	7.276
10	0.791	79.462	10.505	1.415	0.009	0.741	7.867

Forecasted Error Variance Decomposition of Monetary Policy Interest Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.785	0.230	99.770	0.000	0.000	0.000	0.000
2	1.467	0.129	99.411	0.267	0.003	0.053	0.135
3	2.087	0.085	98.896	0.601	0.004	0.160	0.253
4	2.637	0.062	98.411	0.869	0.004	0.286	0.366
5	3.122	0.050	97.994	1.064	0.004	0.409	0.477
6	3.553	0.043	97.648	1.200	0.004	0.516	0.588
7	3.940	0.039	97.363	1.295	0.004	0.601	0.697
8	4.291	0.036	97.133	1.362	0.003	0.662	0.803
9	4.614	0.033	96.948	1.410	0.003	0.701	0.904
10	4.913	0.031	96.801	1.445	0.003	0.720	0.999

Forecasted Error Variance Decomposition of Domestic Credit:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.022	0.043	0.237	99.719	0.000	0.000	0.000
2	0.036	0.022	0.092	99.752	0.0193	0.082	0.031
3	0.047	0.034	0.133	99.360	0.031	0.278	0.162
4	0.057	0.120	0.184	98.712	0.040	0.553	0.389
5	0.065	0.259	0.197	97.938	0.048	0.866	0.692
6	0.073	0.423	0.179	97.116	0.056	1.181	1.044
7	0.080	0.589	0.151	96.293	0.063	1.475	1.427
8	0.087	0.745	0.131	95.493	0.072	1.736	1.822
9	0.093	0.885	0.129	94.728	0.080	1.958	2.218
10	0.099	1.007	0.154	94.003	0.089	2.139	2.607

Forecasted Error Variance Decomposition of International Banks' Claims:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.069	0.244	0.233	0.864	98.657	0.000	0.000
2	0.094	0.136	0.312	2.596	96.863	0.092	4.440
3	0.114	0.093	0.327	3.578	95.688	0.288	0.025
4	0.131	0.072	0.321	4.193	94.776	0.564	0.073
5	0.146	0.063	0.308	4.591	94.009	0.893	0.134
6	0.160	0.061	0.294	4.860	93.327	1.255	0.201
7	0.173	0.065	0.280	5.050	92.704	1.633	0.266
8	0.186	0.074	0.265	5.188	92.131	2.016	0.325
9	0.197	0.087	0.250	5.289	91.600	2.396	0.377
10	0.208	0.103	0.235	5.364	91.109	2.767	0.421

Forecasted Error Variance Decomposition of Banks' Regulatory Capital Ratio:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.014	0.055	0.186	0.347	0.012	99.399	0.000
2	0.029	0.154	1.203	0.429	0.068	98.110	0.035
3	0.043	0.284	2.418	0.540	0.099	96.621	0.038
4	0.058	0.429	3.621	0.650	0.121	95.146	0.031
5	0.071	0.582	4.728	0.750	0.140	93.776	0.022
6	0.083	0.737	5.711	0.838	0.155	92.541	0.016
7	0.094	0.888	6.569	0.914	0.169	91.443	0.015
8	0.104	1.034	7.311	0.979	0.181	90.474	0.020
9	0.112	1.170	7.950	1.035	0.193	89.621	0.030

10	0.119	1.297	8.501	1.083	0.203	88.870	0.045

Forecasted Error Variance Decomposition of Real GDP Growth Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.543	0.010	0.378	0.227	0.084	0.186	99.112
2	0.675	0.123	0.245	0.148	0.197	0.121	99.165
3	0.749	0.403	0.248	0.124	0.228	0.129	98.866
4	0.793	0.774	0.334	0.126	0.252	0.198	98.315
5	0.821	1.176	0.463	0.148	0.269	0.313	97.629
6	0.839	1.569	0.613	0.184	0.284	0.463	96.885
7	0.851	1.927	0.774	0.229	0.296	0.638	96.135
8	0.859	2.235	0.939	0.278	0.306	0.826	95.415
9	0.865	2.488	1.107	0.329	0.314	1.018	94.743
10	0.870	2.688	1.275	0.379	0.322	1.205	94.130

Cholesky Ordering: Inflation Rate, Monetary Policy Interest Rate, Domestic Credit, International Banks' Claims, Banks' Regulatory Capital Ratio, Real GDP Growth Rate.

II. Forecasted error variance decomposition table for the period 2000q1-2006q4

In the pre-crisis period, Appendix Table 4A.2, a shock to monetary policy interest rate has an impact on inflation (up to 16%), banks' regulatory capital (up to 5%) and GDP growth (up to 7%), which shows the strong performance of the economy to the 2007-2008 financial crisis. A shock to GDP growth has an impact on inflation rate (up to 4 per cent) and domestic credit (up to 2 per cent). The forecast horizon is 10 quarters.

Appendix Table 4A.2: Forecasted error variance decomposition for the period 2000q1-2006q4 (all countries, 2 lags PVAR model, per cent)

Forecasted Error Variance Decomposition of Inflation Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.396	100.000	0.000	0.000	0.000	0.000	0.000
2	0.505	98.328	0.837	0.320	0.078	0.102	0.334
3	0.566	95.711	2.318	0.748	0.082	0.221	0.920
4	0.605	92.693	4.164	1.149	0.080	0.311	1.602
5	0.631	89.592	6.200	1.481	0.077	0.361	2.288
6	0.652	86.588	8.312	1.736	0.073	0.379	2.910
7	0.667	83.768	10.423	1.925	0.070	0.377	3.436
8	0.681	81.168	12.486	2.058	0.067	0.365	3.854
9	0.692	78.790	14.473	2.147	0.065	0.353	4.170
10	0.703	76.620	16.370	2.205	0.063	0.345	4.397

Forecasted Error Variance Decomposition of Monetary Policy Interest Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.927	0.144	99.855	0.000	0.000	0.000	0.000

2	1.736	0.066	99.255	0.494	0.019	0.072	0.092
3	2.471	0.032	98.417	1.132	0.029	0.217	0.172
4	3.120	0.028	97.641	1.662	0.034	0.388	0.246
5	3.688	0.038	96.996	2.058	0.038	0.553	0.316
6	4.190	0.055	96.482	2.347	0.042	0.691	0.381
7	4.639	0.075	96.083	2.560	0.045	0.794	0.441
8	5.045	0.095	95.778	2.722	0.049	0.860	0.495
9	5.417	0.116	95.546	2.849	0.054	0.892	0.543
10	5.762	0.135	95.371	2.953	0.059	0.896	0.585

Forecasted Error Variance Decomposition of Domestic Credit:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.023	0.037	0.720	99.24283	0.000	0.000	0.000
2	0.038	0.041	0.265	99.62847	0.010	0.001	0.054
3	0.050	0.024	0.245	99.51723	0.017	0.004	0.191
4	0.060	0.042	0.357	99.16757	0.024	0.012	0.396
5	0.069	0.093	0.465	98.73757	0.032	0.023	0.648
6	0.077	0.163	0.531	98.30235	0.041	0.034	0.926
7	0.084	0.240	0.555	97.89134	0.052	0.044	1.216
8	0.091	0.315	0.550	97.51310	0.065	0.050	1.506
9	0.097	0.384	0.525	97.16773	0.080	0.052	1.790
10	0.103	0.446	0.492	96.85226	0.096	0.052	2.061

Forecasted Error Variance Decomposition of International Banks' Claims:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.077	1.009	0.312	1.008	97.671	0.000	0.000
2	0.104	0.811	0.498	1.773	96.734	0.136	0.047
3	0.126	0.885	0.590	2.252	95.879	0.360	0.032
4	0.145	1.014	0.618	2.639	95.070	0.628	0.030
5	0.163	1.153	0.604	2.952	94.336	0.910	0.044
6	0.178	1.285	0.564	3.210	93.679	1.189	0.070
7	0.193	1.405	0.513	3.423	93.096	1.457	0.104
8	0.206	1.511	0.458	3.599	92.580	1.708	0.143
9	0.219	1.604	0.407	3.744	92.121	1.940	0.183
10	0.231	1.685	0.366	3.862	91.711	2.151	0.223

Forecasted Error Variance Decomposition of Banks' Regulatory Capital Ratio:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.016	0.043	0.274	0.963	0.070	98.649	0.000
2	0.031	0.029	1.219	1.121	0.320	97.309	0.001
3	0.047	0.036	2.260	1.328	0.463	95.910	0.002
4	0.061	0.051	3.196	1.543	0.569	94.635	0.003
5	0.075	0.071	3.959	1.747	0.657	93.559	0.006
6	0.087	0.094	4.536	1.930	0.735	92.696	0.008
7	0.097	0.118	4.946	2.090	0.806	92.028	0.010
8	0.107	0.142	5.214	2.227	0.875	91.529	0.012
9	0.114	0.165	5.366	2.344	0.941	91.168	0.014
10	0.121	0.187	5.428	2.443	1.006	90.919	0.015

Forecasted Error Variance Decomposition of Real GDP Growth Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.517	0.030	0.583	0.075	0.004	0.164	99.143
2	0.642	0.032	0.393	1.002	0.126	0.117	98.329
3	0.711	0.185	0.670	1.405	0.170	0.193	97.376

4	0.7529	0.403	1.347	1.478	0.208	0.350	96.212
5	0.780	0.623	2.270	1.429	0.243	0.555	94.879
6	0.798	0.814	3.314	1.365	0.276	0.782	93.447
7	0.811	0.966	4.398	1.329	0.307	1.015	91.985
8	0.821	1.078	5.474	1.326	0.337	1.241	90.542
9	0.830	1.155	6.518	1.357	0.367	1.454	89.148
10	0.837	1.204	7.517	1.412	0.396	1.649	87.822

Cholesky Ordering: Inflation Rate, Monetary Policy Interest Rate, Domestic Credit, International Banks' Claims, Banks' Regulatory Capital Ratio, Real GDP Growth Rate.

III. Forecasted error variance decomposition table for the period 2007q1-2014q4

In the post-crisis period, Appendix Table 4A.3 below, a shock to monetary policy interest rate and GDP growth have about a 6 per cent variance effect on inflation. A shock to GDP growth has an impact on inflation rate (up to 4 per cent) and domestic credit (up to 2 per cent). A rate of inflation shock has on average a 3 to 4 per cent impact on monetary policy interest rate, international banks' claims and banks' regulatory capital ratio and GDP growth rate. The forecast horizon time period is 10 quarters.

Appendix Table 4A.3: Forecasted error variance decomposition for the period 2007q1-2014q4 (all countries, 2 lags PVAR model, per cent)

Forecasted Error Variance Decomposition of Inflation Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.346	100.00	0.000	0.000	0.000	0.000	0.000
2	0.529	99.263	0.143	0.104	0.262	0.019	0.208
3	0.649	98.131	0.446	0.249	0.352	0.083	0.738
4	0.730	96.664	0.907	0.333	0.392	0.198	1.505
5	0.788	94.936	1.521	0.370	0.405	0.355	2.411
6	0.832	93.034	2.279	0.380	0.405	0.542	3.357
7	0.865	91.044	3.165	0.378	0.400	0.744	4.267
8	0.891	89.035	4.157	0.371	0.393	0.949	5.095
9	0.913	87.059	5.231	0.362	0.385	1.148	5.814
10	0.931	85.152	6.364	0.353	0.377	1.336	6.416

Forecasted Error Variance Decomposition of Monetary Policy Interest Rate:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.551	1.104	98.895	0.000	0.000	0.000	0.000
2	0.905	1.328	98.259	0.194	0.007	0.010	0.202
3	1.184	1.574	97.575	0.381	0.012	0.043	0.413
4	1.413	1.855	96.881	0.496	0.016	0.104	0.648
5	1.607	2.147	96.190	0.557	0.018	0.189	0.897

6	1.777	2.430	95.520	0.585	0.020	0.293	1.152
7	1.928	2.688	94.885	0.594	0.019	0.410	1.403
8	2.066	2.915	94.295	0.592	0.019	0.535	1.643
9	2.192	3.108	93.757	0.583	0.019	0.664	1.867
10	2.309	3.268	93.274	0.570	0.019	0.794	2.074

Forecasted Error Variance Decomposition of Domestic Credit:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.020	0.075	0.243	99.682	0.000	0.000	0.000
2	0.033	0.062	0.406	99.066	0.145	0.320	0.000
3	0.043	0.044	0.629	98.059	0.172	1.011	0.083
4	0.051	0.126	0.925	96.577	0.183	1.925	0.264
5	0.059	0.307	1.290	94.770	0.185	2.934	0.512
6	0.066	0.555	1.719	92.792	0.185	3.950	0.799
7	0.073	0.833	2.204	90.758	0.184	4.920	1.100
8	0.079	1.118	2.737	88.745	0.183	5.814	1.402
9	0.085	1.396	3.312	86.793	0.182	6.620	1.696
10	0.091	1.658	3.923	84.926	0.181	7.335	1.976

Forecasted Error Variance Decomposition of International Banks' Claims:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.061	0.018	0.080	0.824	99.078	0.000	0.000
2	0.082	0.162	0.044	5.431	94.185	0.009	0.168
3	0.100	0.508	0.030	7.390	91.664	0.073	0.334
4	0.115	0.953	0.023	8.427	89.836	0.188	0.572
5	0.129	1.463	0.018	8.960	88.408	0.334	0.816
6	0.141	2.017	0.015	9.242	87.190	0.495	1.040
7	0.152	2.600	0.013	9.388	86.112	0.656	1.228
8	0.163	3.197	0.012	9.460	85.141	0.811	1.379
9	0.173	3.797	0.011	9.488	84.258	0.953	1.492
10	0.182	4.390	0.010	9.491	83.454	1.081	1.572

Forecasted Error Variance Decomposition of Banks' Regulatory Capital Ratio:

Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.013	0.023	0.019	0.038	0.159	99.760	0.000
2	0.026	0.158	0.838	0.077	0.269	98.507	0.150
3	0.039	0.533	1.786	0.118	0.327	97.100	0.135
4	0.052	0.971	2.636	0.161	0.365	95.780	0.087
5	0.064	1.404	3.357	0.206	0.392	94.581	0.059
6	0.075	1.804	3.963	0.251	0.411	93.496	0.074
7	0.086	2.158	4.474	0.297	0.426	92.508	0.135
8	0.095	2.463	4.907	0.343	0.438	91.607	0.241
9	0.103	2.719	5.275	0.389	0.447	90.785	0.384
10	0.110	2.928	5.591	0.435	0.455	90.035	0.554

Forecasted Error Variance Decomposition of Real GDP Growth Rate:

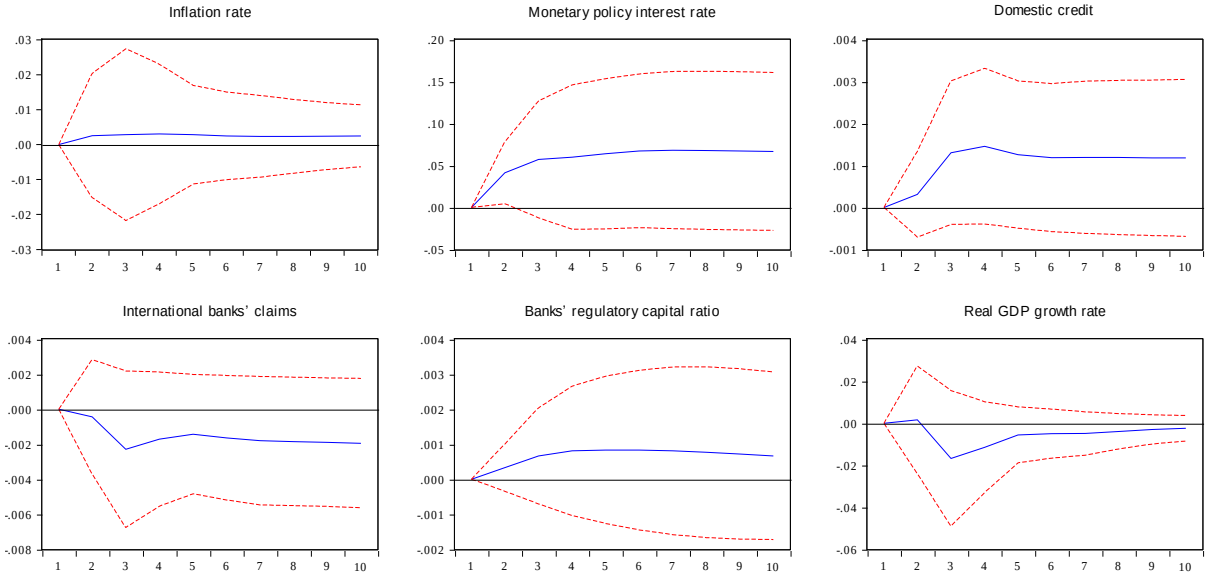
Period	S.E.	Inflation Rate	Monetary policy Interest rate	Domestic Credit	International Banks' Claims	Banks' Regulatory Capital Ratio	Real GDP Growth Rate
1	0.564	0.022	0.166	1.636	0.230	0.062	97.882
2	0.702	0.350	0.146	2.319	0.316	0.059	96.810
3	0.783	0.911	0.160	2.758	0.362	0.179	95.629
4	0.832	1.590	0.191	3.035	0.3911	0.426	94.367
5	0.865	2.290	0.229	3.208	0.409	0.783	93.081
6	0.887	2.945	0.267	3.315	0.419	1.221	91.831
7	0.902	3.515	0.302	3.380	0.425	1.709	90.667

8	0.913	3.982	0.333	3.418	0.428	2.219	89.620
9	0.922	4.346	0.358	3.439	0.428	2.722	88.705
10	0.928	4.617	0.378	3.449	0.428	3.205	87.923

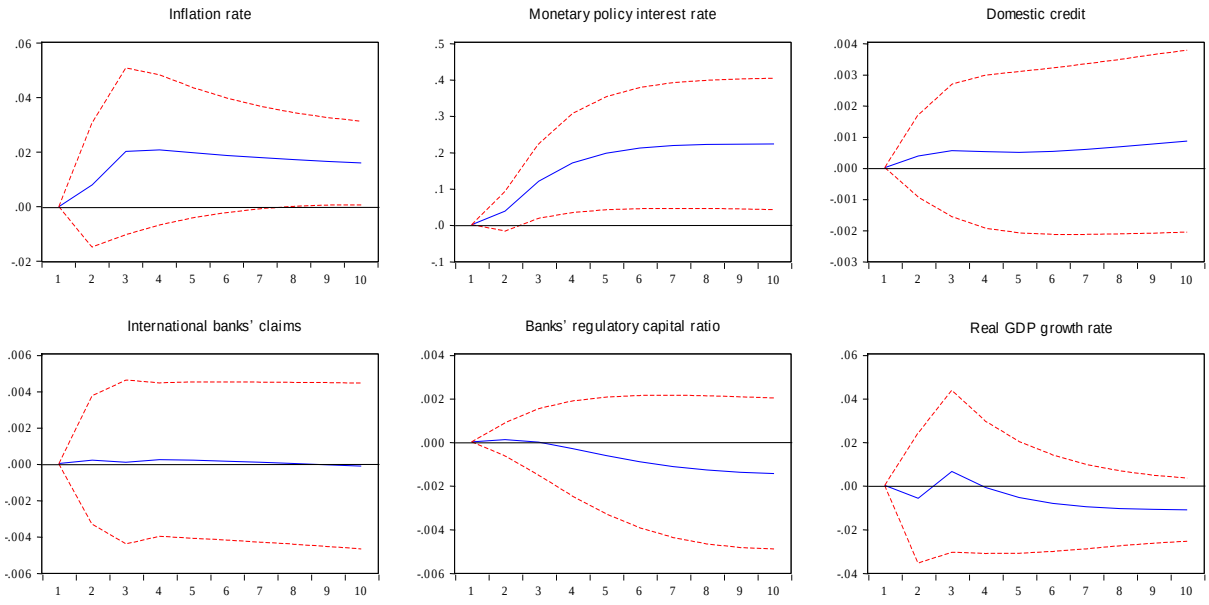
Cholesky Ordering: Inflation Rate, Monetary Policy Interest Rate, Domestic Credit, International Banks' Claims, Banks' Regulatory Capital Ratio, Real GDP Growth Rate.

4A.4. All countries impulse responses to a macroprudential instrument shock of the macroeconomic and banking variables for the 2000q1-2014q4 period (2 lags PVAR model)

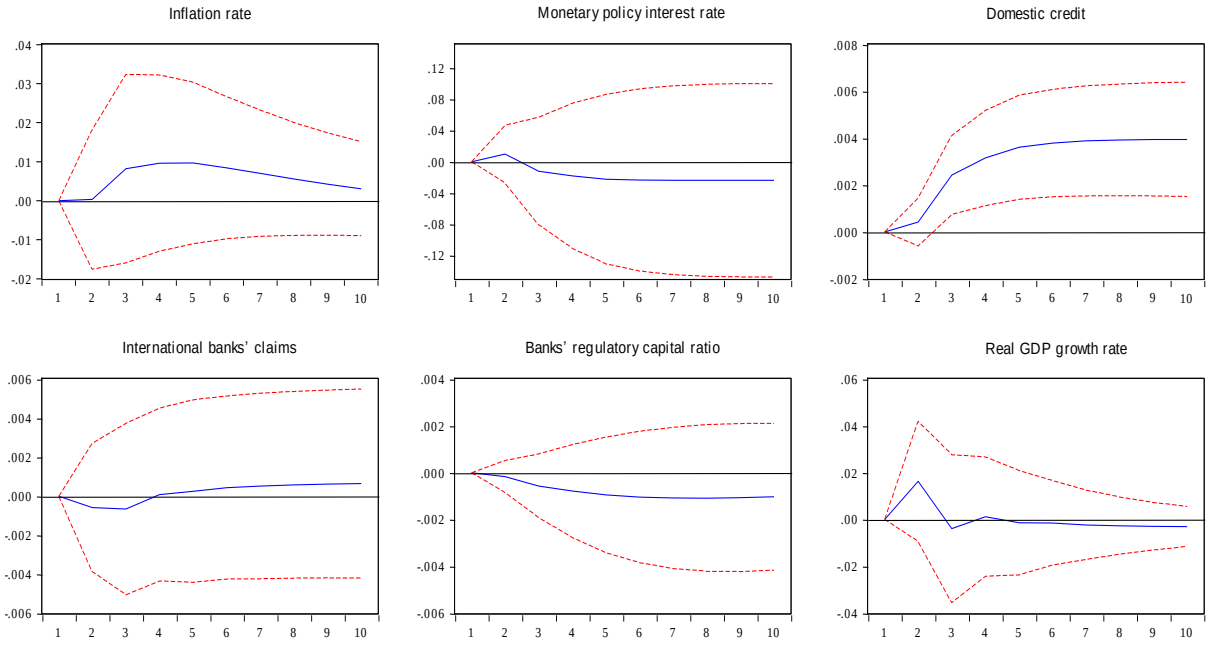
I. Sector specific capital buffer: other sectors (SSCBOTH)



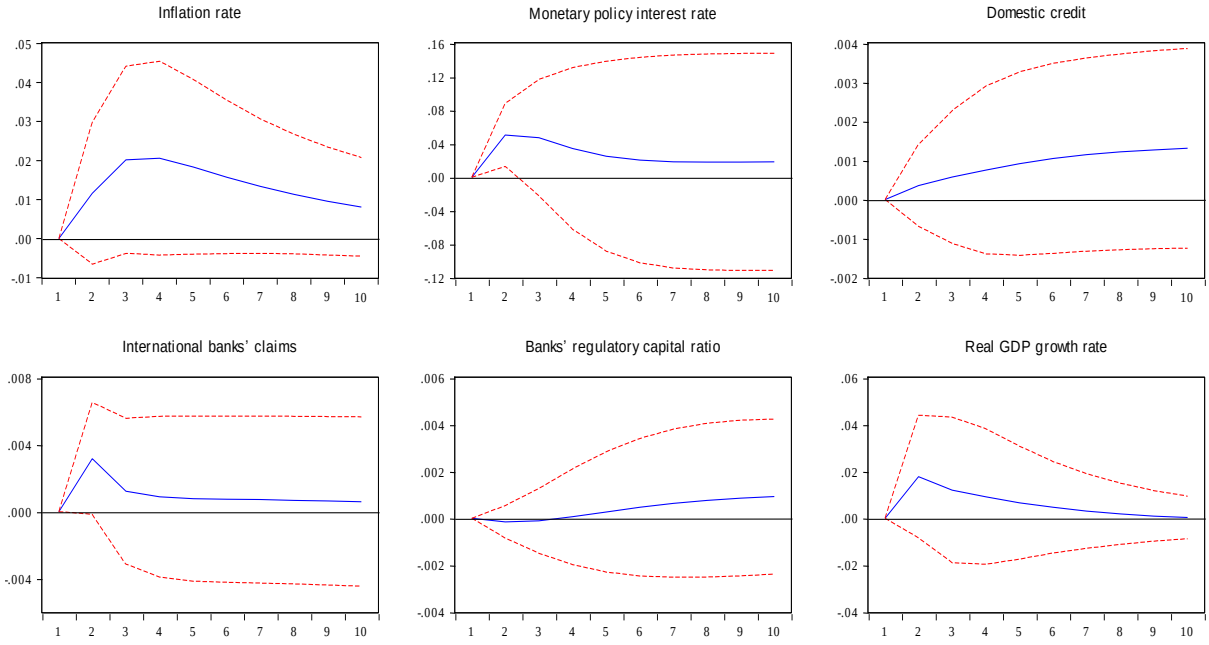
II. Concentration limits (CONCRAT)



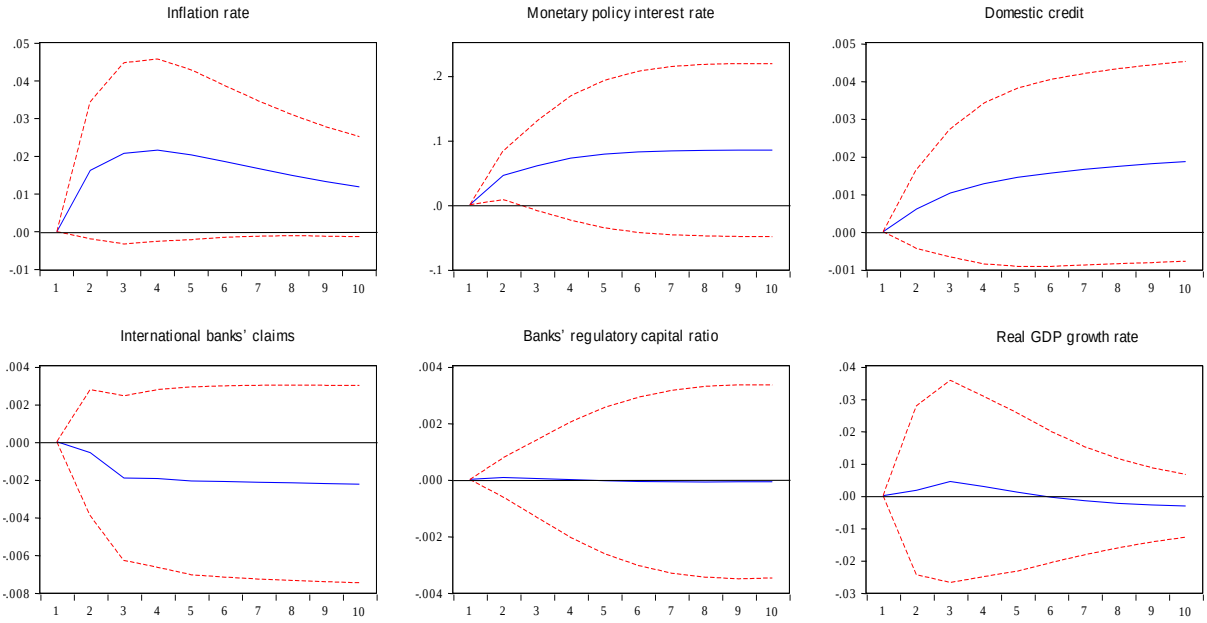
III. Reserve requirements on foreign currency (RRFOREIGN)



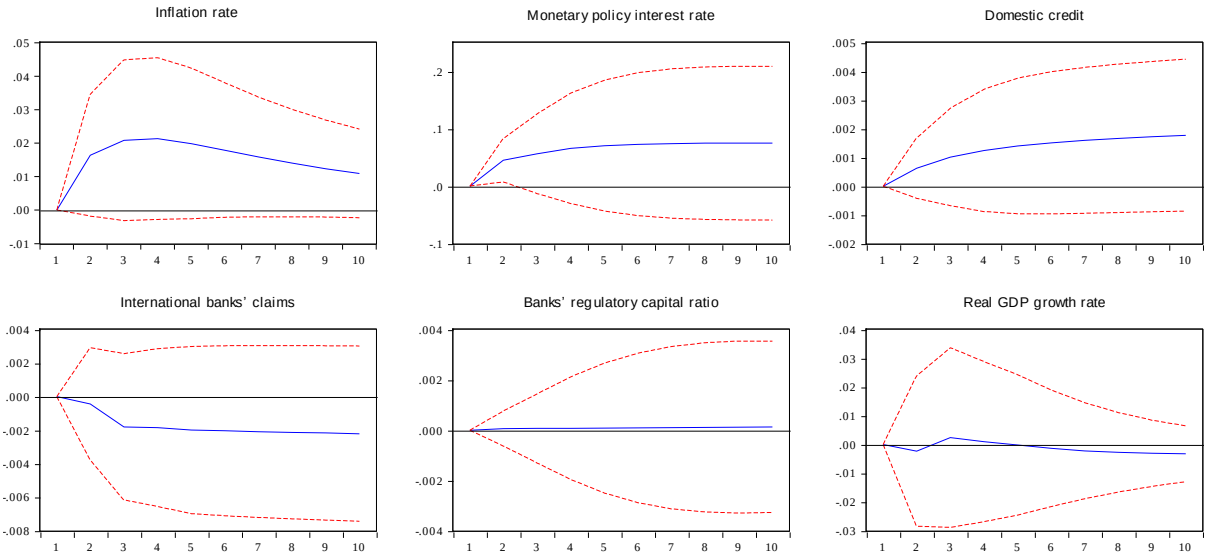
IV. Reserve requirements on local currency (RRLOCAL)



V. Sum of all country prudential instruments (PRUC)

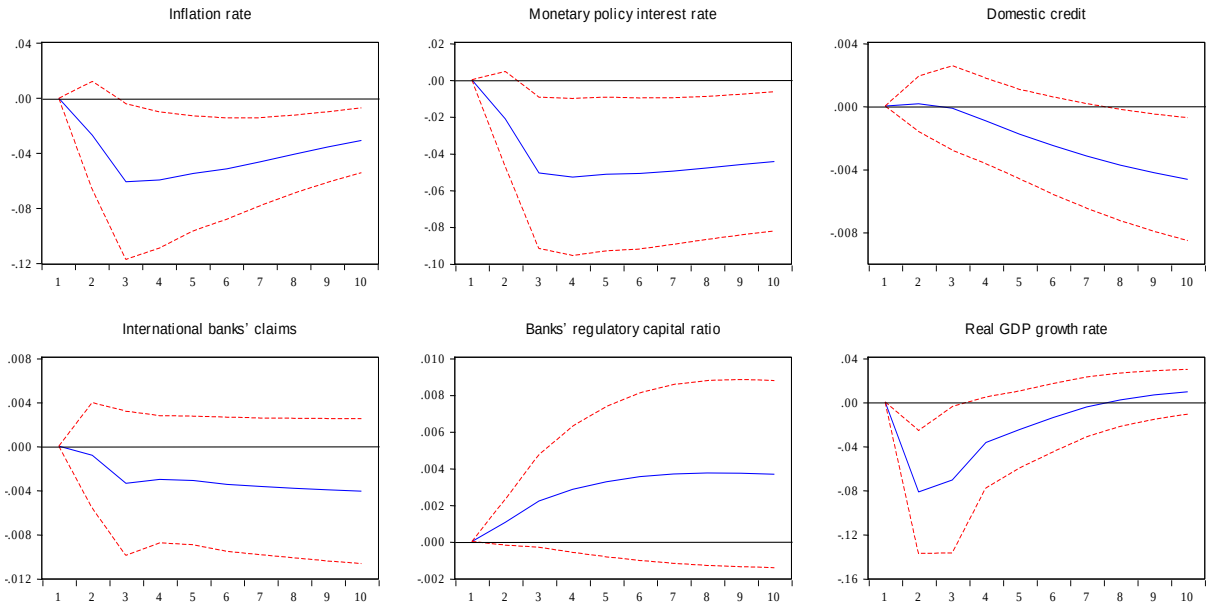


VI. Sum of all country prudential instruments (PRUC2)

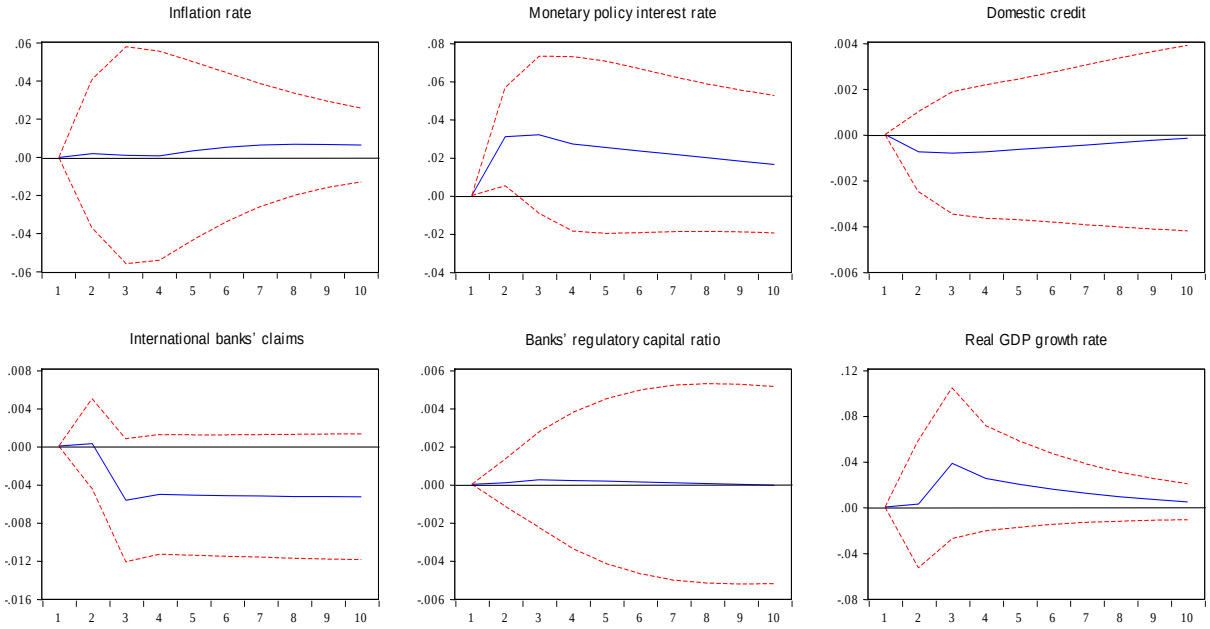


4A.5. Advanced countries impulse responses to a macroprudential instrument shock of the macroeconomic and banking variables for the 2007q1-2014q4 period (2 lags PVAR model)

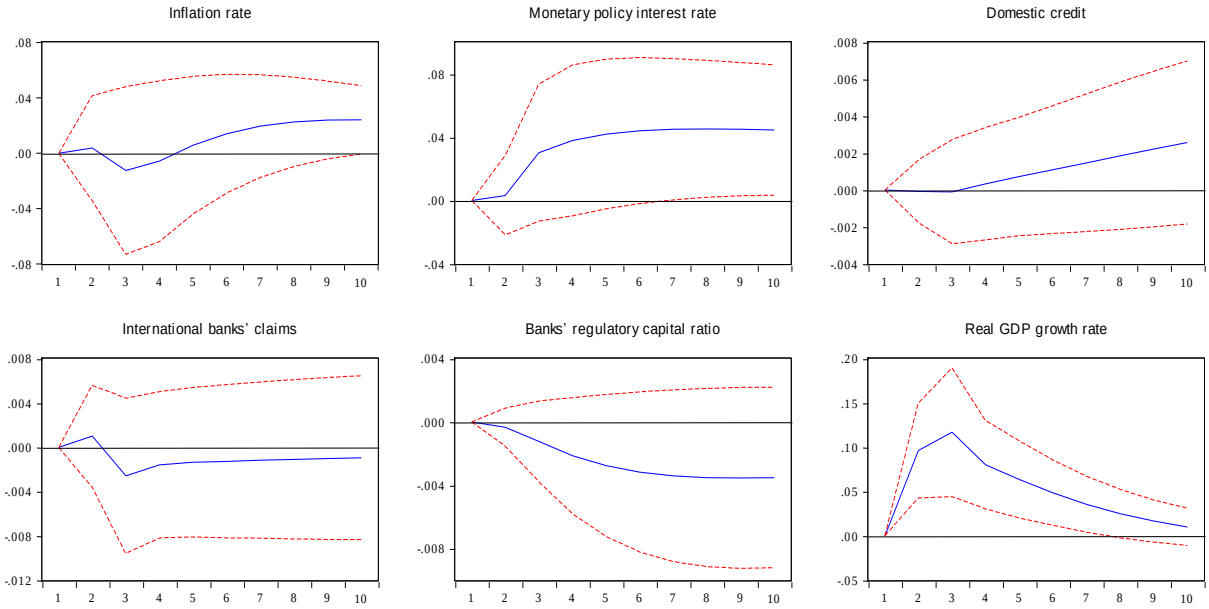
I. Capital requirements (CAPREQ)



II. Reserve requirements on foreign currency (RRFOREIGN)



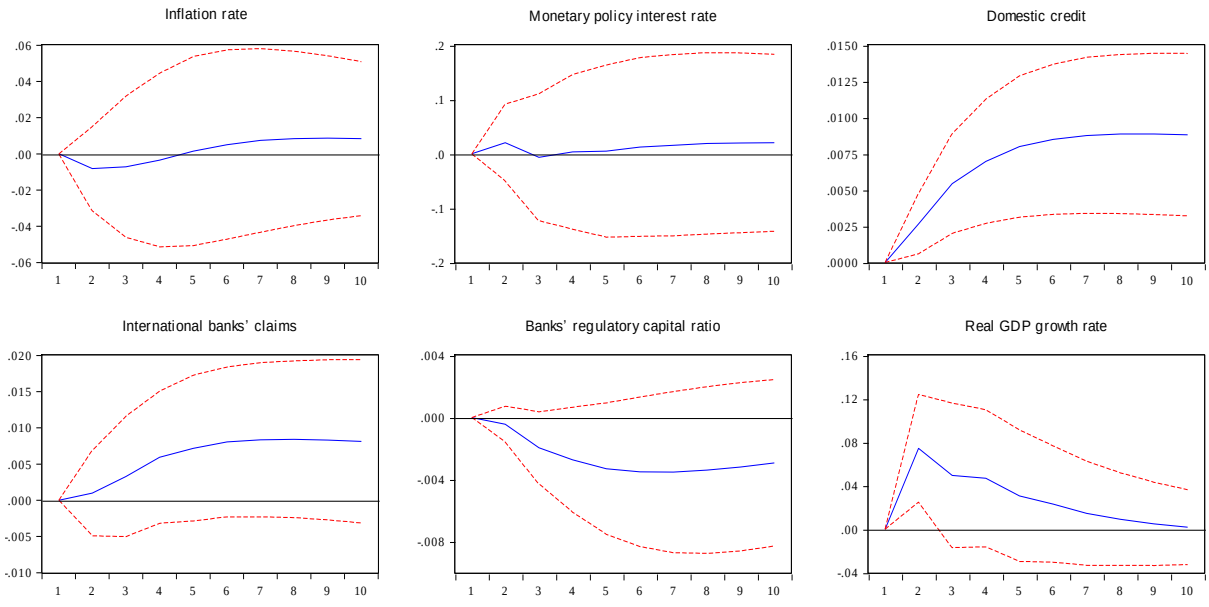
III. Reserve requirements on local currency (RRLOCAL)



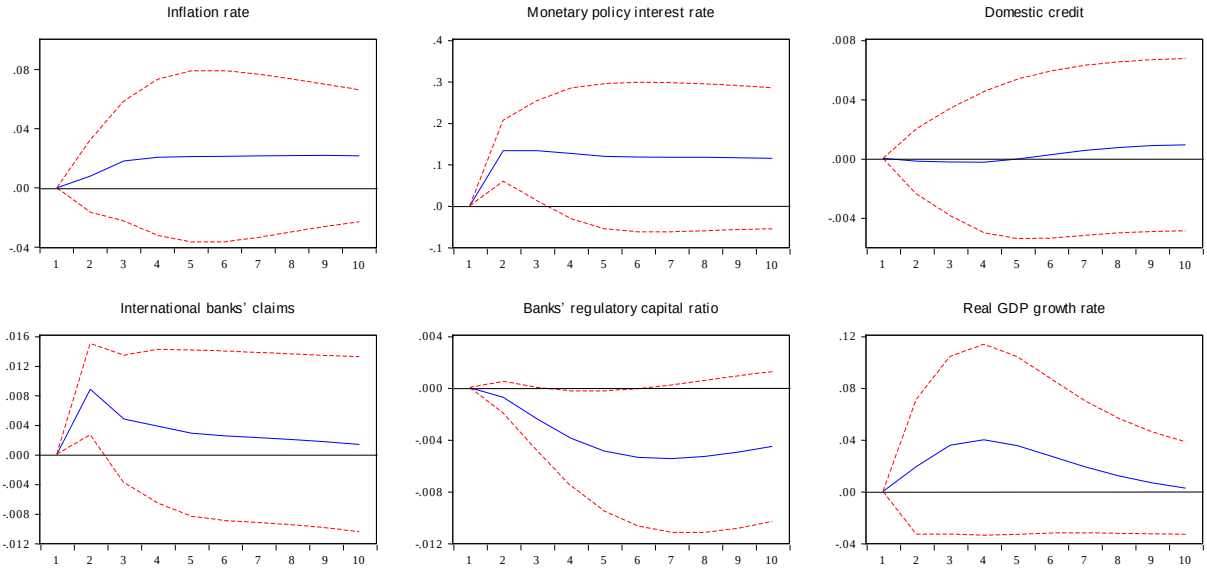
4A.6. Emerging market economies impulse responses to a macroprudential instrument shock of the macroeconomic and banking variables for the 2000q1-2014q4 and 2007q1-2014q4 periods (2 lags PVAR model)

I. Emerging market economies impulse responses for the period 2007q1-2014q4

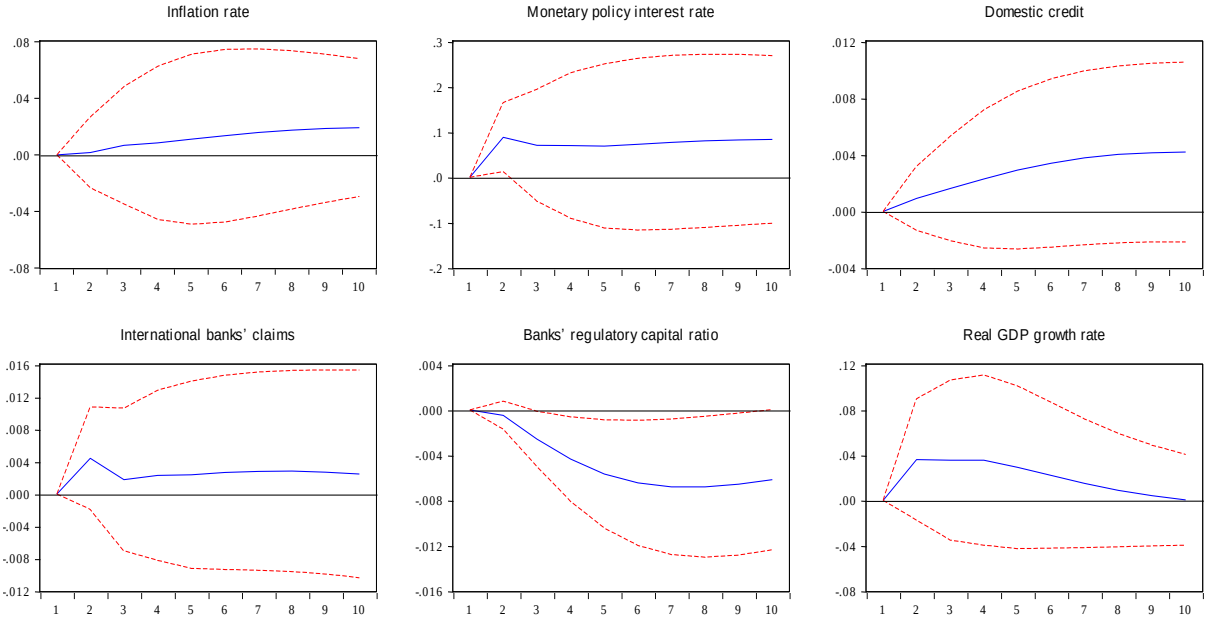
a) Reserve requirements on foreign currency (RRFOREIGN)



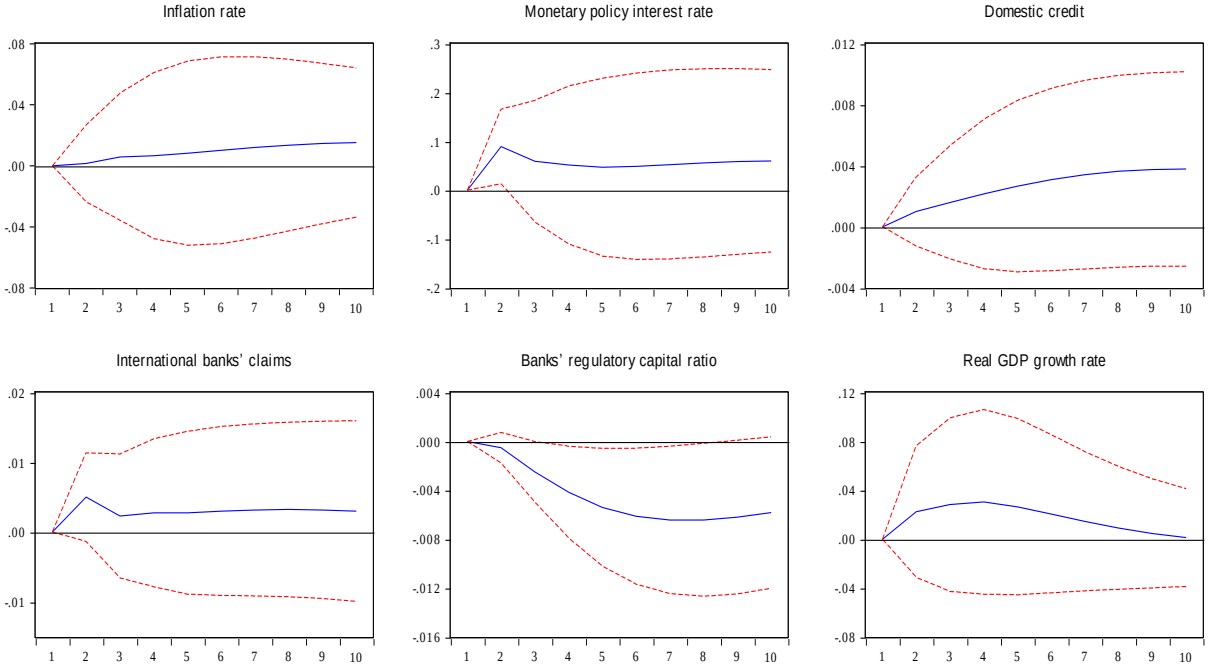
b) *Reserve requirements on local currency (RRLOCAL)*



c) *Sum of all country prudential instruments (PRUC)*

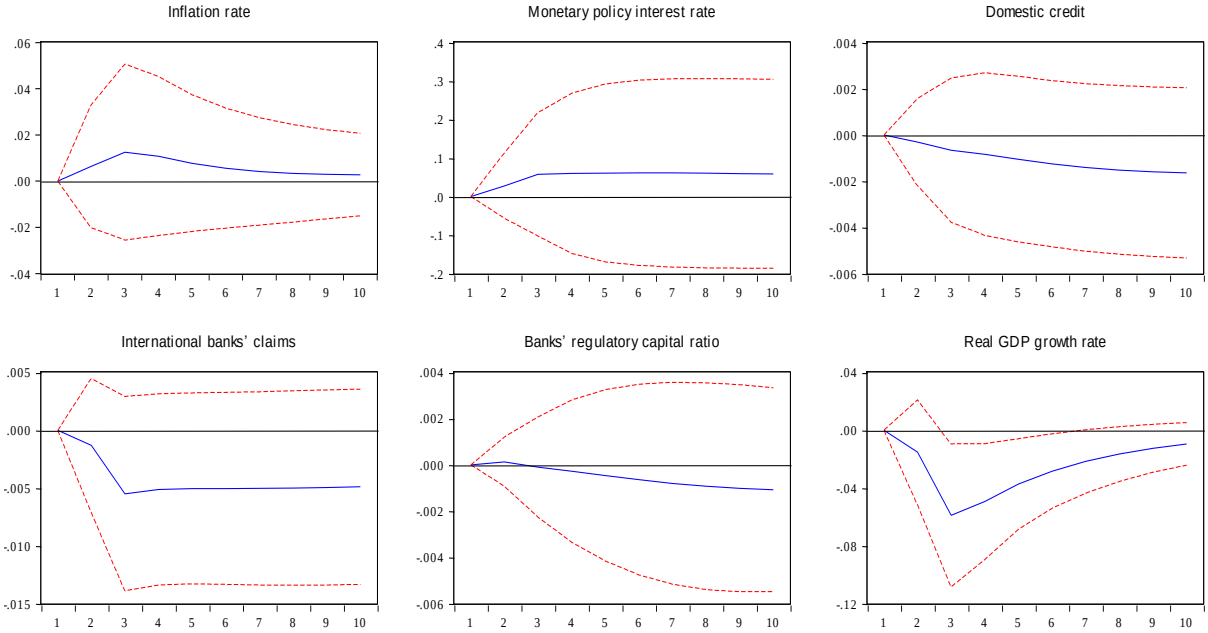


d) Sum of all country prudential instruments (PRUC2)

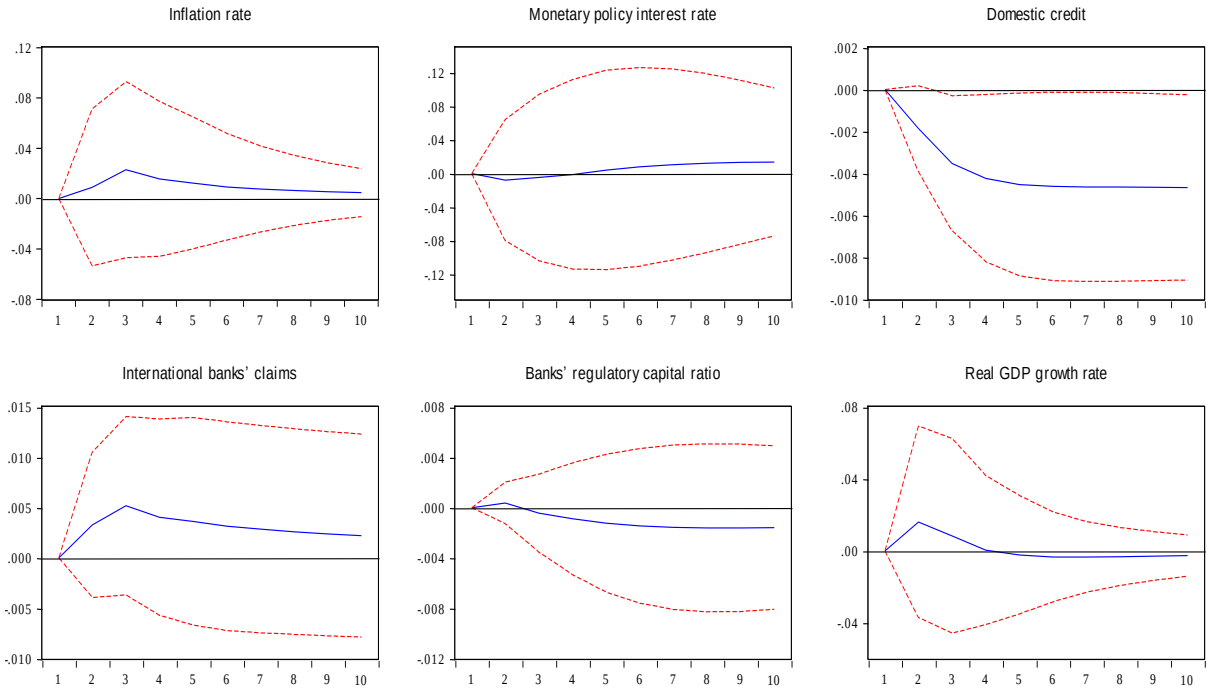


II. Emerging market economies impulse responses for the period 2000q1-2014q4

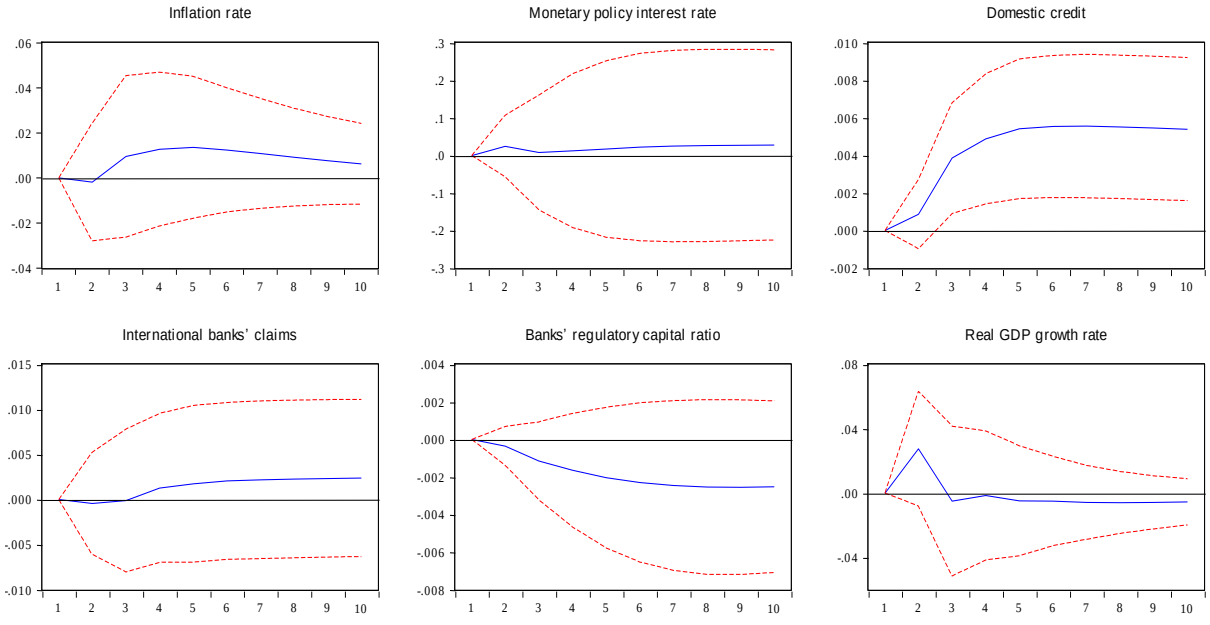
a) Sector specific capital buffer: consumer credit (SSCBCONS)



b) Loan-to-value ratio cap (LTVCAP)

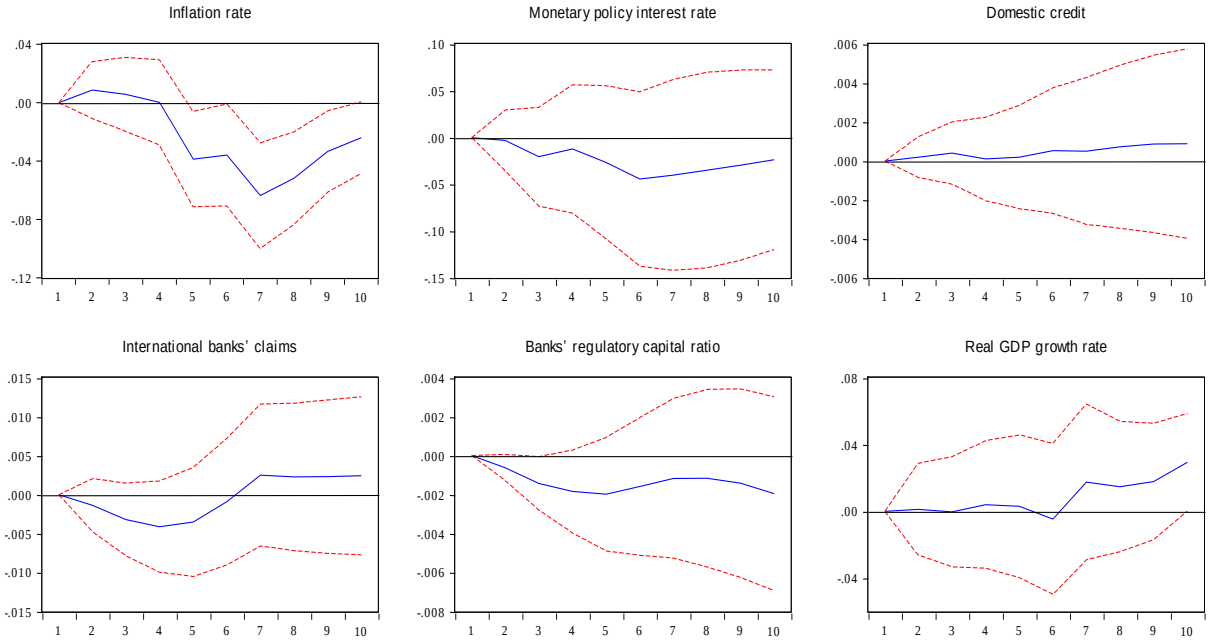


c) Reserve requirements on foreign currency (RRFOREIGN)

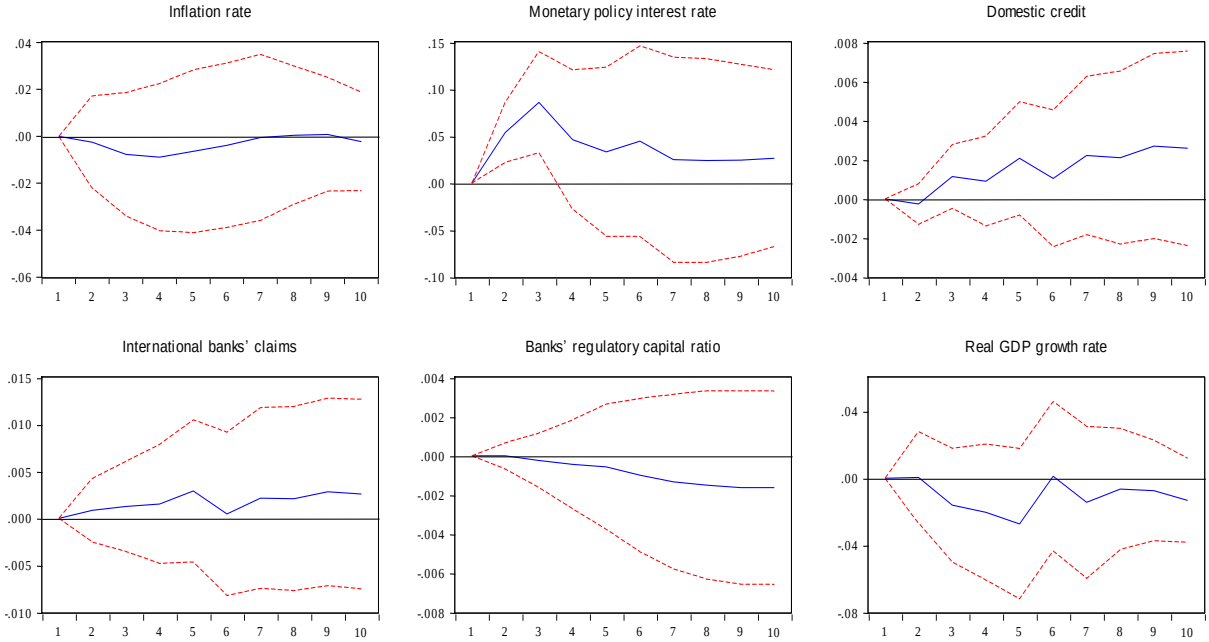


4A.7. Lag order variant (6 lags) impulse response functions for the period 2000q1-2014q4

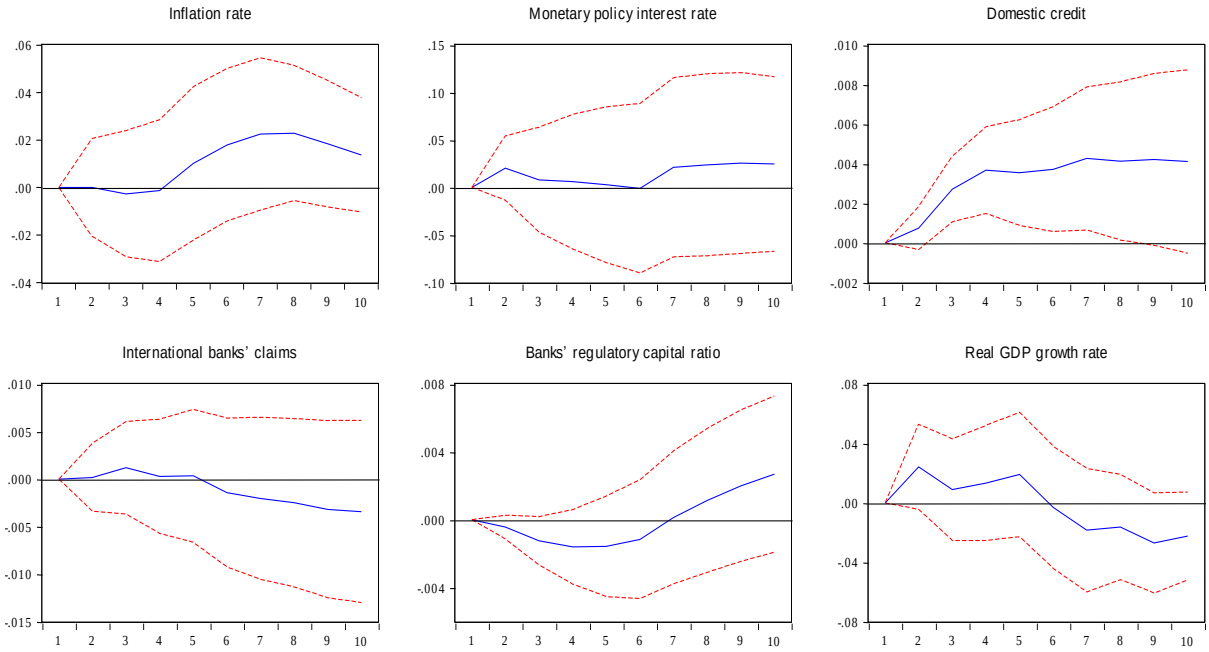
I. Sector specific capital buffer – real estate credit (SSCBRES)



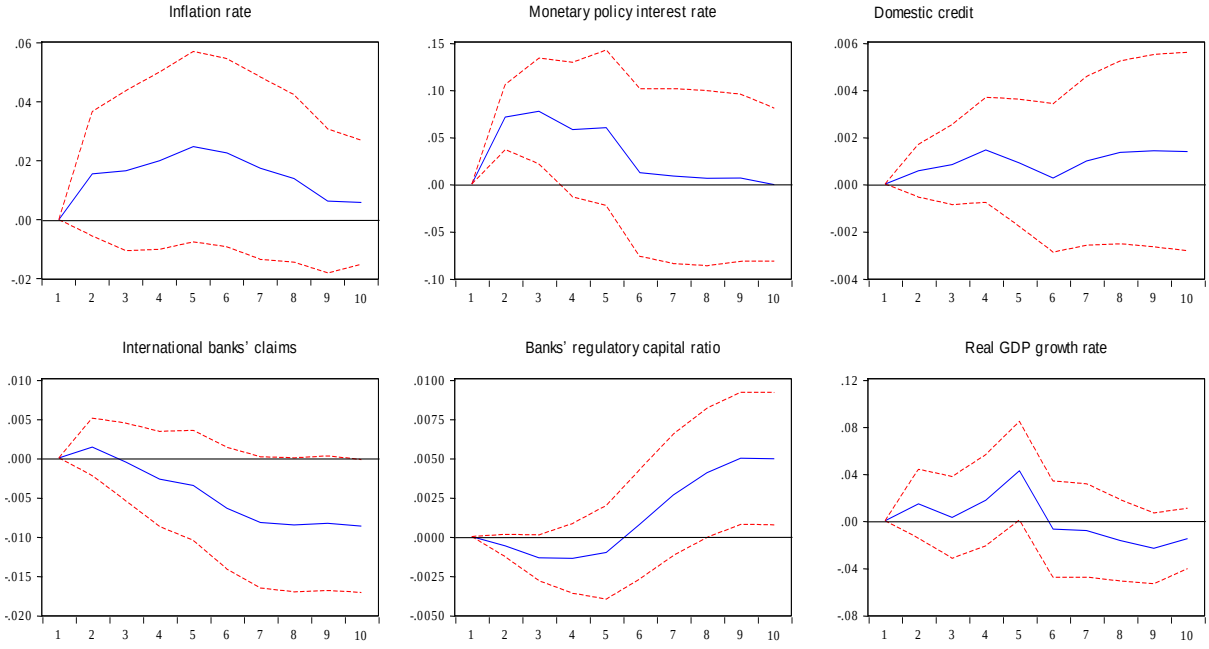
II. Sector specific capital buffer: other sectors (SSCBOTH)



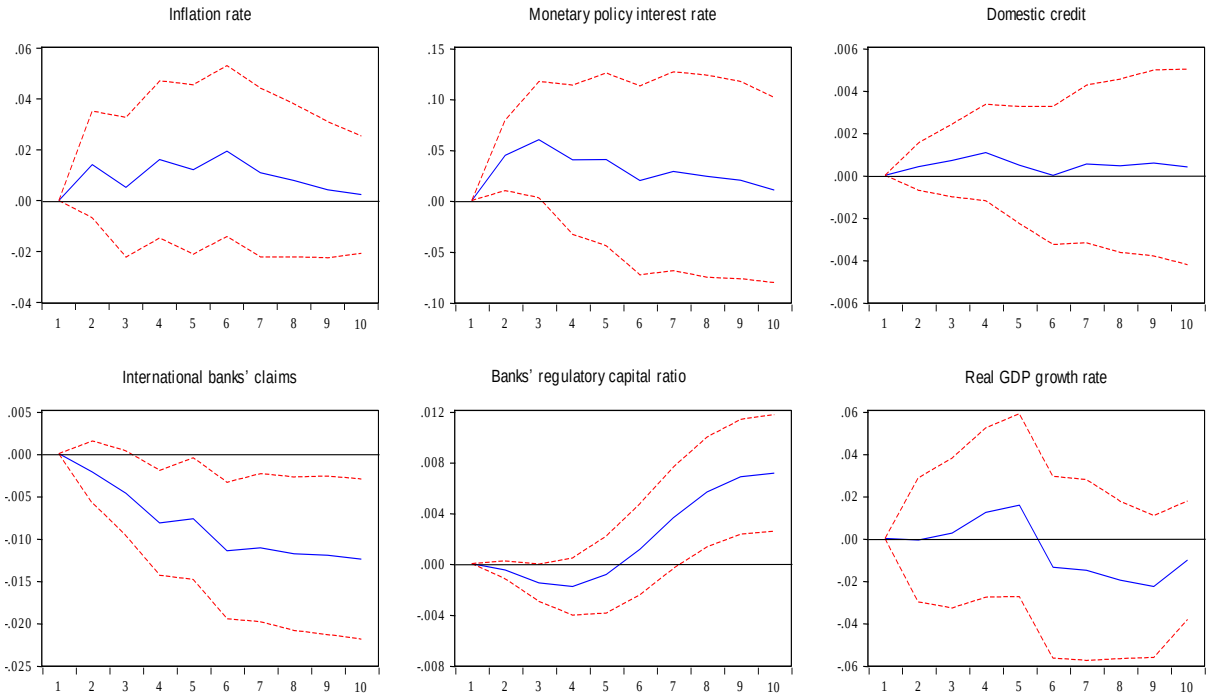
III. Reserve requirements on foreign currency (RRFOREIGN)



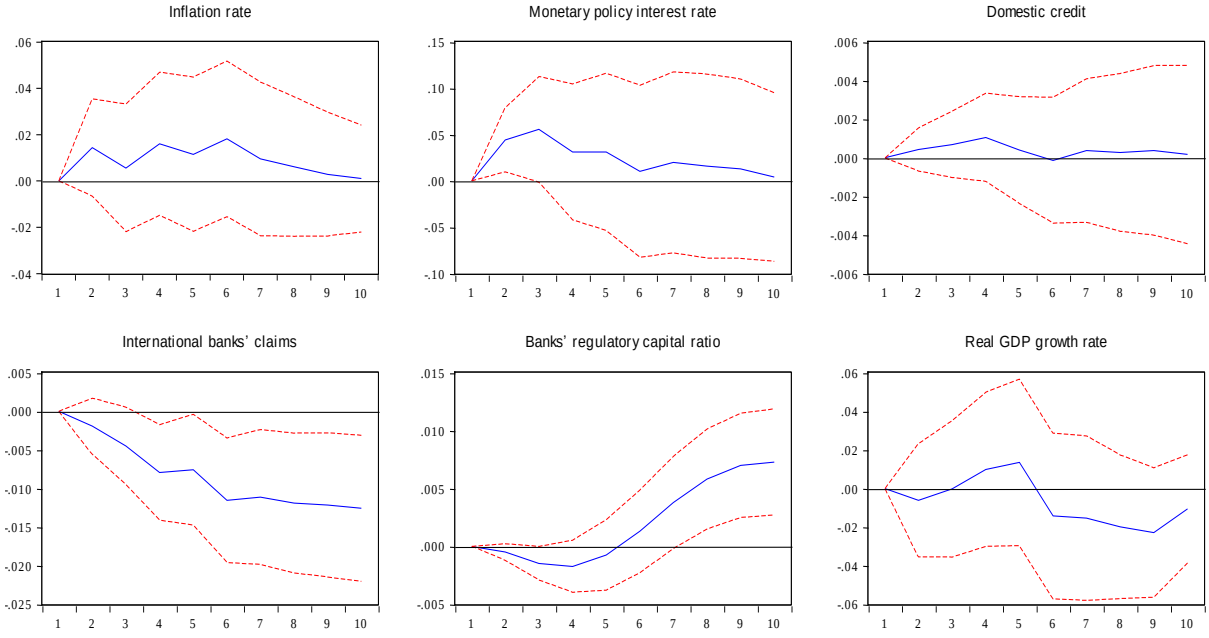
IV. Reserve requirements on local currency (RRLOCAL)



V. Sum of all country prudential instruments (PRUC)

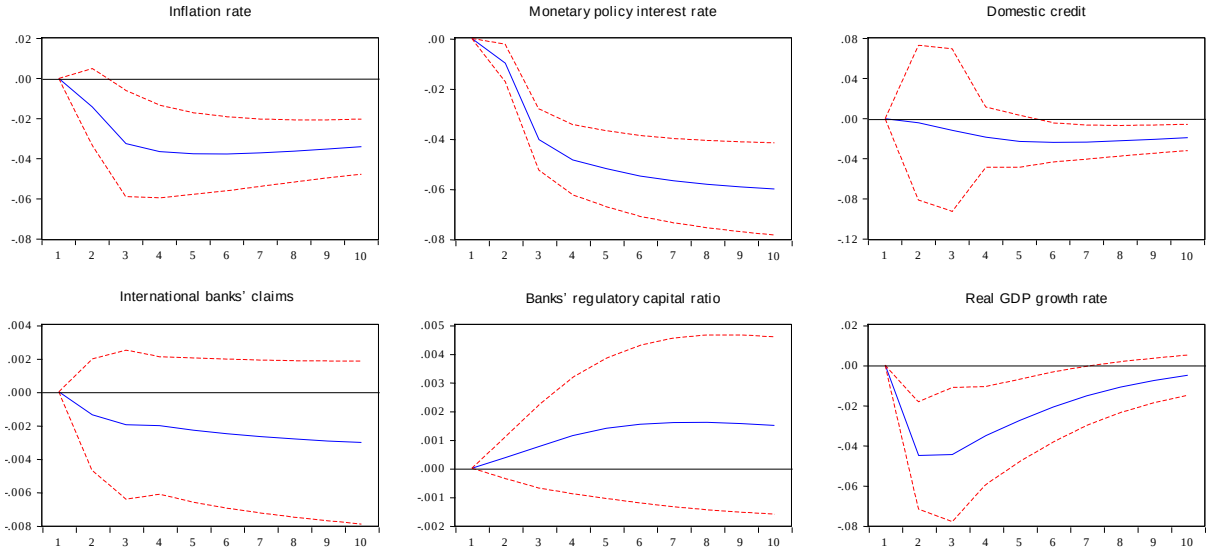


VI. Sum of all country prudential instruments (PRUC2)

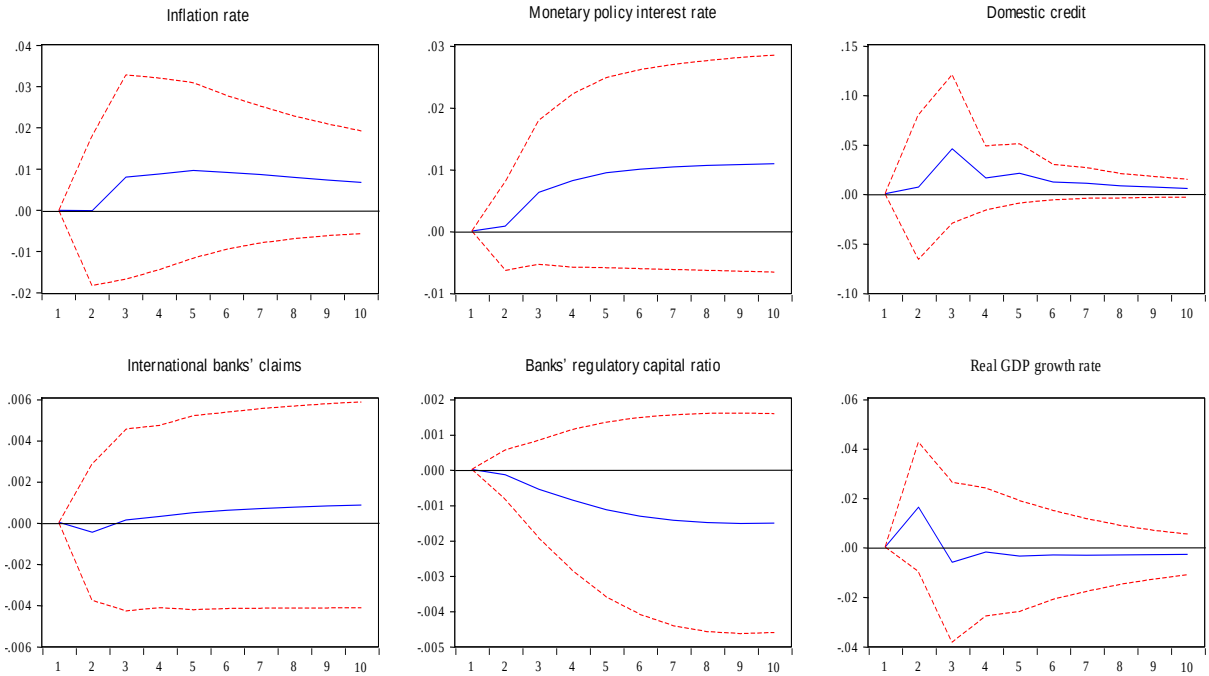


4A.8. First differenced domestic credit impulse response functions (all countries, 2 lags PVAR model)

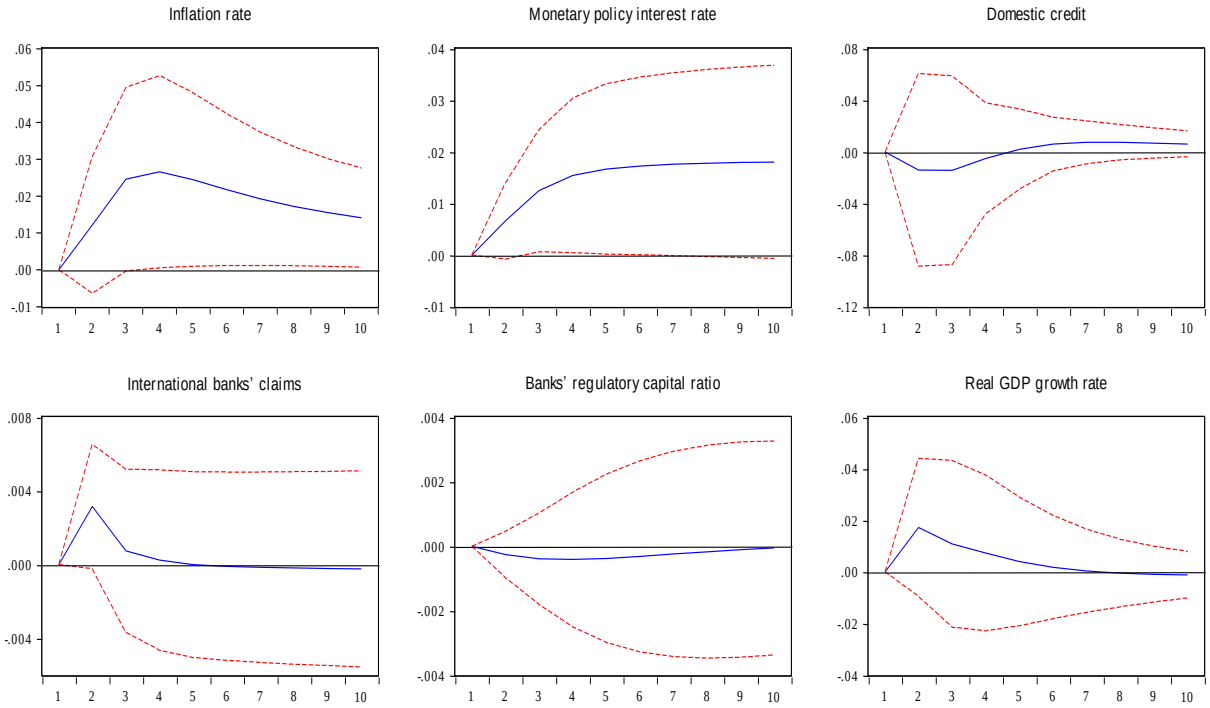
I. Capital requirements (CAPREQ)



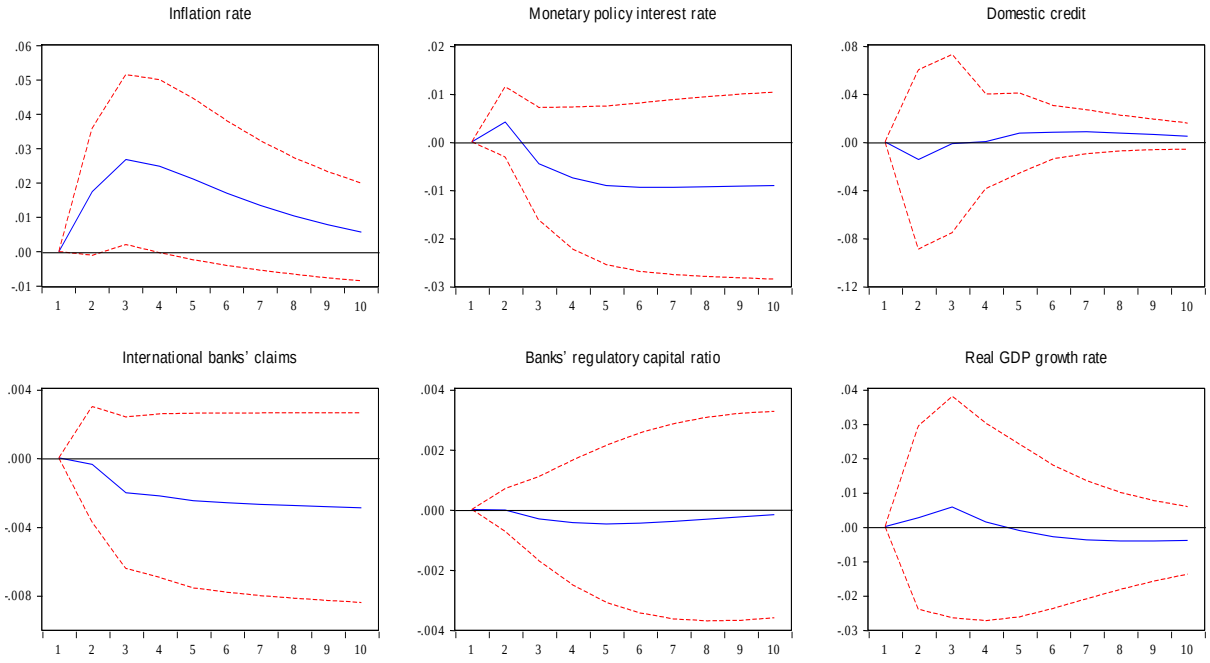
II. Reserve requirements on foreign currency (RRFOREIGN)



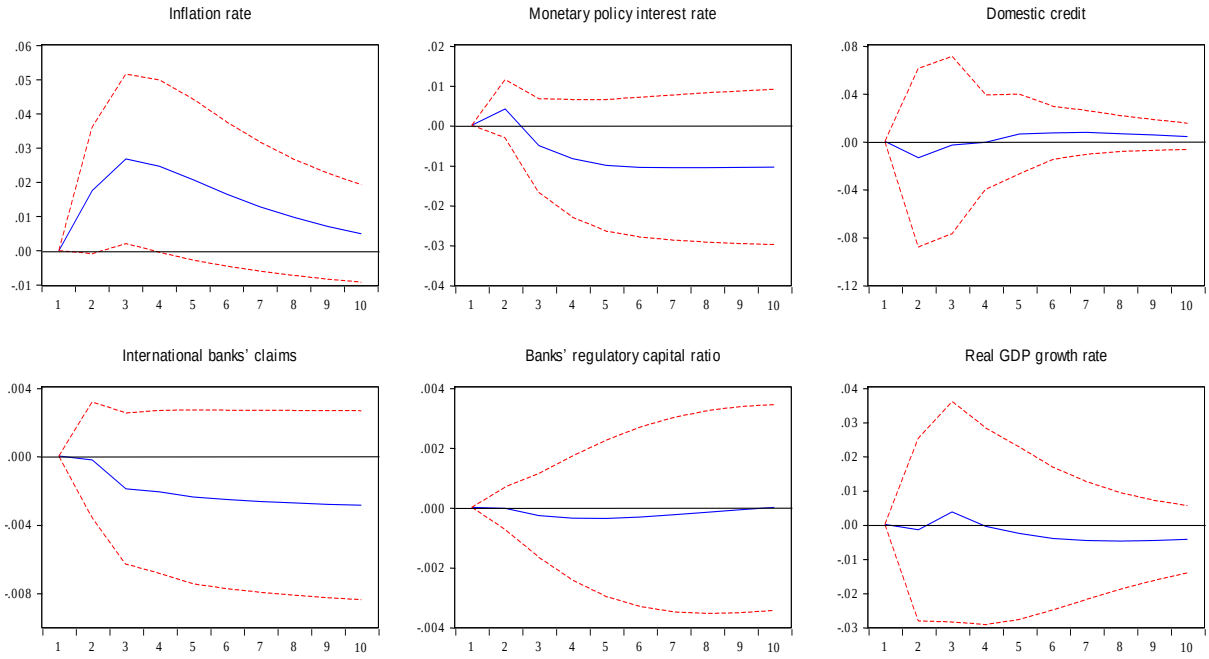
III. Reserve requirements on local currency (RRLOCAL)



IV. Sum of all country prudential instruments (PRUC)

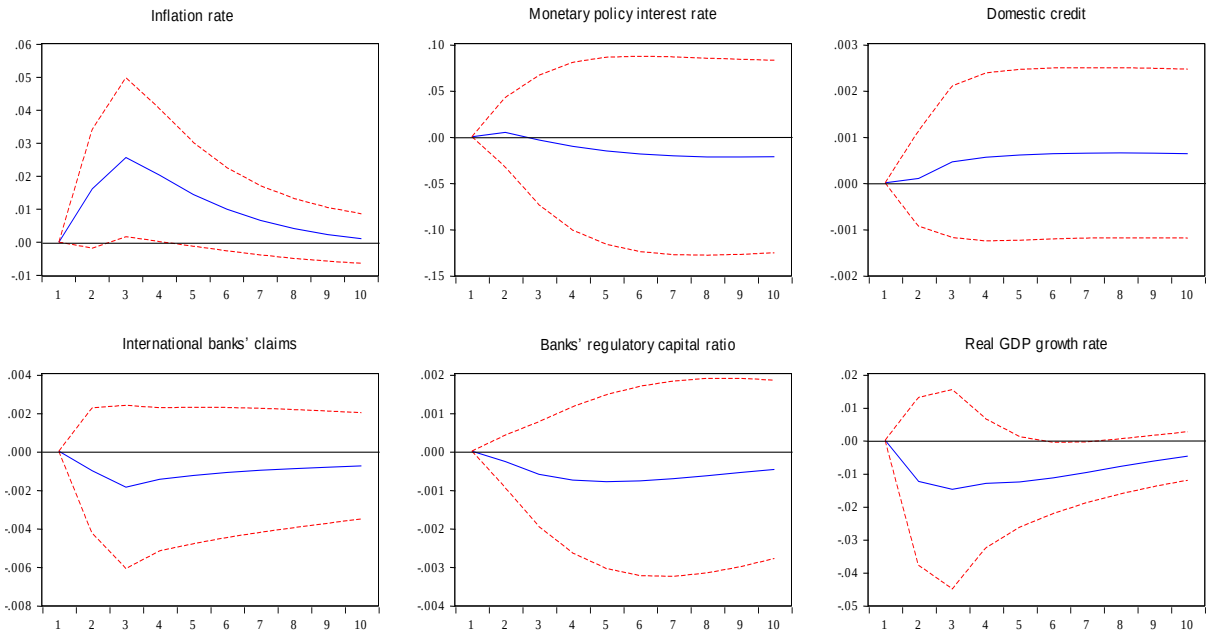


V. Sum of all country prudential instruments (PRUC2)

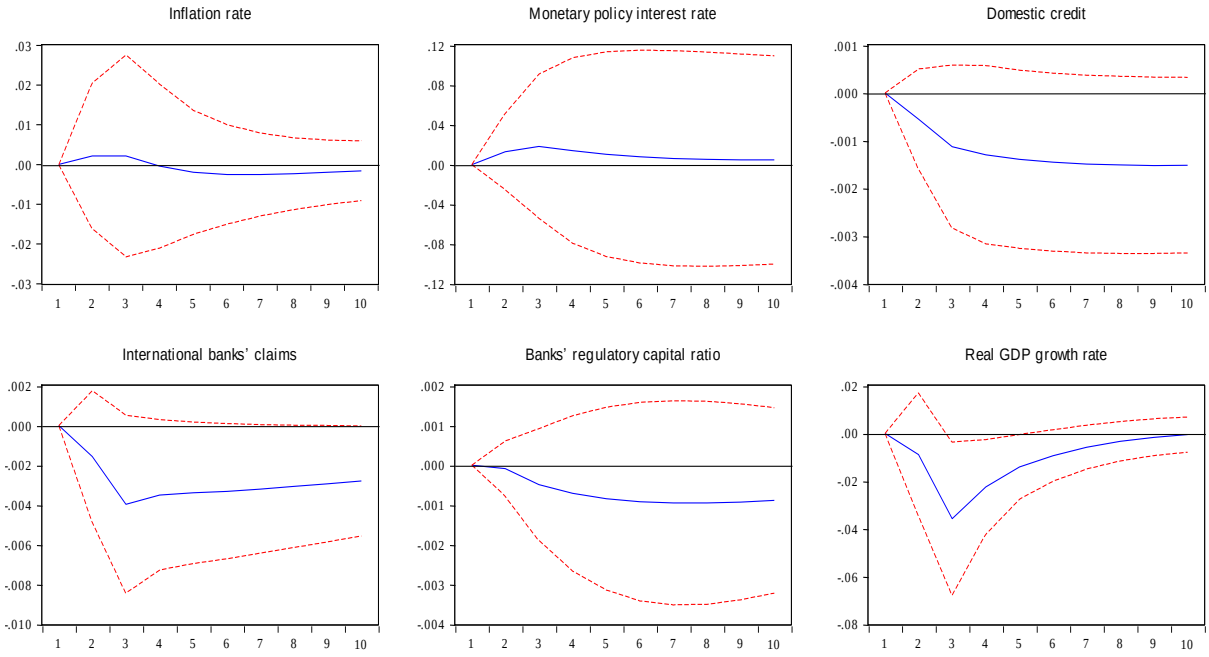


4A.9. Omitted outlying countries impulse response functions as measured by the international banks' claims to GDP ratio (all countries, 2 lags PVAR model)

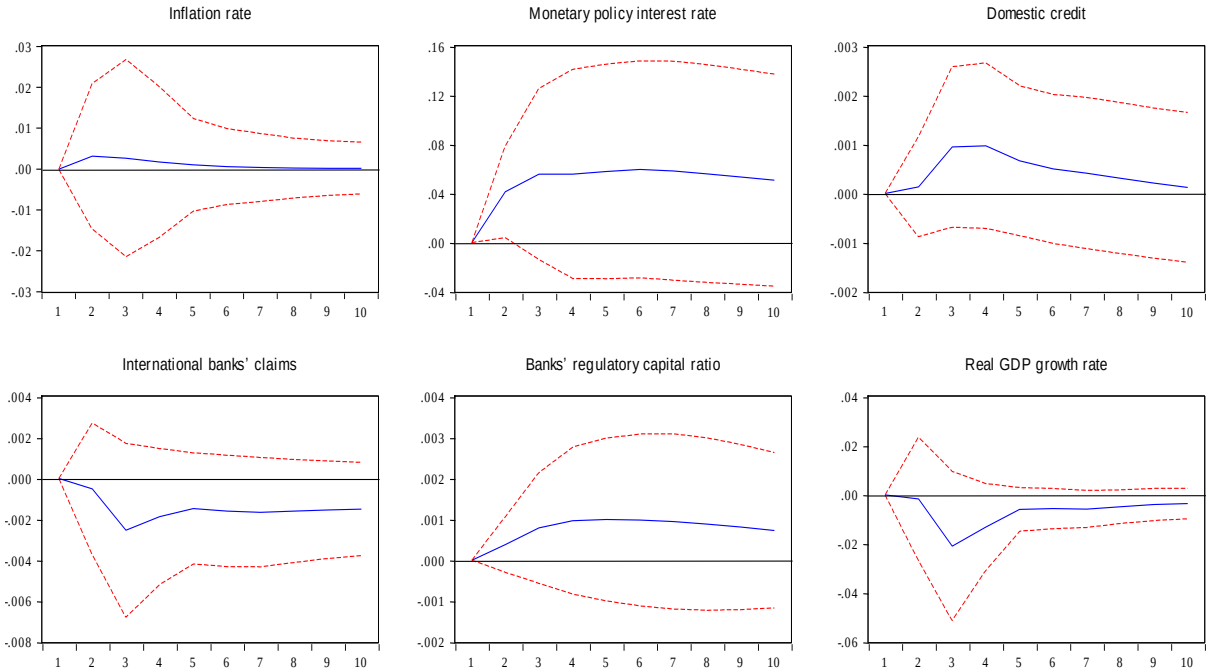
I. Sector specific capital buffer real estate (SSCBRES)



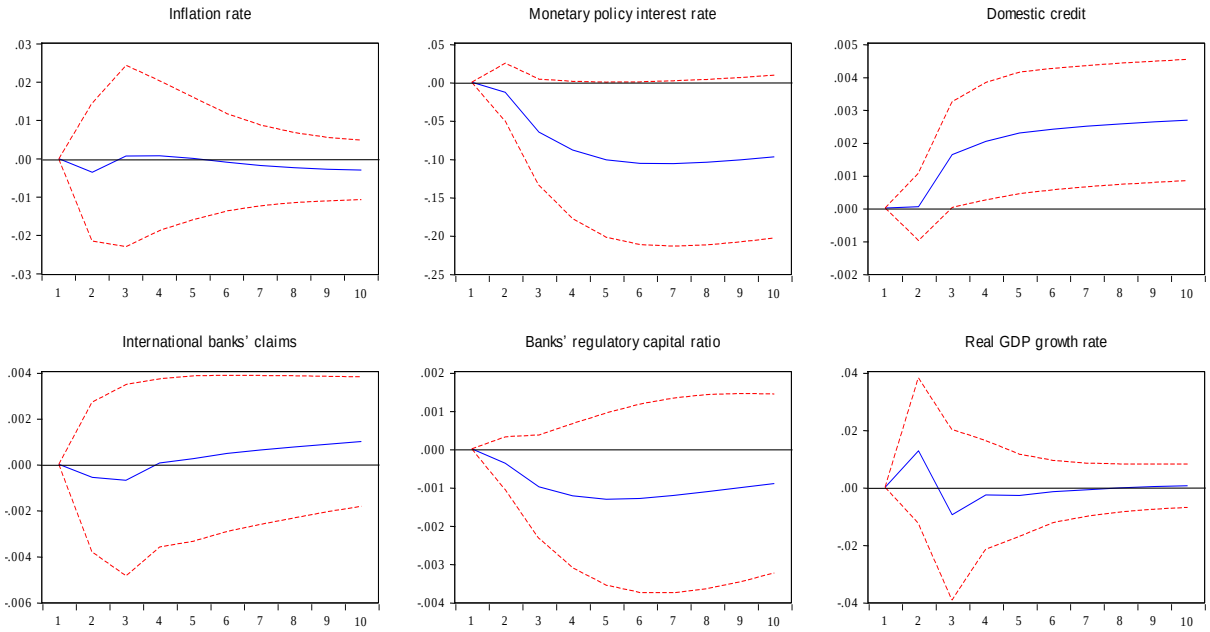
II. Sector specific capital buffer real estate (SSCBCONS)



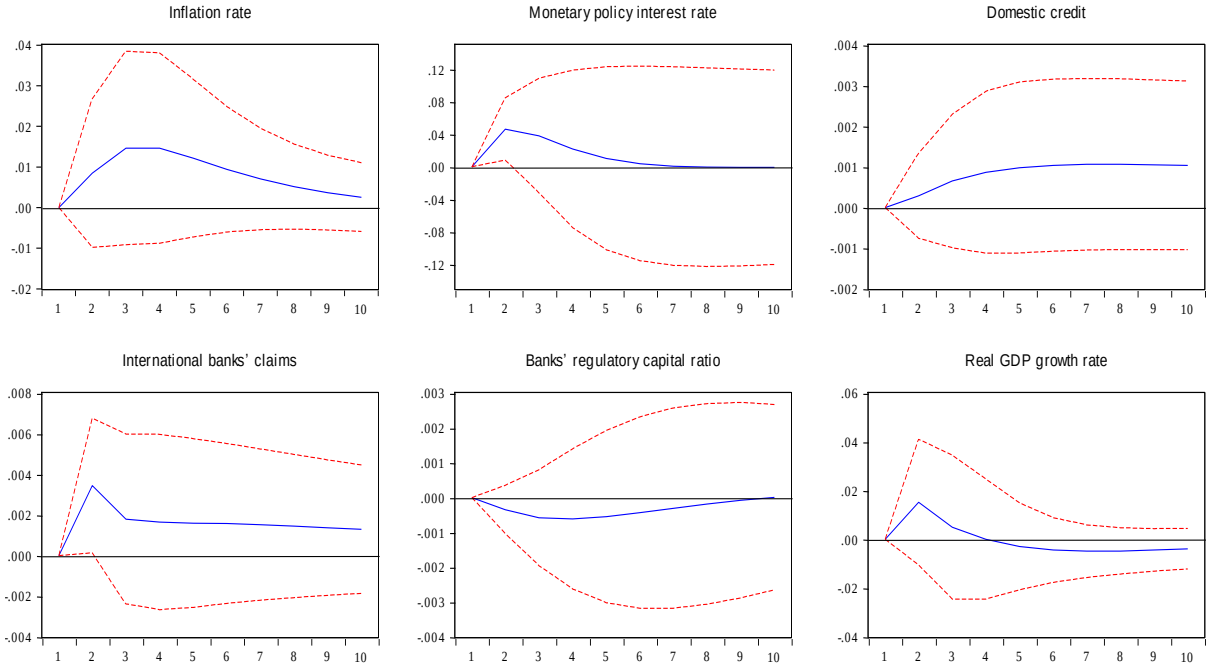
III. Sector specific capital buffer real estate (SSCBOTH)



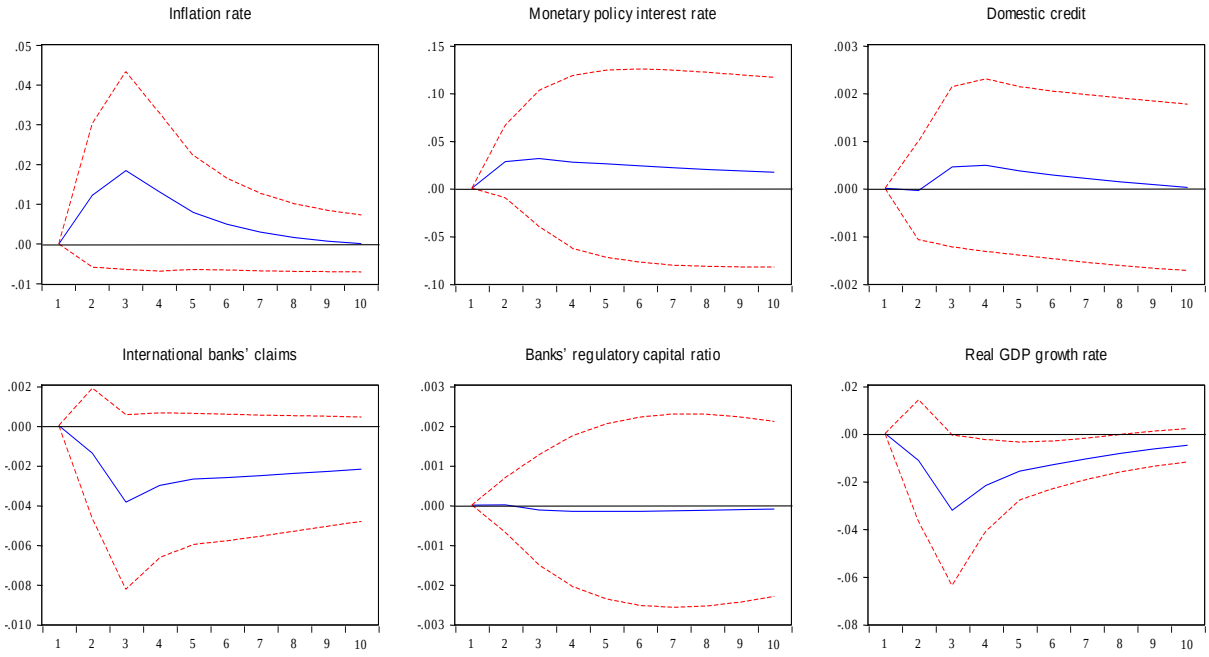
IV. Reserve requirements on foreign currency (RRFOREIGN)



V. Reserve requirements on foreign currency (RRLOCAL)



VI. Sector-specific capital buffers (SSCB)



CHAPTER 5:

Macroprudential Policy, Banks' Profitability and Monetary Policy

5.1. Introduction

It has been more than ten years since the global financial crisis of 2007-2008, which contributed to the widespread introduction of macroprudential policy as an essential financial regulatory policy tool to forestall crises or at least offer a buffer to soften the impact of them. Supporting this, there have been numerous empirical studies which provide robust evidence for the effectiveness of macroprudential policy in advanced countries and emerging market economies such as Carreras et al (2018), Cerutti et al (2017), Davis et al (2017), Akinci and Olmstead-Rumsey (2015), Claessens et al (2014), Dell'Ariccia et al (2012), Lim et al (2011), etc.). Many of these studies have specifically focused on the effectiveness of macroprudential policy in the area of the financial sector where there is the most potential for systemic risk to develop, that is the credit and housing markets and the banking sector (see **Chapter 2 and 3**). In hindsight, these studies of the effectiveness of macroprudential policy and many countries' policy framework are rather narrow, as they mostly focus on the effects operating via the banking sector on the household sector.

In this context, despite the increased trend toward disintermediation of banks (see BIS (1986) - "Cross Report" as well) with the growth of capital and securities markets, improvement in financial system technology and the transformations of banks' operating environment, banks remain central in the financing of economic activity. Both internal and external factors have affected their growth, structure, performance and competition, etc. and their role and dominance vary significantly between countries. Nevertheless, it remains clear that a sound and profitable banking sector is important for the effective functioning of the economy. Furthermore, such as sector is better able to withstand negative shocks from financial disruptions and contribute to financial stability. Given the importance of profitability to banks' growth, survival, stability and the significance of the banking sector for the real economy, and the recent

growth in the standing of macroprudential policy, understanding the effect of macroprudential regulation on banks' profitability is of vital importance.

As such we believe there is a gap in the literature on macroprudential policy, where the focus tends to be on the overall system-wide benefits of such regulation. So, for example, analysis of prudential instruments typically focuses on their effectiveness in dampening aggregate credit growth and house prices and the overall benefits of limiting financial sector disruptions. There tends to be limited emphasis on the effects on banks as measured by the impact on their profitability, structure and activities, etc. Also, there is limited research using micro banking data in analysing the use of macroprudential policy (for an exception, see Claessens et al (2014) which focused on asset growth as a dependent variable).

In the support of the relevance of the question, Van den Heuvel (2008) and Tchana (2012) suggested that although capital requirements limit moral hazard on the part of banks and hence are beneficial for financial stability, they are costly since they reduce the ability of banks to lend, and thus can hamper long term economic growth, which is an unintended side effect of regulations that limit banking activities. We contend further that although the premise of macroprudential policy is to prevent or limit financial instability across the broad financial system, the currently suggested macroprudential tools and new regulations target the banking sector narrowly. As such, macroprudential action can be seen as an added cost to banks which in turn can affect banks' profitability, hence their net income, the cost of credit and their ability to lend. Ultimately, this could affect banks retained earnings and thus accumulated capital and hence could be counterproductive to financial stability as well as economic performance.

In this context, the purpose of this chapter is, firstly, to present empirical research of potential effects of macroprudential policies on banks' profitability which will also help in the understanding of how banks react to macroprudential regulations. We consider this of particular relevance because to our knowledge no extant research on which instrument has the most effect on banks' profitability as well as examining the different between advanced countries and emerging market economies. Furthermore, by tracing such effects we can understand better the transmission process from policy to

credit issuance. Cerutti et al (2017) suggested there is a weaker effect on asset prices and credit in more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy, which should find parallels in profitability.

In addition, the question arises how macroprudential policy interrelates with monetary policy, whether positively or negatively or whether there is no significant effect. The second purpose of the chapter is to look at macroprudential policy's relationship with monetary policy in the context of the specific profitability measure the net interest margin. Constâncio (2016) suggested that macroprudential policy provides monetary policy with additional room to manoeuvre so as to focus on ensuring price stability. In essence, macroprudential policy provides a stable platform (financial stability) for monetary policy to function effectively. Borio el at (2017) and Alessandri and Nelson (2015), who looked at the influence of monetary policy on banks' profitability, suggested that there is positive relationship between the level of short-term interest rates and bank profitability, which suggest that monetary policy tightening benefits banks' profitability. Yet, Borio el at (2017) also found that over time, unusually low interest rates and flat yield curve erode banks' profitability.

Beau et al (2012), who analysed the interactions between monetary and macroprudential policies, suggested that there are circumstances under which such interactions call for their coordinated implementation, given macroprudential policy has an effect on the goals of monetary policy and vice versa for monetary policy. Meanwhile, Agur and Demertzis (2015), suggested that there could be situations where monetary and macroprudential policies could work in contradiction to each other and policy makers would have to favour one policy over the other depending on the situation and the goal of policy makers. In addition, Claessens et al (2015) suggested that the phase of the cycle could give a differing result for policies' impact. We further contend, policy makers would need to weigh the benefits and cost between macroprudential policy (financial stability goal) vs monetary policy (price stability and economic growth goals) in determining which policy needs to act in a secondary role. Hence, there needs to coordination and cooperation between policy makers in the financial system as well as the fiscal agent (government).

In this chapter of the thesis, we estimate Ordinary Least Square (OLS) models using Fitch-Connect database of bank financial statements for 92 countries, which include 6,010 banks (3,095 banks from advanced countries and 2,915 banks from emerging market economies). We will investigate whether and to what extent macroprudential policy could have an impact on banks' profitability as well as the interaction with monetary policy. The period of coverage for the empirical analysis is 2000 to 2013, using the same IMF database of macroprudential policies as in **Chapter 3**.

The chapter is structured in the following manner. Firstly, **Section 5.2. The role of banks and banks' profitability** motivates the study by looking at the role of banks in the financial system, their transformation and profitability. Secondly, **Section 5.3. Banking regulation and the impact on banks' cost and lending** looks at the how banks are regulated and the impact of regulation on banks' activity. **Section 5.4. Empirical analysis of the effects of macroprudential policy on banks' profitability and interaction with monetary policy** provides a quantitative analysis of the effects of macroprudential policy on banks' profitability as well as looking at its interaction with monetary policy using the Net Interest Margin profitability model. Fourthly, **Section 5.5. Robustness checks** provide a check on the model results. Finally, in **Section 5.6. Chapter Summary**, we conclude.

5.2. Banks and the factors affecting banks' profitability

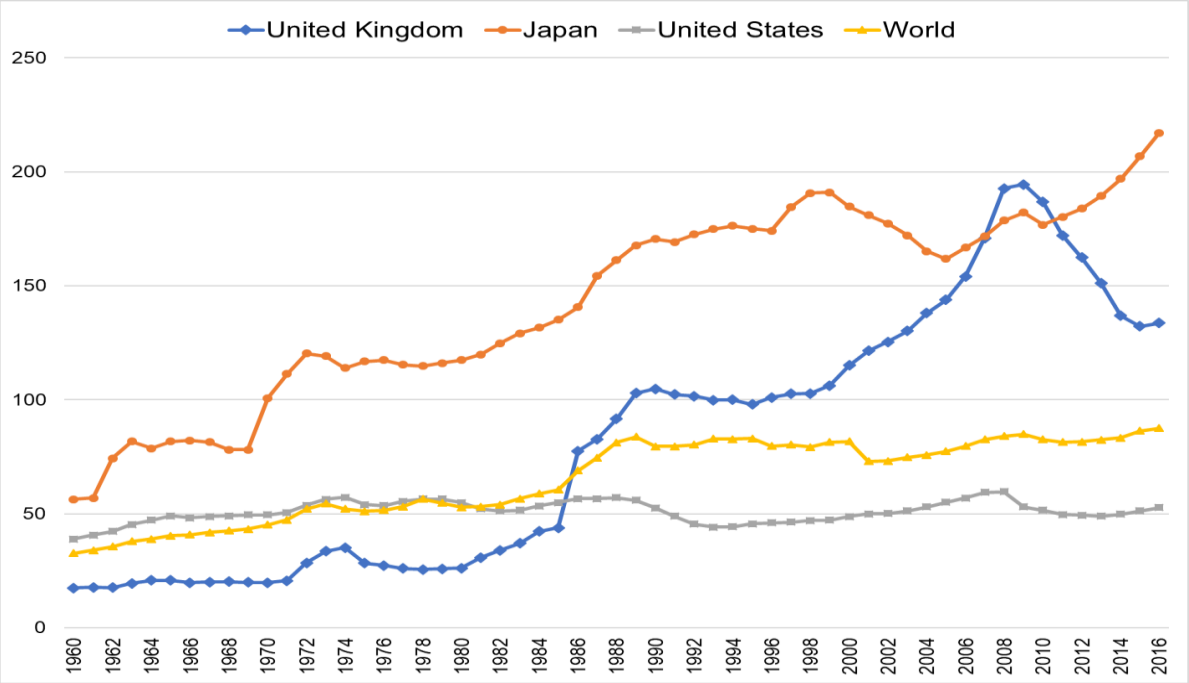
Despite the increased trend toward disintermediation of traditional bank loans and deposits, the financial crisis of 2007-2008 underlined just how important the banking sector is to the financial system and the economy even in highly securitised financial systems. Banks perform many roles in the financial system and understanding these many roles have become one of the fundamental issues in fields of study of financial stability and the transmission of monetary policy as well as the efficient channelling of savings into productive economic activities, etc. As such, the purpose of this section is to look briefly at role of banks in the financial system, the ongoing transformation of their role and the determinants of banks' profitability.

5.2.1. Banks in the financial system

I. The development of the banking sector

The evolution of banks' functions has not changed the link of banking to financial and economic development as is evident from a considerable literature on the topic of financial development and growth (see Popov (2017, Beck (2008), Levine (2005), etc.). Banks continue to be a key player in the financial system yet their functions, role and operation varies significantly between countries. Accordingly, it is important to begin by emphasising the diversity of financial structure and experience.

Figure 5.1: Banks domestic credit to private sector (% of GDP)



Source: World Bank World Development Indicators and author's calculations

Figure 5.1 shows the growth of banks domestic credit to private sector as a per cent of GDP for the UK, Japan, the US and the World (Total) for the period 1960 to 2016. Over the period there has been a rapid rise in banks credit to the private sector especially in the UK and Japan. In the UK, we see the impact of deregulation in the 1980s, where there was a large jump in banks' credit as banking restrictions were removed. In Japan, the Japanese financial system has historically been banking-

oriented but credit fell after the onset of the banking crisis. See below for further discussion.

In the US, figure 5.1 shows relative stability in domestic bank credit/GDP. There have traditionally been many banks due inter alia to restrictions on interstate banking, while securities have long been an important source of financing for the private sector, this underlying the stability of bank credit. DeYoung (2014) noted that merger and acquisition reduced the number of banks in the 1980s. Although many banks still exist, the US has seen the emergence of a number of very large banks. Furthermore, new technologies for production and distribution of financial services, increases in competition and abolition of the separation of banks' business functions between commercial and investment banking that pressured banks to operate more efficiently have also played a major role. DeYoung (2014) suggested that this led to the appearance of strategic dichotomy, with small "community" and regional banks providing person-to-person retail and small business banking services, and with large commercial banks providing high-volume retail banking services in larger domestic markets and cities and corporate and investment banking services, initially largely in other countries (notably via the international capital markets highlighted in **Chapter 4**). These changes in the structure and operation of the banking sector in the US brought improved efficiency to the banking industry and its customers but introduced new financial system instabilities as revealed during the global financial crisis (DeYoung (2014)).

In the United Kingdom (UK), the system had long been quite concentrated and dominated by major clearing banks. With the Competition and Credit Control (CCC) reform (1971-1973), there was the removal of credit controls on all banks, which sharply increased competition in the banking sector. This led to a rapid increase in lending, a stock market and property boom (Figure 5.1). But by the middle of the 1970s, many developed countries were fighting rapid inflation by rising interest rates to reduce demand and tightening fiscal policy. In the UK, the push to control inflation led to a sharp fall in share and property values and the reimposition of credit controls on all banks. This in turn weakened the balance sheet of secondary banks and led to the UK secondary banking crisis in 1973. The 1980's was another period of deregulation and abolition of credit controls, led by the removal of exchange controls

(see Davis (1995)), leading to a vast expansion of banking activity (see Figure 5.1 above). The 1986 “Big Bang” stock market reform led UK banks to increase investment banking activity also. Also, as noted in **Chapter 4**, British banks already had a footprint in many countries especially Commonwealth countries, due to historical and political connections to the British Empire as well as many Commonwealth countries’ legal systems being founded on English common law – a legacy of British colonialism, which further underpinned their growth.

Uchida and Udell (2014) suggested, unlike most other developed countries, the Japanese financial system has historically been banking-oriented (as in Europe) but also segmented, that is the banking sector is segmented by the nature of the services that each type of financial institution provides (as historically in the US). The regulatory segmentation dates back to the World War II, the wartime system, where the purpose was to limit competition in order to promote banking profitability, thereby enhancing the safety and soundness of the financial system. As for the US, Glass–Steagall Act of 1933, Article 65 of the Securities and Exchange Law effectively prohibited commercial banks from engaging in insurance, underwriting and brokerage activities, thus preventing competition between commercial banks and non-depository institutions (insurance companies, investment banks, brokerage firms) (see DeYoung (2014)). Uchida and Udell (2014) further noted that although financial liberalisation in the 1980s and 1990s blurred the divide between different types of financial institutions, there still remain some boundaries. Banks are defined under the 1981 Banking Law (Japan) and they are defined according their activities, either lending, deposit-taking or just provision of payments and settlement services. Also, still remaining are major investment banking institutions. Following the 1980s credit and asset price boom, Japan suffered a banking crisis of 1990s which led to major decline in bank lending and stagnation of economic activity (see Figure 5.1 above).

The tradition in most EU countries is of universal banking, combining commercial and investment banking activities, but also with many local as well as national banks. Banking is much more important than securities for private sector financing. Since the passing of the First Banking Directive in 1977, there has been a rapid change in the European banking sector, as European Union (EU) legislation has been directed consistently towards reducing barriers to cross-border bank ownership and activity

(Goddard et al (2014)). The directive established the principle of home country control and responsibility for the supervision of credit institutions operating in two or more members countries would gradually be shifted from the host country to the home country of the parent bank. This was the first step toward the harmonization of regulations (Dermine (2002)). In addition, Goddard et al (2014)) noted that with the introduction of the euro in 1999 and the creation of the Single Market in financial services after 1992, the financial sector in Europe has been subject to rapid expansion, which extended to non-euro area countries such as Switzerland and the UK. They noted that banks have increased their range of financial products and services to customers, blurring the distinction between banks, insurance companies and other financial firms and entry by foreign-owned banks has led to increased competition.

Likewise, in Latin America, the banking sectors have been subject to extensive deregulation and financial liberalisation, which involved interest rate deregulation, bank privatization and the removal of restrictions on foreign bank entry. In addition to other liberalising reforms pertaining to the macro economy and balance of payments often following IMF programmes in the wake of financial and economic crises such as the Latin American debt crisis of 1982 (see **Chapter 4**). As a result, the banking sectors have become more consolidated and there has been a change in the governance structure of the banking sectors as foreign bank penetration has deepened and there has been a growth in regional capital markets (see De Carvalho et al (2014)). Meanwhile, in Africa, although the banking sectors have experienced some form of financial liberalisation, African banks lend less to the private sector in comparison to banks in non-African developing countries. African enterprises and households are less likely to use financial services but access services in the informal sector, the shadow banking sector (see Beck and Cull (2014)).

Banking systems in developing countries in South and East Asia such as China, Thailand, Pakistan and India, have witnessed important restructuring especially since the 1997 Asia financial crisis. Similar to Latin America and other developing countries, there is a trend toward increasing financial integration, which has resulted from financial sector reforms and structural changes. Countries in South and East Asia have undertaken efforts to clean up the banking system, reduce political interference and state ownership and allow for greater foreign participation (Klapper et al (2014)).

II. International banking

As outlined in **Chapter 4**, international banking expanded rapidly from the early 60s as Euromarkets grew following US regulatory restrictions. This expansion accelerated after the end of the Bretton Woods system of managed exchange rates in the 1970s and international banking plays an important role in the global economy. It also experienced financial crises such as Herstatt (1974), the Latin American debt crisis (1980s) and the 2007-2008 global financial crisis.

The Committee on the Global Financial System (CGFS (2010c)) noted firstly, international banking has taken a significant role in the process of financial globalisation and integration of financial markets. Traditionally, international banking activity expanded largely in line with international trade and performed key functions for international firms. However, with financial liberalisation, especially in emerging market economies, the rise in international securities activity and the increase demand for financial services have accelerated the growth of international banking activity and financial integration much faster than international trade. Secondly, international banks play a vital role in the global economy and it is closely related to activities in international financial markets. International banks perform important functions in term of intermediation, the allocation of credit, and maintaining the resilience of the market infrastructure for the healthy functioning of the global financial system. And thirdly, technological development has advanced financial integration of international banks and paced the way for broader access to markets (see **Chapter 4** for further information on the role and growth of international banking).

III. The role of banks in the financial sector

Against the background of the diverse structure and experience of banks as noted above, some common roles remain. Bollard (2011) noted that banks and other financial intermediaries exist because they are an efficient response to the fact that information is costly. Banks specialise in assessing the credit worthiness of borrowers and providing an ongoing monitoring function to ensure borrowers meet their obligations. Further, he suggested that bank's role as financial intermediaries has a major bearing on how efficiently the economy allocates its resources between

competing uses. Allen et al (2014) suggested that banks allow various informational problems to be solved, so banks act as delegated monitors between investors and borrowers by monitoring the latter and ensuring a proper use of depositors' funds.

Another role of banks is to make the financial system safer by reducing and managing risk, although many financial crises (see **Chapter 2 Appendix 2.A1** for a list of crises since the 1970s) have occurred in the banking sector. Bollard (2011) suggested that banks' own practices as well as financial regulation have an important bearing in reducing or amplifying risk in the financial system and given the interconnection between banks and the rest of the economy, financial fragility can have potentially negative effects on the real economy.

Allen et al (2014) indicated that one of the most important roles of the financial system is the sharing of risk as they saw that households face certain amounts of risk depending on the characteristics of the financial system, such as in the UK and US, where a large amount of households assets are held in equity (mainly via institutional investors such as pension funds) and only a small amount in banks. In Japan (and much of continental Europe), which historically been a banking-oriented financial system, households are shielded from market risk, yet more vulnerable to banking crises, because they hold a majority of their assets in banks and very little in equities unlike in the US and UK, etc. (see Uchida and Udell (2014), Allen et al (2014)).

Banks play an important role in the transmission of monetary policy, which is the process where changes in the monetary policy instrument (e.g. short-term interest rate) work their way through the economy, where for many countries the goal is to ultimately affect the rate of inflation while for others it is to do so indirectly via an exchange rate peg. Changes in monetary policy instrument affects banks' ability to lend either by affecting banks' lending interest rates or restricting the amount of funds available for extending loans (reserve requirements), which has an effect on the level of demand for goods and services. It also impacts on loan demand as the private sector is less likely to borrow at high interest rates. Peek and Rosengren (2014) noted, although the traditional interest rate channel is still important for the transmission of monetary policy, the broad credit channel (See Bernanke and Gertler (1995)) in augmenting the impact of monetary policy on the economy has gained in importance.

Yet, the narrower bank lending (credit) channel, the supply of loans from banks, needs further investigation. In addition, they noted that a key issue is whether a shift in monetary policy affects bank loan supply as opposed to loan demand, and if it does, the extent to which a change in bank loan supply can affect economic activity.

5.2.2. Factors affecting banks' profitability

Research on the factors affecting banks' profitability has attracted a lot of attention due to the importance of the banking sector to the stability of the financial system and the economy, as well as to economic growth. Albertazzi and Gambacorta (2009) suggested that bank profitability is important for understanding financial stability and fragility. However, they noted that monitoring banks' profits is made difficult by the fact that the components of bank profits are observed at low frequencies, at best quarterly reporting, and mainly large and listed banks' information are available publicly.

Kok et al (2015) suggested that weak bank profitability is relevant for financial stability because the inability of banks to build up capital buffers by retained earnings hampers shock-absorption capacity. Also, they noted persistently low profitability could encourage banks to take undue risks in order to generate higher returns, which can increase financial fragility. Deutsche Bundesbank (2018) noted that weak profitability can reduce the ability of banks to generate capital in the form of retained earnings which can lead to restrictive lending policies, thus reducing the impact of accommodative monetary policy measures.

Typically, in the literature bank profitability is measured by the returns on average assets (ROAA) and equity (ROAE) or the net interest margin (NIM). ROAA reflects how a bank is using its assets to generate profits while ROAE measures the performance of a bank based on its average shareholders' equity, the return to shareholders on their equity. NIM is a measure of how successful a bank is in its portfolio investment decisions, that is the bank's interest spread between interest revenue from investment (loans) and their interest expenses paid to lenders (depositors). According to the OECD (2010), NIM is defined to include income on interest-bearing assets, fee income related to lending operations, and dividend income

on shares and participations. In some cases, it may also include income on bonds calculated as the change in the difference between the book value and the redemption value of bonds. Also, unlike the other measurements (ROAA and ROAE), it does not allow for non-interest income and non-interest costs which are the other components of the numerator of ROAA and ROAE such as non-interest income, staff costs and loan loss provisions. Non-interest income is income derived primarily from fees and commission, etc. Loan loss provisions are expected expense set aside as an allowance for uncollected loans and loan payments

The factors that influence banks' profitability in the literature are typically split in two groups, internal and external determinants. The internal determinants include bank-specific factors which are based on financial statements information such as bank size, financial structure (capital/ leverage ratios), risks and management efficiency. The external determinants relate to industry and macroeconomic factors, which include market concentration, competition, economic growth and inflation.

a) Bank-specific factors

Empirical research suggested that *bank size* tends to have a positive and significant effect on bank profitability, at least up to a certain point. This is because large banks are able to raise capital at lower cost and appears more profitable to small banks (Short (1979)). Goddard et al (2004), using data from 665 banks in six European countries (Denmark, France, Germany, Italy, Spain and the UK) over the period 1992-1998, indicated that larger banks can benefit from economies of scale but these become exhausted as size increase. However, they found that size-profitability relationship in their estimations are problematic since the cross-sectional estimations between the countries produced different results. For example, in Germany the small banks appeared to perform better than the larger ones while in the UK larger banks seen to benefit from their size. In France, Denmark, Italy and Spain the results the size-profit relationship appears to be neutral. Similarly, Pasiouras and Kosmidou (2007), using banking data from 15 EU countries over the period 1995-2001 analysed the determinants of ROAA, found that larger banks are likely to have a higher degree of product and loan diversification than smaller banks and they should benefit from economic of scale. Yet, they found that bank size has a negative effect on profitability.

Korytowski (2018), using data from 4,179 European commercial banks in the post crisis period for the period 2011 and 2015 found that bank-size had a negative and significant effect on ROAA while it is insignificant for ROAE.

Berger et al (1987) looked that competitive viability in banking using 1983 Functional Cost Analysis (FCA) in state banks in the US, while Berger and Humphrey (1997) applied frontier efficiency analysis to financial institutions in 21 countries. These studies indicated that little cost saving can be achieved by increasing bank size and eventually large banks could face scale inefficiencies, which could suggest that in some cases there could be a negative relationship between bank size and bank profitability. The issue of "*Too Big to Fail*" can supervene and distort the relationship of size to profitability

Empirical estimates of the effect of *financial structure* (capital adequacy/ leverage ratios) on bank profitability, which show the way bank's assets are financed and the ability of the bank to cover losses, vary from positive to negative. This variable is partially determined by regulatory capital limits such as set out in the Basel Accord, yet it is mostly computed as a reciprocal measure of leverage (see Saona (2016)), which is a measure of solvency unadjusted for risk that has only recently become a regulatory measure under Basel III for most countries. Goddard et al (2004) suggested that higher capital ratios allow banks greater flexibility in taking advantage of new business opportunities which allow for improve profitability. Petria et al (2013) did not find a significant impact of capital adequacy ratio on ROAE but a positive, significant and very weak coefficient effect on ROAA, using banking data from 27 European Union countries over the period 2004-2011. Berger (1995), using 10 years (1980-1989) of banking data from the US with ROA and ROE as dependent variables, argued that a positive relationship between the book values of capital and bank profitability is based on the signalling hypothesis that expected bankruptcy cost may cause banks to increase capital.

Athanasoglou et al (2006) noted that a higher solvency ratio may have positive effect on performance as it reduces the solvency risks taken by the bank for a given balance sheet. This may also reduce funding costs. They examined the profitability (ROA and

ROE) of banks using an unbalanced panel dataset in South Eastern European (SEE)[85] credit institutions over the period 1998-2002. On the other hand, some of the literature supports a negative relationship between capital adequacy and bank profitability as excessive higher capital can imply higher opportunity cost of capital (Hoffmann (2011)). Topak and Talu (2017), who look at the determinants of bank profitability (ROAA and ROAE) in Turkey between 2005 and 2015, found that capital adequacy (equity/ total assets) has a negative and significant effect on bank probability.

The measurement and management of *risks* are an integral part of banking, as well as being important for the stability of the financial system. Poor asset quality and low levels of liquidity are the two major causes of bank failures. In respect to the determinants of traditional bank profitability, risks can be divided into credit and liquidity risks (market risk can be included as well) and these risks have been covered extensively in the research literature and in banking regulations such as the Basel Accords. Athanasoglou et al (2006) found that higher exposure to credit risk, measured as average loan loss provisions to total loans ratio, is associated with lower bank profitability. Miller and Noulas (1997), using US banking data for the period 1984-1990, found a negative and significant relationship between credit risk (loan loss provisions to total loans ratio) and profitability (ROA) as banks with high risk loans tend to have a higher accumulation of unpaid loans. Yet, Korytowski (2018) found in European commercial banks risk appetite to be insignificant in the determinants of banks' profitability (ROAA and ROAE). He measured risk as the ratio of loan loss reserve to gross loans.

Petria et al (2013), measured liquidity risk as the ratio of loans to customer deposits. When this ratio increases, implying that banks use less deposits to grant loans or grant more loans without increasing deposits, then bank performance deteriorates. They saw a negative and significant relationship between liquidity and profitability (ROAA and ROAE). Furthermore, Molyneux and Thornton (1992) found that there is a negative and significant relationship between level of liquidity, measured as cash and bank deposits and investment securities to total assets, and profitability which is to be

[85] The countries are Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic of Macedonia Romania (FYROM), and Serbia-Montenegro.

expected as liquidity holdings (particularly those imposed by the authorities such as reserve requirement, etc.) represent a cost to the bank. They examined the determinants of bank performance across 18 European countries between 1986 and 1989 by replicating Bourke's methodology.[86] On the other hand, Bourke (1989) found that liquidity risk has a positive and significant effect on bank profitability. He studied the performance of banks in 12 countries or territories in Europe, North America and Australia over the years 1972 and 1981. Similarly, Korytowski (2018) found that liquidity has positive and significant effect on bank profitability (ROAA) but the result is insignificant for ROAE. He measured liquidity as the ratio of net loans to total deposits.

Athanasoglou et al (2008) noted that is management cost decisions benefit bank profitability, suggesting that higher *management efficiency* generates higher income and profit. They defined management cost as operating expenses divided by assets. Athanasoglou et al (2008) studied the effect of bank-specific, industry-specific and macroeconomic determinants of bank profitability (ROA and ROE) using a framework that incorporates the traditional structure conduct-performance (SCP) hypothesis in Greek commercial banks spanning the period 1985-2001. Similarly, Goddard et al (2013), noted the cost-to-income ratio, defined as the ratio of total operating cost to total income, is an important determinant of profitability. They found that cost-to-income ratio has a negative and significant effect on bank profitability. Goddard et al (2013) examined the determination and convergence of bank profitability (ROE) in eight EU countries between 1992 and 2007, using a dynamic panel model. Similarly, Korytowski (2018) and Petria et al (2013) found that the cost to income has a negative and significant effect on both ROAA and ROAE.

In addition, *diversification (business mix)* has been noted as having a significant effect on bank profitability. Goddard et al (2013), who defined diversification as non-interest income to total operating income suggested that banks that focused more on non-traditional lines of business were more profitable on average. They saw that synergies

[86] Bourke (1989) used a pooled time series approach to estimate a linear equation, regressing performance measures against a variety of internal (staff expenses, capital ratios, liquidity ratios) and external (concentration ratios, government ownership, interest rates, market growth and inflation) in the determinants of bank profitability.

between core and related activities allow diversified banks to gain and maintain a competitive advantage over less diversified banks. Similarly, Petria et al (2013) found a positive and significant effect of diversification on banks profitability. However, Saona (2016), using commercial banks data from 7 Latin American countries from 1995 to 2012, suggested that there is a negative relationship between revenue diversification and profitability (NIM). As noted, NIM is a subset of profits from interest only, thus revenue diversification results may not be surprising.

b) Bank industry and macroeconomic factors

Many empirical studies of bank profitability include external determinants i.e., *industry and macroeconomic factors* such as interest rates, inflation, GDP growth, taxation, market characteristics (e.g. market concentration and competition) and banking/ financial crisis. Studies that do include them tend to show a positive relationship between inflation, interest rates, GDP growth on the one hand and bank profitability on the other such as Bourke (1989), Molyneux and Thornton (1992), Athanasoglou et al (2008), and Chronopoulos et al (2015). Saona (2016) suggested that if inflation is fully anticipated by bank managers, this will have a positive effect on profitability as it leads earnings to increase faster than costs. Yet, she argued GDP growth impacts negatively on bank profitability, it appears that in periods of substantial economic growth, banks adjust by reducing their profit margins. However, Korytowski (2018) found that the rate of inflation had negative and significant effect on both ROAA and ROAE in the period after the 2007-2008 financial crisis.

In the research literature, only a few studies have included a *monetary policy* or an *interest rate* variable in the study of the determinants of bank profitability. Yet, the link between monetary policy and bank profitability has been established in the research literature. Alessandri and Nelson (2015), using UK banking data for the period 1992-2009, studied the systematic effect of interest rates on bank profitability (net interest margin). They found that high interest rates are associated with large interest income margins and the slope of the yield curve has an important influence on interest income. Yet, interest rate level and yield curve slope have a significant but difference effect on net interest income (both positive) and trading income (negative), which they suggested is consistent with banks hedging interest risk through derivatives. Also,

they provided evidence that maturity mismatches and repricing frictions and a rise in interest rates can, in the short-term, lower banks' income margins. Finally, they concluded that monetary policy has a systematic effect on bank profitability and hence on the capital, which should support the use of an independent macroprudential tool.

Borio et al (2017), using data from 109 large international banks located in 14 advanced countries for the period 1995-2012, studied the influence of monetary policy on banks' profitability and found results similar to Alessandri and Nelson (2015). They measured banks profitability in four ways, net interest income, non-interest income, provisions and return on assets (profit before taxes), which are all divided by total assets. They found that there is a positive and significant relationship between the level of short-term interest rates and the slope of the yield curve (interest rate structure) and bank profitability (return on assets), which suggest that a tight monetary policy stance affects bank profitability favourably. They suggested that the positive effect on net interest income more than offsets the negative effects on non-interest income and loan loss provisions. Yet, they found that over time, the effect on profitability is stronger when the interest rate is lower and the yield curve slope is less steep, which suggest unusually low interest rates and flat yield curve erode banks' profitability. This suggests that monetary policy affects loans rates more than deposits rates at very low interest rates since these compress market (loans) rates toward deposit rates, which cannot fall significantly below zero.

Demirguç-Kunt and Huizinga (1999), using banking data for 80 countries in the years 1988-1995, found that high real interest rates are associated with higher interest margins and profitability (net interest margins and before tax profits), especially in developing countries. They suggested that increases in real interest rate do not raise spreads as much in advanced countries since deposit rates may not be tied down by deposit rate ceilings. Also, in developing countries, they indicated that demand deposits frequently pay zero and below market interest rates. Real interest rate is constructed using short-term government debt yield and other short-term market rates less inflation.

Market concentration and competition, measures of the effect of bank-specific factors in profitability studies are normally proxied by the Herfindhal-Hirschman Index (HHI),

a measure of market concentration[87] or the Lerner Index, which is a measure of the price-cost margin (competition). Demirguç-Kunt and Huizinga (1999) reported a positive and statistically significant relationship between bank concentration and bank profits and larger banks tend to have higher profit margins. Also, Bourke (1989), Molyneux and Thornton (1992), Goddard et al (2013), Petria et al (2013) found that concentration had a positive and significant effect on bank profitability. Maudos and Solis (2009), Kasman et al (2010) found that the Lerner Index had a positive and significant effect on bank profitability. This is consistent with the traditional structure-conduct-performance paradigm (Dietrich and Wanzenried (2011)). It is indicated that banks are able to increase profitability by exploiting market domination, whereas increased competition and less market concentration tend to have a negative effect on profitability. Yet, Korytowski (2018) found that concentration (HHI) had a negative and significant effect on both ROAA and ROAE, using European commercial banks data for the post crisis period 2011 and 2015.

Finally, there are relatively few studies of the effect of *financial/ banking crisis* on bank profitability, yet there are studies of the impact of crisis on bank failures (e.g. see Cariboni et al (2016), Yang (2016), etc.). One exception is Bouzgarrou et al (2018) who examined the profitability of domestic and foreign banks before, during and after the financial crisis using 170 banks operating in France over the period 2000-2012. They found that the financial crisis had a major impact on the French financial system and financial stability, with a negative effect on profitability for domestic banks and positive effect on foreign banks operating in France. They show that foreign banks were more profitable than domestic banks especially during the financial crisis. Xioa (2009) looked at the performance of French banks during 2006-2008 and the impact of the financial support measures taken by the French government. She concluded that French banks were not immune to the turbulence but proved relatively resilient to the financial crisis reflecting their business and supervision features and government policies. Adelopo et al (2017) examined the determinants of bank profitability (ROA and NIM) before (1999-2006), during (2007-2009) and after (2009-2009) the 2007-

[87] Concentration can be a poor measure of competition due to the possibility of contestability, barriers to entry and exit in the market.

2008 financial crisis in West African State's bank. They saw that financial crisis seems to have no effect on banks profitability.

We now move on to **Section 5.3. Banking regulation and the impact on banks' cost and lending**, where we look at the regulatory framework in which banks operate and the impact of regulation on banks.

5.3. Banking regulation and the impact on banks' cost and lending

In the 1980s, in response to many international financial disruptions, banking regulation was strengthened with the introduction of the Basel I (Capital) Accord (1988) by the Basel Committee on Banking Supervision (BCBS). The 1988 Basel Accord, at the time focused mainly on applying common minimum capital standards for the banking sector and addressed credit risk, which was the main risk faced by banks (see **Chapter 2**). Many subsequent financial sector and regulatory reforms tended to focus mostly on the banking sector, which is not surprising, as a stable and efficient banking sector is important to the economy (see section above). As such, the purpose of this section is to look at how banks are regulated (financial system regulatory and supervisory framework) with the role therein of macroprudential policy and the impact regulations have on banks' cost and lending.

I. Financial system regulatory and supervisory framework

The regulation of the banking sector has always been a major fundamental issue for researchers and regulators especially as the sector continues to experience banking crises (see Caprio and Klingebiel (2003), Laeven and Valencia (2018)) as well as the special economic role of money and uncertainty associated with it (Dow (1996)). Even though the role of banks is changing as a result of the increase trend towards disintermediation, banking sector regulations are still imperative as banks remain central in the financing of economic activity and for financial system stability as argued above. In this section, banks' regulatory and supervisory frameworks will be discussed in the broader context of financial system regulatory and supervisory framework (structure). Further, specific banking and financial system regulatory polices such as the Basel Accord (Microprudential Policy) and Macroprudential Policy have been

discussed in **Chapter 2** as such the focus in this section is more on the supervisory framework, with brief references to financial system regulations.

Čihák and Tieman (2008) indicated that there are substantial differences in the quality of regulatory and supervisory frameworks across countries, with the country's income level (per capita income) being a major factor for these cross-country differences. Further, they noted that not all differences are due to economic development and high-income countries characterized by better supervisory structures needs to be put in the perspective that these countries usually have more developed and complex financial system yet gaps still exist in their framework. They studied the quality of financial sector regulation and supervision around the world using the data from IMF-World Bank assessments of compliance with international standards and codes.[88]

Labonte (2017) suggested that major changes in the regulatory and supervisory framework are sometimes driven by the response to various financial crises. In the US, he indicated that the framework evolved piecemeal and punctuated by major changes in the framework in response to various financial crises. He added that the US financial regulator system has been described as being fragmented, with multiple overlapping regulators and a dual state-federal regulatory system. For example, the 2007-2008 financial crisis resulted in changes in the regulatory system through the Dodd-Frank Wall Street Reform and Consumer Protection Act 2010 (Dodd-Frank Act) and the Housing and Economic Recovery Act 2008 (HERA). Labonte (2017) noted to address the fragmented nature of system, the Dodd-Frank Act created the Financial Stability Oversight Council (FSOC), a council of regulators and experts chaired by the US Treasury Secretary.

Yet, Labonte (2017) indicated that financial regulation aims to achieve diverse goals, which vary from regulator to regulator such as the following.

- market efficiency and integrity,
- consumer and investor protections,

[88] See IMF website for the List of Standards, Codes and Principles Useful for Bank and Fund Operational Work and for which Reports on the Observance of Standards and Codes Are Produced, https://www.imf.org/external/standards/scnew.htm.

- capital formation or access to credit,
- taxpayer protection,
- illicit activity prevention, and
- financial stability.

Calvo et al (2018) advised that institutional design for financial sector oversight must fit the purpose for which it is designed and effective oversight depends on the appropriate allocation of functions either to one or more agencies. And in turn, these agencies should be able to act with clear objectives, operational autonomy, comprehensive and effective powers, adequate resources and incentives. Further, they saw that different jurisdictions (authorities) have assigned financial sector responsibilities to various financial sector governing agencies based on a variety of supervisory models. The choice of financial supervisory model entails the trade-offs between synergies across function and possible conflicts of interest between these agencies. Post 2007-2008 global financial crisis, these financial supervisory models have added two new relevant functions for financial sector governing agencies, macroprudential policy and resolution (financial crisis).

Calvo et al (2018) noted in the study of financial supervisory framework in 82 countries and jurisdictions suggests that the framework corresponds to one of the following supervisory models.

- **Sectoral Model** – consists of three separate authorities that supervise three different financial sectors: banking, insurance and securities. Each authority typically has a prudential role and a conduct of business role in the sector they supervise. Countries and jurisdictions with this model include Argentina, Brazil, Chile, Hong Kong. Luxembourg, Mexico, Portugal and South Africa, etc.

- **Integrated Model** – this model, which also referred as the single or unified model, involves the integration of supervisory functions for most of all financial sectors into a single authority either through a central bank (Czech Republic, Hungary, Ireland, Singapore) or a separated supervisory agency (Austria, Colombia, Denmark Germany, Japan, Norway, Switzerland) is responsible for

all oversight functions of all three sectors - banking, insurance and securities. This model includes the oversight of the prudential regulation as well as the conduct of business requirements affecting different types of financial institution and their activities. This model was closely linked to the development of financial conglomerates.

- **Twin Peaks Model** – is based on supervisory specialisation by objectives. One specialised in prudential monitoring of regulated institutions and another agency on the oversight of business conduct. This model permits mitigation of conflicts of interest between promoting the solvency of financial institutions and ensuring protection for their clients and investors. Countries with this model are Australia, Belgium, Canada, El Salvador, Guatemala, Netherlands, New Zealand and the United Kingdom.

- **Two Agency Model** – currently adopted in France, Greece, Italy, Malaysia, Paraguay, Peru and Trinidad and Tobago, where one agency is in charge of prudential and conduct supervision of the banking and insurance sectors and the another is responsible for securities firms. The model takes advantage of the synergies between banking and insurance supervision, yet compared to twin peaks model, it is less well adapted in dealing with possible conflict of interest arising from prudential and consumer/ investor protection objectives.

Twin peaks and two agency models can be considered to be partially integrated models. In addition, the involvement of central banks is a key feature of any financial supervisory framework either through prudential oversight, conduct supervisions or both. As well as they have a major role in economic stability, liquidity management and financial system solvency (lender of last resort). Yet, conflict of interest can arise from the role of central banks in setting monetary policy (interest rates) and the impact it can have on banks' profitability and solvency.

As we mentioned in **Chapter 2**, macroprudential policymaking models (IMF-FSB-BIS (2016)) tend to reflect the financial supervisory framework existing in many countries such as sectoral, integrated twin peaks and two agency supervisory models. It is a

situation where most countries integrated macroprudential policy as well as financial stability framework in the existing financial supervisory framework, thus minimising the need for legislative changes.

Goodhart and Schoenmaker (1995) looked at whether monetary policy and banking supervision should be separated. They began by examining the issue on whether which regime (combined or separated) is less prone to bank failures, yet they noted that regime with the minimum number of banking failures is not necessarily the most efficient in term of welfare costs. Further, they raised two additional issues in the debate, firstly, whether the combination of functions can lead to a conflict of interest, in particular whether concerns for the micro-level health and stability of the banking system might distort a central bank's conduct of monetary policy. Secondly, a main argument for combining the functions within a central bank (single agency) is the concern for systemic stability of the financial system and preventing contagious systemic crises. In this case, they added whether it is appropriate for the central bank should be the lender of last resort. They found that there are no overwhelming arguments for either model, that is, combined or separated functions of banking supervision and monetary policy. In their view, they noted the institutional control of supervision and regulation will depend, aside from national tradition, largely on the matter of who is ultimately going to pay for any banking sector bailout.

Further, Quintyn and Taylor (2002) discussed the issue of financial sector regulatory and supervisory independence (RSI). They argued that bank regulators and supervisors need a substantial degree of independence, both from government and the industry, in order to fulfil their mandate and contribute to the preservation of financial stability. Also, they said that regulatory and supervisory independence complements central bank independence to achieve or preserve the twin goals of monetary and financial stability. They noted two factors have served to give raise to RSI, firstly, the financial sector crises of the 1990s[89], where it was cited that lack of independence of supervisory authorities from political influence contributed to the crises. Secondly, the growing tendency to move to unified financial sector supervision, often removing banking supervision from the central bank, where there was degree of

[89] For examples, Venezuela crisis in the mid-1990s and Asian financial crisis (1997-1998).

independence derived from central bank's independence with respect to monetary policy function. They argued that independence of regulatory agencies is important for financial stability in the same reasons that the independence of central banks matters for monetary policy.

Finally, Calvo et al (2018) noted that supervisory models in the United States and European Union have special characteristics. In the US, different functions are assigned to several agencies at the federal and state level (see Labonte (2017) as well). While in the EU, countries within the euro currency zone share a single prudential supervisory authority (the ECB's Single Supervisors Mechanism[90]) for significant banks[91] and member states for smaller banks and other supervisory functions.

II. The cost of regulation to the banking sector

As suggested previously, overall benefits of financial sector and regulation reforms are evidently sizeable due to the many financial crises over the last few decades especially in light of the 2007-2008 global financial crisis. Yet, Van den Heuvel (2008) and Tchana (2012) suggested that although capital requirements limit moral hazard on the part of banks and hence are beneficial for financial stability, they are costly since they reduce the ability of banks to lend, thus can hamper economic growth, which is an unintended side effect of regulations that limit banking activities. However, Barrell et al (2009) calculated that the cost of tighter regulation is small in the long run and if the costs of crises are potentially high, then tighter regulation would be appropriate, as the cost of the crisis outweighs the cost of the loss of economic output. The cost of regulation was estimated via impacts of higher capital ratios on loan spreads to households and companies in the UK, which were then integrated in the global macroeconomic model (NiGEM). Davis et al (2018) looking at the UK, Germany and Italy in a similar manner, suggested that the hypothetical introduction of

[90] Single Supervisory Mechanism (SSM) refers to the system of banking supervision in Europe. It comprises the ECB and the national supervisory authorities of the participating countries. See website, https://www.bankingsupervision.europa.eu/about/thessm/html/index.en.html.

[91] The ECB directly supervises 117 significant banks of the participating countries of the European Union. These banks hold almost 82% of banking assets in the euro currency area. See website, https://www.bankingsupervision.europa.eu/who is supervised.html.

macroprudential measures such as capital adequacy prior to the subprime crisis might have the reduced the incidence of the crisis and improve macroeconomic performance.

Van den Heuvel (2008) found, using US banking data, that the welfare cost of current capital adequacy (Basel Accords) of 8%, reduces consumption by between 0.1% and 1% because it reduces the ability of banks to create liquidity. The author uses the Sidrauski (1967) modelling framework to measure the welfare cost of capital adequacy, which involve modelling the preferences for liquidity and including it in the utility function. Tchana (2012) found that higher capital adequacy requirements hamper economic growth by shifting banks' portfolios from more productive, risky investment projects toward less productive and safer investment projects. The author uses an Overlapping Generations (OLG) model where banks serve as financial intermediaries and banking regulation is modelled as a constraint on banks' portfolios to analyse the effect capital requirement has on economic growth. Yet, Kim and Sohn (2017) suggested that bank capital has a significant positive effect on lending once banks retain sufficient liquid assets. They used quarterly US banks data for the period 1993 to 2010, to determine whether the effect of bank capital on lending changes depending on the level of bank liquidity.

Noss and Toffano (2015), using UK quarterly banking data from 1986 to 2010, looked at the impact of changes in aggregate bank capital requirements on lending and growth during an economic upswing. Their analysis uses data on the aggregate ratio of UK banks' capital-to-assets where assets are not risk weighted, that is not adjusted by regulatory risk weight as designed to capture their relative risk. This definition of capital is closer to the regulatory leverage ratio of capital than Basel III capital ratio as they suggested using a non-risk weighted data provide a better representation of banks' true leverage. They found that an increased capital requirement during an economic upswing is associated with a reduction in lending. The impact on GDP growth is however statistically insignificant as firms substitute from banks' credit towards the bond markets or shadow banking entities.

Similarly, Aiyar et al (2014a) indicated that regulated banks (UK-owned banks and resident foreign subsidiaries) reduce lending in response to tighter capital requirement

but unregulated banks (resident foreign branches) increase lending in response to tighter capital requirements, suggesting competitive advantages. Also, our results in **Chapter 3** suggested that macroprudential policy (regulation) has a stronger effect on domestic credit (credit-to-GDP gap) and the macroeconomic variables but it is noted that the results cannot be interpreted in isolation of the fact as there is not a very long history of the usage of macroprudential policy, particularly in advanced countries and "time series" macroprudential policy was largely designed to operate in a period of upturn or absence of any financial disturbance.

Pasiouras et al (2009), in providing an international perspective, looked at the effect of regulatory and supervision framework, that is capital adequacy (Basel II), official supervisory power and market discipline mechanisms have on bank efficiency, cost, activities, and profit. The dataset consists of 2,853 observations from 615 publicly quoted commercial banks operating in 74 countries during the period 2000-2004. Pasiouras et al (2009) found that banking regulations that enhance market discipline and empower supervisory authorities increase both cost and profit efficiency of banks. In addition, they suggested that stricter capital requirements improve cost efficiency but lower profit efficiency while restricting bank activities.

Roulet (2017) and Naceur et al (2018), using banking data for 23 countries in the US and Europe following the financial crisis for the period 2008-2015, looked at the effects of capital and liquidity regulations (Basel III) on bank lending. They found that capital ratios have significant and negative impacts on large European banks' retail and other lending growth in the context of deleveraging and the "credit crunch" – difficulty in securing loans, in Europe during the post 2007-2008 financial crisis. More stringent capital adequacy encourages substitution of retail and other loan assets (lending) into less risky (risk-free) and liquid assets such as government bonds as capital is more expensive to hold for assets that are assigned higher risk weights (Basel Accord risk ratings) or when expanding bank balance via credit activities. Yet, capital ratios were not significant in the determination of European bank commercial lending growth. In the US, they saw that small US banks strengthen their financial soundness and loss absorption capacities when expanding both commercial and retail lending activities as such capital and leverage ratios have significant and positive impacts on US bank-lending growth. They suggested that capitalization plays a major role in US bank

lending growth over the period 2008-2015 and the cautious approach of US banks when facing higher risk exposure.

Additionally, Roulet (2017) and Naceur et al (2018) found that liquidity indicators have a positive and perverse effect on bank-lending growth. Liquidity ratios (non-required amount of stable funding/ total assets) has a significant and positive impact on commercial lending growth on US banks, regardless of size and large European banks.

Kupiec et al (2016) looked at the impact a poor banking supervision rating (CAMELS Ratings System) can have on growth rates of individual bank loan portfolios using 381,000 bank-quarter observations from 1994 to 2011 in the US. CAMELS is a rating system that bank supervisory authorities use in order to rate financial institutions according to six factors. The factors are Capital Adequacy, Asset quality, Earnings, Liquidity, and Sensitivity to market risk (see Stackhouse (2018)). They argued that a core goal of bank supervision is to stop banks from making high risks loans that will not meet the requirement for receiving government safety net subsidy. They found that poor CAMELS rating has a strong and significant negative effect on banks loan growth, even controlling for the impact of monetary policy and bank-specific factors such as bank capital and liquidity conditions, loan portfolio performance and bank losses. In contrast, they found that capital adequacy measures (Tier 1 capital, Leverage and Total risk-based capital ratios) have a statistically significant but economically small impact on loan growth. Similarly, Čihák and Tieman (2008) noted that higher regulatory quality in banking is correlated with better banking sector performance.

Finally, Lee (2015) noted that capital and profitability can have a bearing on imposing regulatory policy as higher profit and better capitalised banks may need less regulatory oversight. In analysing Korean banks over the period 2000-2008, he saw that better capitalised banks generate higher profit as they have a lower cost of capital, lower bankruptcy and financial distress costs and less regulatory interference from bank regulators, etc. As such, Lee (2015) suggested in order to improve bank profitability for banking sector's soundness and stability, regulators should implement discriminatory regulatory policy between higher and lower capitalised banks, this is

because ignoring the degree of bank capital strength and imposing uniform regulatory policy may not be effective in improving bank profitability and stability.

We now move on to **Section 5.4. Empirical analysis of the effects of macroprudential policy on banks' profitability and interaction with monetary policy**, where we present empirical results testing the effects of macroprudential policy on banks' profitability and interaction with monetary policy.

5.4. Empirical analysis of the effects of macroprudential policy on banks' profitability and interaction with monetary policy

In this section of the chapter, we outline our empirical analysis of the impact macroprudential policy has on banks' profitability as well as the relationship with monetary policy. The section is organised in the following manner, firstly, we provide a brief overview of the hypothesis for modelling the effect of macroprudential policy on bank profitability. Secondly, we review the key datasets use in our empirical analysis. Thirdly, we discuss, 1) the results of the determinants of banks' profitability model (the baseline model), 2) the results of the effect of macroprudential policy instruments have on reducing banks' profitability and 3) determine whether macroprudential policy has an effect on monetary policy, using the Net Interest Margin profitability model. The empirical analysis uses Ordinary Least Square modelling and Fitch Connect individual bank data for 92 countries, which include 6,010 banks (3,095 banks from advanced countries and 2,915 banks from emerging market economies). The period of coverage for the empirical analysis is 2000 to 2013 as a result of the data available in the Cerutti et al (2015a) database.

5.4.1. Hypothesis for modelling the effect of macroprudential policy on bank profitability

Whereas there has been extensive research on bank profitability, banking regulations' effect on lending and the benefit of a stable and efficient financial system as discussed in sections 5.1 and 5.2 above, there is a need to understand the effect of new regulations on the banking sector since banks remain central in the financing of economic activity. In the literature, studies have found there is a cost of

microprudential regulations to the banking sector, where they are costly since they reduce the ability of banks to lend and engage in productive activities, which can hamper economic growth, an unintended side effect of regulations that limit banking activities (Van den Heuvel (2008) and Tchana (2012)). Yet, due to the many financial crises over the last few decades, especially in light of the 2007-2008 global financial crisis and the important role of banks in the financial system, there remains a need for banks regulation (see Dow (1996)). Further, Barrell et al (2009) and Davis et al (2018) noted that the benefits of regulation especially if limiting the cost of financial crises outweigh the cost of the loss of economic output (see above, **Section 5.3**).

Accordingly, with the introduction of macroprudential policy as an essential financial regulatory policy tool to forestall crises or at least offer a buffer to soften the impact of them, there is a need to understand the detailed effect on banks activities. In the macroprudential policy research literature, there is empirical evidence which suggest that macroprudential policy is effective in reducing the build-up of financial system imbalances, whereas there tends to be a focus on the housing and credit market measures such as credit growth, house prices and the credit-to-GDP gap (see **Chapter 3**). On account of this, macroprudential policy tends to affect credit activities in the domestic banking sector mostly. Beside banks remaining central in the financing of economic activity, they are also the dominant (as measure by asset size or market share) financial institution in the financial system in many countries. Furthermore, **Chapter 4** shows that macroprudential policy (regulation) has a stronger effect on domestic credit, lending originating in the domestic financial system rather than cross-border lending from international banking firms.

Note also that **Chapter 3** gave modelling results suggesting that macroprudential policy is effective in reducing financial imbalances, where the focus tends to be mostly on the aggregate banking sector. The empirical analysis in **Chapter 1** found that debt-to-income ratio (DTI), loans-to-value ratios (LTV and LTVCAP) and concentration limits (CONC) are the most effective macroprudential instruments, being statistically significant and negative related to the credit-to-GDP gap (the measure of financial imbalances).

Secondly, given that in **Chapter 4,** the modelling results indicate that the effects of macroprudential policy are mostly on the domestic banking sector, then one of the premises of this **Chapter 5** is to study the direct effect of macroprudential policy on domestic banks performance, using individual banking data from 92 countries, and this is tested by examining the effect on bank profitability. We have seen earlier in this chapter that a sound and profitable banking sector is important for the effective functioning of the economy and it is better able to withstand negative shocks from financial disruptions and contribute to financial stability.

In this context, we contend that, if macroprudential policy reduces the ability of banks to lend via reducing the credit-to-GDP gap (**Chapter 3**), then there should be a significant and negative effect on banks' profitability relative to what would be expected with standard control variables. The hypothesis is therefore written as follows.

Hypothesis 1: If macroprudential policy is effective in reducing financial system imbalances as measured by the credit-to-GDP gap, there should also be a significant and negative effect on banks' profitability.

Of course, **hypothesis 1** may not hold and an **alternative hypothesis 1** is that banks' profitability may not be affected as banks are able to shift their activities from net interest income to non-traditional activities and increase fee-based income or passed on the cost of the policy to customers. etc.

We note that there have been only a few studies which have focused and included a monetary policy or an interest rate variable in the study of the determinants of bank profitability. The link between monetary policy and bank profitability has nonetheless been established in the research literature (see Alessandri and Nelson (2015) and Borio et al (2017)). In addition, as we discussed in this **Chapter Introduction** above, there is arguments that there is a complementary relationship between macroprudential and monetary policies since macroprudential policy provides monetary policy with additional room for manoeuvre to better focus on ensuring price stability as well as it provides a stable platform (financial stability) for monetary policy to function effectively (see N'Diaye (2009) and Constâncio (2016)). Yet, Beau et al

(2012) suggested that there are situations where both policies can contradict each other and their interactions call for coordinated implementation.

In light of the relationship between monetary policy and bank profitability and the expected complementary relationship to macroprudential policy, the second hypothesis in this **Chapter 3** looks at the relationship between monetary and macroprudential policies using a narrower bank profitability model, namely the Net Interest Margin profitability model. This profitability model measures how successful a bank is in its portfolio investment decisions, that is maximising mostly the revenue from the bank's interest spread, interest revenue received from investment (loans) and their interest expenses paid to lenders (depositors). NIM is suggested to be the most appropriate profitability model to capture the relationship between bank profit and the interest rate environment (monetary policy).

As such, if there is a significant relationship (positive/ negative) between bank profitability and monetary policy, then the aim of the second hypothesis is to examine whether there is an interactive (positive/ negative) relationship between macroprudential policy with monetary policy using the net interest margin profitability model. The hypothesis is as follows.

Hypothesis 2: If there is a significant (positive/ negative) relationship between interest rate (monetary policy) and banks' profitability, then macroprudential policy also has a significant effect on the banks' interest rate margin, thus offsetting or complementing monetary policy.

Likewise, **hypothesis 2** may be falsified and an **alternative hypothesis 2** is macroprudential policy has no effect on the banks' interest rate margin hence no effect on monetary policy.

5.4.2. Datasets for modelling the effect of macroprudential policy on banks' profitability

Our data modelling uses two key datasets, the Fitch Connect database of banks financial statements and the IMF GMPI survey data on macroprudential instruments

(Cerutti et al (2015a)). Additional macroeconomic data were collected from various sources such as the IMF, ECB, the World Bank and individual country central banks and statistical agencies.

I. Fitch Connect banking data

The main bank-specific data source is the Fitch Connect database, which provides annual financial information for banks in many countries around the world. In our unbalanced panel banking data sample, we have banks from 92 countries, 34 advanced countries and 58 emerging market economies, 6,010 banks (3,095 banks from advanced countries and 2,915 banks from emerging market economies) and 84,140 observations. The types of banks included are universal commercial banks, retail and consumer banks, banks, wholesale banks, and Islamic banks. Investment banks and private banks are excluded due to different balance sheet and income structure as are bank holding companies, to avoid double counting.

The number of banks for each country covers at least the top 100 banks based on total assets or less if fewer banks exists. For most countries with more than 100 banks, at the tail end, the top 100 banks changes from year to year due to mergers and acquisitions and the closure of some banks. These banks are included in the data for the years they existed in order to capture the top 100 banks each year as far as possible and to avoid the loss of data points. To help avoid double counting, as indicated above, bank holding companies were excluded from the data and the banking data collected are unconsolidated, which also allow for the reporting of foreign bank subsidiaries in each country. All financial statement data are annual and in US dollars. The period of coverage for the banking data is 2000 to 2013. See **Appendix 5A.1 and 5A.2** for the list of countries and number of banks for each country, as well as a regional breakdown.

The structure of the banking dataset is in line with the work of Davis et al (2019) and Claessens et al (2015). Davis et al (2019) studied the effectiveness of a leverage ratio relative to two measures of the RAR (total regulatory capital ratio and Tier 1 regulatory capital ratio) in predicting bank risk, given competition using over 1,000 banks in the US and Europe for the period 1998-2016. Claessens et al (2015) paper analysed the

use of macroprudential policies aimed at reducing vulnerabilities in the banking system with the main dependent variable being asset growth using 2,820 banks in 48 countries over the period 2000-2010.

II. Macroprudential instruments dataset

As discussed in **Chapter 3**, the IMF dataset on macroprudential instruments is one of the most comprehensive databases on the actual usage of macroprudential instruments by over 119 countries for the sample period 2000-2013, which is publicly available. This database is used in **Chapter 3** as well as many extant studies of macroprudential policy. There are 12 macroprudential survey instruments and 2 additional derived instruments and 3 groups summary instruments in the publicly available dataset. The frequency in the dataset is yearly. We used this data set since it covered all the countries that are included in the empirical analysis and it is based on survey data collected from official reporting agencies to the IMF such as central banks and financial sector regulatory authorities.

Our main focus is on prudential measures that have a negative and significant effect on banks' profitability, reducing banks' profit (ROAA and ROAE) over the sample period. We expect that prudential measures which target banks assets (credit activities) and reduce the credit-to-GDP gap to have the greatest effect on banks' profitability as our results in **Chapter 3** found that debt-to-income ratio (DTI), loans-to-value measures (LTV and LTVCAP) and concentration limits (CONC) are the most effective macroprudential instruments, being statistically significant and negative related to the credit-to-GDP gap (the measure of financial imbalances). This is also supported by empirical research by Cerutti et al (2017), Carreras et al (2018), Akinci and Olmstead-Rumsey's (2015), etc. See **Chapter 2** for a discussion on the description and taxonomy of the macroprudential instruments. Again, we show in Table 5.1 the list of instruments in the IMF dataset.

Table 5.1: Macroprudential instruments dataset

Instrument	**Abbreviation**
Survey Instruments	
Loan-to-Value Ratio	LTV

Debt-to-Income Ratio	DTI
Time-Varying/Dynamic Loan-Loss Provisioning	DP
General Countercyclical Capital Buffer/Requirement	CTC
Leverage Ratio	LEV
Capital Surcharges on SIFIs	SIFI
Limits on Interbank Exposures	INTER
Concentration Limits	CONC
Limits on Foreign Currency Loans	FC
Reserve Requirement Ratios	RR
Limits on Domestic Currency Loans	CG
Levy/Tax on Financial Institutions	TAX
Derived Instruments	
Loan-to-Value Ratio Caps	LTVCAP
FX and/or Countercyclical Reserve Requirements	RREV
Groups of Instruments	
Total macroprudential instruments	MPI
Macroprudential instruments focused on the borrower	MPIB
Macroprudential instruments focused on the financial institution	MPIF

Source: Cerutti et al (2015a) (Version February 24th, 2015). Notes: each variable is a dummy that takes on two values: 0 for no policy and 1 for policy in effect. The database covers a sample from 2000 to 2013 with annual data. The groups instruments are the aggregate of the survey instruments.

5.4.3. Empirical analysis for testing the effect of macroprudential policy on banks profitability

I. Research literature baseline model

We use the research literature on the factors affecting banks' profitability model, such as Korytowski (2018), Petria et al (2013), Goddard et al (2004), to investigate the effect of macroprudential policy on banks' profitability. We have selected to use the standard and common bank-specific, industry and macroeconomic variables (see Table 5.2 below) in the research literature to explain the factors affecting banks' profitability (see above **Section 5.2.1** for further explanation of the variables and their effects on banks' profitability). Also, we include the interest rate factors, short-term interest rate (monetary policy rate) and yield curve as the link between monetary policy and bank profitability has been established in the research literature (see Alessandri and Nelson (2015) and Borio et al (2017)).

Table 5.2 below shows the standard variables as discussed in the research literature to explain the factors affecting banks' profitability. We include in the table the literature

and our expected coefficient relation to the dependent variables (ROAA, ROAE and NIM).

Table 5.2: Factors affecting banks' profitability

Variables	Symbol	Proxy	Literature expected relation (+/-)	Our expected relation (+/-)
Dependent variables				
Return on Average Assets	ROAA	Net Income/ Average Total Assets		
Return on Average Equity	ROAE	Net Income/ Average Total Equity		
Net Interest Margin	NIM	Net Interest Income/ Average Total Assets		
Independent variables				
Bank specific factors (internal)				
Bank size	LNSIZE	Logarithm of Total Assets	+/-	+
Leverage	LEV	Equity/ Total Assets	+/-	-
Credit risk	CRISK	Non-performing loans/ Gross Loans	-	-
Liquidity risk	LRISK	Gross Loans/ Deposits	+/-	-
Management efficiency	COSTINC	Total Operating Expenses/ Total Income	+/-	-
Diversification*	DIVSIF	Non-Interest Income/ Gross Revenue	+/-	+
Banking system specific factor (external)				
Competition	LINDEX	Lerner Index	+	+
Banking crisis	BCRISIS	Laeven and Valencia (2018)	+/-	-
Macroeconomic factors (external)				
Economic growth	RGDPGWR	Real GDP growth rate (annual %)	+/-	+
Inflation	INFLAT	Inflation rate (annual %)	+/-	+

Short-term interest rate	3MTHRATE	3 months interbank lending rate	+	+
Yield curve term structure	YDSLOPE	10 years government bond interest rate – 3 months interbank lending rate	+	+

Data source: Fitch Connect, IMF, World Bank, Laeven and Valencia (2018) and author's calculations.
* We expect a negative effect in the net interest margin profitability model.

The Lerner index is a measure of the price-cost margin. It can be seen as a proxy for current and future profits stemming from pricing power, and it varies at the level of the individual bank. Under perfect competition the index is zero as the output price (marginal revenue) equals marginal cost, and "normal" economic profits are zero. The Lerner index is positive as a firm's market power increase and price rises above marginal cost in a quantity-setting oligopoly model, with the limiting case being monopoly. We derived the Lerner Index following Anginer et al. (2014), Beck et al. (2013), Weill (2013) and Davis et al (2019), see **Appendix 5A.3** for further details.

We expect bank specific factors such as bank size (LNSIZE) and diversification (DIVSIF) to have a positive effect on banks' profitability. Similarly, competition which is measured by the Lerner Index (LINDEX) to have a positive effect. This suggests that the higher the LINDEX, the greater degree of market power by banks. We expect all the macroeconomic factors - economic growth (RGDPGWR), the rate of inflation (INFLAT), short-term interest rate (3MTHRATE) and the yield curve term structure (YDSLOPE) to have a positive effect on banks' profitability.

We expect leverage (LEV), credit and liquidity risks (CRISK, LRISK) to have a negative effect on banks' profitability since higher risks should affect banks negatively. Management efficiency (COSTINC), which capture banks' costs to income level, should have a negative effect on profitability because as costs increase relative to income, this should lower banks' profitability. The banking crisis variable (BCRISIS) is expected to have a negative effect on banks' profitability since during a crisis, banks credit activities are normally affected (see **Chapter 2, Section 2.3.4**).

For the analysis of the effect of the macroprudential policy on bank profitability, the focus will be ROAA and ROAE models. In the next few sections, the focus will be ROAA and ROAE models. The Net Interest Margin (NIM) model will be discussed in the analysis of the relationship between monetary and macroprudential policies later in the chapter.

II. Descriptive statistics of the ROAA and ROAE baseline model variables

a) All countries

The following Table 5.3 shows some descriptive statistics of the variables in the model for all countries. In line with typical practice in the empirical literature on individual bank behaviour (Davis and Karim (2018a), Davis et al (2019)). The variables are winsorised at 99% and in level (not lagged). ROAA has a mean of 1.048 per cent of total assets and a standard deviation (StdDev) of 2.784 per cent. The mean for ROAE is 8.725 per cent but there is a more significant variation than with ROAA, as the standard deviation for ROAE is 17.76 per cent over the period 2000-2013. Credit risk (CRISK), non-performing loans/ gross loans, is on average 9 per cent, with a small variation between the banks. Management efficiency (COSTINC) averages 45 per cent of total income and non-interest income (DIVSIF) represents about 34 per cent of gross revenue. Average GDP growth over the period is about 3.3 per cent and the inflation rate is 4.7 per cent. Finally, the Lerner index (LINDEX) averages 0.203, suggesting some degree of market power by banks. This is very much in line with other estimates of the Lerner Index in the literature such as 0.2 in Davis and Karim (2018a) for European banks.

Table 5.3: ROAA and ROAE baseline model variables descriptive statistics for the period 2000-2013 (all countries)

Variables	Mean	Median	Max	Min	StdDev	Obs
Dependent variables						
ROAA (%)	1.048	0.880	12.035	-13.165	2.784	36,900
ROAE (%)	8.725	8.810	59.053	-84.690	17.665	36,306
LNSIZE (log)	21.348	21.320	27.211	15.843	2.420	45,015

LEV	0.149	0.091	1.267	0.001	0.207	41,273
CRISK	0.091	0.033	1.162	0.002	0.174	25,137
LRISK	2.370	0.890	152.950	0.010	9.090	36,555
COSTINC	0.451	0.390	3.176	0.001	0.450	39,834
DIVSIF (%)	34.270	29.500	142.620	-55.785	30.060	40,557
LINDEX	0.203	0.207	0.998	-2.311	0.501	21,541
BCRISIS						
RGDPGWR (%)	3.260	3.187	12.110	-6.600	3.450	83,892
INFLAT (%)	4.718	2.903	38.470	-1.210	5.690	83,666
3MTHRATE (%)	2.131	2.105	5.994	0.051	1.642	27,020
YDSLOPE (%)	3.732	3.973	8.118	0.730	1.381	26,954

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable and it is coded one in the year the crisis starts until the year it was over and is otherwise zero. The values are a ratio unless otherwise stated. Max – maximum, Min – minimum, StdDev - standard deviation. The variables are winsorised at 99% and in level.

b) Advanced countries

Table 5.4 below shows some descriptive statistics of the variables in the baseline model for advanced countries. Again, the variables are winsorised at 99% and in level (not lagged). For advanced countries, the ROAA has a mean of 0.945 per cent of total assets and a standard deviation (StdDev) of 2.700 per cent. The mean for ROAE is 8.161 per cent. Credit risk (CRISK), management efficiency (COSTINC) and non-interest income (DIVSIF) values are similar to the all countries values (see Table 5.3 above). For advanced countries, average GDP growth over the period is about 2.0 per cent and the inflation rate is 2.1 per cent, which is lower than emerging market economies average (see Table 5.5 below).

Table 5.4: ROAA and ROAE baseline model variables descriptive statistics for the period 2000-2013 (advanced countries)

Variables	**Mean**	**Median**	**Max**	**Min**	**StdDev**	**Obs**
Dependent variables						
ROAA (%)	0.945	0.750	12.035	-13.165	2.700	18,853
ROAE (%)	8.161	8.130	59.053	-84.687	17.635	18,512
LNSIZE (log)	21.580	21.500	27.211	15.843	2.535	23,333

LEV	0.141	0.080	1.266	0.001	0.211	21,022
CRISK	0.087	0.028	1.162	0.006	0.181	12,135
LRISK	2.387	0.900	152.950	0.007	9.424	18,628
COSTINC	0.438	0.375	3.176	0.002	0.453	20,295
DIVSIF (%)	33.550	28.750	142.618	-55.785	30.073	20,670
LINDEX	0.245	0.223	1.000	-2.312	0.536	11,151
BCRISIS						
RGDPGWR (%)	1.960	2.074	12.190	-6.600	2.728	43,338
INFLAT (%)	2.136	2.197	15.402	-1.207	1.527	43,358
3MTHRATE (%)	2.131	2.105	5.994	0.052	1.642	27,020
YDSLOPE (%)	3.732	3.973	8.118	0.730	1.381	26,954

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable and it is coded one in the year the crisis starts until the year it was over and is otherwise zero. The values are a ratio unless otherwise stated. Max – maximum, Min – minimum, StdDev - standard deviation, Obs – number of observations. The variables are winsorised at 99% and in level.

c) Emerging market economies

Table 5.5 below shows some descriptive statistics of the variables in the baseline model for emerging market economies. The variables are again winsorised at 99% and in level (not lagged). For emerging market economies, ROAA and ROAE are higher over the period 2000-2013 in comparison to advanced countries (Table 5.4), which suggest profitability is higher in emerging market economies. Likewise, credit risk (CRISK) and management efficiency (COSTINC) are also higher than advanced countries. Average GDP growth over the period is about 5.0 per cent and the inflation rate is 7.4 per cent, once again higher than advanced countries averages.

Table 5.5: ROAA and ROAE baseline model variables descriptive statistics for the period 2000-2013 (emerging market economies)

Variables	**Mean**	**Median**	**Max.**	**Min.**	**StdDev**	**Obs**
Dependent variables						
ROAA (%)	1.158	1.040	12.035	-13.165	2.887	18,301
ROAE (%)	9.330	9770	59.053	-84.688	17.694	18,038
LNSIZE (log)	21.087	21.122	27.211	15.844	2.259	21,972
LEV	0.159	0.100	1.266	0.001	0.202	20,541

CRISK	0.096	0.039	1.162	0.006	0.170	13,196
LRISK	2.351	0.882	152.338	0.007	8.699	18,188
COSTINC	0.465	0.398	3.176	0.002	0.440	19,818
DIVSIF (%)	34.960	30.340	142.618	-55.786	30.062	20,173
LINDEX	0.158	0.196	1.000	-2.312	0.454	10,539
BCRISIS						
RGDPGWR (%)	4.609	4.797	12.109	-6.600	3.585	41,156
INFLAT (%)	7.414	5.544	38.469	-1.208	7.038	40,910
3MTHRATE (%)	na	na	na	na	na	na
YDSLOPE (%)	na	na	na	na	na	na

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable and it is coded one in the year the crisis starts until the year it was over and is otherwise zero. The values are a ratio unless otherwise stated. Max – maximum, Min – minimum, StdDev - standard deviation, Obs – number of observations, na – not available. The variables are winsorised at 99% and in level.

III. Correlation matrix of the ROAA and ROAE baseline model variables

a. Return on average assets correlation matrix (all countries)

In table 5.6 below none of the variables are highly correlated except for the correlation between management efficiency (COSTINC) and Lerner Index (LINDEX) at -0.749, which is high negatively correlated (Pearson's correlation coefficient) (see Hinkle et al (2003)).[92] This is not surprising since the COSTINC data are also used to calculate the LINDEX. We find a negative relationship between return on average asset (ROAA) and credit risk (CRISK) (-0.099) and management efficiency (COSTINC) (-0.260). As well as, there is a negative correlation between ROAA and bank size (LNSIZE) (-0.068) and banking crisis (BCRISIS) (-0.011). There is a low negative correlation between banking crisis (BCRISIS) and real GDP growth (RGDPGWR) (-0.454). As well as, low negative correlation between leverage (LEV) and Lerner Index (LINDEX) (-0.478). There is a low positive correlation between leverage (LEV) and management

[92] The rule of thumb for interpreting the size of a correlation coefficient is the following: 0.90 to 1.00 (-0.90 to –1.00) very high positive (negative) correlation; 0.70 to 0.90 (-0.70 to -0.90) high positive (negative) correlation; 0.50 to 0.70 (-0.50 to -0.70) moderate positive (negative) correlation; 0.30 to 0.50 (-0.30 to -0.50) low positive (negative) correlation; 0.00 to 0.30 (0.00 to -0.30) little if any correlation.

efficiency (COSTINC) (0.490) and bank size (LNSIZE) and Lerner index (LINDEX) (0.414).

Table 5.6: Correlation matrix for the return on average assets (ROAA) for the period 2000-2013 (all countries)

	ROAA	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT	3MTH RATE	YD SLOPE
ROAA	1.000												
LNSIZE	-0.068	1.000											
LEV	0.089	-0.358	1.000										
CRISK	-0.099	-0.110	0.027	1.000									
LRISK	0.024	-0.028	0.068	0.028	1.000								
COST INC	-0.260	-0.376	0.490	0.086	0.004	1.000							
DIVSIF	0.029	-0.108	0.066	-0.011	0.003	0.224	1.000						
LINDEX	0.104	0.414	-0.478	0.011	0.000	-0.745	-0.314	1.000					
BCRISIS	-0.011	0.016	0.060	-0.043	0.007	0.034	-0.065	-0.003	1.000				
RGDP GWR	0.036	0.062	-0.060	0.001	0.004	-0.073	0.024	0.080	-0.454	1.000			
INFLAT	-0.011	0.127	-0.012	-0.040	0.002	-0.072	-0.048	0.103	0.046	0.293	1.000		
3MTH RATE	0.026	0.108	-0.050	0.030	-0.007	-0.071	0.011	0.089	-0.231	0.507	0.481	1.000	
YD SLOPE	-0.045	0.104	-0.006	0.008	-0.003	-0.002	-0.012	0.031	0.021	0.048	0.460	0.547	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. The variables are winsorised at 99% and in level.

b. Return on average assets correlation matrix (advanced countries)

Similar to the all countries correlation matrix, none of the variables are highly correlated except for the correlation between management efficiency (COSTINC) and Lerner Index (LINDEX) at -0.745, which once again is high negatively correlated (see Table 5.7 below). Once again, we find a negative relationship between return on average asset (ROAA) and credit risk (CRISK) (-0.100) and management efficiency (COSTINC) (-0.260). As well as, there is a negative relationship between ROAA and bank size (LNSIZE) (-0.067). For advanced countries there is a positive relationship between ROAA and interest rate (3MTHRATE) but there is a negative relationship between ROAA the yield curve (YDSLOPE).

Table 5.7: Correlation matrix for the return on average assets (ROAA) for the period 2000-2013 (advanced countries)

	ROAA	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT	3MTH RATE	YD SLOPE
ROAA	1.000												
LNSIZE	-0.067	1.000											
LEV	0.090	-0.358	1.000										
CRISK	-0.100	-0.110	0.270	1.000									
LRISK	0.023	-0.028	0.068	0.028	1.000								
COST INC	-0.260	-0.376	0.490	0.086	0.004	1.000							
DIVSIF	0.030	-0.107	0.066	-0.010	0.003	0.224	1.000						
LINDEX	0.104	0.414	-0.478	0.011	-0.002	-0.745	-0.313	1.000					
BCRISIS	-0.010	0.016	0.060	-0.043	0.007	0.034	-0.064	-0.003	1.000				
RGDP GWR	0.036	0.062	-0.060	0.001	0.004	-0.073	0.024	0.080	-0.454	1.000			
INFLAT	-0.010	0.127	-0.012	-0.040	0.002	-0.072	-0.048	0.103	0.046	0.293	1.000		
3MTH RATE	0.025	0.108	-0.050	0.030	-0.007	-0.071	0.011	0.090	-0.231	0.507	0.481	1.000	
YD SLOPE	-0.044	0.104	-0.006	0.008	-0.003	-0.002	-0.012	0.031	0.021	0.048	0.460	0.547	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. The variables are winsorised at 99% and in level.

c. Return on average assets correlation matrix (emerging market economies)

For emerging market economies, none of the variables are highly correlated (see Table 5.8 below). Once again, we find a negative relationship between return on average asset (ROAA) and credit risk (CRISK) (-0.255) and management efficiency (COSTINC) (-0.450). Yet, there is a positive relationship between ROAA and bank size (LNSIZE) (0.022). The interest rate and yield curve variables are not included in the emerging market economies correlation matrix since the data is not available.

Table 5.8: Correlation matrix for the return on average assets (ROAA) for the period 2000-2013 (emerging market economies)

	ROAA	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT
ROAA	1.000										
LNSIZE	0.022	1.000									
LEV	0.154	-0.367	1.000								
CRISK	-0.255	-0.194	0.066	1.000							
LRISK	-0.003	-0.008	0.039	0.014	1.000						
COST INC	-0.450	-0.254	0.252	0.236	-0.051	1.000					
DIVSIF	-0.041	-0.050	0.012	0.071	-0.029	0.146	1.000				
LINDEX	0.273	0.132	-0.183	-0.112	0.086	-0.511	-0.286	1.000			
BCRISIS	0.006	-0.054	0.008	0.042	0.012	-0.014	0.025	-0.030	1.000		
RGDP GWR	-0.004	0.101	-0.059	-0.059	-0.031	-0.045	-0.009	0.021	-0.247	1.000	
INFLAT	-0.014	-0.085	0.017	0.011	0.027	0.012	0.044	-0.023	0.383	-0.085	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. Interest rate variables data are not available and therefore excluded from the table. The variables are winsorised at 99% and in level. Na – not available.

d. Return on average equity correlation matrix (all countries)

Table 5.9 below presents the correlation matrix for the return on average equity (ROAE) for all countries. Similar to ROAA, none of the variables are highly correlated except the correlation between management efficiency (COSTINC) and Lerner Index at -0.749 which is moderately negatively correlated (Pearson's correlation coefficient). Leverage (LEV) and liquidity risk (LRISK) have a negative relationship with ROAE, unlike ROAA, where the relationships are positive. The rest of correlations are similar to the ROAA results since the independent variables are the same in both model of banks' profitability.

Table 5.9: Correlation matrix for the return on average equity (ROAE) the period 2000-2013 (all countries)

	ROAE	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT	3MTH RATE	YD SLOPE
ROAE	1.000												
LNSIZE	-0.008	1.000											
LEV	-0.008	-0.362	1.000										
CRISK	-0.260	-0.256	0.106	1.000									
LRISK	-0.029	-0.020	0.069	0.066	1.000								
COST INC	-0.253	-0.364	0.513	0.229	-0.010	1.000							
DIVSIF	0.012	-0.096	0.061	0.160	0.004	0.211	1.000						
LINDEX	0.071	0.407	-0.486	-0.111	0.018	-0.749	-0.310	1.000					
BCRISIS	-0.037	0.020	0.059	-0.017	0.001	0.023	-0.074	0.009	1.000				
RGDP GWR	0.057	0.062	-0.061	-0.027	0.012	-0.062	0.027	0.069	-0.452	1.000			
INFLAT	-0.009	0.131	-0.014	-0.042	0.004	-0.076	-0.053	0.106	0.042	0.304	1.000		
3MTH RATE	0.030	0.104	-0.050	-0.020	-0.002	-0.062	0.018	0.079	-0.233	0.513	0.484	1.000	
YD SLOPE	-0.056	0.104	-0.005	-0.005	-0.005	-0.008	-0.012	0.036	0.017	0.062	0.457	0.550	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. The variables are winsorised at 99% and in level.

e. Return on average equity correlation matrix (advanced countries)

For advanced countries, Table 5.10 below presents the correlation matrix for the return on average equity (ROAE) for advanced countries. Similar to ROAA, none of the variables are highly correlated except the correlation between management efficiency (COSTINC) and Lerner Index at -0.749 which once again is moderately negatively correlated (Pearson's correlation coefficient). Likewise, leverage (LEV) and liquidity risk (LRISK) have a negative relationship with ROAE, unlike ROAA, where the relationships are positive. The rest of correlations are similar to the ROAA results since the independent variables are the same in both model of banks' profitability.

Table 5.10: Correlation matrix for the return on average equity (ROAE) for the period 2000-2013 (advanced countries)

	ROAE	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT	3MTH RATE	YD SLOPE
ROAE	1.000												
LNSIZE	-0.008	1.000											
LEV	-0.008	-0.362	1.000										
CRISK	-0.260	-0.256	0.106	1.000									
LRISK	-0.029	-0.020	0.069	0.066	1.000								
COST INC	-0.253	-0.364	0.513	0.229	-0.010	1.000							
DIVSIF	0.012	-0.096	0.061	0.160	0.004	0.211	1.000						
LINDEX	0.071	0.407	-0.486	-0.111	0.018	-0.749	-0.310	1.000					
BCRISIS	-0.037	0.020	0.059	-0.017	0.001	0.023	-0.074	0.009	1.000				
RGDP GWR	0.057	0.062	-0.061	-0.027	0.012	-0.062	0.027	0.069	-0.452	1.000			
INFLAT	-0.009	0.131	-0.014	-0.042	0.004	-0.076	-0.053	0.106	0.042	0.304	1.000		
3MTH RATE	0.030	0.104	-0.050	-0.020	-0.002	-0.062	0.018	0.079	-0.233	0.513	0.484	1.000	
YD SLOPE	-0.056	0.104	-0.005	-0.005	-0.005	-0.008	-0.012	0.036	0.017	0.062	0.457	0.550	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. The variables are winsorised at 99% and in level.

f. Return on average equity correlation matrix (emerging market economies)

For emerging market economies, none of the variables are highly correlated (see Table 5.11 below). Once again, we find a negative relationship between return on average asset (ROAE) and credit risk (CRISK) (-0.293) and management efficiency (COSTINC) (-0.293). As well as, there is a positive relationship between ROAE and bank size (LNSIZE) (0.152) similar to ROAA correlation matrix. Leverage (LEV) and has a negative relationship with ROAE, unlike ROAA, where the relationship is positive. Once again, the interest rate and yield curve variables are not included in the emerging market economies correlation matrix since the data is not available. Also, the rest of correlations are similar to the ROAA results since the independent variables are the same in both model of banks' profitability.

Table 5.11: Correlation matrix for the return on average equity (ROAE) for the period 2000-2013 (emerging market economies)

	ROAE	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT
ROAE	1.000										
LNSIZE	0.152	1.000									
LEV	-0.042	-0.375	1.000								
CRISK	-0.293	-0.218	0.121	1.000							
LRISK	-0.100	-0.008	0.038	0.028	1.000						
COST INC	-0.430	-0.242	0.281	0.240	-0.054	1.000					
DIVSIF	-0.029	-0.047	0.010	0.121	-0.031	0.154	1.000				
LINDEX	0.210	0.120	-0.193	-0.137	0.088	-0.518	-0.276	1.000			
BCRISIS	-0.041	-0.059	0.009	0.045	0.013	-0.008	0.029	-0.035	1.000		
RGDP GWR	0.039	0.100	-0.059	-0.069	-0.031	-0.050	-0.008	0.025	-0.246	1.000	
INFLAT	-0.029	-0.088	0.019	-0.002	0.027	0.011	0.050	-0.026	0.382	-0.083	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. Interest rate variables data are not available and therefore excluded from the table. The variables are winsorised at 99% and in level.

IV. Analysis of the effect of the macroprudential policy on banks' profitability baseline model (ROAA and ROAE)

Using the information above (Table 5.2), we specify the following baseline ordinary least squares (OLS) model of the determinants of banks' profitability for ROAA and ROAE.

$$Y_{it} = \alpha_{it} + ßInternal_{it} + \theta Industryi_{ijt} + ÞMacro_{ijt} + \varepsilon_{it} \qquad (5.1)$$

where *i* denotes the individual bank, *j* refers to the country in which bank *i* operates *t* indicates time period. The dependent variable, Y_{it} denotes the banks' profitability (ROAA or ROAE). Internal denotes the vector of bank specific factors (internal) which are bank size (LNSIZE), leverage (LEV), credit and liquidity risks (CRISK, LRISK), management efficiency (COSTINC) and diversification (DIVSIF). Industry denotes the vector of banking system specific factors, which are the banking crisis (BCRISIS) and

Lerner Index (LINDEX) variables. The banking crisis (BCRISIS) captures the presence of a banking crisis during the period a country experienced a banking crisis as defined by Laeven and Valencia (2018). It is a dummy variable and it is coded one in the year the crisis starts until the year it was over and is otherwise zero. The LINDEX is the industry competition variable, for which we use the Lerner index (see **Section 5.4.3** and **Appendix 5A.3** for further discussion and calculation). Finally, Macro denotes the vector of macroeconomic variables which are economic growth (RGDPGWR), the rate of inflation (INFLAT), short-term interest rate (3MTHRATE) and the yield curve term structure (YDSLOPE).

V. Transformation of the baseline model and estimation methodology

Due to the panel structure of the data, which is a cross sectional and time series information, we transformed OLS equation 5.1 and estimated the baseline model with lagged independent variables. Lagging the variables by a year is to avoid the potential issues of endogeneity (see Davis et al (2019), de-Ramon et al (2018), Beck et al (2013)). As noted above all variables are winsorised at 99% to avoid an impact of outliers, in line with common practice in the literature. The estimated baseline OLS model (equation 5.1) is then formulated as follows.

$$Y_{it} = \alpha_{it} + ßInternal_{it-1} + \theta Industryi_{ijt-1} + ÞMacro_{ijt-1} + \varepsilon_{it} \qquad (5.2)$$

The main estimation model (equation 2) was then evaluated using the Hausman's test to decide the appropriate model, that is between fixed and random effects model. The results of the Hausman test suggested that fixed effects model is appropriate. (ROAA - Hausman test, X^2: 170.62, p-value: 0.00; ROAE - Hausman test, X^2: 103.95, p-value: 0.00). Further, in order to examine the joint significance of the fixed effects (banks and/ with time effects), the fixed effect models are tested using the Likelihood Ratio test. The results are supported by the highly statistical significance of the Likelihood Ratio test at 1%, 5% and 10%, which suggest banks and/ time fixed effected are significant in the models. Accordingly, the models were estimated with bank level fixed effects with White's cross-sectional standard errors and covariance (corrected for

degrees of freedom) as in Davis and Karim (2018a).[93] In addition, a bank level model with time effects models were estimated as well.[94]

5.4.4. Empirical results of the effects of macroprudential policy on banks' profitability (ROAA and ROAE, all countries)

I. Main estimation model results of the factors affecting banks' profitability (all countries) for the period 2000-2013

Table 5.12 reports the empirical results for banks' profitability (bank level fixed effects) measured by ROAA and ROAE (equation 2 above). The ROAA model is estimated using 2,471 banks with 11,308 observations whilst the ROAE model included 2,453 banks and 11,159 observations. Both models were estimated over 13 periods (years) as the independent variables were lagged by one period. The F-test indicates that the variables included in the models are statistically significant for explanation changes in bank profitability. We included the interest rate variables (short-term interest rate and term structure) in the ROAA and ROAE models and they were highly insignificant, as a result they were dropped. These variables are not normally included in banks' profitability models measured by ROAA and ROAE in the research literature.

Table 5.12: Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE			
		ROAA	**ROAE**
	Our expected relation (+/-)	**Panel OLS with bank level fixed effects**	**Panel OLS with bank level fixed effects**
Constant		3.786*** (2.913)	38.227*** (4.310)
LNSIZE(-1)	+	-0.119** (-2.060)	-1.187*** (-3.019)
LEV(-1)	-	0.261 (0.600)	-4.053* (-1.700)
CRISK(-1)	-	-1.041*** (-4.075)	-10.237*** (-6.056)

[93] Country fixed effects models were estimated as robustness checks.
[94] Results for panel OLS with bank level and time fixed effects are available upon request.

LRISK(-1)	-	0.004 (1.222)	-0.038 (-1.149)
COSTINC(-1)	-	-0.747*** (-4.206)	-6.297*** (-3.515)
DIVSIF(-1)	+	0.004*** (3.982)	0.040*** (5.405)
LINDEX(-1)	+	0.206* (1.637)	-0.433 (-0.503)
BCRISIS(-1)	-	-0.187* (-1.859)	-1.638** (-2.243)
RGDPGWR(-1)	+	0.014** (2.488)	0.123* (1.904)
INFLAT(-1)	+	0.014* (1.861)	0.102* (1.805)
R-squared		0.542	0.487
R-squared (adj.)		0.414	0.341
F-statistic		4.222	3.350
Prob(F-statistic)		0.000	0.00
Periods included		13	13
Banks included		2,471	2,453
Observations		11,308	11,159

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Variables are winsorised at 99%. *** significant at 1%, ** significant at 5%, * significant at 10%. The interest rate factors were tested and highly insignificant in the models as a result they were dropped from the models. Results for panel OLS with bank level and time fixed effects are available from the author. The variables are winsorised at 99%.

In terms of the bank-specific factors, the results confirm that bank size (LNSIZE), credit risk (CRISK), and management efficiency (COSTINC) have negative and significant effects on banks' profitability measured by ROAA and ROAE. We expected a positive relationship for bank size and negative signs for CRISK and COSTINC. The literature suggests that larger banks can benefit from economies of scale to a point as they are able to raise capital at lower cost and benefit from economies of scale, thus increasing profit. Yet, researchers such as Korytowski (2018), Dietrich and Wanzenried (2010), Pasiouras and Kosmidou (2007) found a significant and negative effect on banks' profitability, which is in line with our results. Our empirical results suggest indeed that bank size has a significant and negative effect on profits measured by ROAA and ROAE during the period, which indicate that banks did not benefit from their large size over 2000-2013. Also, larger banks tend to higher loan loss provisions which affect profitability (see Dietrich and Wanzenried (2010)). Our results are also in line with the

research of Berger et al (1987) and Berger and Humphrey (1997), who suggested that eventually large banks could face scale inefficiencies and there could be a negative relationship between bank size and banks' profitability.

Credit risk (CRISK), which is an integral part of banking, shows that our results are as expected, similar to the reported results of Petria et al (2013), Athanasoglou et al (2006), Miller and Noulas (1997). This shows that the increase in poor asset quality will have a negative and significant effect on bank profitability. Overall, managing risk, and in some aspect especially credit risk has become one of the most central issues in banking and for regulators (Basel Accord) as poor credit risk practises have been an underlying factor leading to many banking crises, such as the 2007-2008 subprime crisis in the US (FCIC (2011))[95], and the banking crises and economic slowdown in Scandinavian countries over the period 1990-1991 ((Sandel (2004)). On the other hand, liquidity risk (LRISK) as measured by the deposit/loan ratio has an insignificant effect on banks' profitability in our sample.

The cost/income ratio (COSTINC) which is an indicator of management efficiency, defined as total operating expenses/ total income (Goddard et al (2013)) had a significant and negative relationship to banks' profitability. Our result, which is in line with our expectation, is similar to the results reported by Goddard et al (2013) and Petria et al (2013). Leverage (LEV) had a negative and significant effect on ROAE in the bank level fixed effects model at the 10% significant level but it is insignificant in the ROAA model over the period under review. Our result shows that during the period higher leverage or capital leads to lower profitability similar to the results in Hoffmann (2011). This could be due to the effect of the new Basel Accord capital requirements. Yet, Goddard et al (2004) suggested that higher capital ratios allow banks greater flexibility in taking advantage of new business opportunities which allow for improve profitability.

[95] The Financial Crisis Inquiry Commission was created to examine the causes of the 2007-2008 financial and economic crisis in the United States. The Commission was established as part of the Fraud Enforcement and Recovery Act (Public Law 111-21) passed by Congress and signed by the President in May 2009. This independent, 10-member panel was composed of private citizens with experience in areas such as housing, economics, finance, market regulation, banking, and consumer protection. Six members of the Commission were appointed by the Democratic leadership of Congress and four members by the Republican leadership.

In our estimations, diversification (DIVSIF) has a positive and significant effect on both ROAA and ROAE which is in line with our expectation. Goddard et al (2013) suggested that banks which focused more on non-traditional lines of business were more profitable on average. Similarly, Petria et al (2013) who found that business diversification had a positive and significant effect on banks' profitability.

Concerning the banking sector specific factors, the banking crisis (BCRISIS) variables is negative and significant as a determinant of banks' profitability as measured by ROAA and ROAE, which is what we expected. The BCRISIS variable is a time dummy variable which capture crisis by using zeros for no crisis and ones for a crisis. However, our result for the BCRISIS variable is contrary to some of the results in the research literature, see Bouzgarrou et al (2018) and Xioa (2009), where they indicated that the financial crisis had limited effects on banks, especially domestic banks. The competition factor, Lerner Index (LINDEX), as a proxy to market power, had a positive and significant effect on ROAA, yet there is a negative and insignificant effect on ROAE. This suggests that while banks were able to increase their ROAA on account of greater market power according to the literature (see Maudos and Solis (2009), Kasman et al (2010)), this may not be the case with ROAE. Larger banks new capital requirements (Basel II/ III) may have more than offset any gains from market power and negatively affected banks' profitability as measured by ROAE during the period.

In term of the macroeconomic factors, our results are in line with the literature and our expectations for these variables. Our results show that real GDP growth (RGDPGWR) and the rate of inflation (INFLAT) had a positive and significant effect on banks' profitability over the empirical analysis period. Growth in the economy should result in an increase in banks' profitability as suggested by Korytowski (2018) and Petria et al (2013). Saona (2016) suggested that if inflation is fully anticipated by bank managers, which cause earnings to increase faster than costs, this will have a positive effect on profitability. Our result for the rate of inflation, with a positive and significant effect on banks' profitability suggest that banks are not fully anticipating inflation during the period under review. The relatively low coefficient value for the rate of inflation and with it being significant only at the 10% level may suggest that banks are not fully estimating anticipating inflation. In the following section we move on to discuss the results of the macroprudential instruments.

II. Macroprudential instruments results for the effects on banks' profitability (ROAA and ROAE, all countries)

Similar to **Chapter 3**, the macroprudential instruments (see Table 5.1 above for further information) were tested one by one using the main estimation model (equation 5.2) for the full sample period, 2000-2013, and for all countries (see Table 5.12 above for the main estimation models results). Likewise, to the independent variables in the model, the macroprudential instruments were lagged by one period. The transformed main estimation model to include the vector of macroprudential instruments is shown below.

$$Y_{it} = \alpha_{it} + ßInternal_{it-1} + \theta Industryi_{ijt-1} + ÞMacro_{ijt-1} + \theta MAPP_{i,t-1} + \varepsilon_{it} \quad (5.3)$$

MAPP denotes the vector of macroprudential policy instruments, which is a zero-one variable with zero for policy off and one for policy on. It thus captures the macroprudential effect on the credit-to-GDP gap from the beginning of the year they are actually in place and subsequently all quarters after that starting year until the period it is discontinued.

As discussed above, **we expect that prudential measures which target banks assets (credit activities) and reduce the credit-to-GDP gap to have the greatest effect on banks' profitability** as our results in **Chapter 3** found that debt-to-income ratio (DTI), loans-to-value measures (LTV and LTVCAP) and concentration limits (CONC) are the most effective macroprudential instruments, being statistically significant and negative related to the credit-to-GDP gap (the measure of financial imbalances). In addition, as we developed **hypothesis 1** in **Section 5.4.1,** we contend that, if macroprudential policy reduces the ability of banks to lend, then there should be a significant and negative effect on banks' profitability.

a) Full sample period 2000-2013 results

Overall in the period 2000-2013, the model results suggest that a policy limiting borrowings (asset measures) such as loan-to-value ratios (LTV and LTVCAP) and debt-to-income ratios (DTI), liquidity measure, domestic currency loans limits (CG) as

well as the capital measure, general countercyclical capital buffer (CTC) had the most consistent effect on banks' profitability. These instruments are statistically significant and negatively related to ROAA and ROAE. Table 5.13 below outlines the effect of macroprudential instruments on banks' profitability measured by ROAA and ROAE (bank level fixed effects models).

Table 5.13: Macroprudential instruments results using main regression model for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE		
	ROAA	**ROAE**
Macroprudential instruments	**Panel OLS with bank level fixed effects**	**Panel OLS with bank level fixed effects**
Loan-to-Value Ratio (LTV(-1))	-0.129** (-2.001)	-2.441*** (-3.573)
Debt-to-Income Ratio (DTI(-1))	-0.355*** (-5.255)	-3.744*** (-4.777)
Capital Surcharges on SIFIs (SIFI(-1))	-0.150 (-0.724)	0.690 (0.612)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	-2.628** (-2.257)	-15.000* (-1.601)
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-0.414 (-1.373)	-0.495 (-0.279)
Leverage Ratio (LEV(-1))	-0.131 (-1.079)	-0.685 (-0.602)
Limits on Interbank Exposures (INTER(-1))	-0.130 (-1.372)	-0.762 (-0.737)
Concentration Limits (CONC(-1))	0.083 (0.685)	0.233 (0.145)
Limits on Domestic Currency Loans (CG(-1))	-0.994* (-1.790)	-9.373*** (-3.157)
Levy/Tax on Financial Institutions (TAX(-1))	-0.030 (-0.370)	0.777 (1.177)
Reserve Requirement Ratios (RR(-1))	-0.494 (-0.800)	-3.630 (-0.766)
Limits on Foreign Currency Loans (FC(-1))	-0.140 (-0.561)	-1.714 (-0.830)
Loan-to-value ratio caps (LTVCAP(-1))	-0.195** (-2.050)	-3.060** (-3.472)
FX and/or Countercyclical Reserve Requirements (RRREV(-1))	-0.220 (-0.316)	-2.538 (-0.461)
Total macroprudential instruments (MPI(-1))	-0.100** (-1.862)	-0.862* (-1.790)

Macroprudential instruments focused on the borrower (MPIB(-1))	-0.072* (-1.547)	-0.535* (-1.275)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-0.100 (-1.192)	-0.644 (-0.866)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. Results for panel OLS with bank level and time fixed effects are available from the author.

Loan-to-value measures (LTV and LTVCAP) restrict the borrowing capacity of customers as it limits the amount of funds that can be lent relative to the value of the asset. DTI has a direct effect on customers' ability to borrow, as they are determined by one's income level and debt outstanding, thus this will have an effect on bank ability to lend to highly leverage customers. Similarly, limits on domestic currency loans (CG) affects banks' capacity to lend by reducing the amount of domestic currency loans that can be issued. CG is more restrictive on banks' as this is a cap on banks' total lending without regard to the debt-service ratio, loan-to-value ratio, or risk ratings of customers.

General countercyclical capital buffer/ requirement (CTC) which requires banks to hold more capital during economic upturns, that is with growing credit. CTC limits banks capacity to lend and invest, thus reducing banks' capability to increase profits. The overall macroprudential policy (MPI) and the aggregate borrowers-based (MPIB) indexes are statistically significant and negatively affect profits.

These results are fully in line with our expectation as stated above. Credit measures are the most effective in reducing credit activities in an economic upswing as supported by our results in **Chapter 3**, in reducing the credit-to-GDP gap and empirical research by Carreras et al (2018), Cerutti et al (2017), Akinci and Olmstead-Rumsey's (2015), etc. In addition, as indicated in **Chapter 3** most studies in analysing the effectiveness of macroprudential policy focus on credit growth and house prices and the mitigation of the build-up of imbalances in the housing market, the area of the financial sector, mostly the banking sector, where there is the most potential for systemic risk to develop (see Claessens et al (2014), Dell'Ariccia et al (2012) as well).

In this context, since macroprudential policy (mostly asset measures) is effective in reducing the build-up of financial system imbalances (banks' credit activities), our

empirical results confirm that macroprudential policy has a significant and negative effect on banks' profitability as banks' credit activities are restricted, which is the major source of banks' interest income, thus their profitability. This result has not to our knowledge been tested hitherto in the empirical literature on macroprudential policy.

Therefore, we accept that Hypothesis 1 is verified, that is, banks' profitability is negatively affected when macroprudential policy are effective in reducing financial system imbalances.

b) Pre-crisis (2000-2006) and post-crisis (2007-2013) periods results

As done in **Chapter 3** and **Chapter 4**, we then tested the macroprudential instruments results of the full sample period, 2000-2013 (see Table 5.7 above) over two additional periods, the pre-crisis (2000-2006) and post-crisis (2007-2013) periods using the estimation model equation 5.3. This is done, firstly, to test the effects of macroprudential policy on banks' profitability before the 2007-2008 financial crisis as it seems macroprudential policy is designed to work in a period of relative financial stability. We will note that macroprudential policy were used infrequently prior to the financial crisis (see **Chapter 2**). Secondly, to test the strength and effectiveness during and after a financial crisis as to date macroprudential policy has limited effect during an actual financial crisis, as other policies objectives are given priority. To date, most researchers and policy makers are still unsure on the strength and effectiveness of these prudential measures in their financial system and especially in a period of financial crisis. Likewise to the full sample period, the macroprudential instruments were tested one by one using the main regression models (see Table 5.12 above) for the pre-crisis (2000-2006) and post-crisis periods (2007-2013) and consistent with the independent variables in the model, the macroprudential instruments were lagged by one period.

Before, discussing the macroprudential instruments results for the pre-crisis (2000-2006) and post-crisis periods (2007-2013), below we discuss the ROAA and ROAE main estimation models for the periods 2000-2006 and 2007-2013. Table 5.14 shows the summary results of the banks' profitability models, measured by ROAA and ROAE (bank level fixed effects).

Table 5.14: Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable for the pre-crisis 2000-2006 and the post-crisis 2007-2013 periods (all countries)

Dependent variable: ROAA and ROAE					
		ROAA		**ROAE**	
	Our expected relation (+/-)	**Panel OLS with bank level fixed effects 2000-2006**	**Panel OLS with bank level fixed effects 2007-2013**	**Panel OLS with bank level fixed effects 2000-2006**	**Panel OLS with bank level fixed effects 2007-2013**
Constant		3.337* (1.651)	4.230** (2.474)	28.825*** (2.637)	32.115*** (3.070)
LNSIZE(-1)	+	-0.103 (-1.152)	-0.144* (-1.933)	-0.850* (-1.876)	-0.972** (-2.131)
LEV(-1)	-	-1.322 (-2.971)	0.214 (-0.360)	-10.371* (-1.901)	-4.730 (-1.521)
CRISK(-1)	-	-1.297*** (-2.971)	-0.284 (-0.400)	-5.831 (-1.526)	-3.626 (-0.920)
LRISK(-1)	-	0.003 (0.577)	-0.004 (-0.120)	0.027 (-0.640)	0.011 (0.240)
COSTINC(-1)	-	-0.322* (-1.800)	-0.274 (-0.952)	-1.976 (-1.405)	-2.852 (-1.090)
DIVSIF(-1)	+	0.007*** (3.567)	0.003** (2.051)	0.054*** (3.100)	0.041*** (3.580)
LINDEX(-1)	+	0.070 (0.448)	0.170 (1.130)	0.330 (0.562)	-0.681 (-0.690)
BCRISIS(-1)	-	-0.210 (-1.012)	-0.147 (-1.109)	-0.644 (-0.304)	-1.420 (-1.554)
RGDPGWR(-1)	+	0.014 (0.954)	0.010 (1.050)	0.100 (0.634)	0.042 (0.545)
INFLAT(-1)	+	0.018* (1.787)	0.001 (0.020)	0.123 (1.370)	-0.010 (-0.074)
R-squared		0.673	0.607	0.623	0.580
R-squared (adj.)		0.508	0.447	0.434	0.406
F-statistic		4.100	3.803	3.294	3.360
Prob(F-statistic)		0.000	0.00	0.000	0.00
Periods included		6	7	6	7
Banks included		1,640	1,826	1,626	1,813
Observations		4,948	6,360	4,888	6,271

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. Results for panel OLS with bank level and time fixed effects are available from the author. The variables are winsorised at 99%.

In the period 2000-2006, the specific factors which are significant and have the appropriate coefficient sign (positive/ negative) in the determinants of profitability, either ROAA or ROAE are leverage (LEV), credit risk (CRISK), bank size (LNSIZE), management efficiency (COSTINC) and the rate of inflation (INFLAT). Of particular interest, CRISK has a significant impact on ROAA and not on ROAE. This may require further analysis of the data. For the 2007-2013 period, bank size is the most important determinant of bank profitability, which is negative and significant in both the ROAA and ROAE models. In hindsight, this is not surprising since in the last decade there has been a keen interest in the size of bank and their important for understanding financial system interconnectedness and financial stability. Also, special regulatory requirements have been introduced for these "too big to fail" systemically important financial institutions (SIFIs). Diversification (DIVSIF) consistently has a positive and significant effect on ROAA and ROAE over the estimation periods, which suggest the growing important of non-interest income to profitability of the banking sector.

The banking crisis (BCRISIS) variable is insignificant in both periods, which is not consistent with the full sample period modelling results (see Table 5.12 above). Overall, the results for the sub-periods in Table 5.4 may warrant further investigation as there are some variation in the results for the full sample period (see Table 5.12 above). Some factors such as LNSIZE, CRISK, COSTINC and INFLAT are significant either ROAA or ROAE only, which is not the case in the full sample period where these factors are significant for both ROAA and ROAE.

Table 5.15 below shows the macroprudential instruments results effects on banks' profitability for both periods. In Table 5.9, the results for the pre-crisis period (2000-2006) show that time-varying/dynamic loan-loss provisioning (DP) is statistically significant and has a negative impact on banks' profitability, that is for both ROAA and ROAE. DP acts as a countercyclical capital buffers tool, which help smooth credit supply cycles. DP contracts credit availability (volume and cost) in good times but expand it in bad times (see Jiménez et al (2012)). Yet, the result is not consistent with the results in **Chapter 3** where DP was significant and had a positive effect on the credit-to-GDP gap in the corresponding period 2000-2006 as well as with the results in Table 5.7 above, as DP was insignificant although it has the correct coefficient sign. This may warrant further investigation.

Table 5.15: Macroprudential instruments results using the main regression model for the pre-crisis 2000-2006 and the post-crisis 2007-2013 periods (all countries)

Dependent variable: ROAA and ROAE				
	ROAA		ROAE	
Macroprudential instruments	Panel OLS with bank level fixed effects 2000-2006	Panel OLS with bank level fixed effects 2007-2013	Panel OLS with bank level fixed effects 2000-2006	Panel OLS with bank level fixed effects 2007-2013
LTV(-1)	-0.075 (-0.323)	-0.100 (-0.970)	-2.834 (-0.780)	-0.792 (-0.604)
DTI(-1)	0.237* (1.728)	-0.150* (-1.641)	-0.494 (-0.309)	-0.078 (-0.081)
SIFI(-1)	NA	-0.290 (-1.325)	NA	-0.178 (-0.60)
CTC(-1)	NA	-2.273** (-1.921)	NA	-11.432 (-1.294)
DP(-1)	-0.814** (-2.057)	-0.755** (-2.211)	-5.461** (-2.181)	-1.070 (-0.448)
LEV(-1)	0.156** (2.233)	-0.375*** (-2.720)	0.473 (0.558)	-2.073*** (-4.067)
INTER(-1)	0.98** (2.198)	-0.242 (-2.551)	6.703* (1.801)	-0.372 (-0.290)
CONC(-1)	0.147 (1.443)	-0.180 (-0.862)	1.274 (0.854)	-0.457 (-0.270)
CG(-1)	-0.802 (-1.367)	-0.635 (-1.308)	-8.232* (-1.820)	-8.164** (-2.380)
TAX(-1)	0.154* (1.881)	-0.121 (-0.875)	3.348*** (3.022)	0.896 (0.910)
RR(-1)	1.511*** (3.167)	-0.635 (-1.310)	15.100*** (3.738)	-8.432*** (-3.722)
FC(-1)	0.740 (1.211)	-0.277*** (-3.002)	8.324 (1.501)	-2.744*** (-5.686)
LTVCAP(-1)	-0.101 (-0.476)	-0.110 (-0.730)	-3.535 (-1.040)	-0.930 (-0.600)
RRREV(-1)	1.666*** (2.921)	-0.635 (-1.308)	15.100*** (3.737)	-8.164** (-2.380)
MPI(-1)	0.131 (1.343)	-0.136*** (-6.149)	0.765 (0.656)	-0.608*** (-2.875)
MPIB(-1)	0.134 (0.950)	-0.111*** (-2.895)	0.555 (0.348)	-0.112 (-0.273)
MPIF(-1)	0.290* (1.790)	-0.208*** (-4.050)	2.830** (2.110)	-1.042*** (-3.571)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. NA not applicable as the instrument has not been used by many countries. Results for panel OLS with bank level and time fixed effects are available from the author.

Likewise, FX and/or countercyclical reserve requirements (RRREV) reported a significant and positive effect on banks' profitability, which is not consistent with the effect on the credit-to-GDP gap in the period 2000-2006, where the effects are significant and negative. In Table 5.13, RRREV coefficient signs are negative but the effect is insignificant. As noted previously, reserve requirement measures generally have a dual role as an instrument of monetary policy and of macroprudential policy and as such it is difficult to interpret these results (see for example Izquerido et al (2013) on related issues in Latin America). Also, debt-to-income ratio (DTI) has some significant and positive effect on ROAA and once again is not consistent with the result for credit-to-GDP gap in the 2000-2006 period, where it is highly significant and negative. On the other hand, limits on interbank exposures (INTER) recorded a positive and significant effect on banks' profitability, which is consistent with the effect on the credit-to-GDP gap for the corresponding period, where it has a positive and significant effect on the gap (see **Chapter 3**).

Limits on domestic currency loans (CG) has a significant and negative effect on ROAE, similar to the result for CG in Table 5.13, but there is an insignificant effect on ROAA although the coefficient sign is correct, being negative. Loan-to-value ratio instruments (LTV and LTVCAP) mostly have a negative effect on banks' profitability but it is statistically insignificant. Concentration limits (CONC) has a positive sign but it is insignificant in the period.

Other instruments such as limits on interbank exposures (INTER), reserve requirement ratio (RR), levy/tax on financial Institutions (TAX) are statistically significant but have a positive impact on banks' profitability, either ROAA or ROAE or both measures of profitability. These results are in contrast to the results in Table 5.4, where most of the instrument coefficients signs are negative although being insignificant. In term of the macroprudential indexes, financial institutions-based (MPIF) is statistically significant but the signs are positive. The total macroprudential policy index (MPI) has a positive and mostly insignificant effect on ROAA and ROAE and with the general borrowers-based (MPIB) being insignificant.

The many positive coefficients signs in the pre-crisis period (2000-2006) are not surprising as many countries, especially advanced countries were experiencing an

asset price boom with strong economic growth, which allow banks to make large profits (see Barrell and Davis (2008)) while banks could have passed on the potential cost associated with the macroprudential instruments to customers in form of higher interest rates (interest income) or banking fees (non-interest income) while provisions were low. The results in the pre-crisis might reflect the imposition of macroprudential policies in a booming economy where the strength of the growing economy outweighs the cost associated with its employment. Also, this could be due to the limited use of macroprudential policy prior to the financial crisis.

In the post-crisis period 2007-2013, see Table 5.15 above, mostly it is capital and foreign exchange prudential measures that had a significant and negative effect on banks' profitability. This is not consistent with the results in Table 5.13, where the asset measures such as LTV and DTI had the greatest effect on banks' profitability. Most of the asset measures have negative coefficients but are insignificant. This suggest that other policies such as microprudential policy (Basel II and III) and non-assets/ credit activities related measures which target banks' capital and leverage as well as expansionary fiscal policy are taking precedence over macroprudential policy. With hindsight, expansionary credit measures such as quantitative easing, expansionary monetary and fiscal policies were employed to stimulate credit growth and lending which could account for the ineffectiveness of the asset/ credit prudential measures.

An underlying cause of the 2007-2008 financial crisis was the build-up of excessive on- and off- balance sheet leverage in the financial system, and as such there was a great deal of focus on banks' leverage ratio by the BCBS (see Davis et al 2019a and b). In the post-crisis period macroprudential use of the leverage ratio (LEV) is negative and statistically significant, which is consistent with the effect leverage had on the credit-to-GDP gap for the corresponding period (see **Chapter 3**). On the other hand, an alternative capital measure, namely general countercyclical capital buffer/requirement (CTC), had a negative and significant effect on ROAE only.

Limits on foreign currency loans (FC) had a negative and significant effect on banks' profitability as measured by ROAA and ROAE. This is consistent with Cerutti et al (2017) where they noted that emerging market focus on foreign exchange policies,

suggesting the dual objective of stabilising the country foreign exchange market. Debt-to-income ratio (DTI) and time-varying/dynamic loan-loss provisioning (DP) have a negative and significant effect on ROAA, which is somewhat in line with Table 5.4 results. Other measures such as limits on domestic (CG) and reserve requirement ratio (RR) had a negative and significant effect on ROAE only. Loan-to-value ratio instruments (LTV and LTVCAP) were insignificant which is not consistent with the significant effect they have on the credit-to-GDP gap for the period 2007-2013.

The summary macroprudential indexes have varying effects on banks' profitability with the total macroprudential policy index (MPI) and financial institutions-based (MPIF) having a significant negative effect while the general borrowers-based (MPIB) are not significant, in line with the individual macroprudential instrument results.

In the post-crisis period (2007-2013), with the increase in the usage of the macroprudential instruments, the macroprudential instruments results are favourable in that they show restraint of profits, in contrast to the pre-crisis period (2000-2006). Yet, asset measures targeting credit activities had limited effects on banks' profitability post-crisis as capital and foreign exchange measures had the most effects during the 2007-2013. In effect, we cannot ignore the effects of other policies such as microprudential policy (Basel II and III) which focused on banking sector stability using capital and leverage measures as well as expansionary credit measures such as quantitative easing, expansionary monetary and fiscal policies being employed to stimulate credit growth and lending. In addition, it seems that macroprudential policy is designed to work in periods of financial stability as a restraint on procyclical lending and asset prices. The results rather suggest that macroprudential policy has a greater impact in periods of instability. However, this may warrant further future investigation.

In this context, for the post-crisis period 2007-2013, we can accept that our **Hypothesis 1 is verified**, that is, if macroprudential policy reduces the ability of banks to lend mostly using capital and foreign exchange measures, then there should be a significant and negative effect on banks' profitability as we can see from the results in Table 5.6. For the period 2000-2006, we can't make a definitive conclusion on **Hypothesis 1,** rather we accept that it **is inconclusive** in the pre-crisis period**,** on

account of the many positive effect of the instruments on banks' profitability in context of limited usage.

III. Results for emerging market economies and advanced countries

As a further analysis, we tested the macroprudential instruments according to country division that is emerging market economies (EME) and advanced countries (ADV). There are 58 emerging market economies and 34 advanced countries in the sample (see **Appendix 5A.1.** for a list of countries). It is noted that emerging market economies have a longer history of using macroprudential than advanced countries (see **Chapter 2**). Furthermore, as shown by Cerutti et al (2017), emerging markets focus on foreign exchange policies, suggesting the dual objective of stabilising the country foreign exchange market while advanced countries use more borrower-based policies which specifically target consumer spending and the real estate market. Further, they reported that there is a weaker effect in more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy. As for the full global sample, the macroprudential instruments were tested one by one using the main regression models (see Table 5.6 above) and consistent with the independent variables in the model, the macroprudential instruments were lagged by one period.

Before, discussing the macroprudential instruments results according to country grouping that is emerging market economies (EME) and advanced countries (ADV), below we discuss the ROAA and ROAE main estimation models. Table 5.16 below shows the summary results of the banks' profitability models, measured by ROAA and ROAE (with bank level fixed effects) for the period 2000-2013.

Table 5.16: Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable for emerging market economies and advanced countries for the period 2000-2013

Dependent variable: ROAA and ROAE					
		Emerging market economies		**Advanced countries**	
	Our expected relation (+/-)	**ROAA Panel OLS with bank level fixed effects**	**ROAE Panel OLS with bank level fixed effects**	**ROAA Panel OLS with bank level fixed effects**	**ROAE Panel OLS with bank level fixed effects**
Constant		3.470** (1.911)	33.110*** (3.013)	4.540*** (3.820)	46.834*** (5.300)
LNSIZE(-1)	+	-0.120 (-1.405)	-0.970** (-1.896)	-0.140*** (-2.691)	-1.476*** (-3.918)
LEV(-1)	-	0.212 (0.346)	-15.990*** (-4.018)	0.270 (0.516)	2.546 (0.902)
CRISK(-1)	-	-1.394*** (-3.100)	-12.960*** (-4.728)	-0.855*** (-2.638)	-7.661*** (-2.943)
LRISK(-1)	-	0.006 (0.693)	-0.014 (-0.210)	0.003 (0.887)	-0.052 (-1.584)
COSTINC(-1)	-	-0.360* (-1.805)	-3.185** (-2.471)	-1.153*** (-3.990)	-9.954*** (-3.261)
DIVSIF(-1)	+	0.008*** (4.240)	0.065*** (3.460)	0.001 (0.080)	0.012 (0.880)
LINDEX(-1)	+	0.390** (2.082)	1.087 (1.090)	-0.075 (-0.340)	-2.777 (-1.549)
BCRISIS(-1)	-	-0.054 (-0.281)	0.130 (0.085)	-0.240* (-1.772)	-2.164*** (-2.394)
RGDPGWR(-1)	+	0.020** (2.345)	0.116* (1.685)	0.010 (0.814)	0.160 (1.55)
INFLAT(-1)	+	0.012 (1.527)	0.082* (1.220)	-0.0071 (-0.350)	-0.115 (0.749)
R-squared		0.561	0.483	0.527	0.491
R-squared (adj.)		0.448	0.350	0.380	0.330
F-statistic		4.955	3.605	3.572	3.060
Prob(F-statistic)		0.000	0.000	0.00	0.000
Periods included		13	13	13	13
Banks included		1,219	1,210	1,274	1,264
Observations		5,985	5,925	5,397	5,304

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. Results for panel OLS with bank level and time fixed effects as well as the sub periods are available from the author. The variables are winsorised at 99%.

Briefly, in Table 16 above, the main regression model for emerging market economies (EME) shows that over the period 2000-2013 credit risk (CRISK - negative), management efficiency (COSTINC - negative), diversification (DIVSIF – positive) and GDP growth (RGDPGRW - positive) are significant, with appropriate coefficient signs and important determinants of bank profitability for both ROAA and ROAE. In addition, leverage (LEV), bank size (LNSIZE) and to some extent inflation rate (INFLAT) are significant determinants for ROAE. The competition Lerner Index (LERNER) is significant and positive as expected for ROAA but insignificant for ROAE. In term of advanced countries (ADV), credit risk (CRISK), management efficiency (COSTINC), bank size (LNSIZE) and banking crisis (BCRISIS) are significant, with appropriate coefficient signs, important determinants of ROAA and ROAE over the period 2000-2013. These results are mostly in line with the results in Table 5.12, the full sample period, all countries models.

IV. Macroprudential instruments results for emerging market economies and advanced countries

The focus of the analysis for emerging market economies (EME) will cover all periods, 2000-2006, 2007-2013 and 2000-2013 since as suggested from the macroprudential index database, EME have a longer history in using the macroprudential instruments (See Cerutti et al (2017), Lim et al (2011), etc.). In terms of advanced countries (ADV), the analysis emphasis will look at the period 2007-2013 and 2000-2013 as most advanced countries used macroprudential policy after the 2007-2008 financial crisis.

a) Emerging Market Economies.

Table 5.17 below shows the macroprudential instruments results for emerging market economies over the following periods, pre-crisis 2000-2006, post-crisis 2007-2008 and full sample 2000-2013.

Table 5.17: Macroprudential instruments results for emerging market economies

Dependent variable: ROAA and ROAE						
	ROAA			ROAE		
	Panel OLS with bank level fixed effects			Panel OLS with bank level fixed effects		
Instruments	**2000-2006**	**2007-2013**	**2000-2013**	**2000-2006**	**2007-2013**	**2000-2013**
LTV (-1)	-0.250 (-1.005)	-0.167 (-1.025)	-0.141 (-1.050)	-4.176 (-1.118)	-1.233 (-0.691)	-1.576 (-1.387)
DTI(-1)	0.193 (1.111)	-0.321*** (-3.203)	-0.453*** (-6.063)	-0.058 (-0.033)	-1.193 (-1.192)	-3.774*** (-5.1829
SIFI(-1)	NA	-0.333 (-1.028)	-0.191 (-0.665)	NA	0.469 (0.401)	1.326 (1.155)
CTC(-1)	NA	-2.295** (-1.983)	-2.670** (-2.330)	NA	-10.932 (-1.327)	-14.674 (1.600)
DP(-1)	-0.872** (-2.310)	-0.720** (-1.955)	-0.420 (-1.381)	-5.553** (-2.225)	-0.271 (-0.114)	-0.222 (-0.130)
LEV(-1)	0.152** (2.357)	-0.282 (-0.864)	-0.170 (-0.787)	-0.711 (0.815)	-2.103* (-1.626)	-1.425 (-1.306)
INTER(-1)	1.076** (2.4969	-0.040 (-0.294)	-0.005 (-0.056)	6.881* (1.902)	0.118 (-0.113)	0.320 (0.310)
CONC(-1)	0.390* (1.627)	0.380 (0.772)	0.096 (0.800)	2.189 (0.963)	1.461 (0.525)	-0.515 (-0.324)
CG(-1)	-0.721 (-1.064)	-0.707* (-1.629)	-0.970* (-1.770)	-5.759 (-1.217)	-8.530*** (-2.823)	-9.271*** (-3.287)
TAX(-1)	-0.020 (-0.130)	-0.070 (-0.250)	0.160* (1.615)	1.737 (0.895)	0.923 (0.752)	1.781*** (2.940)
RR(-1)	1.490*** (3.280)	-0.901*** (-2.772)	-0.491 (-0.827)	12.282*** (4.100)	-8.660*** (-4.112)	-3.467 (-0.775)
FC(-1)	0.702 (1.190)	-0.355*** (-3.351)	-0.122 (-0.405)	7.221 (1.440)	-2.880*** (-4.022)	-0.530 (-0.210)
LTVCAP(-1)	-0.292 (-1.347)	-0.245 (-0.904)	-0.096 (-0.688)	-5.213 (-1.560)	-1.912 (0.766)	-1.811 (-1.207)
RRREV(-1)	1.671*** (3.027)	-0.707* (-1.630)	-0.222 (-0.331)	13.814*** (3.553)	-8.530*** (-2.823)	-2.375 (-0.453)
MPI(-1)	0.133 (1.154)	-0.171*** (-3.120)	-0.097 (-1.441)	0.722 (0.575)	-0.937*** (-3.719)	-0.694 (-1.192)
MPIB(-1)	0.096 (0.680)	-0.124** (-2.070)	-0.054 (-0.875)	0.392 (0.262)	-0.175 (-0.465)	-0.225 (-0.411)
MPIF(-1)	0.276* (1.828)	-0.242* (-1.822)	-0.010 (-0.878)	2.438** (2.001)	-1.582*** (-3.485)	-0.620 (-0.635)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. NA not applicable as the instrument has not been used by many countries. Results for panel OLS with bank level and time fixed effects are available from the author.

Firstly, in the pre-crisis period 2000-2006, most of the macroprudential instruments that are significant such as interbank exposure (INTER), leverage (LEV) concentration limits (CONC) and reserve requirements measures (RR and RRREV) had a positive effect on banks' profitability, either ROAA or ROAE or both measures of profitability. Time-varying/dynamic loan-loss provisioning (DP) had a negative and significant effect on ROAA and ROAE but this is consistent with the results in **Chapter 3**, where we found DP to be insignificant in lowering the credit-to-GDP gap for the corresponding period. The aggregate indexes, total macroprudential instruments and financial based, macroprudential instruments also had a positive and significant on banks' profitability. These results are consistent with the full sample results for the corresponding period 2000-2006, see Table 5.15 above. As mentioned previously, the many positive coefficients signs in the pre-crisis period (2000-2006) are not surprising as many countries were experiencing an asset price boom with strong economic growth, which allow banks to make large profits (see Barrell and Davis (2008)).

Secondly, in the post-crisis period 2007-2013, there is a reversal of coefficient signs, as all of the significant macroprudential instruments as well as their corresponding aggregate macroprudential instruments indexes had a negative effect on banks' profitability, either ROAA or ROAE or both measures of profitability. Once again, these results are consistent with the full sample results in the corresponding post-crisis period 2007-2013, see Table 5.15 above. The instruments that had a negative and significant effect on both profitability measures are limits on local and foreign currency loans (CG and FC) and reserve requirements measures (RR and RRREV). Debt-to-income ratio (DTI), time-varying/dynamic loan-loss provisioning (DP) and general Countercyclical Capital Buffer/ Requirement (CTC) had a negative and significant effect on ROAA, while leverage ratio (LEV) had a negative and significant effect on ROAE during the period.

Thirdly, in the overall full sample period 2000-2013, asset limiting policy such as debt-to-income ratios (DTI), liquidity measure, domestic currency loans limits (CG) as well as the capital measure, general countercyclical capital buffer (CTC) had the most consistent effect on banks' profitability. These instruments are statistically significant and negatively related to ROAA and ROAE. These results are supported by the results

in Table 5.13 above for the full sample period 2000-2013 for the individual macroprudential instruments. However, the results for the aggregate macroprudential instruments indexes are statistically insignificant although the coefficients are negative. The macroprudential instruments indexes are an aggregate of the individual instrument as such it is difficult to tell which instrument is influencing the results. Of interest, levy/tax on financial institutions (TAX) instrument had a positive and significant effect on both measures of profitability, which suggest banks are able to pass on the cost of the tax/ levy to customers.

In summary, the results over the three periods suggest that emerging markets mostly focus on foreign exchange policies, which have a dual purpose of stabilising the country foreign exchange market (Cerutti et al (2017)). Loan-to-value measures (LTV and LTVCAP) are statistically insignificant as having an effect on banks' profitability although the coefficient signs are negative. We note for comparison that in **Chapter 3,** the results were inconclusive for emerging market economies in which macroprudential instruments had a statistically significant effect on the credit-to-GDP gap for the full sample period 2000-2013. Although, we found loan-to-value ratio caps (LTVCAP) and MPIB, borrower-based instruments are negatively and statistically significant during the 2000-2006 period. We note that emerging market economies sample size in **Chapter 3** (16 countries) is smaller than the sample in this **Chapter 5** (58 countries), which could account for the inconclusive results of the effectiveness of the macroprudential instruments on the credit-to-GDP gap. Therefore, we accept that **Hypothesis 1 is inconclusive** although our results show that macroprudential measures had a negative and significant effect on banks' profitability, we are unable to confirm the impact of the instruments on our broad definition of credit as measured by credit-to-GDP gap for emerging market economies. However, the results are consistent with the research literature such as Dell'Ariccia et al (2012), Jiménez et al (2012), Vandenbussche et al (2012), Akinci and Olmstead-Rumsey (2015), Cerutti et al (2017), etc. (see **Chapter 3**), who found that the instruments are effective in reducing the financial system imbalances as measured by their narrow definition of credit as well as house price growth.

b) Advanced countries

Table 5.18 below shows the macroprudential instruments results for advanced countries over the following periods, post-crisis 2007-2008 and full sample 2000-2013. The pre-crisis period 2000-2006 is not included as many advanced countries in the sample did not used macroprudential policy prior to the 2007-2008 financial crisis.

Table 5.18: Macroprudential instruments results for advanced countries

Dependent variable: ROAA and ROAE				
	ROAA		**ROAE**	
	Panel OLS with bank level fixed effects		**Panel OLS with bank level fixed effects**	
Instruments	**2007-2013**	**2000-2013**	**2007-2013**	**2000-2013**
LTV (-1)	-0.217 (-0.885)	-0.191** (1.983)	-2.181 (-1.397)	-3.602*** (-3.790)
DTI(-1)	-0.184 (-0.402)	-0.220 (-1.090)	-0.875 (0.280)	-4.642*** (-3.222)
SIFI(-1)	0.108* (1.850)	0.012 (0.242)	-1.207 (-1.398)	-1.960*** (-2.695)
CTC(-1)	na	na	na	na
DP(-1)	na	na	na	na
LEV(-1)	-0.457 (1.290)	-0.060 (-0.192)	-1.221 (-0.575)	0.368 (0.169)
INTER(-1)	-0.290 (-1.351)	-0.256 (-1.531)	0.135 (0.063)	-1.811 (-1.281)
CONC(-1)	-0.827*** (-4.143)	0.065 (0.390)	-2.712** (-2.013)	1.030 (0.645)
CG(-1)	na	na	na	na
TAX(-1)	-0.090 (-0.609)	-0.151 (-1.308)	1.580 (1.010)	0.330 (0.313)
RR(-1)	NA	NA	NA	NA
FC(-1)	0.003 (0.020)	-0.141 (-1.060)	-2.317 (-1.191)	-5.554* (-1.943)
LTVCAP(-1)	-0.226 (-0.857)	-0.418** (-2.376)	-2.297 (-1.415)	-5.057*** (-3.552)
RRREV(-1)	NA	NA	NA	NA
MPI(-1)	-0.120 (-1.169)	-0.115* (-1.713)	-0.371 (-0.539)	-1.257*** (-2.931)

MPIB(-1)	-0.144 (-1.152)	-0.136* (-1.751)	-0.473 (-0.597)	-1.210*** (-3.067)
MPIF(-1)	-0.127 (-1.488)	-0.083 (-1.203)	0.087 (0.010)	-0.557 (-1.050)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10. NA not applicable as the instrument has not been used by many countries. Results for panel OLS with bank level and time fixed effects are available from the author.

In the period 2007-2013, concentration limits (CONC) had significant and negative effect on ROAA and ROAE, while capital surcharges on SIFIs (SIFI) had a positive and significant effect on ROAA only, which suggested large systemic banks are able to pass on the cost of higher capital charges to customers. Concentration limits (CONC) affects financial firms' ability to lend to specific sectors, reducing their exposure to these sectors. Capital surcharges on SIFIs (SIFI) requires systemically important financial institutions to hold a higher capital level than other financial institutions. The aggregate macroprudential instruments indexes are statistically insignificant although the coefficient signs are negative during this period. These results are not consistent with the results in Table 5.9 above for the corresponding period.

In the full sample period 2000-2013, loan-to-value measures (LTV and LTVCAP) had the most effect on banks' profitability as measured by ROAA and ROAE. Other instruments such as debt-to-income (DTI), Capital surcharges on SIFIs (SIFI) and limits on foreign currency loans are statistically significant and affect ROAE negatively. The corresponding aggregate macroprudential instruments indexes, total (MPI) and borrowers-based (MPIB) are significant and affect banks' profitability as measured by ROAA and ROAE. These results are consistent with the results in Table 5.15 above for the corresponding period.

As noted previously, loan-to-value measures (LTV and LTVCAP) have become one of the most common macroprudential instruments for reducing credit growth since the 2007-2008 financial crisis, as cited by studies such as Carreras et al (2018), Cerutti et al (2017), Claessens et al (2014), Crowe et al (2011). However, Jácome and Mitra (2015) suggested that although LTVCAP is effective in reducing loan-growth, it is not always the case in curbing house prices growth. Further Cerutti et al (2017) noted

that advanced countries used borrowers-based instruments more. Our results for advanced countries are consistent with Cerutti et al (2017).

Similar to the results for emerging market economies, we were unable to ascertain which macroprudential instruments (see **Chapter 3**) had a statistically significant effect on the credit-to-GDP gap for the sample periods. Therefore, we also accept that **Hypothesis 1 is inconclusive** although our results show that macroprudential measures had a negative and significant effect on banks' profitability, we are unable to confirm the impact of the instruments on our broad definition of credit as measured by credit-to-GDP gap for advanced countries. Once again, however, the results are consistent with the research literature such as Dell'Ariccia et al (2012), Jiménez et al (2012), Vandenbussche et al (2012), Akinci and Olmstead-Rumsey (2015), Cerutti et al (2017), etc. (see **Chapter 3**), who found that the instruments are effective in reducing the financial system imbalances as measured by their narrow definition of credit as well as house price growth.

V. Summary of the results of the effects of macroprudential policy on banks' profitability (ROAA and ROAE)

In Table 5.19, we summarise the results of the effects of macroprudential policy on banks' profitability (ROAA and ROAE) and compare the results with the research literature on the effectiveness of macroprudential policy in reducing financial system imbalances as measured by the credit-to-GDP gap (see **Chapter 3**), credit, house prices, etc., using the same IMF dataset of macroprudential instruments and time period, namely Carreras et al (2018) and Cerutti et al (2017). As noted in **Chapter 3**, the Carreras et al paper used as a target variable the growth rate of real household credit, while the Cerutti et al work focused on the growth of real credit or real house prices growth in the country, although they noted that effects were greater for household credit. The former paper was for advanced countries only, the latter for a much wider range of both advanced and emerging/developing countries.

Table 5.19: Summary table of the results of the effects of macroprudential policy on banks' profitability

	Table 5.13		Table 5.17		Table 5.18		Chapter 3			Research Literature	
	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE	Credit-to-GDP gap			Memo: Carreras et al (2018) (Real household credit growth)	Memo: Cerutti et al (2017) (Credit growth)
Country coverage	All	All	EME	EME	ADV	ADV	All	EME	ADV	OECD	All
Sample period	2000-2013	2000-2013	2000-2013	2000-2013	2000-2013	2000-2013	2000-2013	2000-2006	2000-2006	2000-2013	2000-2013
LTV	-**	-***			-**	-***	-***			-***	
DTI	-***	-***	-***	-***		-***	-***		-**		-**
SIFI						-***					
CTC	-**	-*	-**								
DP							-**				-***
LEV											
INTER									+*	-***	-**
CONC							-***				-*
CG	-*	-***	-*	-***							
TAX			+*	+***						-***	
RR											
FC						-*		+**			-*
LTVCAP	-**	-**					-***	-*			-*
RRREV											-*
MPI	-**	-*			-*	-***	-***			-***	-***
MPIB	-*	-*			-*	-***	-***	-***			-**
MPIF							-***	+***		-***	-*

Notes: For macroprudential instruments definitions please see Chapter 2. Signs of significant variables are shown where *** significant at 1%, ** significant at 5% * significant at 10%. IMF WEO country classification (April 2017), ADV - advanced countries, EME - emerging market economies. Comparative ROAA and ROAE results for the sub periods are available from the author.

Table 5.19 above shows the summary table of the results of the effects of macroprudential policy on banks' profitability for all countries (All), advanced countries (ADV) and emerging market economies (EME) over the period 2000-2013 and compare the results with the research literature on the effectiveness of macroprudential policy in reducing financial system imbalances, specifically Chapter 3, Carreras et al (2018) and Cerutti et al (2017). It is noteworthy that the tools that we find that have the most significant effect on banks' profitability and consistently effective in reducing the credit-to-GDP gap or credit/ house prices related measures of financial imbalances are the credit/ housing-market focused instruments (asset measures) such as the loan-to-value ratios (LTV and LTVCAP) and the debt-to-income ratio (DTI). There is a significant result for the limit on foreign currency loans (FC) in the full sample for advanced countries ROAE and Cerutti et al (2017), where the effect is negative. However, for the credit-to-GDP gap for EME, the FC effect is positive for the period 2000-2006.

We also show that there are some measures that have a significant and negative effect on banks' profitability such as general countercyclical capital buffer/ requirement (CTC) and limits on domestic currency loans (CG) but no effects on credit-to-GDP gap and credit/ house prices related measures of financial imbalances especially in EME. Also, we found that levy/tax on financial institutions (TAX) instrument had a positive and significant effect on profitability in EME, which suggest banks are able to pass on the cost of the tax/ levy to customers. Yet, Carreras et al (2018) found that TAX has a negative and significant effect on growth rate of real household credit in OECD countries.

Finally, in term of the summary indexes, total macroprudential instruments (MPI) and borrowers-based index (MPIB) are statistically significant and have a negative effect on banks' profitability and the credit-to-GDP gap and/or credit/ house prices related measures of financial imbalances.

5.4.5. Net Interest Margin, Macroprudential Policy and Interest Rates

In the macroprudential policy literature, there have been considerable debates on the interaction of macroprudential policy with a range of other policies especially monetary policy (see **Chapter 2**). Constâncio (2015) argued that macroprudential policy is essential in any economy as the business and financial cycles are not synchronised and monetary policy is not designed to deal with specific financial sector imbalances. This is supported by N'Diaye (2009), who, using a multi-country macroeconomic model for monetary policy analysis, saw that countercyclical prudential policy can help reduce output fluctuations and lessen the risk of financial instability. However, Agur and Demertzis (2015), using a bank-based model (profitability and leverage), concluded that there are times when monetary policy (expansionary interest rate policy) and macroprudential policies can partial offset each other and at the same time, monetary policy can affect financial stability adversely. They show that monetary policy rate affects the bank's risk decisions through two channels, profit and leverage, with countervailing effects. Hence, our **Hypothesis 2** (see **Section 5.4.1** above) in this chapter is based on looking at the interaction of monetary and macroprudential polices using the net interest margin profitability model. We expect a positive/ negative interaction between interest rate and macroprudential policy.

I. Analytical framework and model specification

In order to test our **Hypothesis 2,** first, we need to establish the relationship between the interest rate and a bank profitability model. In this empirical analysis, we estimate a bank-based model of profitability as measured by the net-interest margin (NIM) to test the interaction between macroprudential and monetary policies.[96] Second, we test what effect macroprudential policy has on net-interest margin. Third, we can analyse the interaction between the interest rate and the macroprudential instruments when macroprudential policy is employed.

[96] In the research literature analysing the relation between monetary policy and the financial sector, two types of models are used, 1) Dynamic stochastic general equilibrium macro models (DSGE) and 2) Bank-based model. Our approach belongs in the Bank-based model approach. See Agur and Demertzis (2015).

As noted, NIM is a measure of how successful a bank is in its portfolio investment decisions, that is the bank's interest spread between interest revenue from investment (loans) and their interest expenses paid to lenders (depositors). It can be seen as a subcomponent of ROAA and ROAE (which also allow for non-interest income, noninterest costs and provisions). Interest rates are not normally included as independent variables in banks' profitability models measured by ROAA and ROAE in the research literature (consistent with this, we tested and interest rates were not significant); as such NIM is the most appropriate model to use. Fitch Connect calculates NIM as net interest income divided by average earning assets. Average earning assets are assets that directly generate income.

Our NIM model is based on the work of Alessandri and Nelson (2015) where we adopted their approach in using a short-term interest rate (3-month interbank rate) as proxy for monetary policy interest rate, as well as the yield curve is calculated as the difference between a 10-year government bond rate and the 3-month rate ($Rate^{10y} - Rate^{3mth}$).[97] Also, we include the difference of the interest rate (*DRate)* and slope (*DYSlope)* factors in level and first lag as well as the lagged dependent variable (NIM(-1)) in the model similar to Alessandri and Nelson (2015). This permits a clear separation between short rate and yield curve slope effects (through the rate and slope terms, respectively. The lagged dependent variable was not included in the ROAA and ROAE models, in line with the literature (see Korytowski (2018), Petria et al (2013)).

We carry out the econometric analysis by expanding linear equation 5.2 above (see **Section 5.4.3**) to include interest rate and the term structure of interest (yield curve). All variables are winsorised at 99% to avoid an impact of outliers as is common in the literature on individual banks such as Davis and Karim (2018a). We stipulate the following ordinary least squares (OLS) NIM model of the determinants of banks' profitability as in Alessandri and Nelson (2015).

$$Y_{it} = \alpha_{it} + Y_{it-1} + ¥Rate_{ir} + §DRate_{ir} + §DRate_{ir-1} + ÇYDSlope_{ir} + ΨDYDSlope_{ir} + ΨDYSlope_{ir-1} + ßInternal_{it-1} + \theta Industryi_{ijt-1} + ÞMacro_{ijt-1} + \varepsilon_{it} \quad (5.4)$$

[97] Borio et al (2017) also used a similar approach.

where *i* denotes the individual bank, *j* refers to the country in which bank *i* operates *t* indicates time period. The dependent variable, Y_{it} denotes the banks' profitability (NIM). The monetary policy indicators are the 3-month interbank rate (3MTHRATE) and the slope of the yield curve (YDSLOPE), which is the difference between the 10-year government bond yield and 3-month interbank rate ($Rate^{10y} – Rate^{3mth}$), which are in level. And exactly as added before (equation 5.2 above), the variables denoted by Internal is the vector of bank specific factors, Industry is the banking system specific factors and Macro is the vector of macroeconomic variables as shown in Table 5.2.

Empirical testing of the model was completed using banks in a relatively small sample of countries mostly from advanced countries due to data limitation. This is because for many countries the 3-month interbank interest rate and/ 10-year government bond yield is/are not readily available. Other estimates/ approximations of monetary policy interest rates were used such as monetary authorities' overnight rate, reserve requirements rate, money growth and bank interest rate spread but these models were either difficult to interpret or highly insignificant as well there were too many missing data points for some countries. The countries included in the NIM model are accordingly Austria, Belgium, Canada, Finland, France, Germany, the Netherland, Ireland, Italy, Japan, Portugal, Spain, Switzerland, United Kingdom and the United States. These are all advanced countries. We expect that both the level of interest rates and slope of the yield curve should be positively associated with higher net interest margin (see Alessandri and Nelson (2015), Borio et al (2017)) and Demirguç-Kunt and Huizinga (1999)). The NIM model was evaluated using ordinary least squares (OLS) over the period 2000-2013.

II. Descriptive statistics of the net interest margin baseline model variables

Table 5.20 below shows the descriptive statistics of the net interest margin baseline model variables for the advanced countries used in the model (listed above) for the period 2000-2013. NIM has a mean of 4.750 per cent of total assets but there is increasing variation between the banks as the standard deviation is 8.80 per cent. Consistent with ROAA and ROAE (see Tables 5.3 and 5.4 above) descriptive statistics, credit risk (CRISK), non-performing loans/ gross loans, is on average 9 per cent, with a small variation between the banks. Management efficiency (COSTINC) is

averaging 42 per cent of total income and with non-interest income (DIVSIF) representing about 34 per cent of gross revenue. Average GDP growth over the period is about 1.4 per cent and the inflation rate is about 2.0 per cent. Finally, the Lerner Index (LINDEX) is not zero, suggesting some degree of market power by banks.

Table 5.20: NIM baseline model variables descriptive statistics for the period 2000-2013 (NIM model countries)

Variables	Mean	Median	Max	Min	StdDev	Obs
Dependent variables						
NIM (%)	4.750	2.780	76.712	-2.885	8.800	11,730
LNSIZE (log)	21.873	21.843	27.211	15.843	2.610	14,975
LEV	0.137	0.071	1.266	0.001	0.220	13,160
CRISK	0.087	0.028	1.162	0.006	0.189	7,543
LRISK	2.415	0.900	152.947	0.007	9.372	11,625
COSTINC	0.420	0.351	3.176	0.002	0.470	12,660
DIVSIF (%)	33.627	28.465	142.618	-55.785	30.610	12,908
LINDEX	0.290	0.260	0.998	-2.312	0.595	7,138
BCRISIS						
RGDPGWR (%)	1.404	1.772	9.456	-6.600	2.290	26,670
INFLAT (%)	1.957	2.097	5.591	-1.207	1.238	26,670
3MTHRATE (%)	2.129	2.105	5.993	0.052	1.644	26,669
YDSLOPE (%)	3.707	3.972	8.118	0.730	1.359	26,603

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable and it is coded one in the year the crisis starts until the year it was over and is otherwise zero. The values are a ratio unless otherwise stated. Max – maximum, Min – minimum, StdDev - standard deviation. The variables are winsorised at 99% and in level.

III. Correlation matrix of the net interest margin baseline model variables

Table 5.21 below shows the correlation matrix of the net interest margin model variables. As with the ROAA and ROAE correlation matrices (see Tables 5.6-5.7 and 5.9-5.10 above) none of the variables are highly correlated except for the correlation between management efficiency (COSTINC) and Lerner Index (LINDEX) at -0.745, which is high negatively correlated (Pearson's correlation coefficient) (see Hinkle et al (2003)). As indicated above for ROAA and ROAE, this is not surprising since the

COSTINC data are also used to calculate the LINDEX. There is a negative relationship between NIM and bank size (LNSIZE) but there is a positive relationship between credit risk (CRISK) and management efficiency (COSTINC), which is not consistent with the ROAA and ROAE correlation matrices. As well, there is a negative relationship between the NIM and GDP growth rate (RGDPGWR), interest rate (3MTHRATE) and the yield curve (YDSLOPE). Banking crisis (BCRISIS) has a positive relationship with the NIM.

Table 5.21: Correlation matrix for the net interest margin variables for the period 2000-2013 (NIM model countries)

	NIM	LNSIZE	LEV	CRISK	LRISK	COST INC	DIVSIF	LINDEX	BCRISIS	RGDP GWR	INFLAT	3MTH RATE	YD SLOPE
NIM	1.000												
LNSIZE	-0.377	1.000											
LEV	0.143	-0.358	1.000										
CRISK	0.073	-0.110	0.031	1.000									
LRISK	0.028	-0.023	0.071	0.019	1.000								
COST INC	0.123	-0.384	0.501	0.068	-0.001	1.000							
DIVSIF	-0.116	-0.106	0.066	-0.006	0.006	0.235	1.000						
LINDEX	-0.035	0.421	-0.488	0.026	0.012	-0.745	-0.322	1.000					
BCRISIS	0.026	0.010	0.060	-0.053	0.004	0.020	-0.059	0.006	1.000				
RGDP GWR	-0.007	0.079	-0.062	0.022	0.009	-0.047	0.014	0.066	-0.436	1.000			
INFLAT	-0.012	0.121	-0.002	-0.043	0.004	-0.079	-0.042	0.109	0.039	0.313	1.000		
3MTH RATE	-0.033	0.108	-0.047	0.036	-0.005	-0.065	0.010	0.088	-0.227	0.510	0.484	1.000	
YD SLOPE	-0.060	0.093	0.003	-0.008	-0.004	-0.025	0.000	0.050	-0.008	0.117	0.468	0.580	1.000

Data Source: Fitch Connect, IMF and author calculations. Banking Crisis (BCRISIS) is a dummy variable. The variables are winsorised at 99% and in level.

IV. Empirical testing of the net interest margin model

Similar to the empirical testing of the all countries ROAA and ROAE profitability models, the NIM model was evaluated using the Hausman's test to decide the appropriate model, that is between fixed and random effects model. The results of the Hausman test suggested that fixed effects model is appropriate, (NIM - Hausman test,

X^2: 74.687, p-value: 0.00). Further, in order to examine the joint significance of the fixed effects (banks and/ with time effects), the fixed effect models are tested using the Likelihood Ratio test. The results are supported by the high statistical significance of the Likelihood Ratio test at 1%, 5% and 10% for banks fixed effect but time fixed effects are insignificant. Accordingly, the NIM model was estimated with bank level fixed effects with White's cross-sectional standard errors and covariance (corrected for degrees of freedom) similar to the ROAA and ROAE models in **Section 5.4.3** above for the period 2000-2013.

V. Empirical results of the net interest margin model

Table 5.22 reports the empirical results for banks' profitability (banks level fixed effects) measured by NIM (see equation 3 above). The NIM model is estimated using 1,277 banks with 6,730 observations. The model was estimated over the period 2000-2013. The F-test indicates that the variables included in the models are statistically significant for explaining changes in bank profitability. Credit risk (CRISK), management efficiency (COSTINC), banking crisis (BCRISIS), Lerner Index (LINDEX) and the inflation rate variables (INFLAT) were tested and found to be insignificant in the model as such they are excluded and not reported.

Table 5.22: Regression results for net interest margin as dependent variable for the period 2000-2013

Dependent variable: Net Interest Margin		
	Literature/ our expected relation (+/-)[a]	NIM Panel OLS with banks level fixed effects
Constant		7.180*** (5.011)
NIM(-1)	+	0.267*** (4.726)
3MTHRATE	+	0.112* (1.790)
D3MTHRATE	-	-0.043 (-1.582)
D3MTHRATE(-1)	-	-0.171*** (-3.785)
YDSLOPE	+	0.086** (2.044)

DYDSLOPE	-	-0.134*** (-6.581)
DYDSLOPE(-1)	-	-0.158*** (-3.687)
LNSIZE(-1)	+	-0.202*** (-3.188)
LEV(-1)	+/-	0.635 (0.921)
LRISK(-1)	+/-	-0.001 (-0.002)
DIVSIF(-1)	-	-0.003 (-1.310)
RGDPGWR(-1)	+	-0.014 (-0.696)
R-squared		0.776
R-squared (adj.)		0.723
F-statistic		14.660
Prob(F-statistic)		0.000
Periods included		12
Cross sections included		1,277
Observations		6,730

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. [a] This is based on Alessandri and Nelson (2015), Borio et al (2017) as well as the research literature on the determinants of banks' profitability and author interpretation. The variables are winsorised at 99%.

The results in Table 5.22 show that that the level of the short-term interest rate (3MTHRATE) and the yield curve (YSLOPE) are significant and contribute positively to banks' net interest margin (NIM). This is consistent with our expectation and the research literature of Alessandri and Nelson (2015) as well as Borio et al (2017) and Demirguç-Kunt and Huizinga (1999). Also, the levels results imply that when short term rates are low, there is downward pressure on the net interest margin as banks lower loan rates and expand credit provision. The significant and positive effect of the level of the yield curve slope (YDSLOPE) on NIM suggests the positive impact declines when the steepness of the curve decreases.

There are also short-term dynamic effects when interest rates change (as in Alessandri and Nelson (2015)). The effect of the difference in the short-term interest rate (D3MTHRATE) and yield slope (DYSLOPE) are both significant and negatively related to the NIM. The negative short-run impact of interest rate changes suggests

the presence of repricing frictions. This suggests that increases in short-term interest rates, initially compress banks' margin and only in the long run, when repricing becomes possible, will higher interest rates contribute to higher NIM (Alessandri and Nelson (2015)). Also, in an increasingly competitive banking market as banks competing on interest rate margin to attract customers may not move first especially when there is a change (increase/ decrease) in short-term interest rate.

Similar to all countries ROAA and ROAE model results (see Table 5.6) bank size (LNSIZE) has a significant and negative effect on profit measured by NIM. This is also consistent with the results of Alessandri and Nelson (2015) and Borio et al (2017). GDP growth had an insignificant effect on NIM, which is consistent with Alessandri and Nelson (2015) and Borio et al (2017) but not with the all countries ROAA and ROAE model results (see Table 5.3). Leverage (LEV) had an insignificant effect on the net interest margin model although Alessandri and Nelson (2015) and Borio et al (2017) found some positive and significant effects. Liquidity risk (LRISK) and diversification (DIVSIF) variables were not included in Alessandri and Nelson (2015) or Borio et al (2017) models; the effects of these variables on the NIM are insignificant. DIVSIF is expected to have a negative effect on the NIM as non-interest income is not included in the calculation of the NIM, unlike the ROAA and ROAE, where the impact is expected to be positive. The lagged dependent variable (NIM(-1)) is positive and significant, which suggest the past net-interest margin affect current earnings.

VI. Empirical results of the macroprudential instruments on net interest margin and interaction with monetary policy

As in the case of the all countries ROAA and ROAE models, the macroprudential instruments (see Table 5.1 above for further information) were tested one by one using the NIM regression models (equation 5.4) over the period 2000-2013 for the countries in the sample (see Table 5.22 above for the NIM model results). The transformed NIM estimation model to include the vector of macroprudential instruments is shown below.

$$Y_{it} = \alpha_{it} + Y_{it-1} + ¥Rate_{ir} + §DRate_{ir} + §DRate_{ir-1} + ÇYDSlope_{ir} + ΨDYDSlope_{ir} + ΨDYSlope_{ir-1} + ßInternal_{it-1} + \theta Industryi_{ijt-1} + ÞMacro_{ijt-1} + \theta MAPP_{i,t-1} + \varepsilon_{it} \quad (5.5)$$

Likewise, to the ROAA and ROAE models, the macroprudential instruments (MAPP) were lagged by one period similar to the banks and country specific independent variables in the model. The macroprudential instruments were also estimated in level and they were all found to be insignificant, which is explained further below.

VII. Macroprudential policy effect on the net interest margin profitability model

Table 5.23 below shows the effect of the macroprudential instruments on the net interest margin profitability model.

Table 5.23: Macroprudential instruments results impact on net interest margin and interaction with monetary policy for the period 2000-2013

Dependent variable: NIM	
Macroprudential instruments	**NIM Panel OLS with bank level fixed effects 2000-2013**
LTV(-1)	-0.009 (-0.038)
LEV(-1)	-0.309 (-1.008)
INTER(-1)	0.068 (0.410)
CONC(-1)	-0.145 (-0.405)
TAX(-1)	0.444 (1.456)
FC(-1)	0.047 (0.158)
LTVCAP(-1)	0.063 (0.278)
MPI(-1)	0.049 (0.542)
MPIB(-1)	-0.035 (-0.453)
MPIF(-1)	0.047 (0.515)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. Debt-to-Income Ratio (DTI), Capital Surcharges on SIFIs (SIFI), General Countercyclical Capital Buffer/Requirement (CTC), Time-Varying/Dynamic Loan-Loss Provisioning (DP), Limits on Domestic Currency Loans (CG), and Reserve Requirement Measures (RR and RRREV) are excluded since they resulted in a near singular matrix which could be on account that they have not been used by many countries in the sample.

The results in Table 5.23 above suggest that the effect of all the macroprudential instruments on banks' profitability measured by net interest margin (NIM) is insignificant over the full sample period. Nevertheless, in some aspect the results for NIM for these selected advanced countries are consistent with the view of Cerutti et al (2017), who noted that there is a weaker effect of macroprudential policy in more developed and more financially open economies, suggesting some avoidance and/or disintermediation of the policy. We will add also that these countries don't have a long history of using macroprudential policy as such it could be difficult to interpret these results. These results are not consistent with the macroprudential instruments results using the all countries ROAA and ROAE models (Table 5.13) as well as the advanced countries ROAA and ROAE models (Table 5.18). This will require further investigation.

VIII. Assessing macroprudential policy interaction with monetary policy

Although, macroprudential policy had an insignificant effect on the net-interest margin when the interest rate is included, we will still look at the interaction between macroprudential and monetary policies as both are important for financial system stability. It will also help to understand whether macroprudential policy is offsetting or complementing monetary policy.

First, we look at the individual relationship between both policies and their effect on the NIM (see Table 5.24). We look at the effect on net interest margin of monetary policy, represented by the three-month interest rate (3MTHRATE), when macroprudential policy is included/ excluded from the NIM model. The estimations for the macroprudential instruments are in level to be consistent with the 3MTHRATE since it is included in the model in level. As indicated above (see Table 5.23), the macroprudential instruments were estimated with lagged one period in the model but the effect on three-month interest rate is similar to the instruments results in level, as such it is not reported. Tables 5.24 shows the summary results of the effects of monetary and macroprudential polices on net interest margin when macroprudential policy is included/ excluded from the NIM model in level.

Table 5.24: Summary results of the effects of monetary and macroprudential polices on the net interest margin for the period 2000-2013 (in level)

Variable	Coefficients effect on NIM
Baseline model estimation excluding macroprudential instrument	
3MTHRATE	0.112* (1.790)
Baseline model estimation including macroprudential instrument	
LTV	0.404 (0.906)
3MTHRATE	0.129* (1.854)
LEV	-0.145 (-0.405)
3MTHRATE	0.107* (1.690)
INTER	0.065 (0.398)
3MTHRATE	0.118* (1.870)
CONC	-0.035 (-0.083)
3MTHRATE	0.111* (1.730)
TAX	0.200 (0.876)
3MTHRATE	0.143** (2.154)
FC	-0.107 (-0.393)
3MTHRATE	0.108* (1.646)
LTVCAP	1.516 (1.927)
3MTHRATE	0.177** (2.456)
MPI	0.117 (1.106)
3MTHRATE	0.168* (1.949)
MPIB	0.072 (0.761)
3MTHRATE	0.147* (1.733)
MPIF	0.009 (0.126)

3MTHRATE	0.115* (1.707)

Note: The macroprudential instruments*3MTHRATE coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The macroprudential instruments are in levels.

Table 5.24 shows that when macroprudential instruments are included in the NIM model, there is some effect on the impact on the NIM of the three-month interest rate (3MTHRATE) as the coefficient value changes, either with small increases or decreases and also changes in significance. The three-month interest rate remains significant and has a positive effect on net interest margin, consistent with the results in Table 5.22 above. Also, TAX and LTVCAP increase the significant value of the interest rate over the period. These results suggest that macroprudential policy is having some effect on short term interest rate impacts on banks' net interest margin Once again, the effect of all the macroprudential instruments on banks' profitability measured by net interest margin is insignificant over the full sample period.

Second, we look at the combined relationship effect between short-term interest rate (3MTHRATE) and macroprudential policy (MAPP) and the impact it has on net interest margin. We use a leveraged coefficient for the combined relationship (monetary and macroprudential polices) to see whether their effects differ from the mean. We introduce the combined relationship of macroprudential policy and short-term interest rate as MAPP*3MTHRATE in the NIM model. Once again, the leveraged coefficient was lagged and the effect on three-month interest rate is similar to the leveraged coefficient results in level, as such it is not reported. We use the NIM model in Table 5.22 to analyse the interaction between both policies. The results are in following Table 5.25.

Table 5.25: Summary results of the leveraged coefficients effect on net interest margin for the period 2000-2013

Variable	**Coefficients effect on NIM**
Baseline model estimation excluding macroprudential instrument	
3MTHRATE	0.112* (1.790)
Baseline model estimation including macroprudential instrument leverage coefficient	

LTV*3MTHRATE	-0.144* (-1.977)
3MTHRATE	0.178** (2.387)
LEV*3MTHRATE	-0.080* (-2.014)
3MTHRATE	0.144** (2.208)
INTER*3MTHRATE	-0.014 (-0.287)
3MTHRATE	0.127** (2.028)
CONC*3MTHRATE	0.096*** (2.902)
3MTHRATE	0.058 (0.886)
TAX*3MTHRATE	0.236*** (2.766)
3MTHRATE	0.114* (1.834)
FC*3MTHRATE	-0.425*** (-4.302)
3MTHRATE	0.114* (1.725)
LTVCAP*3MTHRATE	0.062 (0.693)
3MTHRATE	0.180** (2.581)
MPI*3MTHRATE	0.020 (1.151)
3MTHRATE	0.134 (1.420)
MPIB*3MTHRATE	0.093*** (5.673)
3MTHRATE	0.115 (1.437)
MPIF*3MTHRATE	0.069*** (5.873)
3MTHRATE	0.080 (1.262)

Note: The macroprudential instruments*3MTHRATE coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

As can be seen in Table 5.25 above, there are indeed some significant results for combined effects of macroprudential instruments and interest rates in the advanced countries. The leveraged coefficients concentration limits (CONC) and levy/tax on financial institutions (TAX) multiplied by the interest rate have positive and significant

effect on net interest margin. Similar effects are reported by the macroprudential indexes general borrowers-based (MPIB) and financial institutions-based (MPIF) multiplied by the interest rate. These results suggest that there is a greater positive effect of interest rate on the NIM when the instruments are in operation. Loan-to-value ratio (LTV) and limits on foreign currency loans (FC) multiplied by the interest rate have a significant and negative effect on net interest margin. These results suggest that there is a lesser effect of interest rate on the NIM when the instruments are in operation. We suggest that the effect on the NIM is not zero as when credit is restricted by policies such as LTV and FC, net interest income declines relative to the positive effect of interest rate on net interest margin. In terms of leverage (LEV) multiplied by the interest rate, which had a negative and significant effect on the NIM, this suggests a greater negative effect with the introduction of Basel III in the Advanced countries.

Also, Table 5.25 results show that including the leveraged coefficient concentration limits (CONC) in the model resulted in the short-term interest rate (3MTHRATE) becoming insignificant in the model. There is a substitution between the concentration leverage coefficient and the short-term interest rate positive effect on the banks' net interest margin. Similar results are noted for the leveraged coefficients macroprudential indexes general borrowers-based (MPIB) and financial institutions-based (MPIF). This suggests that the combined effects of macroprudential instruments and interest rates are significant determinant in banks' net interest margin even if the individual effects of the macroprudential instruments are not significant.

Third, we use Granger causality (panel) test (Granger (1969)) to assess the temporal relationship between macroprudential and monetary policies. Panel Granger causality performs panel data specific causality testing between the variables in a panel dataset. Monetary policy is measured by the short-term interest rate (3MTHRATE). We also test Granger causality using both the difference of interest rate (D3MTHSRATE) and the macroprudential instruments. Macroprudential policy is tested via the instruments themselves (the time in operation) and their first difference (showing the changes in macroprudential policy stance). Both variables are stationary. We use a 2-lag specification for Granger causality as higher lag specifications were insignificant. The following Table 5.26 shows the panel Granger causality test results.

Table 5.26: Summary results of the Granger causality test and panel VAR impulse responses for the period 2000-2013

Null Hypothesis	No. of lags	F-value	P-value	Decision	Type of causality	Panel VAR Impulse responses
LEV does not Granger Cause 3MTHSRATE	2	4.685	0.009***	Reject Null	Unidirectional	-
LTVCAP does not Granger Cause D(3MTHSRATE)	2	4.676	0.009***	Reject Null	Unidirectional	-
FC does not Granger Cause D(3MTHSRATE)	2	9.258	0.000***	Reject Null	Unidirectional	+
D(LTVCAP) does not Granger Cause D(3MTHSRATE)	2	6.101	0.002	Reject Null	Unidirectional	-
3MTHSRATE does not Granger Cause LTVCAP	2	2.843	0.058*	Reject Null	Bidirectional	-
LTVCAP does not Granger Cause 3MTHSRATE	2	2.747	0.064*	Reject Null	Bidirectional	-
3MTHSRATE does not Granger Cause D(MPLTV)	2	6.796	0.001***	Reject Null	Unidirectional	+
D(3MTHSRATE) does not Granger Cause MPI	2	6.922	0.001***	Reject Null	Unidirectional	-

Note: Only the significant results for panel Granger causality is shown in the table. *** significant at 1%, ** significant at 5%, * significant at 10%. LTV, CONC, TAX, MPIB and MPIF Granger causality are insignificant at 1%, 5% and 10% and are excluded from the table. + positive and significant effect; - negative and significant effect. The frequency is yearly. We report the directional sign for maximum 2 periods (2 years). The Panel VAR results are available from the author.

The results in Table 5.26 show that the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that there is a temporal relationship between the variables in the table. First, we see that leverage (LEV) Granger cause short-term interest rate (3MTHRATE) and the type of causality is unidirectional. We suggest that during the period under review, with a change in leverage, with the introduction of

Basel III in advanced countries, this had an effect on short-term interest rate. This is supported by the results in Table 5.25, as the leverage (LEV) multiplied by the interest rate coefficient had a negative and significant effect on the NIM. Loan-to-value cap (LTVCAP) and limits on foreign currency loans (FC) Granger cause the change in short-term interest rate (D3MHTRATE). As well, the change in LTVCAP (DLTVCAP) Granger cause the change in short-term interest rate. Once again, the type of causality is unidirectional. This suggests that by placing restrictions on banks credit activities, this can affect short term interest rate. As suggested above, restrictions on credit activities lower the net interest income of banks.

In the term of short-term interest rate (3MTHRATE), Table 5.26 results show that the level 3MTHRATE Granger cause loan-to-value cap (LTVCAP) and the change in the loan-to-value ratio (DLTV). The change in short term interest (D3MTHRATE) rate Granger cause the aggregate total macroprudential index (MPI). For LTVCAP, the type of causality is bidirectional as LTVCAP Granger cause 3MTHRATE. The type of causality for DLTV and MPI is unidirectional.

Further, we ran a simple Panel VAR to assess the interrelations between the macroprudential instrument and the short-term interest rate (3MTHRATE). We took two lags of each variable in the VAR. The results of the impulse responses are in Table 5.26. Impulse responses were run using generalised impulses and Choleski ordering based on the type of causality but we also tested with the reverse ordering. The results are based on a short-term impulse response that we report the directional sign for maximum 2 periods (2 years).

We see that LEV and LTVCAP have a negative and significant interaction with short term interest rate which suggest there is an offsetting effect between macroprudential and monetary policy. Meanwhile, FC and LTV have a positive and significant interaction with the short-term interest rate, suggesting that the interaction is complementary.

In conclusion, we suggest that there is a positive/negative interaction between monetary and macroprudential policies. **Therefore, we accept that Hypothesis 2 is verified, that is, there could be an offsetting or complementing effect on**

monetary policy as measured by short-term interest. However, this needs further research and analysis.

5.5. Robustness checks

I. Country fixed effects

First, we ran estimates on the above ROAA and ROAE models results (**Section 5.4.4.** above) using country fixed effects. The main model (equation 2 – **Section 5.4.3.**) was adjusted to include country fixed effects instead of bank fixed effects (see **Appendix 5A.4** for the model results using country fixed effects). Banks are exposed to different country risks (e.g. regulations and laws) and operate in different financial system structures and institutions, at different stages of development, etc. Therefore, we verify whether country characteristics can affect the empirical results.

Firstly, the country fixed effects model results (see **Appendix 5A.4**) show that banks' profitability (both ROAA and ROAE) are determined by credit risk (CRISK, negative), management efficiency (COSTINC, negative), and GDP growth (RGDPGWR, positive). In addition, bank size (LNSIZE) has negative and significant effect on ROAA, while leverage (LEV) and diversification (DIVSIF) has positive and significant effect on ROAA. In some aspect these results are consistent with the results in Table 5.12, ROAA and ROAE all countries models result with bank fixed effects except for the rate of inflation (INFLAT), Lerner Index (LINDEX) and banking crisis (BCRISIS), which are insignificant in the country fixed effects model. This indicate that a country's characteristics (which could include regulatory structure as discussed in **Section 5.3** above) having an effect on the determinants of banks' profitability.

Secondly, in term of the macroprudential instruments, Table 5.27 below, the debt-to-income ratio (DTI) has the most significant effect on bank profitability, similar to the all countries with banks fixed effects macroprudential instruments results in Table 5.6. DTI is also significant and negatively affect the credit-to-GDP gap (**Chapter 3**). Time-varying/dynamic Loan-Loss Provisioning (DP) and general countercyclical capital buffer/requirement (CTC) have significant and negative effects on ROAA only which are not in line with all countries with banks fixed effects macroprudential instruments

results in Table 5.13 where CTC had a negative and significant effect on both ROAA and ROAE, while DP was insignificant. Loan-to-value measures (LTV and LTVCAP) have a significant and negative effect on ROAE only, unlike the results in Table 5.4, where both ROAA and ROAE are negatively affected and significant. Loan-to-value measures also have a significant and negative on the credit/GDP gap (see **Chapter 3)**. Levy/tax on financial institutions (TAX) has a positive and significant effect on bank profitability suggesting that banks are able to pass on the cost of the tax to customer, as well as it is time limited yet it was insignificant in the all countries with banks fixed effects model for ROAA and ROAE (see Table 5.13). These results suggest that, although some macroprudential instruments are significant and negatively affect banks' profitability as in line with the results in Table 5.4, countries characteristics can influence which macroprudential instrument have the greater impact on banks' profitability and extension the credit/GDP gap (see **Chapter 3**). This will require further investigation.

Table 5.27: Macroprudential instruments results with country fixed effects for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE		
	ROAA	**ROAE**
	Panel OLS with country fixed effects	**Panel OLS with country fixed effects**
Macroprudential instruments		
Loan-to-Value Ratio (LTV (-1))	-0.042 (-0.406)	-1.940** (-2.078)
Debt-to-Income Ratio (DTI(-1))	-0.303*** (-4.775)	-3.603*** (-5.797)
Capital Surcharges on SIFIs (SIFI(-1))	-0.272 (-0.980)	-1.482 (-1.343)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	-1.339* (-1.748)	-4.841 (-0.962)
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-0.561** (-1.976)	-1.776 (-1.388)
Leverage Ratio (LEV(-1))	-0.120 (-0.828)	-1.649* (-1.881)
Limits on Interbank Exposures (INTER(-1))	-0.172 (-1.326)	-1.071 (-1.051)
Concentration Limits (CONC(-1))	-0.021 (-0.169)	-0.801 (-0.562)

Limits on Domestic Currency Loans (CG(-1))	-0.553 (-1.232)	-6.013 (-1.706)
Levy/Tax on Financial Institutions (TAX(-1))	0.075 (1.237)	0.629 (0.953)
Reserve Requirement Ratios (RR(-1))	-0.057 (-0.103)	-1.833 (-0.441)
Limits on Foreign Currency Loans (FC(-1))	-0.121 (-0.524)	-2.324 (-1.160)
Loan-to-value ratio caps (LTVCAP(-1))	-0.055 (-0.727)	-2.591*** (-2.914)
FX and/or Countercyclical Reserve Requirements (RRREV(-1))	0.225 (0.391)	-0.444 (-0.094)
Total macroprudential instruments (MPI(-1))	-0.061 (-1.310)	-0.862** (-2.025)
Macroprudential instruments focused on the borrower (MPIB(-1))	-0.058 (-1.220)	-0.785 (-1.876)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-0.056 (-0.762)	-0.664 (-1.000)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

II. Bank types – retail and consumer banks and universal banks

Second, using the ROAA and ROAE equation 2 (**Section 5.4.3.** above), we estimated ROAA and ROAE models with banks fixed effects based on the two most common type of banks in the Fitch Connect dataset. These are retail and consumer banks and universal banks. Retail and consumer banks are typical mass-market banking in which individual customers use local branches of larger commercial banks. Retail and consumer banking aims to be the one-stop shop for as many financial services as possible on behalf of individual retail clients such as checking accounts, savings accounts, personal loans, lines of credit, mortgages, etc. These banks are common in the US. Universal bank is a system in which banks provide a wide variety of financial services, including commercial and investment services. These banks are common in Europe (see **Section 5.2.1.**).

The ROAA and ROAE models results based on retail and consumer banks (See **Appendix 5A.5** for the model results based on bank types) show that banks' profitability is determined by bank size (LNSIZE, negative) credit risk (CRISK, negative), management efficiency (COSTINC, negative), which is similar to the All

countries with banks fixed effects ROAA and ROAE model results (see Table 5.4). Liquidity risk (LRISK) had a negative and significant effect on ROAA and ROAE, which is difference from the results in the all countries models (see Table 5.4) where LRISK is insignificant. In the research literature (see **Section 5.2.1**) Petria et al (2013) and Molyneux and Thornton (1992) found that there is negative and significant relationship between level of liquidity and banks' profitability. On interest is the negative and significant effect of the Lerner Index which suggest that banks are unable to increase profit based on their market power. In the literature, it is expected that Lerner Index has a positive and significant effect on profits. The rate of inflation has positive and significant effect on ROAA only.

For universal banks (see **Appendix 5A.5**), the ROAA and ROAE model results are the same as with the retail and consumer banks in respect to bank size (LNSIZE, negative) credit risk (CRISK, negative) and management efficiency (COSTINC, negative). In addition, diversification (DIVSIF) and the rate of inflation had a positive and significant effect on ROAA and ROAE which is consistent with the result of all countries with banks fixed effects ROAA and ROAE models. The banking crisis (BCRISIS) variable coefficient sign is negative and significant suggesting that the 2007-2008 financial crisis affected universal banks more than retail and consumer banks. Liquidity risk (LRISK) had a positive and significant effect on ROAA only similar to Korytowski (2018), who found that liquidity has positive and significant effect on bank profitability (ROAA) after the 2007-2008 financial crisis. The Lerner Index is had a positive and significant effect on ROAA and with GDP growth having positive and significant effect on ROAE.

In term of the macroprudential instruments, see Table 5.28 below, the results show that the effect of macroprudential instruments on universal banks are most in line with the results of the All countries with banks fixed effect results (Table 5.4 above). The model results suggest that a policy limiting borrowings (asset measures) such as debt-to-income ratios (DTI), liquidity measure, domestic currency loans limits (CG) as well as the capital measure, general countercyclical capital buffer (CTC) had the most consistent effect on banks' profitability. These instruments are statistically significant and negatively related to ROAA and ROAE. These instruments also have a significant and negative on the credit/GDP gap (see **Chapter 3)**. Reserve requirements are also

significant and negatively related to the ROAA and ROAE. Other instruments that have a significant and negative effect on banks profitability measured by either ROAA or ROAE are the loan-to-value measures (LTV and LTVCAP), limits on foreign currency loans (FC) and FX and/or countercyclical reserve requirements (RRREV). The aggregate indexes of total macroprudential and financial institution-based instruments are statistically significant and negatively related to ROAA and ROAE. The aggregate borrowers-based instruments index mostly affect ROAE.

Table 5.28: Macroprudential instruments results based on bank types for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE				
	Retail and Consumer Banks		**Universal Banks**	
	ROAA Panel OLS with banks fixed effects	**ROAE Panel OLS with banks fixed effects**	**ROAA Panel OLS with banks fixed effects**	**ROAE Panel OLS with banks fixed effects**
Macroprudential instruments				
Loan-to-Value Ratio (LTV (-1))	-0.318* (-1.791)	-2.019 (-1.431)	0.016 (0.150)	-1.670** (-1.941)
Debt-to-Income Ratio (DTI(-1))	-0.184 (-0.786)	-0.007 (-0.004)	-0.343*** (-2.778)	-4.202*** (-4.315)
Capital Surcharges on SIFIs (SIFI(-1))	-0.071 (-0.125)	-0.867 (-0.193)	-0.260 (-0.654)	1.168 (0.373)
General Countercyclical Capital Buffer/Requirement (CTC(-1))	-0.138 (-0.136)	-1.385 (-0.171)	-5.910*** (-6.560)	-44.33*** (-4.771)
Time-Varying/Dynamic Loan-Loss Provisioning (DP(-1))	-3.073*** (-5.495)	-14.308*** (-3.200)	0.135 (0.507)	2.349 (1.100)
Leverage Ratio (LEV(-1))	-0.113 (-0.337)	1.398 (0.523)	-0.154 (-0.760)	-2.491 (-1.560)
Limits on Interbank Exposures (INTER(-1))	-0.185 (-0.895)	0.534 (0.318)	-0.083 (-0.476)	-2.632 (-1.905)
Concentration Limits (CONC(-1))	-0.015 (-0.047)	-2.370 (0.896)	0.158 (1.097)	0.631 (0.556)
Limits on Domestic Currency Loans (CG(-1))	0.308 (0.461)	3.710 (0.700)	-1.244*** (-4.272)	-12.168*** (5.240)
Levy/Tax on Financial Institutions (TAX(-1))	-0.528** (-1.964)	0.135 (0.062)	0.017 (0.118)	0.276 (0.245)
Reserve Requirement Ratios (RR(-1))	-0.460 (-0.948)	-4.184 (-1.085)	-0.582** (-2.558)	-5.605*** (-3.104)

Limits on Foreign Currency Loans (FC(-1))	-0.313 (-1.134)	-2.900 (-1.321)	-0.174 (-1.167)	-2.773** (-2.347)
Loan-to-value ratio caps (LTVCAP(-1))	-0.380* (-1.870)	-2.242 (-1.390)	-0.148 (-1.203)	-2.759*** (-2.826)
FX and/or Countercyclical Reserve Requirements (RRREV(-1))	-0.295 (-0.536)	-4.046 (-0.926)	-0.296 (-1.204)	-4.778** (-2.457)
Total macroprudential instruments (MPI(-1))	-0.179*** (-2.703)	-0.708 (-1.327)	-0.085** (-2.292)	-1.156*** (-3.934)
Macroprudential instruments focused on the borrower (MPIB(-1))	-0.202*** (-2.691)	-0.286 (-0.475)	-0.034 (-0.778)	-0.717** (-2.049)
Macroprudential instruments focused on the financial institution (MPIF(-1))	-0.218** (-2.495)	-0.557 (-0.788)	-0.092* (-1.787)	-1.250*** (-3.051)

Note: The macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%.

The results for retail and consumer banks (Table 5.28 above) shows that at time-varying/dynamic loan-loss provisioning (DP) had the most effect on both ROAA and ROAE. Other instruments that have a significant and negative effect on banks profitability measured by either ROAA or ROAE are the loan-to-value ratios (LTV) and levy/tax on financial institutions (TAX). The aggregate macroprudential instruments indexes have the appropriate negative signs and significant.

5.6. Chapter summary

The purposes of the chapter are, firstly, to present empirical research of potential effects of macroprudential policies on banks' profitability which will also help in the understanding of how banks react to macroprudential regulations. To our knowledge this analysis has not been undertaken in the research literature. Secondly, the chapter seek to examine macroprudential policy's relationship with monetary policy in the context of bank profitability as there have been considerable debates on the interaction of macroprudential policy with a range of other policies especially monetary policy.

The empirical results suggest in the sample period, 2000-2013, a number of measures of macroprudential policy such as assets measures, loan-to-value ratios measures (LTV and LTVCAP) and debt-to-income ratios (DTI), liquidity measure, domestic currency loans limits (CG) as well as the capital measure, general countercyclical

capital buffer (CTC) had a negative and significant effect on banks' profitability as measured by return of average assets (ROAA) and return on average equity (ROAE). Since our **Chapter 3** has shown that macroprudential policy (mostly assets measures) are effective in reducing the build-up of financial system imbalances (banks' credit activities) as measured by the credit-to-GDP gap, our empirical results suggest that we accept that **Hypothesis 1** is verified, that is, banks' profitability is negatively affected when macroprudential policy are effective in reducing financial system imbalances**.** However, the results were inconclusive when we examine the effects by country characteristics, advanced countries and emerging market economies. We found that macroprudential policy had a negative and significant effect on banks' profitability advanced countries and emerging market economies but the macroprudential impact on the credit gap could not be determined (see **Chapter 3**), therefore **Hypothesis 1** was accepted as being inconclusive for these country groups.

Also, we found that country and bank characteristics have an influence on the effect of macroprudential policy on banks' profitability. The results show that, although some macroprudential instruments are significant and negatively affect banks' profitability, country and bank characteristics can influence which macroprudential instrument have the greater impact on banks' profitability and extension the credit/GDP gap.

In term of macroprudential policy's relationship with monetary policy, we found that there is positive/ negative interaction between macroprudential and monetary policies. We accept that **Hypothesis 2** is true as there could be an offsetting or complementing effect on monetary policy as measured by short-term interest which could affect banks' profitability

Further research could be undertaken to analyse the impact macroprudential policy has on the real economy when banks' credit activities are restricted. A good starting to examine how large is the impact on economic growth as a result of macroprudential policy restricting banks' credit. In addition, research can be undertaken to understand the monetary and macroprudential policies nexus in how banks deposit and lending interest rates react to the employment of macroprudential policy. Furthermore, there could be investigation whether there is a nonlinear relation of profitability to bank size.

5A. Appendix Chapter 5

5A.1. The list of countries and banks used in the empirical analysis

Appendix Table 5A.1 shows the list of countries and the number of banks in the empirical analysis. The list includes all countries from Claessens et al (2014), where they used 48 countries, 1650 banks in 23 advanced countries and 1,170 banks in 25 emerging markets and some 18,000 observations.

We include 92 countries, 34 advanced countries and 58 emerging market economies, 6,010 banks (3,095 banks from advanced countries and 2,915 banks from emerging market economies) and 84,140 observations. The types of banks included are universal commercial banks, retail and consumer banks, banks, wholesale banks, and Islamic banks. Investment banks and private banks are excluded due to different balance sheet and income structure as well as bank holding companies, to avoid double counting.

Appendix Table 5A.1: List of countries and number of banks

Country	ISO Code	IMF category	No. of banks	
			ADV	EME
Algeria	DZA	EME		16
Angola	AGO	ADV		22
Argentina	ARG	ADV		112
Australia	AUS	EME	89	
Austria	AUT	EME	125	
Bahamas	BHS	ADV		41
Bahrain	BHR	EME		40
Barbados	BRB	EME		9
Belgium	BEL	EME	102	
Belize	BLZ	ADV		2
Bolivia	BOL	ADV		17
Brazil	BRA	EME		100
Bulgaria	BGR	EME		20
Canada	CAN	EME	73	
Chile	CHL	EME		80
China	CHN	EME		100
Colombia	COL	ADV		77
Costa Rica	CRI	ADV		81
Cote D'Ivoire	CIV	ADV		18
Croatia	HRV	EME		51

Cyprus	CYP	ADV	26	
Czech Republic	CZE	ADV	48	
Denmark	DNK	ADV	138	
Ecuador	ECU	ADV		53
Egypt	EGY	ADV		37
El Salvador	SLV	ADV		21
Estonia	EST	EME	11	
Finland	FIN	ADV	68	
France	FRA	ADV	126	
Germany	DEU	EME	136	
Ghana	GHA	ADV		48
Greece	GRC	EME	25	
Guatemala	GTM	EME		39
Guyana	GUY	ADV		8
Honduras	HND	ADV		30
Hong Kong	HKG	ADV	123	
Hungary	HUN	EME		134
Iceland	ISL	ADV	42	
India	IND	ADV		105
Indonesia	IDN	ADV		103
Ireland	IRL	EME	66	
Israel	ISR	EME	20	
Italy	ITA	ADV	188	
Jamaica	JAM	EME		12
Japan	JPN	EME	141	
Jordan	JOR	ADV		18
Kenya	KEN	ADV		60
Korea	KOR	ADV	105	
Kuwait	KWT	ADV		24
Latvia	LVA	EME	25	
Lithuania	LTU	ADV		12
Luxembourg	LUX	EME	132	
Malaysia	MYS	EME		90
Malta	MLT	EME	20	
Mexico	MEX	ADV		49
Mongolia	MNG	ADV		13
Morocco	MAR	ADV		25
Mozambique	MOZ	EME		18
Netherlands	NLD	ADV	87	
New Zealand	NZL	EME	30	
Nicaragua	NIC	EME		17
Nigeria	NGA	EME		84
Norway	NOR	ADV	135	
Oman	OMN	EME		14
Panama	PAN	EME		114
Paraguay	PRY	EME		32
Peru	PER	EME		36
Philippines	PHL	EME		46

Poland	POL	EME		103
Portugal	PRT	ADV	121	
Qatar	QAT	EME		12
Romania	ROM	EME		40
Russia	RUS	EME		148
Saudi Arabia	SAU	EME		14
Serbia	SRB	EME		49
Singapore	SGP	ADV	38	
Slovak Republic	SVK	ADV	26	
Slovenia	SVN	ADV	27	
South Africa	ZAF	EME		53
Spain	ESP	ADV	218	
Suriname	SUR	EME		4
Sweden	SWE	ADV	133	
Switzerland	CHE	ADV	136	
Tanzania	TZA	EME		42
Thailand	THA	EME		32
Trinidad and Tobago	TTO	EME		15
Turkey	TUR	EME		103
UK	GBR	ADV	159	
Ukraine	UKR	EME		174
United Arab Emirates	ARE	EME		38
Uruguay	URY	EME		60
USA	USA	ADV	156	
Total	**92**		**3,095**	**2,915**

Main data source: Fitch Connect, IMF and author calculation. IMF WEO country classification (April 2017), ADV - advanced countries, EME - emerging market economies.

5A.2. Regional breakdown of countries

Appendix Table 5A.2 below shows the regional analysis of the list of countries used in the empirical analysis. The countries were included based GDP and the availability of data covering the sample period, 2000-2013.

Appendix Table 5A.2: Regional breakdown of the countries

North America
Canada
USA

Central America
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

South America
Argentina
Bolivia
Brazil
Chile
Colombia
Ecuador
Paraguay
Peru
Uruguay

Caribbean
Bahamas
Barbados
Belize
Guyana
Jamaica
Suriname
Trinidad and Tobago

Africa
Algeria
Angola
Cote D'Ivoire
Egypt
Ghana
Kenya
Morocco
Mozambique
Nigeria
South Africa
Tanzania

Europe
Austria
Belgium
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Norway
Poland
Portugal
Romania
Russia
Serbia
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Turkey
UK
Ukraine

Oceania
Australia
New Zealand

Eurozone
Austria
Belgium
Cyprus
Estonia
Finland
France
Germany
Greece
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Portugal
Slovakia
Slovenia
Spain

Asia
China
Hong Kong
India
Indonesia
Japan
Korea
Malaysia
Mongolia
Philippines
Singapore
Thailand

Middle East
Bahrain
Jordan
Kuwait
Oman
Qatar
Saudi Arabia
United Arab Emirates

5A.3. Lerner index

In measuring competition, we use the Lerner index of Iwata (Bikker 2004), which is calculated using the approach in Davis et al (2019). We note that in the research literature the banking sector concentration index (Herfindahl-Hirschman Index - HHI) is mostly use as the banking sector specific competition (monopolistic) factor. However, to measure concentration in the market, it is predicated upon the ability to define the market properly, which is a challenge for the banking sector since banks operate under different business models such commercial, retail, merchant, Islamic and investment banking and faced competition challenges. Further, can a highly concentrated market means that there are fewer number of firms and the price that is charged in the market is higher than a competitive market, which is not straight-forward to answer as a market with a few firms can still be very competitive (see Pepall et al (2014).

The Lerner index is one way to measure market performance based on efficiency as such the competitive nature of the market. The Lerner index is a measure of the price-cost margin. It can be seen as proxy for current and future profits stemming from pricing power and it varies that the level of the individual bank.

The Lerner Index is measures in the following way.

$$LI = (P - MC) / P \qquad (5.6)$$

The Lerner Index directly reflects the difference between price and marginal cost and it gives an indication of market power. Under perfect competition the index is zero as the output price (marginal revenue) equals marginal cost and “normal” economic profits are zero. The Lerner index is positive as a firm’s market power increase and price rises above marginal cost in a quantity-setting oligopoly model, with the limiting case being monopoly (see Shaffer and Spierdijk (2015)).

We derived the Lerner index for banks in the sample following Anginer et al. (2014), Beck et al. (2013) and Weill (2013). To obtain the Lerner index, we first estimate the following translog cost function:

$$\log(C_{it}) = \alpha + \beta_1\log(TA_{it}) + \beta_2(\log(TA_{it}))_2 + \beta_3\log(W_{1,it}) + \beta_4\log(W_{2,it}) + \beta_5\log(W_{3,it}) + \beta_6\log(TA_{it})\log(W_{1,it}) + \beta_7\log(TA_{it})\log(W_{2,it}) + \beta_8\log(TA_{it})\log(W_{3,it}) + \beta_9(\log(W_{1,it}))_2 + \beta_{10}(\log(W_{2,it}))_2 + \beta_{11}(\log(W_{3,it}))_2 + \beta_{12}\log(W_{1,it})\log(W_{2,it}) + \beta_{13}\log(W_{1,it})\log(W_{3,it}) + \beta_{14}\log(W_{2,it})\log(W_{3,it}) + \Theta\text{Year Dummies} + \varepsilon_{it} \quad (5.7)$$

where C_{it} is total costs and TA_{it} is the quantity of output and is measured as total assets. The input prices are $W_{1,it}$, which is the ratio of interest expenses to the sum of total deposits and other deposits borrow (IED); $W_{2,it}$, is measured as personnel expenses divided by total assets (PTA); and $W_{3,it}$ is the ratio of other operating expenses to fixed assets (OCF). We include time fixed effects, in line with the existing literature. Having estimated this equation, we impose the following restrictions, again in line with earlier authors, to ensure homogeneity of degree one in input prices:

$$\beta_3 + \beta_4 + \beta_5 = 1;\ \beta_6 + \beta_7 + \beta_8 = 0;\ \beta_9 + \beta_{12} + \beta_{13} = 0;\ \beta_{10} + \beta_{12} + \beta_{14} = 0;\ \beta_{11} + \beta_{13} + \beta_{14} = 0 \quad (5.8)$$

We then use the coefficient estimates from the previous regression to estimate the marginal costs for bank i in calendar year t:

$$MC_{it} = \delta C_{it}/\delta TA_{it} = Cit/TA_{it} * [\beta_1 + 2\beta_2\log(TA_{it}) + \beta_6\log(W_{1,it}) + \beta_7\log(W_{2,it}) + \beta_8\log(W_{3,it})] \quad (5.9)$$

The Lerner index for each bank–year is

$$Lerner_{it} = (P_{it} - MC_{it})/P_{it} \quad (5.10)$$

where P_{it} is the price of assets and is equal to the ratio of total revenue to total assets.

The expected relation to banks' profitability is positive, which suggest that more market power, less competitive should have a positive effect on profitability (Abel et al (2018), yet it is suggested that increase competition can lead to competition-fragility as banks take greater risk (Davis and Karim (2018a), Beck et al (2013), Keeley (1990), etc.). The literature on competition and risk is divided between those supporting "competition-fragility" (more competition leads to higher risk) and "competition-

stability" which suggests more competition leads to lower risk. See Davis and Karim (2018a) and Zigraiova and Havranek (2016), etc.

5A.4. Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable (all countries) with country fixed effects

Appendix Table 5A.3 shows the determinants of bank's profitability using the main model (equation 2) adjusted to include country fixed effects instead of bank's fixed effects. The ROAA model is estimated using 2,471 banks with 11,308 observations whilst the ROAE model included 2,453 banks and 11,159 observations. Both models were estimated over 13 periods (years) as the independent variables were lagged by one period.

Appendix Table 5A.3: Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable with country fixed effects for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE		
	ROAA	**ROAE**
	Panel OLS with country fixed effects	**Panel OLS with country fixed effects**
Constant	-	-
LNSIZE(-1)	-0.040* (-1.933)	0.066 (0.480)
LEV(-1)	2.612*** (7.069)	1.780 (0.948)
CRISK(-1)	-2.012*** (-9.567)	-16.148*** (-12.843)
LRISK(-1)	-0.005 (-1.021)	0.098*** (-2.741)
COSTINC(-1)	-1.601*** (-9.787)	-10.163*** (-6.921)
DIVSIF(-1)	0.002* (1.684)	0.001 (1.520)
LINDEX(-1)	0.204 (1.633)	-0.728 (-1.227)
BCRISIS(-1)	-0.055 (-0.677)	-0.545 (-0.776)
RGDPGWR(-1)	0.019** (2.440)	0.125** (1.953)

INFLAT(-1)	0.007 (1.298)	0.018 (0.387)
R-squared	0.120	0.095
R-squared (adj.)	0.112	0.086
F-statistic	15.144	11.463
Prob(F-statistic)	0.000	0.000
Countries fixed effects	Yes	Yes
Periods included	13	13
Cross sections included	2,471	2,453
Observations	11,308	11,159

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The interest rate factors were tested and highly insignificant in the models as a result they were dropped. Results for panel OLS with country level and time fixed effects are available upon request and the results are similar to the results in the above table. The variables are winsorised at 99%.

5A.5. Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable (all countries) based on bank types

Appendix Table 5A.4 shows the determinants of bank's profitability using the main model (equation 2) based on bank types. The retail and consumer banks ROAA and ROAE models are estimated using just over 760 banks with 2,390 observations whilst universal banks ROAA and ROAE model included about 1,783 banks and 8,130 observations. Both models were estimated over 13 periods (years) as the independent variables were lagged by one period.

Appendix Table 5A.4: Regression results for return on average assets (ROAA) and return on average equity (ROAE) as dependent variable based on bank types for the period 2000-2013 (all countries)

Dependent variable: ROAA and ROAE				
	Retail and Consumer Banks		**Universal Banks**	
	ROAA	**ROAE**	**ROAA**	**ROAE**
	Panel OLS with banks fixed effects	**Panel OLS with banks fixed effects**	**Panel OLS with banks fixed effects**	**Panel OLS with banks fixed effects**
Constant	6.996*** (4.735)	66.526*** (5.661)	4.534*** (6.612)	45.327*** (8.333)
LNSIZE(-1)	-0.242*** (-3.594)	-2.470*** (-4.598)	-0.159*** (-5.254)	-1.473*** (-6.150)
LEV(-1)	0.093 (0.213)	5.078 (-1.448)	0.461 (1.290)	-6.980**
CRISK(-1)	-1.114*** (-3.897)	-7.652*** (-2.781)	-1.046*** (-4.404)	-10.752*** (-5.309)
LRISK(-1)	-0.016*** (-2.681)	-0.165*** (-3.276)	0.008** (-2.243)	0.004 (0.137)
COSTINC(-1)	-1.538*** (-6.402)	-13.144*** (-6.671)	-0.640*** (-5.763)	-5.965*** (-6.267)
DIVSIF(-1)	-0.002 (-0.706)	0.024 (1.221)	0.005* (3.887)	0.039*** (3.428)
LINDEX(-1)	-0.613*** (-2.836)	-4.473*** (-2.684)	0.358*** (3.221)	-0.698 (-0.771)
BCRISIS(-1)	-0.031 (-0.210)	-0.463 (-0.388)	-0.215*** (-2.747)	-1.879*** (-3.055)
RGDPGWR(-1)	0.013 (0.890)	0.067 (0.561)	0.010 (1.243)	0.117* (1.902)
INFLAT(-1)	0.020* (1.651)	0.115 (1.190)	0.015** (2.518)	0.121** (2.603)
R-squared	0.717	0.607	0.541	0.506
R-squared (adj.)	0.584	0.419	0.412	0.367
F-statistic	5.400	3.229	4.186	3.628
Prob(F-statistic)	0.000	0.000	0.000	0.000
Periods included	13	13	13	13
Cross sections included	770	766	1,798	1,783
Observations	2,435	2,393	8,219	8,130

Note: Independent variables coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The interest rate factors were tested and highly insignificant in the models as a result they were dropped. The variables are winsorised at 99%.

CHAPTER 6:

Conclusion and Policy Implications

6.1. Introduction

The global financial crisis of 2007-2008 ushered in a new era of regulatory reform, updated microprudential regulations such as Basel III, a renewed focus on financial stability and financial market interconnectedness as well as contributing to the widespread introduction of macroprudential policy as an essential financial regulatory policy tool to forestall crises or at least offer a buffer to soften the impact of them. Although the literature on macroprudential policy is still evolving and policy has not been truly tested in a financial crisis, there is a consensus among most policymakers and researchers that macroprudential policy is an important tool for financial system stability. However, the focus of research on macroprudential policy in has been narrowly focused on the area of the financial sector where financial imbalances are considered most likely by policymakers at present, which is the domestic credit and housing markets and the banking sector. There is limited focus of both policy and research on macroprudential policy's potential impact on the non-banking sector, commercial property market and in some aspect the real economy where potential imbalances can develop. Furthermore, limited research has been completed on examining the cross-border effect of macroprudential policy and the impact on activities and profitability of deposit- and non-deposit- taking financial institutions. In this context, the principal objective of the thesis is to contribute to the ongoing body of empirical research on the evolution of macroprudential policy, its objectives and effects in the financial sector specifically focusing on the differences between developed and developing countries.

With these points as background, **Chapter 1** introduced the thesis and provided an overview of its structure. **Chapter 2** discussed the evolution of macroprudential policy, its objectives and a critique of literature.

6.2. Summary of findings

Chapter 3 investigated the effectiveness of macroprudential policy and its instruments in reducing the build-up of financial system imbalances as measured by the credit-to-GDP gap. The gap is considered to be a good predictor of instability and it captures a wider definition of credit in the financial system unlike the research literature which tends to focus narrowly on household sector or at most non-financial sector credit. To our knowledge the analysis we carried out has not been undertaken to date in the research literature. Our empirical work seeks to achieve two purposes, 1) to determine whether macroprudential instruments are effective in reducing the credit-to-GDP gap, and 2) to identify which instrument(s) would be more effective in advanced countries versus emerging market economies.

Our country sample included 43 countries, 27 advanced countries and 16 emerging market economies and the analysis was done over the period 2000-2013 using the Cerutti et al (2015a) IMF database of macroprudential instruments. The empirical results from this **Chapter 3** were also used in **Chapter 5** to help evaluate the effect of macroprudential policy on banks' profitability. Our results show that, firstly, macroprudential policy is effective in reducing financial system imbalances as measured by the credit-to-GDP gap. Secondly, we found that housing market related instruments, or instruments targeting borrowers, such as debt-to-income ratio (DTI), loans-to-value measures (LTV and LTVCAP) and concentration limits (CONC) are most effective in reducing the gap.

In **Chapter 4**, we extended the analysis of macroprudential policy further by examining whether there are cross-border effects of macroprudential policies. We looked at the interconnectedness of international financial markets via international banks claims (lending) and assessed whether domestic macroprudential policies can spill over into other countries. Once again, this is a relatively new field as there is limited research on the issue as the focus of macroprudential policy; research tends to be on the domestic financial market, and with limited emphasis on the interconnectedness of international financial markets. Also, the practise of using panel-vector autoregressive (PVAR) analysis in studying the effect of macroprudential policy is not common in the research literature.

Once again, our country sample included 43 countries, 27 advanced countries and 16 emerging market economies. The period of analysis was 2000-2014 using the International Banking Research Network (IBRN) macroprudential instruments database. The empirical results suggest that macroprudential policy cross-border spillovers are generally insignificant although there was a positive result in emerging market economies for local currency reserve requirements. We consider the impact to be negligible in term of affecting financial stability. In addition, macroprudential instruments have a stronger effect on domestic credit and the macroeconomic variables.

Finally, in **Chapter 5**, we investigated the potential effects of macroprudential policies on banks' profitability as measured by return on average assets (ROAA) and return on average equity (ROAE), which will also help in the understanding how banks react to macroprudential regulations. We contend that there is a further gap in the research literature on macroprudential policy, where the focus tends to be on the overall economy/system-wide benefits of such regulation and limited emphasis on the effects on individual banks as measured by the impact on their profitability, structure and activities, etc. This despite the fact that the research literature indicates that bank profitability is important for the understanding of financial stability and it is significant for the effective functioning of the economy. Weak bank profitability can have an adverse effect on lending activities and can reduce the impact of accommodative monetary policy measures. We expected that macroprudential measures which target banks assets (credit activities) and reduce the credit-to-GDP gap (**Chapter 3**) will have the greatest effect on banks' profitability.

Our banking data sample included banks from 92 countries, 34 advanced countries and 58 emerging market economies. There were 6,010 banks (3,095 banks from advanced countries and 2,915 banks from emerging market economies) and 84,140 observations. The period of analysis was 2000-2013 using the same instrument database as in Chapter 3. In addition, the chapter examined how macroprudential policy interrelates with monetary policy, whether positively or negatively using the net interest margin profitability model as there have been considerable debates on the issue. Only advanced countries were included in the data sample in analysing the macroprudential/ monetary policies interaction. Our empirical results found, first,

macroprudential policy (mostly asset measures) had a negative and significant effect on banks' profitability as measured by ROAA and ROAE broadly in line with the effect on the credit gap shown in **Chapter 3**. Therefore **Hypothesis 1** was accepted as being verified. Also, we found that macroprudential policy had a negative and significant effect on banks' profitability advanced countries and emerging market economies but the macroprudential instruments impact on the credit gap could not be determined (see **Chapter 3**), therefore **Hypothesis 1** was accepted as being inconclusive for these country groups. Second, we found that there is positive/ negative interaction between macroprudential and monetary policies. We accept that **Hypothesis 2** is verified as there could be an offsetting or complementing effect on monetary policy as measured by short-term interest which could affect banks' profitability

6.3. Major contributions and achievements

In this thesis we have studied three areas of macroprudential policy where limited research has been undertaken. In **Chapter 3**, we discussed the effectiveness of macroprudential policy on reducing the credit-to-GDP gap. Our research in this chapter contributed to the literature in that, firstly, we extended the analysis of the effectiveness of macroprudential policy by looking at a wide measure of financial system imbalances. We provided the first set of empirical research looking at the effect of macroprudential policy on the gap. In the literature, the focus tends to be on a subset of the credit market (mainly the household sector) and with limited research in other areas of the financial system where potential imbalances can occur. The 2007-2008 financial crisis has shown that policymakers need to take a broad view of financial system regulation, hence the introduction of macroprudential policy. Likewise, policymakers need to look at the development of imbalances from a wide view not least in the light of experience is earlier crises where commercial property exposures have been crucial. Secondly, we provided another robust check for confirming the effectiveness of macroprudential policy of reducing financial system imbalances as measured by the credit-to-GDP gap. Our results are quite useful for policymakers because of the prominent role given to the credit-to-GDP gap in Basel III as a signalling tool (early warning indicator (EWI)) for policymakers in identifying

looming build-ups of imbalances in the financial market and in setting the countercyclical capital buffers.

In **Chapter 4**, by examining the cross-border effects of macroprudential policy, our contributions to the literature are as follows. First, we provided the first set of empirical research on the cross-border effect between countries using macro-level data from the BIS database. We believe our macro-level analysis is useful as it is capturing the effects on the entire financial sector, thus allowing for macroeconomic analysis not feasible with individual banks. Second, we adopted a Panel-vector Autoregressive (PVAR) approach in our empirical research, which has not been used commonly in the literature in the analysis of the cross-border effects of macroprudential policy. As noted in the literature, the main advantage of using a panel approach is that it increases the efficiency of the statistical inference, which would otherwise suffer from a small number of degrees of freedom when the VAR is estimated at the country level. Further it is noted that PVAR can be a useful tool to address the transmission of shocks across borders and understanding the spill over effects between countries when a cross-sectional dimension is added since it can capture country level heterogeneity. Thirdly, we added to the literature on financial market interconnectedness and the transmission mechanism of financial system shocks. In the literature there is limited emphasis on the interconnectedness of international financial markets and there is often a disregard for cross-border flows as a transmission mechanism of financial shock between countries. The rapid spread of the 2007-2008 financial crisis confirmed the relevance of understanding the interconnectedness of financial markets, the spill over effects and the transmission mechanism of shocks.

In **Chapter 5**, we explored the effects of macroprudential policy on banks' profitability and assessed the interaction between monetary and macroprudential policies. Our research in this chapter added to the literature as follows. First, to our knowledge we provided the first set of empirical research on examining the effect of macroprudential policy on individual banks as measured by profitability. This research is important from four reasons. These are, 1) banks continue to be a key player in the financial system yet their function, role and operation varies significantly between countries; 2) the importance of profits to banks' growth, survival and the understanding of financial system stability and fragility; 3) the significance of the banking sector for the real

economy and the transmission of monetary policy; and in this context we 4) identified which macroprudential instruments have the most significant effect on banks' profitability. Our second contribution to the literature from the chapter is the link we made between the effect of macroprudential policy on the credit-to-GDP gap and banks' profitability. By making such link, we can understand better the transmission process from policy to credit issuance. Also, in the literature there tends to be a focus on the system-wide benefit of financial regulation and limited focus on the effect on the individual banks. The third contribution is the positive/ negative interaction between macroprudential and monetary policies using the net-interest margin profitability model. Once again, limited research has been undertaken linking macroprudential and monetary policies via the banking sector using banks' profitability model (NIM).

Finally, throughout the thesis we have looked at the effect of macroprudential policy based on country characteristics, that is we provided research on the evolution and effects of macroprudential policy by focusing on the differences between developed and developing countries. Furthermore, our research assessed separately for effects over three periods, pre-crisis period 2000-2006, post-crisis period 2007-2013/4 and the full sample period 2000-2013/4. These are important contributions to the literature as they give crucial information on how country characteristics and time periods can affect macroprudential policy.

6.4. Policy implications

Although the findings of **Chapter 3** provide policymakers with information on the effectiveness of macroprudential policy in reducing a wider definition of financial imbalances (credit-to-GDP gap), the nature of macroprudential policy to date is that it commonly affects mainly banks and the household sector. Similarly, with the introduction of the counter cyclical buffer, the application of it is to banks. Yet, one policy implication of the results is that policymakers need to be mindful that the growth in the credit-to-GDP gap may not be bank or household sector related. As such, before the employment of macroprudential policy to address imbalances as measured by the credit-to-GDP gap, there needs to be a careful analysis of the causes of the rising gap and this should be complemented with other early warning indicators (see Bank of

England (2014), Drehmann and Tsatsaronis (2014)). Also, another policy implication is that our results show that housing market related instruments, or instruments targeting borrowers, such as debt-to-income ratio (DTI), loans-to-value ratios (LTV and LTVCAP) and concentration limits (CONC) are the most effective on the gap. However, these instruments especially LTV and DTI are less likely to affect financial imbalances originating in sectors not relating to the household or housing sector such as the corporate sector or commercial property market.

The findings in **Chapter 4** suggest that the cross-border impact of macroprudential policy is negligible between countries which is also consistent with the International Banking Research Network (IBRN) results as discussed in the chapter. However, a policy implication of this result is that, policymakers cannot interpret these results in isolation as there is not a very long history in the usage of macroprudential policy particularly in advanced countries. Also, macroprudential policies are designed to operate in periods of sustain economic growth or the absence of any financial disturbance. There needs to be further analysis of the transmission of the cross-border effect of macroprudential policy between countries.

As mentioned above, most of the research literature on macroprudential policy focus mainly on banks and the housing sector. Chapter 3 also highlighted that growth in the credit-to-GDP gap may not be related to the banking sector. Hence if there is the used of macroprudential policy to broadly address financial imbalances without understanding the source of the imbalances, a policy implication based on the empirical results in **Chapter 5** suggests that banks' profitability could be adversely affected even if growth in the gap is unrelated to the banking sector. As such, the stability of banks with weak profitability can be affected. Another policy implication is the potential cost of macroprudential policy to the banking sector and the real economy in term of lower profitability as well as reduced lending activities. By weakening banks, the system-wide approach of macroprudential policy could have unintended consequences on limiting highly productive investment opportunities. Finally, policy implication of the results on the macroprudential/ monetary policies interaction shows that macroprudential policy can complement/ substitute for monetary policy in lowering financial system imbalances.

6.5. Topics for future research

We believe that this thesis can act as a useful guide to future research. In fact, the empirical evidence we have presented in the thesis suggests that further research is needed in order to understand the effectiveness and operational aspect of macroprudential policy in the financial system. First, the research in the thesis can be conducted using more recent data especially for the information on the use of macroprudential policy. The most widely used macroprudential instruments datasets provide information up to 2014. Second, further research can be undertaken to analyse the impact of a financial disturbance on the effectiveness of the macroprudential instruments particularly in emerging market economies since they have a longer history of using macroprudential instruments. It seems that macroprudential policy was designed to operate in periods of financial stability. Third, research can be undertaken looking at the effect of macroprudential policy by including more market-based information, which constitutes a forward-looking approach. Using historical accounting-based information constitutes a backward-looking approach which may not necessary predict the future. Fourth, research can be undertaken to analyse the impact macroprudential policy has on the real economy since banks' credit activities are restricted. A good starting to examine how large is the impact on economic growth as a result of macroprudential policy restricting banks' credit to particular sectors of the economy. Fifth, further regional research on macroprudential policy can be done by focusing on particular areas such as Africa, Latin America and the Caribbean, etc. Finally, the thesis did not analyse the impact of banks' ownership, type of banks, and regulatory structure on the effectiveness of macroprudential policy. Research in these areas will be very useful. As for example, several macroprudential policy governance structures have been discussed in the literature and understanding how the governance structure affect the implementation of macroprudential policy would be useful information to assess the success of macroprudential policy.

GLOSSARY

Broad credit channel, also referred as balance sheet channel, is the direct impact of monetary policy on aggregate demand and output, that is, the potential impact on borrowers' balance sheets and income statements, including borrowers' net worth, cash flow and liquid assets.

CAMELS is a rating system that bank supervisory authorities use in order to rate financial institutions according to six factors. The factors are Capital Adequacy, Asset quality, Earnings, Liquidity, and Sensitivity to market risk.

Credit crunch is defined as an economic condition in which investment capital is hard to secure. Banks and investors become wary of lending funds to individuals and corporations, which drives up the price of debt products for borrowers. Often an extension of a recession, a credit crunch makes it nearly impossible for companies to borrow because lenders are scared of bankruptcies or defaults, resulting in higher rates.

Decision tree is a schematic, tree-shaped diagram used to determine a course of action or show a statistical probability. Each branch of the decision tree represents a possible decision, occurrence or reaction. The tree is structured to show how and why one choice may lead to the next, with the use of the branches indicating each option is mutually exclusive.

The **Herfindahl-Hirschman Index (HHI)** is a common measure of market concentration and is used to determine market competitiveness. It is calculated as the sum of the squares of each participants' market share.

Interest rate channel is the mechanism where monetary policy can influence aggregate demand through interest changes.

Interest rate mismatch occurs when a bank borrows at one interest rate but lends at another.

Money-centre banks are banks that borrow from and lend to governments, large corporations, and other banks on national and international financial markets.

Note issuance facility is a medium-term legally binding commitment under which a borrower can issue short-term paper in its own name, but where underwriting banks are committed either to purchase any notes which the borrower is unable to sell, or to provide standby credit.

Single Supervisory Mechanism (SSM) refers to the system of banking supervision in Europe. It comprises the ECB and the national supervisory authorities of the participating countries.

Tail risk is the risk associated with an event with a very small possibility of occurring but that has a very large implications of the economy and financial markets.

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