CHARLES UNIVERSITY
FACULTY OF SOCIAL SCIENCES
Institute of Economic Studies

Does monetary policy reinforce the effects of macroprudential policy?

Master's thesis

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Academic Year: 2021/2022

Declaration of Authorship

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Prague, May 2, 2022

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Abstract

This thesis examines whether the effects of macroprudential policy on credit and house price growth differ across diverse phases of the monetary policy cycle. The dataset covers 33 advanced and 39 emerging market countries in the period 1990-2019. Using the GMM estimation method, the results for individual types of macroprudential policy instruments and their cumulative effect represented by macroprudential policy index show that tightening of monetary policy does on average reinforce the effects of macroprudential policy on credit and house price growth. Furthermore, the effects of various types of macroprudential policies on credit and house price growth differ depending on the monetary policy cycle phase. The results suggest that macroprudential policies are effective in curbing house price growth in advanced countries but less so in emerging markets. The effects of macroprudential policy tools on credit growth are somewhat larger in emerging market economies than in advanced economies. The thesis contributes to the growing literature on the effectiveness of macroprudential policy on credit and housing markets and on the interaction between macroprudential and monetary policies.

JEL Classification	E52, E58, G21, G28, E32
Keywords	Macroprudential Policy, Monetary Policy, Credit Growth, House Price Growth, Panel Data

Title	Does monetary policy reinforce the effects of macroprudential policy?

Abstrakt

Tato práce zkoumá, zda se liší vliv makroobezřetnostní politiky na růst úvěrů a cen nemovitostí během různých fází cyklu měnové politiky. Data zahrnují 33 států s vyspělou a 39 států s rozvíjející se tržní ekonomikou v průběhu let 1990-2019. Pro odhad parametrů modelů byla použita ekonometrická metoda GMM. Výsledky pro jednotlivé typy makroobezřetnostních nástrojů a jejich souhrný efekt reprezentovaný indexem makroobezřetnostní politiky ukazují, že utahování měnové politiky v průměru posiluje vlivy makroobezřetnostní politiky na růst úvěrů a cen nemovitostí. Účinek různých typů makroobřetnostních nástrojů na růst úvěrů a růst cen nemovitostí se vzájemně liší podle fáze měnové politiky. Výsledky naznačují, že nástroje makroobřetnostní politiky účinně omezují růst cen nemovitostí v zemích s vyspělou tržní ekonomikou. Avšak jejich účinnost je menší v zemích s rozvíjející se tržní ekonomikou. Vlivy makroobezřetnostních nástrojů na růst úvěrů jsou o něco větší v zemích s rozvíjející se tržní ekonomikou než v zemích s vyspělou tržní ekonomikou. Diplomová práce přispívá k rozrůstající se literatuře zabývající se účinky makroobezřetnostní politiky na úvěry a ceny nemovitostí a na interakci makroobezřetnostní a měnové politiky.

Klasifikace JEL E52, E58, G21, G28, E32
Klíčová slova Makroobezřetnostní politika, Měnová politika, Růst úvěrů, Růst cen nemovitostí, Panelová data

Název práce Posiluje měnová politika efekty makroobezřetnostní politiky?

Acknowledgments

I am grateful especially to doc. PhDr. Adam Geršl, Ph.D. for his time, valuable comments and willingness to provide guidance at any time.

Bibliographic Record

Livorová, Barbara: *Does monetary policy reinforce the effects of macroprudential policy?*. Master's thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies, Prague. 2022, pages 126. Advisor: doc. PhDr. Adam Geršl, Ph.D.

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Acronyms

BIS Bank for International Settlements

BoE Bank of England

BOJ Bank of Japan

CNB Czech National Bank

DSGE Dynamic stochastic general equilibrium

ECB European Central Bank

EU European Union

Fed Federal Reserve

G20 Group of Twenty

GDP Gross Domestic Product

GFC Global financial crisis

GMM Generalized method of moments

iMaPP integrated Macroprudential Policy Database

IMF International Monetary Fund

OECD Organisation for Economic Cooperation and Development

OLS Ordinary Least Squares

UK United Kingdom

U.S. United States

Master's Thesis Proposal

Author	Bc. Barbara Livorová
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Proposed topic	Does monetary policy reinforce the effects of macroprudential policy?

Motivation The global financial crisis led to the development of banking regulation with macroprudential tools. The emphasis is among other on the financial stability risks connected with an excessive credit growth. The developments of regulation brought along theoretical research on finding the optimal combination of macroprudential and monetary policies in order to manage the business cycle and safeguard financial stability (Van der Ghote, 2019). As the growth of credit issued by the banks is a strong predictor of systemic financial crisis (Schularick and Taylor, 2012), the understanding of what impact has the macroprudential policies on monetary policy transmission via credit is crucial for the establishment of a financial stability.

As both macroprudential and monetary policy affect financial markets and economic activity, there are spillovers between them (Martin et al., 2021). In the situation when there is an effective management of the macroprudential policy, the Tinbergen principle applies. This principle says that monetary policy is able to focus on keeping inflation close to its target whereas macroprudential policy can focus on dealing with systemic risk. On the other hand, it is believed that in practice it is possible that the macroprudential framework is not yet fully effective.

There are few studies focusing on the interaction of monetary and macroprudential policy. The paper by Bruno et al. (2017) uses cross-country aggregate data on 12 countries from the Asia-Pacific region and focuses on the assessment whether the monetary and macroprudential policies are substitutes or complements. Altavilla et al. (2020) examines the data from European credit registers and finds the evidence that monetary policy easing increases bank lending and lending to riskier borrowers, moreover, their findings suggest that monetary and macroprudential policies work as complements. Last but not least, Gambarcorta and Murcia (2017) perform a meta-analysis of various studies that analyze macroprudential policies based on data from credit-registers for commercial loans in Latin America. The recent literature (Benchimol et al., 2021; Cao, 2021) uses bank-level data from one or two countries for their analyses.

Hypotheses

1. Hypothesis #1: Macroprudential and monetary policy do reinforce each other's effect.

2. Hypothesis #2: The effects of macroprudential and monetary policies are asymmetric in financial and business upturns and downturns.

3. Hypothesis #3: Effects of individual macroprudential policies are different for various macroprudential instruments.

Methodology In the thesis, the relationship between monetary and macroprudential policies and their individual and aggregate effect on credit growth and house prices is going to be estimated. The model will verify the effectiveness of macroprudential tools on the intermediate targets when the monetary policy pushes the economy in the same direction and in opposite one. The second type of models will estimate the effect of the monetary policy on the inflation or output gap, the analysis will be focused on whether the effects of monetary policy are stronger when the macroprudential policy is used in parallel. During the research, we will explore whether to use GMM or the fixed effects approach in order to be able to deal with endogeneity that may appear in the model. Moreover, we will estimate VAR models showing the effects of macroprudential and monetary policies. The effect of macroprudential policy instruments will be included in the model in the form of an index based on the iMaPP database created by IMF. This index is based on the number of measures that are put in place at a given point of time. In the analysis, the macroprudential tools will be considered item by item as well. In order to capture the monetary rates in the ZLB period, we will use the CAB-GATSM approach introduced by Krippner (2013). The data source for our credit data are CB's databases of individual countries. The main source of housing prices will be BIS database on residential property prices. As mentioned before, the main data sources will be CB's databases of the individual countries, BIS, IMF, and ECB databases. The models will be estimated for a sample of emerging and advanced countries. Since data for some countries may be available for a longer period than for other countries, the study will aim to use a data frame starting as early as possible in order to successfully capture booms and crises that the economies have gone through in the past.

Expected Contribution This thesis is going to contribute to the not so developed area of studies on the impact of macroprudential policies on housing prices, specifically on its individual and combined with monetary policies effects. The analysis will be focused on the possible reinforcement of macroprudential and monetary policies which is not yet very deeply explored. To my knowledge, the studies do not evaluate if there is a different interaction between the macroprudential and monetary policies in financial and business upturns and downturns. The recent studies have focused their discussion on the individual countries based on the data from credit registers. My study is going to be based on country-level data from CB's databases aiming to describe the situation in a broader set of advanced and emerging economies. The results of my thesis will offer another point of view on the use of macroprudential and monetary policies and their impacts on the economy, these results could be interesting especially for politicians and central bankers.

Outline

1. Introduction and motivation
2. Literature review
3. Analysing data and methodology
4. Discussion of results and robustness checks
5. Conclusion and suggestion for further research

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Chapter 1

Introduction

The global financial crisis has shown weaknesses in the macro-financial policy frameworks. The stabilisation of inflation was not sufficient in safeguarding financial stability, and monetary policy alone was not able to prevent the global financial crisis of 2008/2009 (GFC). The development of macroprudential policies is one of the major policy responses to the GFC. The establishment of an effective macroprudential framework has become one of the prime objectives of the country authorities worldwide, supported by the G20 and international financial institutions such as the IMF (Kenç, 2016). The importance of the macroprudential supervision is highlighted by the fact that during financial upturns, financial intermediaries may seem sound on a microprudential level; however, their combined actions may lead to a risk on the system-wide level. The target of macroprudential policy is to prevent and mitigate systemic risk to ensure that the financial system is resilient to shocks and does not further amplify the effects of a financial crisis. Following the fact that the macroprudential policy framework has been developed only recently and is still in progress, some policy questions remain not answered, or the evidence is mixed, such as on the links between macroprudential and other macroeconomic policies (Aikman *et al.*, 2016).

The aim of this thesis is to contribute to the existing literature on the interaction between macroprudential and monetary policy by evaluating the effectiveness of macroprudential policy interventions under different phases of monetary policy cycle. The effectiveness of macroprudential policy is measured by its impact on what is typically called "intermediate targets," i.e. credit growth and house prices.

Based on the existing literature and economic theory, testable hypotheses are formulated to evaluate the interaction between macroprudential and monetary policy, the effectiveness of various types of macroprudential tools, and the difference in the effectiveness in advanced versus emerging market economies.

The hypotheses are tested based on a sample of 72 countries all over the world (of which 33 advanced and 39 emerging market economies) for the period 1990-2019 using quarterly data. Credit growth and house price growth are used as dependent variables. Macroprudential policy data are based on the database of Alam *et al.* (2019), while monetary policy appears in the estimations as monetary policy rate and in the form of the monetary policy cycle. The estimated models contain a set of control variables like real GDP growth, inflation rate, exchange rate, and a crisis dummy. The results are obtained using the GMM estimation method. The sample is further divided into advanced and emerging markets, investigating if there is a difference between these two groups of countries. Additionally, the effects of individual macroprudential policies are also evaluated.

The results show that on average, monetary policy reinforces the effects of macroprudential policy both on credit and house prices. However, these results are driven mainly by advanced markets. In emerging markets, macroprudential policy in general impacts credit growth but we have not found any reinforcing effect of monetary policy. Based on our estimations, macroprudential policy is effective in curbing house price growth in advanced economies but not so in emerging market economies. Various types of macroprudential measures have different effects on credit and house price growth, depending on the monetary policy cycle phase. For example, capital instruments, liquidity instruments, and loan restrictions have stronger impact when applied monetary policy tightens. The effects of macroprudential measures on credit are somewhat larger in emerging market economies than in advanced economies. However, some results do not hold under alternative specifications and are thus not robust enough, deserving additional research.

The rest of this thesis is organised as follows. Chapter 2 reviews the relevant literature on macroprudential policy, its objectives, effectiveness, and interaction with monetary policy. Chapter 3 describes the data and provides a summary of the use of macroprudential policy based on our sample. Chapter 4 specifies the methods employed to estimate our models and presents the hypotheses. In Chapter 5, the results are presented and commented. Finally, Chapter 6 provides conclusions and policy recommendations.

Chapter 2

Literature Review

In this chapter, the existing literature on macroprudential policy is examined. In the first section, the main objectives, tools, and history of macroprudential policy are summarized. The second section presents findings of the literature on the effects of macroprudential policy on credit growth and house prices. The third section deals with literature on the impacts of macroprudential policy on monetary policy objectives, inflation, and output. The rest of this part presents findings on interactions between monetary and macroprudential policy.

2.1 History, objectives, and tools of macroprudential policy

The global financial crisis showed the necessity but not sufficiency of price stability (ensured by monetary policy) in safeguarding financial stability. Moreover, it showed that the stability of the whole financial system is not guaranteed by the soundness of individual credit institutions, monitored by micro-prudential supervision (Constâncio *et al.*, 2019). Thus, the global financial crisis revealed a need for a discipline of financial regulation that would aim to mitigate the risk of the financial system as a whole (Kenç, 2016). The development of a "missing piece" from the pre-crisis policy regime, macroprudential frameworks, has been one of the primary policy responses to the crisis (Saporta, 2009). To ensure financial stability, central banks and supervisory authorities globally got new mandates and new macroprudential instruments to fulfil their mandates (Financial Stability Board, 2011).

Although the global adoption of macroprudential policy follows the GFC, the United States implemented macroprudential policies in order to control credit growth in major economic sectors such as housing already in the 1920s (Elliott *et al.*, 2013).

The main objective of the macroprudential policy is to assure the resilience of the whole financial system to shocks of different nature and, thus, to prevent economic downturns amplified by these shocks. Macroprudential policy aims also to prevent the build-up of imbalances during the upswing of the financial cycle and thus, limit the financial sector's procyclicality. So that in downturns, the financial sector is able to absorb losses and support the real economy (Ampudia *et al.*, 2021). During economic upturns, the macroprudential policy can be challenged by other policies. While leaning against rising credit and housing prices, the implementation of the policy may go against tax and other social policies which aim at encouraging credit availability and house ownership (Hartmann, 2015).

The macroprudential policy consists of various types of tools. Capital measures, liquidity measures, and borrower-based measures are widely used by banks. The macroprudential tools for non-banking institutions are yet not fully developed. Provisioning requirements, other quantitative restrictions on the balance sheet of financial intermediaries, taxation or levies on activities or balance sheet composition have been used mainly in emerging markets to a different extent (Ampudia *et al.*, 2021). To be more specific about the instruments used in the banking sector, increasing the resilience of the financial institutions is the primary objective of the capital-based measures. The capital-based instruments aim to provide an assurance that institutions have sufficient loss-absorbing capacity on a "going concern" basis. Addressing risks originating from maturity mismatches on the balance sheets is the objective of liquidity-based measures. Borrower-based measures focus on vulnerabilities of banks' clients directly (Constâncio *et al.*, 2019).

Despite a rapidly increasing literature on the effectiveness of the macroprudential policy, there is still a limited consensus on how well the macroprudential policy tools work in practice, and even more limited one on which tools work most efficiently.

2.2 Effect of macroprudential policy on credit growth and house prices

As mentioned in the previous section, the main objective of macroprudential policy is to suppress the financial risk. Assessing whether the macroprudential policy is successful based on a crisis that never happened would be demanding. However, in practice, policymakers aim at pursuing intermediate targets - like credit and house prices. Thus, the literature assesses the efficiency based on these two targets. As the macroprudential policies are most frequently used in emerging countries, a majority of research is based on data from these countries (Cerutti *et al.*, 2017).

The results of meta-analysis by Araujo *et al.* (2020) show that a tightening of macroprudential policy tools have a statistically significant effect on credit. Moreover, the results provide evidence for stronger effects from policy tightening than from loosening. The results show weaker and imprecise effects of Loan-to-Value (LTV) and Debt-Service-to-Income (DSTI) on house prices than on reduction of household credit.

A part of the literature evaluating the effects of various prudential tools on credit growth and house prices is based on aggregate macroeconomic data. These papers usually perform panel data regressions at a country level. Using an extensive dataset of 119 countries, Cerutti *et al.* (2017) provide evidence that macroprudential policy tools have a significant negative effect on credit growth. These results are based on the aggregate index of use of various prudential tools, macroprudential policy index (MPI). The paper shows the different sizes of the strength of the prudential tools in emerging market and advanced economies. Moreover, the results show a significant negative effect of interconnection limits and tax measures on the growth of house prices in emerging countries.

Results based on data from 57 advanced and emerging markets of Akinci & Olmstead-Rumsey (2018) show that provision requirements, LTV caps, risk weight on mortgages, and other housing measures are efficient tools for a reduction of credit growth. Moreover, the results suggest that LTV and DSTI constrain increasing of house prices. However, the results are more significant for countries where the banking sector plays an important role.

Analysis of Vandenbussche *et al.* (2015) based on a set of Central, Eastern and Southeastern Europe (CESEE) countries suggests that capital adequacy ratio, maximum ratio of household loans to share capital, marginal reserve requirements (MRRs) on foreign funding, and MRRs linked to credit growth have a significant effect on house prices.

Poghosyan (2020) provides evidence based on a sample of EU countries that macroprudential tools are generally effective in curbing credit and house prices. However, the effect is delayed and reaches peak after three years. Moreover, the results suggest that the effects of tools are asymmetric in downturns and upturns.

Fendoğlu (2017) indicates that the overall tightening of macroprudential tools has a significant impact on containing credit cycles. Moreover, the results provide evidence that the combined use of countercyclical capital requirements, provisions, restrictions on FX lending, and limits on net open position have a significant effect on credit growth. These results are based on data from 18 major emerging market economies.

Analysis of Küçükbıçakcı *et al.* (2020) approves that a combination of macroprudential policy tools is an efficient tool how to slow down credit growth in the upturns of the financial cycle. Moreover, based on a sample of emerging markets, they provide evidence that by using a combination of tools, the credit growth may be used even more efficiently and argue that macroprudential policy tools work as complements.

Another part of the literature is based on bank-level data. Results of Claessens *et al.* (2013) based on bank-level data from 48 countries suggest that Debt to Income (DTI) and LTV ratios are effective in the limitation of credit growth. They also provide evidence for the ability of bank leverage and assets mitigation of countercyclical buffers. The paper by Lim *et al.* (2011) is based mainly on data from the period before and during the GFC. The paper shows that LTV, DTI, reserve requirements, and dynamic provisioning have statistically significant effects on credit growth.

Using bank-level data for Vietnam, Nguyen *et al.* (2021) find evidence that restriction on foreign currency loans is effective in reducing credit growth. Moreover, the paper finds mixed evidence for ceiling credit growth rates for commercial banks, as this measure seems to be effective only in the case of SIBs[1] and not small banks. However, it fails to provide evidence of the effectiveness of other prudential tools on credit growth.

Based on three decades of data for 57 countries, Kuttner & Shim (2016) show a significant effect of housing-related taxes on house prices. However, the paper fails to provide evidence for significant impacts of supply-side credit policies (like liquidity requirements or limits on credit growth) on house prices. The results show a significant effect of maximum DSTI ratio and maximum LTV ratio on credit growth, where DSTI ratio appears to be more efficient than LTV ratio. However, both tools have no significant impact on house prices.

Noss & Toffano (2016) show that an increase in the bank capital requirements during upturns has a significant negative effect on credit growth. The effect is larger on corporate credit growth than on household credit growth.

Based on the sample of European emerging market economies, Pochea & Niţoi (2021) suggest that prudential tools significantly negatively affect credit growth. Lending standards restrictions and limits on credit growth and volume have the strongest aggregate effect.

Last but not least, part of the literature is based on data from credit

[1]Systemically important banks

registers. The results of Jiménez *et al.* (2017) based on data from Spain provide evidence of a significant effect of countercyclical provisions on reducing the effects of a credit crunch. However, the tool is based on their results unsuccessful in limiting the credit growth. Dassatti Camors *et al.* (2019) provide evidence that tightening of credit requirements for banks has a significant effect on credit growth limitation. This study based on data from Uruguay also raises two concerns: banks shift credit towards more riskier firms after the introduction of tightening, and big banks are able to compensate the impact of reserve requirements.

The findings of Gómez *et al.* (2020), based on loan-by-loan data from Colombia, suggest that dynamic provisioning and countercyclical reserve requirements have a significant effect on reducing credit growth. The paper provides evidence that macroprudential policies and monetary policy have worked as complements to reduce credit growth.

Thus, according to the literature on the effects of macroprudential policy tools on credit growth, the tools are generally effective in limiting credit growth. Especially LTV and DTI ratios seem to be effective tools according to the majority of studies. However, there is no consensus about the effectiveness of other policy instruments on credit growth and about the level of effectiveness of individual tools in general. The literature also provides mixed evidence about which instruments are effective in limiting the growth of house prices. As well, the results seem to differ across countries or groups of countries. One of the possible explanations for the different results of the effectiveness of policy tools may be the direction of monetary policy if the monetary policy is working in the same direction or against the macroprudential policy. Another explanation may be that the effects of the policies are asymmetric in financial and business upturns and downturns.

2.3 Effects of macroprudential policy on output and inflation

The literature also focuses on the effects of macroprudential policy on output growth and inflation. As the macroprudential policy is, together with fiscal and monetary policy, influencing the macroeconomic framework, it may have unintended leakages and side effects on various macroeconomic variables. The knowledge about the side effects on output growth and inflation is important as policymakers do not want to limit some exposures at the cost of harming, for example, economic growth. If an economic slowdown was at that time significant, it could even raise a risk of financial instability and lead to crisis in an extreme case. On the other hand, if the macroprudential policy reinforced the effects of other policies, it may be an advantage.

Kim & Mehrotra (2017) find that macroprudential policies have a statistically significant impact on inflation. Moreover, that macroprudential and monetary policies can help each other achieve each other's objective of price and financial objectives. Results of Sánchez & Röhn (2016) provide evidence that less extreme positive growth shocks are implied by the greater use of macroprudential policies.

Richter *et al.* (2019) analyse the effects of LTV ratios on output and inflation. Their analysis provides evidence for a relatively insignificant effect of changes in the LTV ratios on output and inflation. Moreover, based on their results, they argue that in advanced economies, central banks are able to use macroprudential policy to manage financial booms without significantly influencing the monetary policy objectives.

Similar results are presented by Aikman *et al.* (2016) using data for the UK in the range from the 1950s to the 1980s. The effects of macroprudential policy tools on output are weak, and there is no effect on inflation. On the other hand, Poghosyan (2020) provides evidence that the impact of macroprudential policies in the EU countries is delayed and reaches a peak after three years from implementation. Moreover, the impact tends to be asymmetric; tightening measures have weaker effects compared to loosening policies.

Boar *et al.* (2017) use panel data for a large set of advanced and emerging market economies to show how output growth is influenced by macroprudential policy. Their results show that the higher use of macroprudential measures leads to higher and less volatile output growth.

Overall, the literature does not provide a consensus about the effects of macroprudential policy on output growth and inflation, whether they are significant or not. This raises the question whether different results are not caused by spillovers between macroprudential and monetary policies, if the policies work in the same direction or in the opposite one.

2.4 Data for the use of macroprudential policy

In order to address the lack of systematic data about the macroprudential policy tools in the EU and to enable the research and examination of the effectiveness of prudential tools, Budnik & Kleibl (2018) have created a comprehensive dataset on macroprudential policies in the 28 EU member states. The Macroprudential Policies Evaluation Database (MaPPED) covers the use of eleven categories of policy instruments within the period from 1995 to 2017. This detailed database covers all from capital requirements and capital buffers to liquidity requirements and limits on currency and maturity mismatches.

Database covering the worldwide data with a similar goal is called the integrated Macroprudential Policy Database (iMaPP). This database is created by Alam *et al.* (2019) and it is updated annually. By a combination of five previously existing databases with the IMF's Annual Macroprudential Policy Surveys and some other sources, this database provides data for 134 countries for the time period between 1990 and 2020. The database classifies the macroprudential instruments into 17 categories like countercyclical capital buffers, capital conservation buffers, limits on leverage of banks, loan loss provisions, loan restrictions, etc. As these two databases are considered the best that currently exist for the data about the use of prudential tools, we have decided to use the database by Alam *et al.* (2019) as the main source about macroprudential policy for our analysis. The database of Budnik & Kleibl (2018) is additionally consulted on the use of macroprudential policy instruments in the EU countries.

2.5 Monetary policy and financial stability

After the Great Recession, there has risen debate about the causes of the financial instability, to be more specific, about what effects does monetary policy have on the financial system and its stability, sometimes referred to as the monetary policy cycle. Taylor (2007) states that by keeping the federal funds rate "too low for too long,“ the Fed has strengthened the increase of instability that has led to the global financial crisis. In the periods after the GFC, many central banks have set their policy rates near zero, which led to a rise of concerns that the asset prices which are growing could reverse and spill over into the real economy. This approach to monetary policy may strengthen financial vulnerabilities – excess credit for both households and businesses, high risk-taking by investors and high leverage of banks and other financial institutions. Thus, the rise of interest rates should reduce financial instability. However, Paul (2020a) has shown that this might not be the case. Higher policy rates can increase market leverage of financial institutions and lead to enlargement of assets that are the source of money market funds funding (Paul, 2020b). The enlargement of held assets by money market funds was a source of financial instability within the global financial crisis. Therefore, it is crucial to take into account the effects of the stance of monetary policy when we are assessing the effectiveness of macroprudential policy.

2.6 Impact of monetary policy on house prices

Beside the questions about the effects of macroprudential policy on house prices, the effects of monetary policy on house prices were also examined in the research. Before the global financial crisis, the research was focused on the relationship between conventional monetary policy and house prices. The paper by Aspachs-Bracons & Rabanal (2011) shows that a shift in the policy rate causes a change of the house prices in the opposite direction. Musso *et al.* (2011) find a larger negative effect of policy rates on the house prices and lower but still significant negative impact in the euro area. Iacoviello & Minetti (2003) fail to provide a piece of evidence for the significant impact of the monetary policy on the house prices for the overall situation in the countries included.

Currently, the literature focuses on the impacts of unconventional monetary policy on house prices. Based on the data for eight OECD countries, Rahal (2016) shows a significant relationship between house prices and monetary policy rate shocks. This response reaches its peak between twelve and twenty-four months after the shock. Similar results were achieved by Rosenberg (2019) for the Scandinavian countries that expansionary shocks of the conventional and unconventional monetary policy lead to an increase in house prices.

Results of Nocera & Roma (2018) based on an extended dataset from 1980 till 2014 of some European countries provide evidence for a significant negative and strong impact of monetary policy shocks on house prices. Overall, the literature suggests that an increase in a policy rate has a negative effect on the level of house prices.

2.7 Interactions between macroprudential and monetary policy from the theoretical point of view

Based on the discussion in the previous sections, whether the different results are not caused by spillovers between macroprudential and monetary policy, the overview of theoretical and empirical literature is provided.

Martin *et al.* (2021) provide an overview of the debate regarding the effects of macroprudential policy and its interaction with monetary policy. One of the main conclusions of this paper implies that if it is possible to use macroprudential policy effectively, then monetary policy is able to focus on eliminating the distortions associated with nominal rigidities. However, when the prudential policy is limited and cannot fully address the distortions related to systemic risk, monetary policy may play a macroprudential role; tightening to reduce credit and leverage ex-ante, and loosening in order to speed up economic recovery ex-post. The paper also argues that implementing the second result in practice is not straightforward; any practical attempt to significantly alter monetary policy when financial imbalances are building up or once a financial crisis materializes is likely to be ineffective and could be counterproductive.

Similar argumentation appears in the paper by Nier & Kang (2016) - that despite the "side effects" of macroprudential policy on the objectives of monetary policy and vice versa, if the macroprudential and monetary policies are effective, then the policies complement each other, which yields to superior outcomes where one of the policies is pursued on its own and in the absence of the other one.

2.8 Impact of the spillovers on credit growth

Literature on the effects of the interactions between macroprudential and monetary policies on credit growth is quite extensive. Some of the first studies using data from the times before the Global Financial Crisis find the interactions between the two policies to be insignificant (Aiyar *et al.*, 2014; Dell'Ariccia *et al.*, 2012). However, using a similar data range, De Marco *et al.* (2021) provide empirical evidence for small banks that monetary and macroprudential policies reinforce each other.

The results of Bruno *et al.* (2017) show that macroprudential policy tools have a causal impact on domestic credit and capital flows and find evidence that there are spillover effects between macroprudential and monetary policies. Moreover, their results from 12 Asia-Pacific economies suggest that macroprudential policy is most effective when it acts as complement to monetary policy.

Altavilla *et al.* (2020) examine the data from European credit registers to study whether used macroprudential policy tools influence the strength of the bank lending and risk-taking channels of the monetary policy. Their findings suggest that monetary and macroprudential policy work as complements, as the increase in the bank lending that follows monetary policy easing is greater if the macroprudential policy is more accommodative.

Gambacorta & Murcia (2020) perform a meta-analysis that evaluates the effectiveness of macroprudential policy and its interaction with monetary policy in Latin America using bank-loan data. The paper provides evidence that macroprudential tools have a significant effect on credit growth. Furthermore, their results show that monetary policy and macroprudential policies reinforce each other. The paper also evaluates the level of effectiveness of the macroprudential policy instruments over the business cycle; their results suggest that during an economic upturn, tightening of the macroprudential tools tends to have a larger effect on credit growth.

Using the data from Israel, Benchimol *et al.* (2021) find the interaction between macroprudential and monetary policy to be important; however, in their results, the interaction has an unclear effect on credit growth based on if the policies worked in the same direction or against each other.

Bussière *et al.* (2021) summarise the broad results of the project of International Banking Research Network, which, using the data from core and smaller advanced economies, examines macroprudential tools targeted at capital flows and the potential spillovers from monetary economies in core countries to recipient economies. The paper provides evidence that macroprudential tools in recipient countries may partly offset the spillover effects of monetary policies from the core countries. Remarkable is the considerably different impact of various macroprudential tools, which suggests the importance of deeply focused analysis on different types of prudential tools. One of the papers taking part in this project, Cao *et al.* (2021) argues for the importance of taking into account the foreign monetary policy when analyzing the data from a small open economy. On the other hand, Everett *et al.* (2021) find mixed evidence, where the foreign monetary policy has a significant effect on bank lending only in one of the two countries used in the analysis. Their results also suggest that macroprudential policies are able to mitigate monetary policy shocks but not in every case.

Thus, literature provides evidence that there are spillover effects of interaction between macroprudential and monetary policy. If the monetary policy works in the same direction as macroprudential policy, these spillovers tend to have a more significant effect on credit growth.

2.9 Impact of the spillovers on house prices

Literature on the effects of spillovers between policies on house prices is quite limited compared to the one on credit growth. Literature shows that both monetary and macroprudential policies have individual effects on housing prices. Leaning against the wind strategy of monetary policy is able to mitigate housing bubbles partly; however, the policy rate is a crude tool for mitigation, and it is costly in terms of unemployment and inflation (Ehrenbergerova *et al.*, 2021).

The spillover effect of macroprudential and monetary policy is studied by Jiang *et al.* (2019). Their results suggest that both monetary and macroprudential policies can control the rise in house prices. However, if both policies aim to regulate house prices, they may offset one another in the short run. Results of the DSGE model by Pan & Zhang (2020) find that the optimal combination of monetary and macroprudential policies may lead to stability of the real estate market.

In the existing literature, the debate if monetary policy reinforces the effects of macroprudential policy on house prices is still ongoing. Moreover, the studies do not evaluate if the effects of interactions between monetary and macroprudential policies differ in financial and business upturns and downturns.

Chapter 3

Data description and descriptive analysis

This chapter describes the data used in our analysis. Section 3.1 introduces the dependent and independent variables. This section includes an analysis of the developments of credit growth, house price growth, and monetary policy rate over our sample period. Section 3.2 provides a review of how the macroprudential instruments were used over time and across countries. This section is followed by descriptive statistics.

3.1 Variables

3.1.1 Dataset

In our analysis, we use quarterly data for 72 countries; this sample covers both emerging market (39) and advanced (33) economies from all over the world (for the list of countries, see Table A.3). Due to the data availability, 11 countries like Argentina, Jamaica or Nigeria are excluded from the house price analysis, meaning that the models for house price growth are based on a sample of 61 countries. The dataset is an unbalanced panel covering the period 1990-2019; this choice is influenced by the use of the integrated Macroprudential Policy Database (iMaPP), which covers data from 1990. As the end year, 2019 has been chosen in order to exclude the COVID-19 crisis period and the measures taken as a response to the crisis that may bias our results. The panel is unbalanced due to the insufficient data availability of the monetary policy rate, credit and house prices for some countries especially for the early years of the sample period. However, for the results of our analysis on the use and effectiveness of the macroprudential instruments, the missing data from the very beginning of the sample period are not expected to have any significant influence as the macroprudential instruments have been rarely used at that time (Figure 3.7).

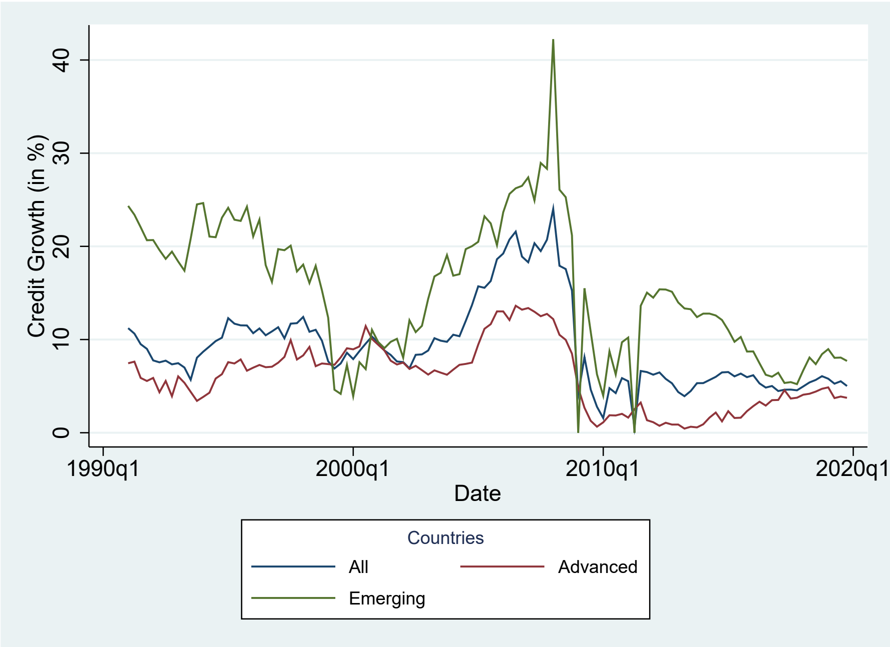
3.1.2 Dependent variables

Credit Growth

Following the existing literature, credit growth and house price growth are used in our analysis as the dependent variables. Both credit and house prices are intermediate targets of the macroprudential policy, as discussed in the previous chapter. The data for these dependent variables were obtained from various sources as especially for the emerging markets, the data are sometimes not provided in the worldwide databases.

Credit growth is defined in our model as the year-on-year percentage change of credit stock. Similarly to Cerutti *et al.* (2017), bank credit to a private sector and depository corporations' domestic claims on the private sector are used as credit data. Credit data for bank credit to private non-financial sector used in our analysis are collected from the Bank for International Settlements. Where these data were not available, we have added the data for depository corporations' domestic claims on the private sector from the IMF International Financial Statistics. Last but not least, some data were obtained directly from the central banks of the individual countries. The data are used in nominal terms; we include inflation as an independent variable in the model to account for this issue. The data are expressed in the domestic currency. Because some countries have dollarized financial sectors, with a large share of FX lenders, exchange rate effects might

Figure 3.1: Dynamics of Credit Growth

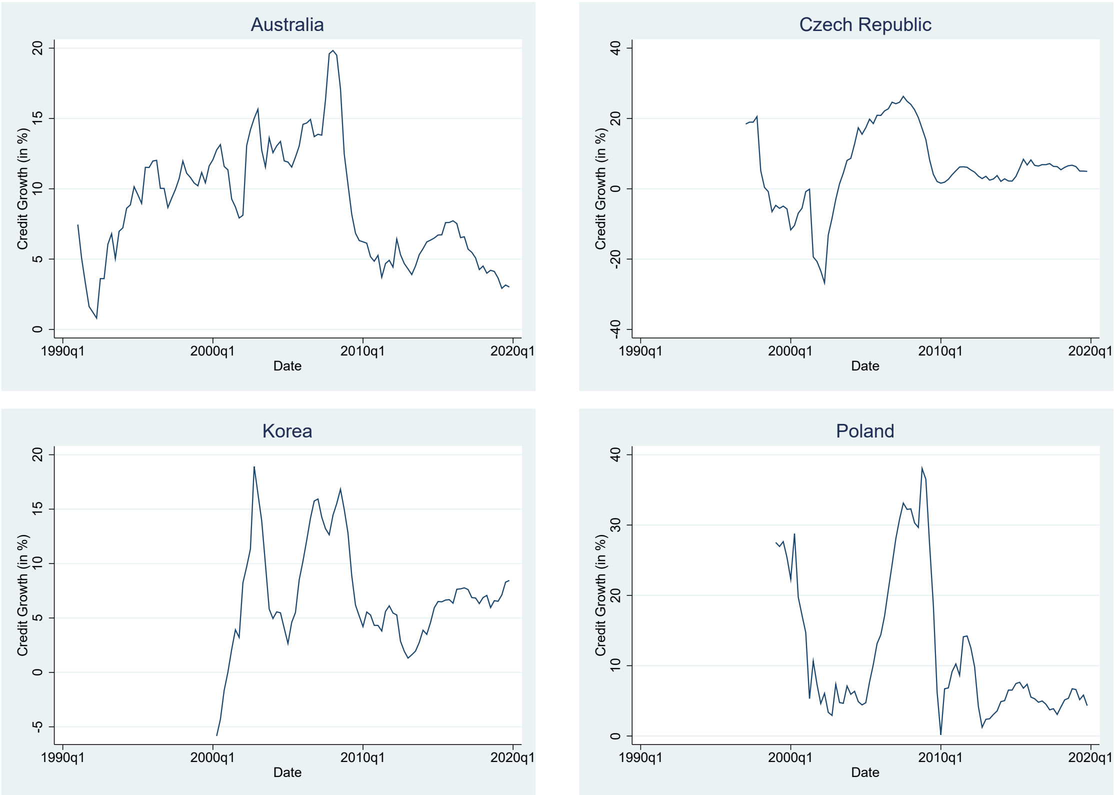


influence the credit stock developments. Thus, exchange rate is included among the explanatory variables to control for this.

The dynamics of credit growth is presented in Figure 3.1. The figure shows the median credit growth across countries and its development over the period 1990-2019. The median credit growth in advanced economies is lower than the median credit growth in emerging market economies during most of the time, in line with the expectations due to catching up and financial deepening, although a higher inflation and occasional exchange rate depreciation in emerging market economies may also play a role. Moreover, median credit growth in advanced markets is less volatile than in emerging markets. In advanced markets, a drop in credit growth is observed after 2000, this drop is capturing the effect of the Dot-com bubble. A strong credit growth is observed before the global financial crisis. After the fall connected to the global financial crisis, a recovery has followed. However, in the periods after the global financial crisis, the growth of credit in both advanced and emerging markets has a slower pace than in the 2000's.

To illustrate the concrete developments, Figure 3.2 shows credit growth

Figure 3.2: Dynamics of Credit Growth

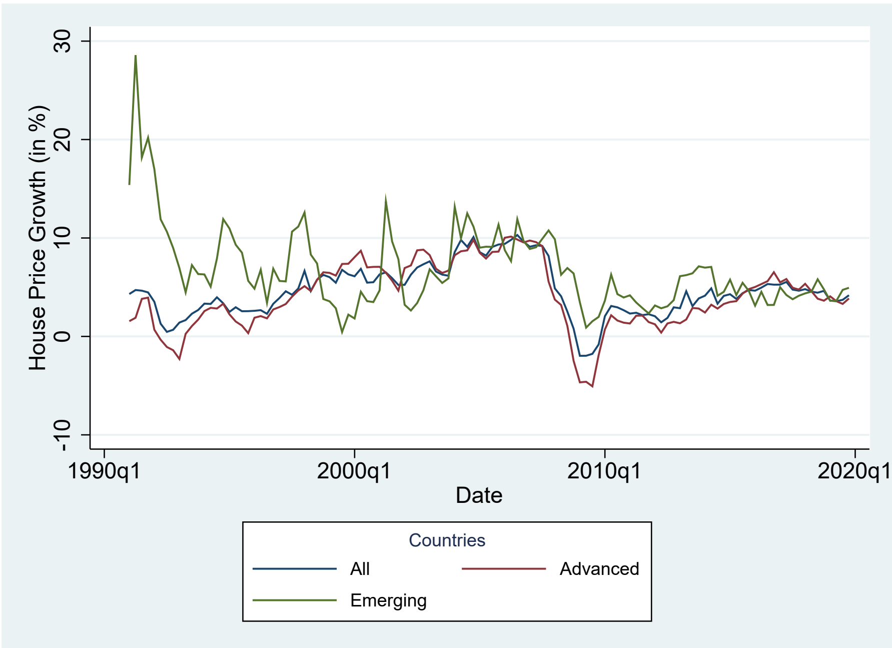


in four selected countries: Australia, Czech Republic, Korea, and Poland. In all of the selected countries, there was a drop in credit growth during and after the global financial crisis. In Australia, the credit growth within the whole sample period has a positive value with the strongest growth in 2008Q1. In the period 2008-2010, the pace of credit growth slowed down from about 20% to about 5%. In the data for Korea, the rise of credit is depicted after 2000, this increase follows recovery from the Asian crisis. Credit growth in Poland was strongest in 2009Q1. After 2010, credit growth in Poland had been moving around 6%. Credit growth development in the Czech Republic captures the consequences of currency crisis that has caused a drop in credit growth between 1997 and 2000.

House Price Growth

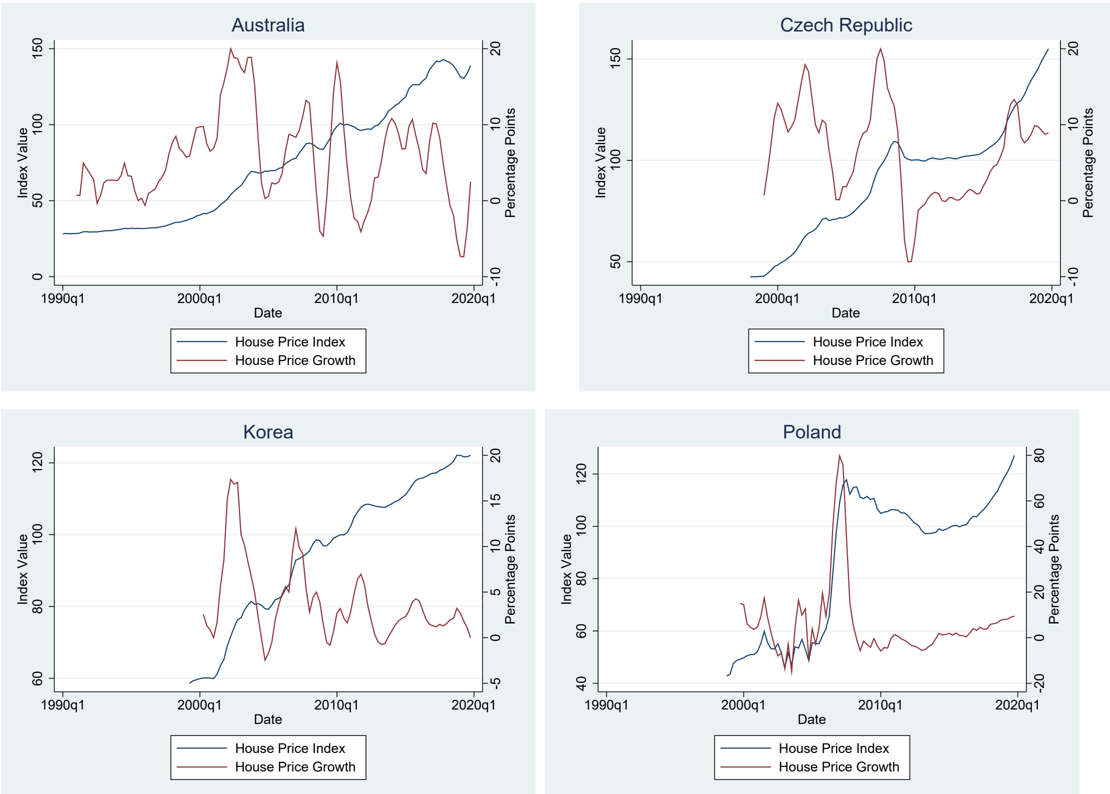
House price growth is defined as the year-on-year percentage change of the house price index. Part of the used data for house prices comes from the property price database of the Bank for International Settlements. The data for housing prices from the OECD are used as well. Again, additional missing data were obtained directly from the central banks of the individual countries. Similarly as for the credit growth, the model includes an inflation variable to account for the rise caused by the increase in the level of prices.

Figure 3.3: Dynamics of House Price Growth



The developments of house price indices during the period 1990 - 2019 are presented in Figure 3.3. Median house price growth in emerging markets at the beginning of the sample period is more volatile and significantly higher than in advanced economies, this may be caused by a bias of insufficient data availability for house prices in emerging market economies in 1990's and thus, the high median value is driven by the data from Asia. A sudden decrease of house price growth is captured in the figure starting in 2007Q3. This drop is connected to the global financial crisis. After the drop there was a recovery, however, median house price growth in nominal terms shows house price growth at a slower pace than before the global financial crisis. For comparison of the pace of growth, house price growth in real terms would be more appropriate. However, given that in our model nominal house price growth is used as the dependent variable and evaluation of the dynamics is out of scope of this thesis, only nominal terms are presented.

Figure 3.4: Dynamics of House Price Growth and Developments of House Price Index



Again, a closer analysis of the development of house price growth and house price index in a set of economies from our sample is based on Figure 3.4. In all selected countries, house prices were strongly growing before the global financial crisis and the growth slowed down afterwards. House price growth in Australia is quite volatile, reaching the peak of 20% in 2002Q2. In 2018 there was a fall in house prices, this cooling of the house price growth was a consequence of tighter macroprudential policy, to be more specific, tighter credit policies in

Australia. The dynamics of house price growth in Korea shows several drops, the most severe one in 2003 follows a growth caused by tax-breaks for construction in the period 1998 - 2003. The drop is caused by limiting the size of bank loans that the households could take. In 2006 the government reacted to the rise in house prices by tightening taxes on capital gains from properties for speculative purposes. Before the global financial crisis, Poland had one of the biggest booms in the housing sector in Europe. During the global financial crisis, the Polish Zloty depreciated and a lot of mortgages which were denominated in a foreign currency defaulted. In the Czech Republic, the rise of house prices in the early 2000's, caused by a loosened monetary policy, is followed by a slowdown in 2004 and a rise in 2006 caused by a higher demand for housing. From 2015 the recovery has been replaced by a rise of house prices. This trend is observed in other European countries as well.

3.1.3 Explanatory variables

The key variables of interest to estimate the effect of the macroprudential and monetary policy on credit and house prices are the index of use of macroprudential instruments, monetary policy rate, real GDP growth, inflation rate, change of exchange rate, and crisis dummy variable. The last four variables play a role of the control variables in the model.

Our data for the use of macroprudential policies are based on the integrated Macroprudential Policy Database (iMaPP) by Alam *et al.* (2019). The database captures the use of a macroprudential tool by a dummy variable that takes the value of +1 in the period when the tool is being tightened, -1 in the period when the tool is being loosened and 0 when there is no change in the use of the tool. The original database contains monthly data; this data have been aggregated into quarterly data by summing the values for the individual months. We aggregate this data into an index showing the use of instruments in the respective country and quarter. If the overall progress within the quarter was tightening, the quarterly value is -1, if it was loosening, the quarterly value is 1, otherwise, it is zero. As there is an assumption that the influence of the macroprudential measures is not immediate and may not have a constant lag within the whole sample, the variable

MacroPru is calculated as a sum of the calculated index over the previous four quarters. The database includes 17 various types of tools which are more in detail described in the Table A.5. This simplification by using the index rather than the type and specific value of the change is used due to the availability of the data for the multi-country analysis. In order to address some of the restrictions that this simplification causes, we have decided to include the analysis for the individual macroprudential policy instruments as well.

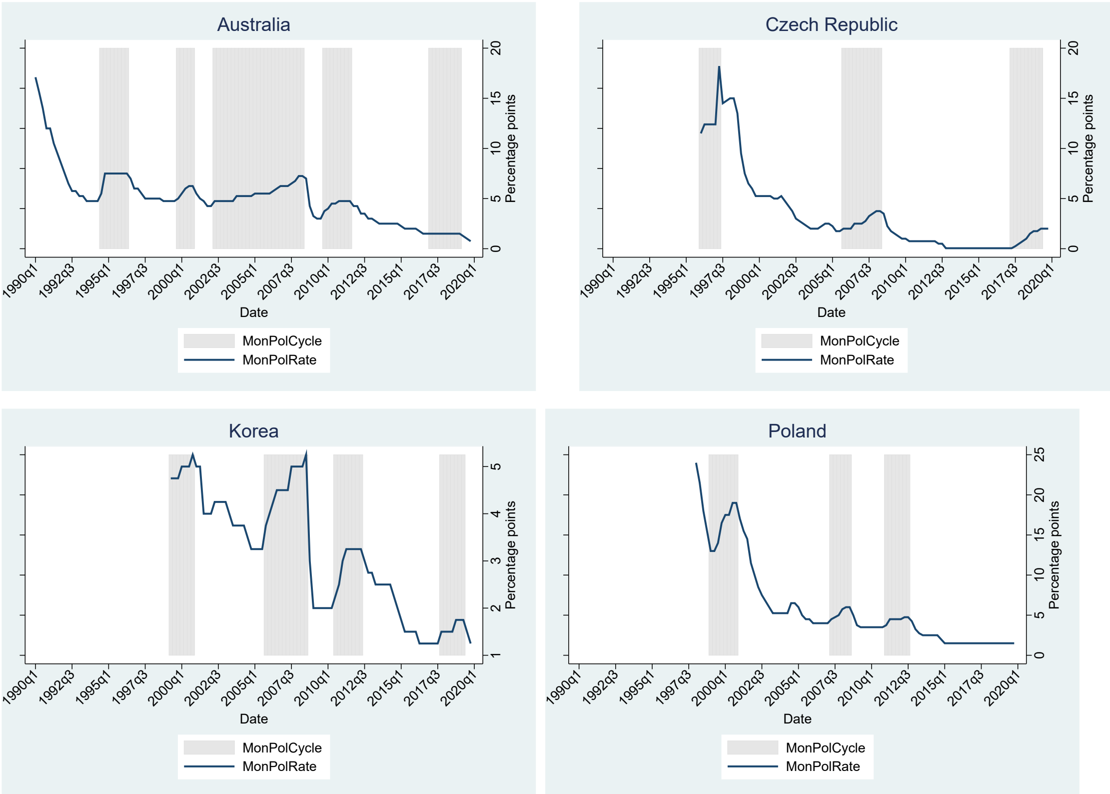
As a measure of the monetary policy rate, we use central banks policy rates obtained from the Bank for International settlements for most countries. The additional sources are listed in Table A.1.

In the post-global financial crisis period, the European Central Bank, the Federal Reserve, the Bank of England, and the Bank of Japan have lowered their policy interest rate to the effective lower bound and have used unconventional monetary policies to further stimulate the economy by lowering long-term policy rates. In this time period, the short-term policy rates of these central banks do not capture the stance of monetary policy. To account for this issue, we have decided to use estimates of the shadow rates by Krippner (2012) for countries of the euro area, Japan, the United Kingdom, and the United States. The shadow rate for the euro area is used only for the period when the countries were a part of the euro area; otherwise, monetary policy rate of their individual central bank is used. The development of the shadow rates is presented in Figure 3.6.

The peaks and throughs of the monetary policy cycle were identified using the Bry-Boschan algorithm (Bry & Boschan, 1971). The minimum length of the cycle has been set to 9 quarters, and the minimum length of the phase to 4 quarters. The monetary policy cycle variable takes a value of 1 in the phase of monetary policy tightening and takes a value of 0 in the phase of monetary policy easing. The cycles were visually checked and adjusted[1], so the upturns and downturns correspond to the state of monetary policy based on the country's monetary policy reports. For example, for the Czech Republic, we have to adjust the produced result

[1] e.g. For the euro area, the peaks in 2013 and 2016 were disregarded as the shadow rate is very volatile and this tightening lasts too short to be considered as a tightening phase

Figure 3.5: Monetary Policy Rate and Monetary Policy Cycle

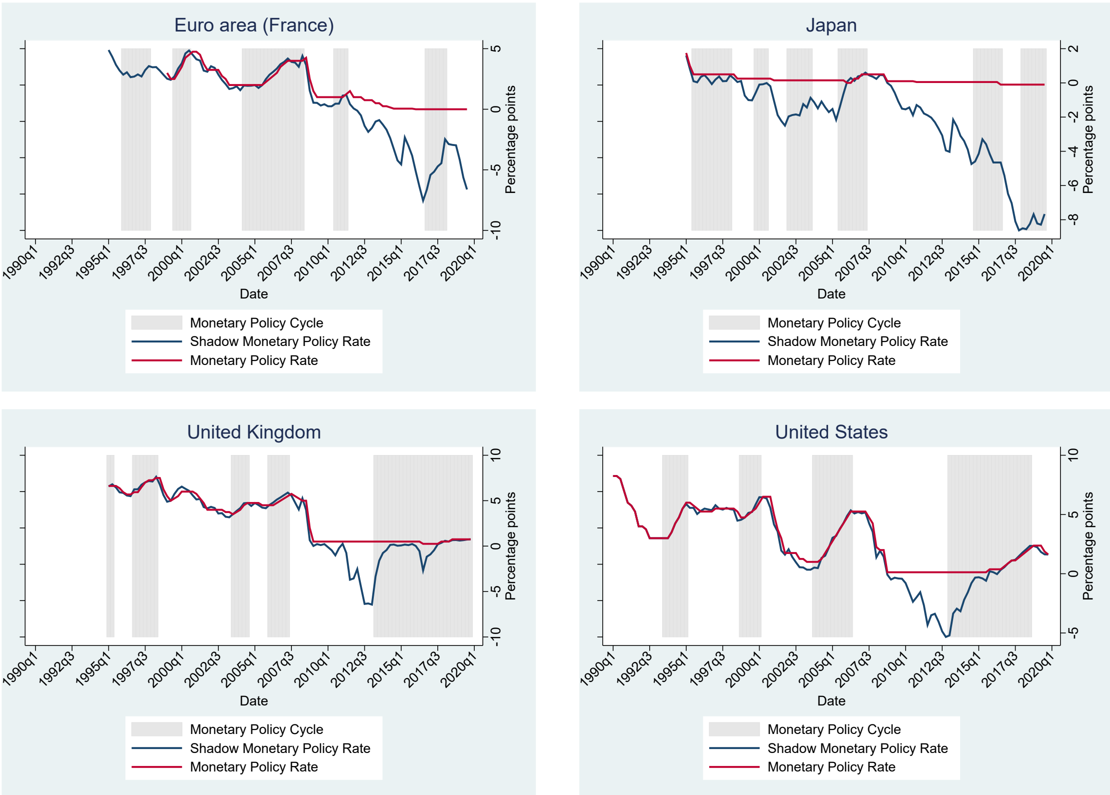


for the currency interventions that cannot be seen from the monetary policy rate directly. The calculated monetary policy cycles are presented in Figures B.3-B.13 in the Appendix. Variables of *long-term tightening* and *long-term loosening* are dummy variables taking the value of 1 if the monetary policy cycle has been tightening (loosening) in all of the previous four quarters. To evaluate the hypothesis if the monetary policy reinforces the effects of macroprudential policy, these variables are used to divide the sample into subsamples.

In Figure 3.5, the dynamics of monetary policy rate and monetary policy cycle in Australia, Czech Republic, Korea, and Poland are presented. The data for Australia show a long period of tightening monetary policy before the global financial crisis. The monetary policy eased after the global financial crisis as a reaction to the fallen Australian dollar exchange rate. Within our sample period, monetary policy of Korea was four times in a tightening phase. First tightening phase follows the recovery phase after the currency crisis in 1997, the second one we can observe before the global financial crisis, the third tightening period was a reaction to the growing recovered economy after the global financial crisis, and last but not least, the fourth rise of monetary policy rate aimed at slowing down the growth of the economy and inflation. Since 1999 the National Bank of Poland has been using inflation targeting to maintain price stability as the main objective. Within the sample period, three tightening phases are identified. The first one follows an introduction free-floating exchange rate of Zloty. The first tightening period of the monetary policy rate of the Czech National Bank (CNB) aimed at slowing down the incoming investments, however, the actions taken by the CNB were not successful in preventing crisis, and currency crisis followed in 1997. The second tightening phase was a reaction of the CNB to the growth of the economy. The last period of monetary policy tightening aimed to bring inflation near to the inflation target.

Figure 3.6 shows shadow monetary policy rates, nominal monetary policy rates and monetary policy cycles based on shadow monetary policy rates. In the shadow rate for the European Central Bank (ECB), a drop in 2014 captures the quantitative easing program of the ECB. Moreover, in 2014 the nominal monetary policy rate of the ECB has entered negative territory. The ECB initially aimed to close the Asset Purchasing Program is 2018, a tightening of shadow monetary policy rate is observed in this period. In 2019, the ECB has introduced a new series of long-term refinancing operations in order to preserve favourable bank lending conditions and smooth transmission of monetary policy into the economy. The Bank of Japan (BOJ) introduced zero interest rate policy in 1999. The loosening phase in 2001 represents quantitative easing in order to increase money supply. In 2013, the BOJ doubled the monetary base with another round of quantitative easing. The monetary policy rate of the BOJ entered negative territory in 2016. The Bank of England (BoE) introduced the first round of quantitative easing in 2009, other two rounds followed in 2010 and 2012. This loosening of monetary policy is captured by decline of shadow monetary policy rate in this period. In 2012, the BoE launched Funding for Lending Scheme program, that aimed to encourage financial institutions to boost their lending. The shadow monetary

Figure 3.6: Shadow Monetary Policy Rate, Monetary Policy Rate, and Monetary Policy Cycle



policy rate has returned to the values around zero in 2014. The drop in 2016 captures the expansion of the quantitative easing program of the BoE. The shadow rate for the United States reflects large-scale asset purchasing program of the Federal Reserve between 2008 and 2010. This loosening is followed by a phase of quantitative tightening in 2017-2019. The shadow rate has entered a positive territory in 2016.

In the set of control variables, real GDP growth is used in order to capture the growth of credit and house prices that is connected to the growth of the size of the economy. Year-on-year level of inflation is used in order to control for the rise of the nominal value of the dependent variable which would not be present in the real terms. Moreover, the year-on-year percentage change of the end of period value of exchange rate against the U.S. Dollar is used as a control variable. The variable controls for FX effect on stock of credit and house prices[2] respectively. For the United States, the exchange rate against Euro is included in the variable. The financial crisis dummy variable is taken from the database by Laeven & Valencia (2012) and captures the decline of the dependent variable connected to the financial downturn in the respective quarter.

An additional resource of capital in the economy are the foreign direct, portfolio, and other investments. Data for the ratios of foreign direct investment to GDP, portfolio investment to GDP, and other investment to GDP are taken as an average of the last four quarters. These averages are then divided by the average of the previous four quarters of the nominal GDP. The obtained variables are used as the instrumental variables in the models.

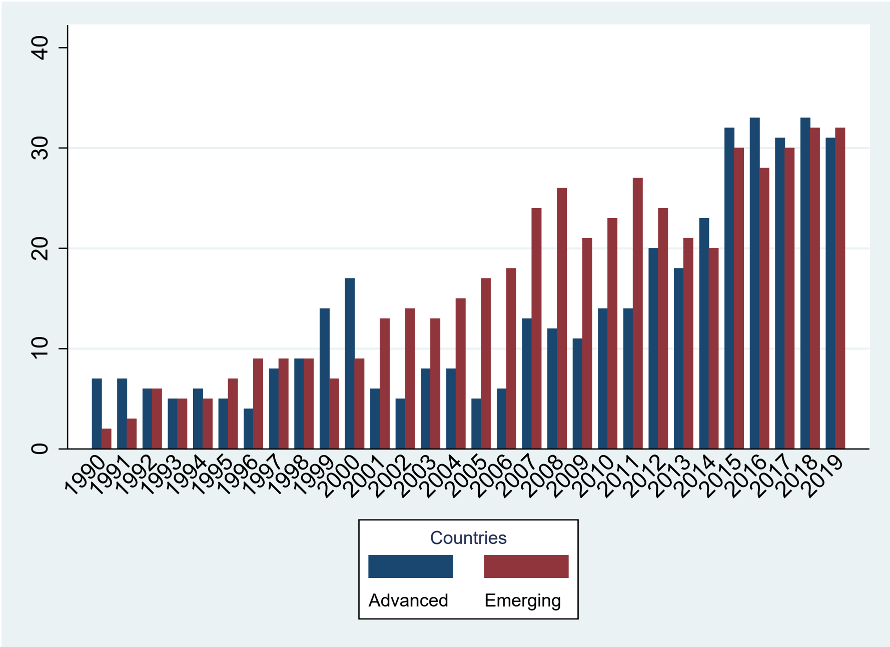
3.2 Use of Macroprudential Policy Instruments

Macroprudential instruments have been used by countries all over the world during the last three decades. Asian countries have started to apply macroprudential tools already before the Asian financial crisis in 1997-98. Figure 3.7 illustrates the boom of the use of macroprudential instruments especially by emerging markets in the 2000s. Only after the global financial crisis, advanced economies have started to introduce macroprudential policy at a higher intensity. For illustration, all 33 advanced economies in our dataset used at least one macroprudential instrument in the years 2016 and 2018. This trend captures the current stance of the central bankers and regulators on the usefulness of macroprudential policy in enhancing financial stability.

In Figure 3.8, the frequency of the use of the individual macroprudential policy instruments is presented. The figure captures the country-year use, therefore one unit means that the instruments have been used within a calendar year, not differentiating the loosening and tightening of the measure. Reserve requirements, liquidity measures, and capital requirements have been the most frequently used in the emerging market economies. The most frequently used mea-

[2] In some countries, especially emerging market countries, house prices are quoted in USD.

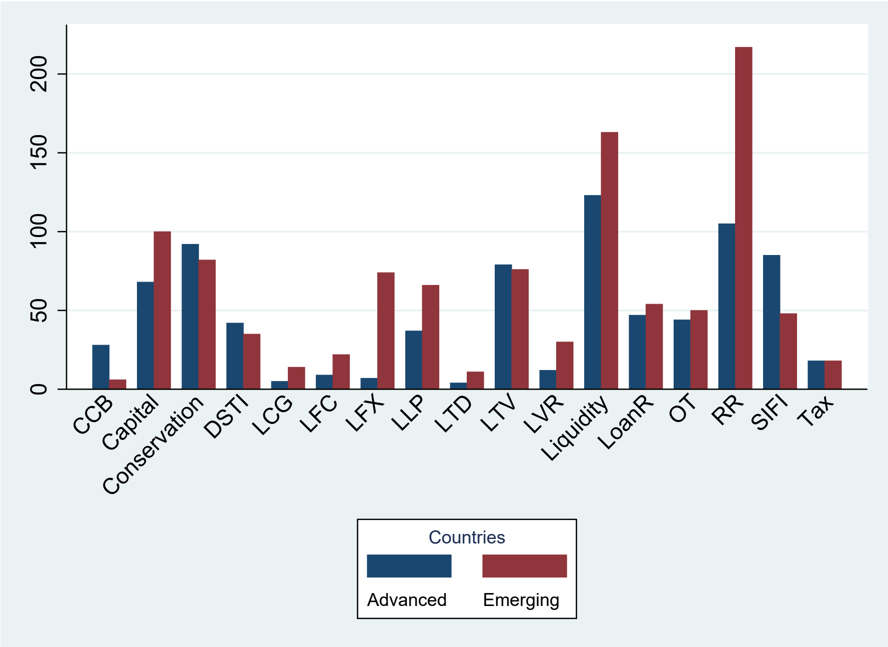
Figure 3.7: Number of countries using macroprudential policy tools



sures by the advanced markets are liquidity measures, reserve requirements, capital conservation buffer, and measures concerning the systematically important financial institutions. The limits on open foreign exchange positions (LFX) and loan loss provisions (LLP) have been mainly used by the emerging market economies. On the other hand, countercyclical capital buffer (CCB - abbreviation used by Alam *et al.* (2019)) and measures concerning the systematically important financial institutions (SIFI) have been mainly used by the advanced economies.

With the introduction of Basel III requirements, the structure of the measures frequently used has changed. In Figure B.1 is shown that after 2009, the most frequently used are liquidity measures, capital conservation buffer, other capital requirements, and measures concerning the systematically important financial institutions. In comparison with the previous Figure 3.8, there is a significant difference in frequency of use of the reserve requirements. Moreover, as the countercyclical buffer and liquidity requirements have been introduced with the Basel III, these instruments have been used recently and Figure B.1 shows a similar amount of appearance as 3.8. Overall, more types of macroprudential policy measures have

Figure 3.8: Frequency of use of individual macroprudential policy instruments

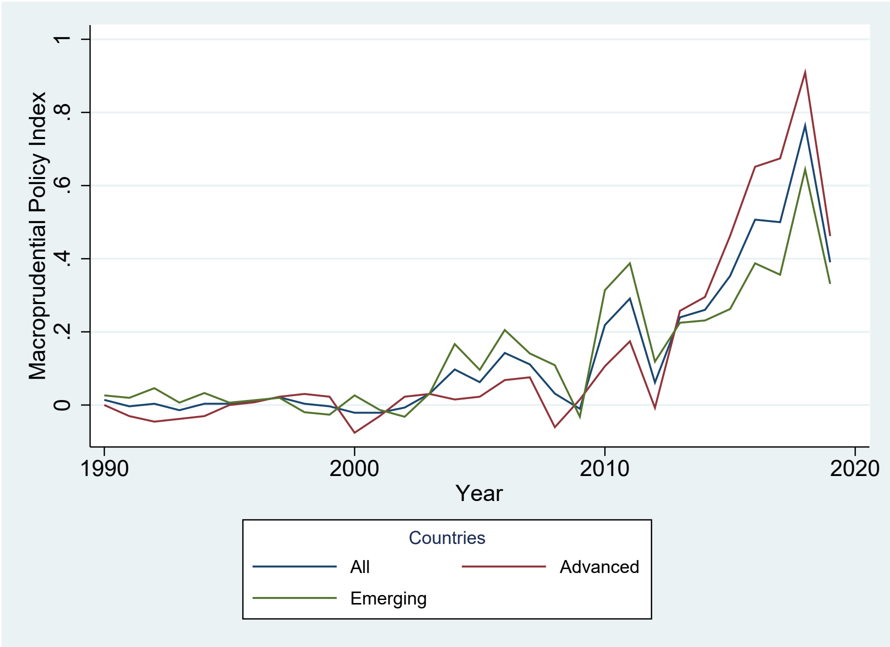


been implemented over time, especially after the global financial crisis.

Figure 3.9 captures the development of average macroprudential policy index over the period 1990 - 2019 in the dataset. To show the overall increasing trend of use of macroprudential policies, the presented values are averages of the respective years. In advanced countries, the average macroprudential policy index is negative at the beginning of our sample, capturing macroprudential policy loosening. The average macroprudential policy index in emerging market countries is most of the years higher than in advanced countries before 2013, when the average macroprudential policy index became higher in advanced markets than in emerging markets and remained higher for the rest of the sample period. The peak of the average is reached in 2018, a similar trend is observed in Figure 3.7.

Figure B.2 shows the development only of the tightening of macroprudential policy measures combined to an index. A similar dynamics of the index including both tightening and loosening measures is observed with a drop of the index in 2008 and 2009 connected to the global financial crisis. Moreover, a drop

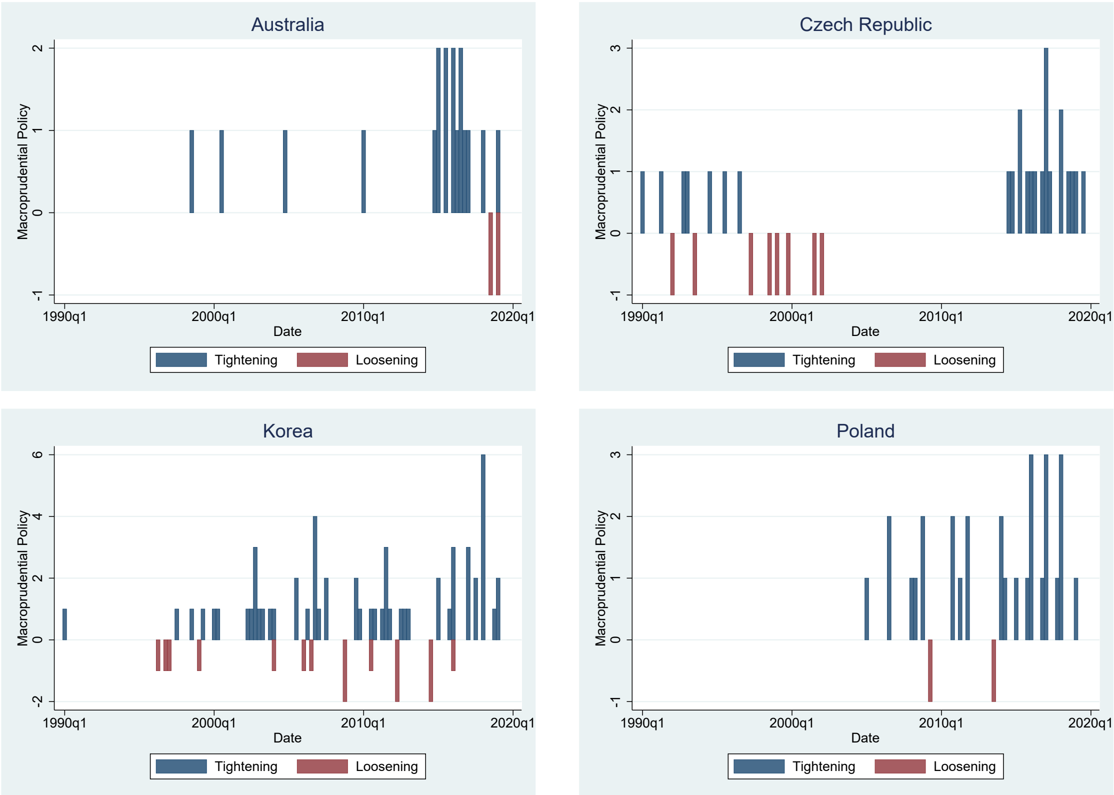
Figure 3.9: Development of Macroprudential Policy Index



of the index in advanced markets is shown in 2001, after the Dot-com bubble. The increased use of tightening of macroprudential instruments is observed since 2012.

Figure 3.10 shows tightening and loosening of macroprudential policy tools in four selected countries. In this figure, tightening of a type of prudential instrument in a respective quarter is depicted as +1. On the other hand, loosening of a prudential tool is shown as -1. In Australia and Poland, within the period 1990-2019, there was significantly more tightening of macroprudential policy instruments than loosening. In Poland, we can observe that first tightening of an instrument is used in 2005. In Australia, macroprudential policy tools are more frequently used since 2014. In the Czech Republic, there was a lot of tightening and loosening in the 1990s and early 2000s. The tool used in that time were reserve requirements. Similarly to other selected countries, we can observe a higher frequency of tightening since 2014. Compared to other selected countries in this figure, Korea is the country where macroprudential policy tools were the most frequently tightened and loosened.

Figure 3.10: Use of Macroprudential Policy Tools



3.3 Descriptive statistics

In this section, the descriptive statistics of the main variables engaged in the models is presented.

Table 3.1 presents the descriptive statistics for the main regression variables. A large variation is in the dependent variable of credit growth as it ranges from -59.9% to 363.8%, with a standard deviation of 15.8% and a mean of 11.3%. The other dependent variable, the HPI growth, is less volatile with the range from -42.3% to 84.9%, with a standard deviation of 9.9% and a mean value of 6.0%. Not surprisingly, the exchange rate is the most volatile from the independent variables, with a standard deviation of 18.6%. The table shows the variation in the overall index of macroprudential policies and the individual macroprudential policies. The macroprudential policy index ranges from -8 to 12 with a mean of 0.76

Table 3.1: Summary Statistics

Variable	Mean	Median	Min	Max	Standard deviation
Credit Growth	11.343	7.768	-59.892	363.836	15.773
HPI Growth	6.029	4.825	-42.262	84.902	9.911
Δ Mon.Pol.Rate	-.3621	0	-75.830	49.790	3.358
GDP Growth	3.633	3.253	-37.972	73.526	5.320
Δ Ex. Rate	2.931	.646	-55.268	508.163	18.648
Inflation Rate	4.256	2.671	-6.128	132.512	6.133
MacroPru	.755	0	-8	12	1.661
CCB	.0167	0	-1	2	.159
Conservation	.107	0	-1	2	.323
Capital	.087	0	-2	3	.380
LVR	.026	0	-1	1	.160
LLP	.051	0	-2	3	.271
LCG	.003	0	-3	2	.133
LoanR	.055	0	-2	3	.279
LFC	.015	0	-1	2	.143
LTV	.050	0	-3	4	.349
DSTI	.037	0	-2	3	.240
Tax	.020	0	-2	3	.190
Liquidity	.151	0	-2	4	.477
LTD	-.001	0	-1	1	.094
LFX	.025	0	-3	3	.227
RR	-.018	0	-4	4	.643
SIFI	.085	0	-1	3	.293
OT	.048	0	-1	2	.250

and a standard deviation of 1.7. For the individual instruments, there holds that reserve requirements (RR) and limits on loan-to-deposit (LTD) have both a negative mean value, meaning that the mean suggests more frequent loosening than tightening periods of these measures. The most volatile indices out of the measures taken are reserve requirements (RR), measures to mitigate systemic liquidity and funding risks (Liquidity), and capital requirements (Capital).

The analysis is also done for subsamples of the original sample, separately for advanced and emerging market economies or for tightening and loosening phase of the monetary policy cycle. To assess if the use of macroprudential tools differ in the particular situations, the summary statistics of the $MacroPru$ variable is shown in the table A.7 in the appendix. In the sample of all countries, the average of the $MacroPru$ variable is higher in the subsample when the monetary policy cycle was in the phase of tightening than when it was in the phase of loosening. This statement also holds for the long-term phases, meaning the phase has been lasting for the previous four periods. On the other hand, the maximum value of the $MacroPru$ is included in the loosening part of the monetary policy cycle, meaning that there is a situation in our sample, when the loosening monetary policy goes against the tightening of macroprudential policy. A comparison between the advanced and emerging markets is provided as well. The average of $MacroPru$ variable is higher in the emerging market economies; this corresponds to the observation mentioned in the next section that historically, the macroprudential measures have been mainly used by the emerging market economies. The difference between the average of the $MacroPru$ variable in the emerging and advanced markets is approximately 0.1. A closer look at the advanced countries suggests that the macroprudential policy index over the previous four quarters is, on average, higher during the tightening phase of the monetary policy cycle, similarly to the whole sample. The difference in the average of the $MacroPru$ variable is the most distinctive in the emerging market economies, where the average in the tightening periods is higher than one, and the average in the loosening periods is on average 0.6.

Chapter 4

Methodology

This Chapter describes the model and the estimation methods. Section 4.1 specifies the model structure used in our analysis. Section 4.2 explains the reasons behind the choice of the estimation method. In Section 4.3, the results of the tests applied are commented. Last but not least, Section 4.4 includes the hypotheses that are tested in our analysis.

4.1 Model

In the analysis, we start with the estimation of the effects of the macroprudential policies on house prices and credit growth without the restriction of whether the monetary policy is tightening or loosening. The baseline empirical specification is of the following form:

$$Y_{i,t} = Y_{i,t-1} + \beta_1 \times MacroPru_{i,t-1} + \beta_2 \times \Delta MonPol_{i,t-1} + \beta_3 \times GDPGrowth_{i,t-1} +$$

$$+\beta_4 \times InflationRate_{i,t-1} + \beta_5 \times \Delta ExchangeRate_{i,t} + \beta_6 \times Crisis_{i,t} + \alpha_{i,t} + \epsilon_{i,t}$$

where i denotes countries and t denotes time. Y stands in the equation for the dependent variable, credit growth or house price index growth. In the equation, the value from the previous quarter is included to capture the trend from the previous period. $MacroPru$ is the variable for the vector of the aggregate index MPI as the sum of the previous four quarters, thus, the use of the macroprudential instruments over the previous four quarters. We cannot expect an immediate effect of the macroprudential measures on the dependent variables and the duration of the lag to be stable over the whole sample period. The decision was made to capture the effects of the macroprudential measures effectively. $\Delta MonPol$ represents the year-on-year difference of monetary policy rate in the respective country. This variable captures the effect applied within the last four quarters of the monetary policy on the dependent variable. As the growth of the dependent variable is connected to the development of the economy, the growth of the GDP is used to explain the influence of economic development. $GDPGrowth$ stands for the year-on-year percentage growth of the real Gross Domestic Product. $InflationRate$ represents the year-on-year rate of inflation in the respective country. As the dependent variable is expressed in the nominal terms, the inflation term is used in the equation to account for the effect of the change in the price level. $\Delta ExchangeRate$ stands for the year-on-year percentage change in the exchange rate of the domestic currency against the U.S. Dollar. Treatment of these data for the United States has been already discussed in the previous chapter. This variable is used to explain both the economic effect where depreciation of a currency is typical for downturns and the "mechanical" effect of the repricing of the loans taken in foreign currency that are reported in the domestic currency. $Crisis$ represents the effect of the business downturns on the development of the dependent variable as the business downturns usually lead to the slowdown or even negative growth of credit and house prices. The $Crisis$ variable is in the equation applied in real time and not with a lag, as the slowdown in the growth of the dependent variable is usually simultaneous with the crisis. α contains the country-fixed effects and ϵ is the error term.

To investigate if the monetary policy reinforces the effects of macroprudential policy, the following approach has been applied. The equation is further estimated for two subsamples, based on the value of the $MonPolCycle$ variable in the previous period, i.e. if the monetary policy was in the previous period in the phase of tightening or loosening. As the monetary policy cycles are quite long and do not change on a quarterly basis, there is a consistency in the phase of the monetary policy. Thus, for example, if the monetary policy cycle was in the previous quarter in the phase of tightening, there is quite a large probability that the previous quarter the monetary policy had also been tightening. If the monetary policy reinforces the effects of the macroprudential policy, the effects of the macroprudential measures should be larger in the phase of the monetary policy tightening. Moreover, the equations have been also estimated for the periods of the "long-term tightening" and "long-term loosening." Thus, these samples include only the quarters for which holds that the monetary policy has been tightening (loosening) for all four previous quarters. This division of the sample is used to further evaluate if the effects of the macroprudential policy are more efficient because of the state of the monetary policy. As the results may be different for the advanced and emerging market economies, the estimation is also done separately for the advanced and emerging market economies.

As not all the types of macroprudential measures are taken with the aim to slow down the growth of the house prices and credit and the macroprudential measures taken are represented by the index as a sum of the types of measures used, this might not capture the effectiveness of the measures on the growth of the dependent variables. Thus, the estimation is also done for the individual types of macroprudential policy instruments. In the equation, the variable $MacroPru$ is substituted by the index of use of the individual type of instrument that is obtained by a similar method as the original $MacroPru$ variable. Thus, the variable is a sum of the indexes of the previous four quarters.

4.2 Methods used

The equation could be estimated with the OLS and the country fixed effects, however this approach may lead to a biased result as both the lagged dependent variable and fixed effects variable will be simultaneously present in the equation. Further, the equation could be estimated with instrumentals variable regression. In a case, when heteroskedasticity is present, the GMM estimator is more efficient than the simple instrumentals variable estimator (Baum *et al.*, 2003). The long time series would seem to suggest that appropriate modelling strategy would be to analyse each country separately (Greene, 2012). However, this approach would neglect the hypothesized commonalities across countries in our sample. Another approach we could have used is to modify quarterly data to yearly data, in this approach a lot of the dynamics in the data would be lost and the effects of macroprudential policy on the dependent variables could be unobservable. Thus, despite the fact that the GMM estimator is designed for small T, large N data, we have decided to estimate our model by two-step GMM; this approach should alleviate the endogeneity and mitigate the concerns about endogeneity between house price growth, credit growth, and macroprudential policy tools use. As the central bank usually implements macroprudential policy instruments in a reaction to the development of the credit and house prices, the coefficient of the macroprudential tools may be an observation of the reverse causality (Poghosyan, 2020). Therefore, we include in the equation the macroprudential measures in lags. The reverse causality may lead to an upward bias in the estimated coefficient. As the tighter macroprudential policy may be used in periods of increasing credit, this would create a positive correlation between the residual and the macroprudential tool. Thus, in the existing literature, the estimated coefficients have been interpreted as a lower bound, i.e. if the estimated coefficient is significant and has the right sign, the conclusion is that macroprudential instruments are effective. On the other hand, the assessment of the insignificant or wrong sign is uncertain as this can be a result of the upward bias. Moreover, there have been some cases, when a central bank has tightened the policy tools when some concerns about financial stability began to appear and the credit growth has slowed down in the same period because of weaker bank demand and supply constraints.

In the analysis, we have applied the GMM estimation method as it is an appropriate method for the panel data model with unobserved unit-specific heterogeneity and endogenous variables; these two aspects are both fulfilled in our model. Under the assumption of serially uncorrelated idiosyncratic errors, the Ahn & Schmidt (1995) estimator allows to combine the traditional linear moment conditions with the nonlinear moment conditions to increase the efficiency of the estimates. This approach uses a smaller set of moment conditions without loosing asymptotic efficiency. As it is possible for the system GMM estimator to be written as the level GMM estimator, this approach has been taken in the estimation (Arellano & Bover, 1995). To minimize the GMM criterion function, the Gauss-Newton technique is used. Ahn & Schmidt (1999) have shown that the GMM estimator takes the form of an instrumental variable estimator, if there holds the assumption of no conditional heteroskedasticity. The efficiency of standard errors can be often established showing that the moment conditions that are not utilized by these estimators are redundant under this assumption. They also conclude that this assumption necessarily fails in the case when the full set of moment conditions for the dynamic panel model data is used. The need to find modified version of the GMM that reduces set of moment conditions and lead to reasonable finite sample properties has been addressed by Windmeijer (2005). The two-step estimation with the Windmeijer (2005) finite-sample correction for panel-robust standard errors is applied. According to Roodman (2009), general standard errors without Windmeijer (2005) correction are downward biased and the one-step estimation that was used by researches before had asymptotically inefficient standard errors.

Two types of the GMM estimation method were considered, difference GMM and system GMM. Difference GMM uses the first-difference transformation in order to eliminate the unobserved fixed effect. By this transformation, the gap in unbalanced data (which we have) is magnified. System GMM is based on orthogonal deviations. This transformation subtracts the average of all future observations for each variable. This kind of transformation allows us to use lag of explanatory variables as instruments. The lag does not enter the transformation in System GMM. Thus, we have decided to use System GMM in our model estimation. In our model, 6 lags of dependent, independent variables, and capital flows data described in the previous chapter are added as the instrumental variables.

4.3 Tests

Several tests are performed to evaluate the specification of the model and choice of instrumental variables. The model was at first estimated by the pooled OLS and fixed effects, however the Breusch-Pagan and modified Wald tests showed that there is heteroskedasticity in the models (for results of the models see Table

A.4). Moreover, the Woolfridge and Pesaran test suggested a serial correlation in the models. As the existing literature discusses the appropriateness of use of GMM model, this analysis follows the existing literature by applying GMM method.

First, Arellano and Bond tests for absence of higher-order serial correlation are applied. The null hypothesis assumes that there does not exist autocorrelation. In contrast, the alternative hypothesis assumes there is an autocorrelation. The results indicate for our models that the null hypothesis cannot be rejected, thus, there is no higher-order serial correlation.

Secondly, Sargan-Hansen test for the validity of the overidentifying restrictions is done. Sargan test is appropriate only for a difference GMM estimator under the hypothesis of homoskedacity and no serial correlation. Validity of our instruments is tested with Hansen J statistics. One should be aware of the results as Hansen test may be weakened with a high number of instruments. The null hypothesis states that the overidentification restrictions are valid. Thus, the null hypothesis of the test implies that all instruments are valid as they are uncorrelated with the error term. The p-value vary across the different models, however, the null hypothesis cannot be rejected for all our models.

4.4 Hypotheses

Using cross-country quarterly data on macroprudential policy instruments, monetary policy rates, and other economic indicators, the following hypotheses will be tested:

1. **Hypothesis 1:** Monetary policy reinforces the effects of macroprudential policy.

2. **Hypothesis 2:** The effects of the macroprudential policies in emerging market economies are larger than in advanced economies.

3. **Hypothesis 3:** The effects of macroprudential policies differ for individual macroprudential instruments.

Chapter 5

Results

In this chapter, the proposed models are estimated and interpreted in terms of results, proposed hypothesis, and compared to existing literature. The chapter is structured in a following pattern: Section 5.1 and 5.2 cover the effects of the index of all macroprudential policies on credit and house price growth. Further, the Section 5.3 provides these results separately for advanced markets and Section 5.4 comments the estimation for emerging markets. Section 5.5 shows the effects of individual types of macroprudential policies on credit and house price growth for the full sample and advanced and emerging market economies separately. In Section 5.6, the models are reestimated with a different specification to test for their robustness and sensitivity. Finally, Section 5.7 evaluates the hypotheses.

5.1 Credit Growth

The estimation starts with credit growth as it is the dependent variable that appears more often in the existing literature. Table 5.1 presents the regression results based on the sample of all countries. The first column shows the model based on the whole sample of countries. The second and third column are results for the subsamples, where the original sample is split into two subsamples based on if the monetary policy in the previous quarter was in the phase of loosening or tightening. The fourth and fifth column show the results for the subsamples, when the monetary policy is in the long-term tightening and loosening, meaning that the monetary policy has been in the phase of tightening (loosening) all four previous quarters. The same pattern of presenting the results appears within the whole thesis.

The macroprudential policy has a significant negative effect on the credit growth, if we do not distinguish if the monetary policy is tightening or loosening. The index has a positive value if macroprudential measures are tightening and grows with the number of macroprudential policy tools currently used. Thus, the results are in line with the theoretical expectations that tightening of the macroprudential policies slows down the growth of credit. These results correspond to the results of the existing literature (Araujo *et al.*, 2020; Cerutti *et al.*, 2017; Poghosyan, 2020; Pochea & Niţoi, 2021; Dassatti Camors *et al.*, 2019; Gambacorta & Murcia, 2020). The existing literature is sometimes focused only on the tightening measures and shows stronger effects for tightening than loosening (Araujo *et al.*, 2020), our analysis includes both tightening and loosening measures in the index with opposite signs and the macroprudential policy still seems to have an expected effect and is significant. The growth of the real GDP supports the growth of credit, on the other hand, the crisis dummy variable has a negative effect on the credit growth. The difference in the monetary policy rate has a negative effect on the credit growth, meaning if the monetary policy rate has increased, it has a negative effect on the credit growth and the other way around, if the monetary policy rate has decreased, it has a positive effect on the credit growth. The difference in the exchange rate has a positive significant effect. The significance of the credit growth from the previous quarter suggests that the trend in the growth is persistent.

If the monetary policy cycle was the previous quarter in the phase of tightening, the effect of the macroprudential policies is significant and in the absolute terms stronger than in the whole sample. The difference in the monetary policy rate is significant as well, helping the macroprudential policy further reducing the credit growth. The effect of the macroprudential policy is insignificant if the monetary policy was in the phase of loosening the previous period. As the monetary policy cycle is quite persistent with the cycle in the previous periods,

Table 5.1: Estimation of the model for credit growth for the full sample of 72 countries

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.962***	0.932***	0.982***	0.930***	0.919***
	(47.68)	(38.02)	(36.51)	(29.38)	(27.29)
L.MacroPru	-0.108*	-0.154*	-0.083	-0.186*	-0.186*
	(-2.18)	(-2.57)	(-1.20)	(-2.17)	(-2.24)
L.GDPGrowth	0.111**	0.091	0.116***	0.074	0.130***
	(3.21)	(1.55)	(4.96)	(1.05)	(5.07)
L.InflationRate	-0.067	-0.009	-0.104	0.013	0.096
	(-1.20)	(-0.15)	(-1.05)	(0.23)	(1.26)
L.MonPolRate	-0.210***	-0.272**	-0.217*	-0.242***	-0.123
	(-3.32)	(-3.00)	(-2.22)	(-4.51)	(-1.46)
Exrate	0.042*	0.033*	0.018	0.002	-0.0001
	(2.56)	(2.49)	(0.56)	(0.04)	(-0.00)
Crisis	-1.918***	-1.365	-1.765***	-2.510*	-1.473**
	(-4.02)	(-1.68)	(-4.24)	(-2.12)	(-2.81)
Constant	0.234	0.755***	0.006	0.913**	0.225
	(1.89)	(3.73)	(0.05)	(2.85)	(1.38)
Observations	5583	2604	2979	1929	2232
J test	0.227	0.403	0.317	0.350	0.272
AR(2)	0.093	0.102	0.137	0.155	0.215

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

these results suggest that the monetary policy reinforces the effects of macroprudential policy on credit growth. This statement is further supported by the results of model estimated for the periods when the monetary policy is in the phase of tightening for the previous four quarters. Although the estimated effect is similar to the one for the long-term loosening, as the average of the $MacroPru$ variable is higher for the periods of tightening, the effect is stronger in the periods of tightening. Moreover, the increased monetary policy rate significantly helps to reduce the credit growth. These results can be further interpreted as that the monetary policy and macroprudential policy act as complements, this conclusion is in accordance with the existing literature (Bruno *et al.*, 2017; Altavilla *et al.*, 2020; Gambacorta & Murcia, 2020). Overall, the explanatory variables have expected signs and their significance differs based on the subsample. The inflation rate does not have a significant effect on the credit growth in any of the five estimated models.

5.2 Growth of House Prices

Beside the growth of credit, the macroprudential policy aims on the growth in the housing sector. The existing literature is somewhat inconclusive if the macroprudential policy has a significant effect on the house prices. Table 5.2 presents the results of the estimation for the whole sample of 61 countries.

The results for the whole sample show an insignificant effect of the combination of macroprudential policy instruments on house prices. This result is in line with the research of Cerutti *et al.* (2017) and Araujo *et al.* (2020). Poghosyan (2020) shows by the impulse response analysis a significant effect of the macroprudential policy on the housing prices after 3 years, which is a range out of our estimated effect. The real GDP Growth has a positive effect on house prices. The sign is positive, as expected, meaning that the growth of the economy leads to a rise in house prices. The inflation rate has a negative effect on house price growth. The crisis dummy variable has a negative effect on house price growth, suggesting that the growth is smaller in the times of financial crisis. The previous value of house price growth is significant, showing that the growth is highly persistent.

The macroprudential policy has a significant negative effect on house price growth if the monetary policy is tightening, this result is robust for the specification of the short-term and long-term tightening. These results support the hypothesis that the monetary policy reinforces the effects of macroprudential policy not only

Table 5.2: Estimation of the model for house price growth for the full sample of 61 countries

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.898***	0.916***	0.875***	0.935***	0.871***
	(74.32)	(35.07)	(33.94)	(37.94)	(32.12)
L.MacroPru	-0.070	-0.122**	-0.002	-0.107*	-0.053
	(-1.49)	(-2.59)	(-0.05)	(-2.00)	(-0.87)
L.GDPGrowth	0.079**	0.094	0.086*	0.131**	0.089*
	(3.14)	(1.89)	(2.42)	(2.95)	(2.26)
L.InflationRate	-0.107**	-0.087*	-0.071*	-0.125**	-0.058
	(-2.84)	(-1.97)	(-2.15)	(-2.72)	(-1.81)
L.MonPolRate	-0.081	0.079	-0.222**	0.104	-0.182*
	(-1.32)	(0.57)	(-2.99)	(0.68)	(-2.19)
Exrate	0.020	0.063	-0.029	0.063	-0.021
	(0.54)	(1.57)	(-1.82)	(1.73)	(-1.18)
crisis	-1.014***	-1.626**	-1.055*	-2.384**	-0.568
	(-3.59)	(-2.96)	(-2.05)	(-2.60)	(-1.13)
Constant	0.721***	0.403	0.621***	0.154	0.653**
	(5.37)	(1.68)	(4.14)	(0.67)	(3.22)
Observations	4512	2004	2508	1429	1882
J test	0.138	0.269	0.203	0.197	0.225
AR(2)	0.352	0.870	0.348	0.880	0.930

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

on credit growth but on house price growth as well. The effect of the macroprudential policy is insignificant in times of monetary policy loosening. Moreover, the decrease of monetary policy rate in the times of monetary policy loosening causes a further increase in the house prices.

5.3 Advanced Economies

Chapter 3 discusses the difference between advanced and emerging markets in using macroprudential policy tools. To evaluate if there is a diversity in effectiveness of macroprudential measures, the model is estimated for advanced and emerging markets individually.

Table 5.3 shows the relationship between macroprudential policy tools and credit growth in advanced economies. In the full sample, the tightening of macroprudential policy has a negative significant effect on the credit growth. The effect is significant for the periods, where in the previous period, the monetary policy cycle was both in the phase of loosening and tightening. If the monetary policy was in the phase of tightening, the effect is stronger than in the phase of loosening. This is in line with the estimations for the full sample covering both advanced and emerging markets. In the estimation for periods where in all of the previous four quarters the monetary policy was in one phase, the effect is significant only for the periods of loosening. This may be a consequence of too restrictive cut of the sample. Moreover, the effect of change in the monetary policy rate has not significant effect on credit growth in the advanced economies. The credit growth from the previous quarter has a significant effect capturing the persistence in credit growth.

Table 5.4 presents results of model estimation for effects of macroprudential policy on house prices in advanced economies. The effect of macroprudential policy instruments is significantly negative in the full sample that does not distinguish between the phase of the monetary policy cycle. The effect is even stronger for the phases of monetary policy tightening. The effects of macroprudential policy are insignificant in the phases when monetary policy is loosening. These results are in line with the estimated effects for all countries. From the control variables, real GDP growth has a positive effect on house prices, on the other hand, the effect of crisis is negative.

Table 5.3: Estimation of the model for credit growth for the sample of advanced markets

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.905***	0.879***	0.926***	0.864***	0.927***
	(33.91)	(18.69)	(63.84)	(12.46)	(46.05)
L.MacroPru	-0.219**	-0.202*	-0.135**	-0.225	-0.162**
	(-2.98)	(-1.98)	(-3.06)	(-1.54)	(-2.58)
L.GDPGrowth	0.086	0.132	0.073	0.159	0.094*
	(1.20)	(1.33)	(1.94)	(0.98)	(2.55)
L.InflationRate	-0.014	0.201	-0.195**	0.264	-0.126
	(-0.13)	(0.85)	(-3.02)	(0.68)	(-1.92)
L.MonPolRate	0.007	0.030	-0.009	0.016	-0.063
	(0.15)	(0.28)	(-0.15)	(0.09)	(-0.83)
Exrate	0.014	0.063	-0.019	0.090*	-0.028
	(0.68)	(1.91)	(-1.64)	(2.25)	(-1.50)
crisis	-3.502*	-4.979	-2.033***	-6.586	-1.708*
	(-2.10)	(-1.45)	(-4.70)	(-1.28)	(-2.45)
Constant	0.883**	0.750	0.732***	0.818	0.547***
	(3.05)	(1.79)	(4.38)	(1.83)	(3.32)
Observations	2847	1273	1574	927	1183
J test	0.998	0.993	0.999	0.995	0.998
AR(2)	0.444	0.145	0.529	0.590	0.731

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4 Emerging Market Economies

For the emerging markets, there holds that macroprudential instruments have a significant negative effect on credit growth. In the full sample, the effect is stronger for emerging markets than for the advanced markets (Table 5.5). In their

Table 5.4: Estimation of the model for house price growth for the sample of advanced markets

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.911***	0.932***	0.876***	0.941***	0.884***
	(55.08)	(58.35)	(33.60)	(50.65)	(34.97)
L.MacroPru	-0.118*	-0.184***	0.009	-0.126*	-0.047
	(-2.24)	(-4.51)	(0.09)	(-2.23)	(-0.53)
L.GDPGrowth	0.071*	0.089	0.091*	0.154*	0.040
	(2.19)	(1.40)	(2.08)	(2.10)	(0.88)
L.InflationRate	-0.347**	-0.442***	-0.311**	-0.500***	-0.220
	(-3.16)	(-3.75)	(-2.62)	(-4.17)	(-1.88)
L.MonPolRate	-0.140	-0.096	-0.116	-0.116	-0.043
	(-1.91)	(-0.79)	(-1.31)	(-0.87)	(-0.41)
Exrate	-0.054*	-0.019	-0.092**	0.005	-0.032
	(-1.98)	(-1.04)	(-2.86)	(0.21)	(-0.90)
crisis	-0.708	-1.086**	-0.413	-1.034	0.517
	(-1.66)	(-2.73)	(-0.89)	(-0.82)	(0.65)
Constant	1.050**	1.169***	1.029**	0.933***	0.929*
	(3.21)	(3.40)	(3.00)	(3.66)	(2.51)
Observations	2785	1216	1569	870	1176
J Test	0.996	0.997	0.996	0.986	0.982
AR(2)	0.405	0.979	0.389	0.780	0.647

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

paper, Cerutti *et al.* (2017) also compare the effects of macroprudential policy on credit growth in advanced and emerging markets. In that analysis, macroprudential policy in emerging market economies has a stronger effect than in the advanced ones; however, the difference in strength of the effect is larger than in our results. The results of Cerutti *et al.* (2017) are based on a significantly larger sample of more than sixty emerging market economies and about thirty advanced economies, covering the time period until 2013. In our analysis, a sample of 33 advanced and 39 emerging markets is used covering a longer data until 2019 and more importantly, more years after the global finacial crisis, when macroprudential policy has been more frequently used by advanced markets compared with the times before the GFC. Moreover, we use a different definition of MPI than Cerutti *et al.* (2017), their index takes a value of 1 when the macroprudential policy tool is applied and 0 when the instrument is not used.

Tightening of the monetary policy rate has a negative significant effect on credit growth in emerging market economies. From the control variables, the real GDP growth has a significant positive effect on credit growth. As well, the difference in exchange rate and rising inflation have a positive significant effect on credit growth. On the other hand, when the economy is in the crisis, this has a negative effect on the growth of credit.

When the sample is divided between the periods following loosening and tightening of monetary policy cycle, the index of macroprudential policy tools is insignificant. On the other hand, the effect of the change in monetary policy rate is significant. However, the effect of loosening of monetary policy sample has a stronger effect in supporting the further credit growth than the tightening of monetary policy rate on slowing down credit growth. In comparison with advanced economies, the effects of macroprudential policy on credit growth are insignificant in the phase of monetary policy tightening, thus, the results for both advanced and emerging markets are driven mainly by results for the advanced economies. From these results, the hypothesis that monetary policy reinforces the effects of macroprudential policy cannot be supported for the index containing all macroprudential policies. At the same time, the hypothesis cannot be rejected. Therefore, the analysis of individual types of macroprudential policy tools is done in our thesis.

Table 5.5: Estimation of the model for credit growth for the sample of emerging markets

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.810***	0.758***	0.862***	0.749***	0.920***
	(31.12)	(24.83)	(26.61)	(22.92)	(29.68)
L.MacroPru	-0.230*	-0.174	-0.166	-0.249	-0.273*
	(-2.35)	(-1.09)	(-1.09)	(-1.70)	(-2.40)
L.GDPGrowth	0.161**	0.155**	0.150***	0.127	0.093*
	(3.13)	(2.65)	(3.97)	(1.90)	(1.99)
L.InflationRate	0.119*	0.174***	0.076	0.206***	0.119
	(2.15)	(3.40)	(0.93)	(4.50)	(1.63)
L.MonPolRate	-0.292***	-0.287*	-0.390*	-0.150	0.181
	(-3.32)	(-2.53)	(-2.25)	(-1.39)	(0.63)
Exrate	0.094*	0.049	0.090	-0.028	-0.113
	(2.51)	(1.86)	(1.70)	(-0.51)	(-0.91)
crisis	-16.230**	-8.713*	-16.600	-10.310*	14.600
	(-3.28)	(-2.09)	(-1.76)	(-2.03)	(0.90)
Constant	1.670***	2.565***	0.662	3.014***	0.930
	(4.17)	(4.33)	(1.64)	(4.49)	(1.64)
Observations	2736	1331	1405	1002	1049
J Test	0.963	0.972	0.967	0.968	0.980
AR(2)	0.430	0.095	0.290	0.381	0.209

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.6 provides the results of estimation of effects of macroprudential and monetary policy on house prices in emerging market economies. In line with the existing literature, only the house price growth from the previous quarter has a significant effect on house prices in emerging market economies. Other

Table 5.6: Estimation of the model for house price growth for the sample of emerging markets

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.886***	0.894***	0.863***	0.917***	0.880***
	(54.57)	(21.31)	(23.85)	(24.48)	(29.65)
L.MacroPru	0.067	-0.004	-0.0004	-0.080	-0.312
	(0.36)	(-0.04)	(-0.00)	(-0.63)	(-1.29)
L.GDPGrowth	0.046	0.071	0.077	0.139	0.087
	(1.45)	(0.91)	(1.71)	(1.86)	(1.24)
L.InflationRate	-0.068*	0.030	-0.059	0.049	-0.054
	(-2.05)	(0.34)	(-1.49)	(0.51)	(-1.26)
L.MonPolRate	-0.084	0.074	-0.191	0.082	-0.071
	(-1.27)	(0.34)	(-1.70)	(0.34)	(-0.59)
Exrate	0.008	0.043	-0.025	0.043	-0.022
	(0.25)	(1.03)	(-1.36)	(1.43)	(-1.01)
crisis	-0.827	-2.452	-2.073	-4.723	-1.514
	(-0.68)	(-1.40)	(-1.91)	(-1.00)	(-0.93)
Constant	0.803*	-0.008	0.867*	-0.624	1.154*
	(2.35)	(-0.01)	(2.58)	(-0.62)	(2.34)
Observations	1727	788	939	559	706
J Test	0.869	0.875	1.00	0.999	0.999
AR(2)	0.628	0.770	0.616	0.564	0.831

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

variables in the estimation are insignificant, capturing the fact that usually, house price growth in emerging market economies cannot be explained by either the growth of the economy, macroprudential or monetary policies. The insignificance of macroprudential policy on house prices is in line with Cerutti *et al.* (2017). Thus, the results for house prices covering the sample of both advanced and emerging markets were mainly driven by results for advanced markets. In advanced markets, macroprudential policy is effective in regulating house price growth. In emerging markets, macroprudential policy does not have effect on house price growth when the comparison of the effectiveness of macroprudential policy on house prices is based on the index containing all types of macroprudential policies.

5.5 The effectiveness of the individual types of macroprudential measures

The previous analysis is focused on the overall effect of a combination of all macroprudential measures. However, not all the individual macroprudential measures target at house price and credit growth. Therefore, the next part of the analysis focuses on the effect of individual types of macroprudential measures on credit and house price growth. The aim of this part is to evaluate the hypothesis that effects of macroprudential policies differ for individual macroprudential instruments.

5.5.1 Impact on Credit

Table A.18 presents the estimation results of the 17 individual types of macroprudential measures based on the database of Alam *et al.* (2019). The countercyclical capital buffer has the strongest negative effect on credit growth. The analysis of Fendoğlu (2017) shows negative significant effects of the countercyclical capital buffer as well. Capital conservation buffer and other capital requirements have also a negative significant effect on credit growth when these measures are tightened. Same result was obtained by Vandenbussche *et al.* (2015). The loan restriction measures have a negative significant effect as well. From the borrower-based measures, the limits to the loan-to-value ratios have a significant negative effect on credit growth. This is in line with the results of Akinci & Olmstead-Rumsey (2018), Claessens *et al.* (2013), Kuttner & Shim (2016), and Lim *et al.* (2011). From the liquidity measures, tightening of the measures taken to mitigate systemic liquidity and funding risks have a negative significant effect on credit growth, this is in line with Kuttner & Shim (2016). Last but not least, the measures taken to mitigate risks from systematically important institutions have tightening effects on credit growth. In contradiction with the existing literature, the analysis does not provide evidence that reserve requirements, limits on debt-service-to-income ratio or limits on open foreign exchange positions have a significant effect on credit growth. However, the effectiveness on these measures has been shown on the data before the global financial crisis or data for individual countries (Lim *et al.*, 2011; Claessens *et al.*, 2013; Nguyen *et al.*, 2021). The results do not prove the overall unusefullness and ineffectiveness of the other measures. As is discussed in Chapter 4, these results may be caused by the upward bias. Or these tools might be effective only in individual countries. However, for credit growth there holds that individual macroprudential instruments have a different effect on the dependent variable.

Overall, the increase in the monetary policy rate has a negative significant effect on credit growth. This is a similar result to the one that is obtained by the estimation of the index of all types of macroprudential measures. The real GDP growth has a positive effect on credit growth as well as change in exchange rate. On the other hand, the crisis dummy variable has a negative effect on credit growth. The significant positive effect of credit growth in the previous period suggests the persistancy of credit growth. The results are in line with the initial estimation.

Further, the regressions based on individual measures are estimated for the subsets of the original, thus, the estimation is done for the periods when the previous period the monetary policy cycle is in the phase of tightening. This is done in order to evaluate whether the hypothesis that monetary policy reinforces the effects of macroprudential policy holds also for the individual macroprudential instruments.

If the monetary policy was in the phase of tightening the previous period, the counter-cyclical capital buffer, capital requirements, loan restrictions, liquidity measures, and measures aiming at systematically important institutions have a significant negative effect on credit growth. In comparison with the estimation based on full sample, capital requirements and loan-to-value measures lost the significance. An explanation might be that these measures have not been used that often in the phase of monetary policy tightening. On the other hand, for all measures that are significant in the estimation based on the full sample and the other sample, the effect is stronger in the phase when monetary policy is tightening. Thus, this further supports the hypothesis that monetary policy reinforces the effects of macroprudential measures. Moreover, the increase of monetary policy rate has a significant negative effect on credit growth.

If the monetary policy was in the phase of loosening in the previous quarter, only liquidity measures and limits on open foreign exchange positions have a significant effect. However, the effect of limits on open foreign exchange positions is positive, meaning that loosening of this measure has a negative effect on credit growth in the phase of monetary policy loosening, and tightening of this measure has a positive effect on credit growth. Thus, monetary policy loosening does not support the effects of limits on open foreign exchange positions in the right direction. Overall, the monetary policy reinforces the effects of individual types of macroprudential policies on credit.

Advanced Economies

To evaluate the Hypothesis #2 that the effects of macroprudential policies are larger in emerging market economies than in advanced economies, the effects of individual types of macroprudential instruments are estimated separately for advanced and emerging market countries. Moreover, the estimation results are also connected to the Hypothesis #3, effects of individual macroprudential policies are different for various macroprudential instruments, where the stability of the results is checked for the subsamples of advanced and emerging markets.

In advanced economies, there are eight types of macroprudential policies that have a negative significant effect on credit growth. Macroprudential measures labeled as Other in the database of Alam *et al.* (2019) (for the definition see Table A.6) have the strongest negative effect. From the capital measures, countercyclical capital buffer and conservation buffer have a significant effect on credit (Table A.19). Loan loss provisions, loan restrictions, and liquidity measures are significant in the estimation. Loan-to-value measures that are more frequently used in advanced economies than in emerging market economies have a negative significant effect on credit growth. Last but not least, measures taken against a cumulation of risk in systematically important financial institutions are an efficient tool in slowing down the growth of credit.

Table A.19 shows the results for periods when the monetary policy cycle is in the phase of tightening and loosening. In the phase of tightening, loan loss provisions and SIFI measures have a significant effect on credit growth. In the opposite phase, when the monetary policy is loosening, conservation buffer, loan loss provisions, liquidity requirements, and SIFI instruments have a significant effect on credit growth. The effects of loan loss provisions and SIFI are larger in the phase of tightening than in the loosening phase. These results further support the Hypothesis #1. The size of effects of conservation buffer and liquidity requirements are larger in the full sample than in the loosening phase. Unfortunately, in the tightening phase, these two measures have an insignificant effect in our sample. Overall, the results for advanced markets and credit growth suggest that different macroprudential measures have diverse effects, supporting Hypothesis #3.

Emerging Market Economies

In emerging market economies, there are four types of macroprudential measures having a significant effect on credit growth in the full sample. These four types are capital conservation buffer, liquidity requirements, SIFI, and Other (Table A.20). Similarly to the estimation for advanced economies, the largest effect have the measures labeled as Other. In comparison with the obtained results for the sample of all countries, the significance of capital conservation buffer, liquidity measures, and SIFI measures is stable over the both subsamples. On the other hand, the effectiveness of counter-cyclical capital buffers and loan-to-value is mainly driven by the advanced markets.

Taking into account the phase of monetary policy cycle, Table A.20 provides results for periods of monetary policy tightening and loosening. During the tightening phase, capital conservation buffer and Other measures have a significant effect on credit growth in emerging market economies. Capital conservation buffer with a significant effect also in the phase of loosening, has a stronger effect within the tightening phase. Liquidity measures have a significant effect on credit growth in the phase of loosening.

Overall, the effects of capital conservation buffer, liquidity measures, and SIFI measures are stronger in emerging markets than in advanced markets. These results support the Hypothesis #2 for some individual types of macroprudential policies. The effects of individual types of macroprudential measures on credit growth also differ for emerging markets.

5.5.2 Impact on House Prices

The results of the estimation of the effects of individual macroprudential measures on house prices are shown in Table A.21. The difference between the estimation for credit growth and house prices is that the one for development in housing sector is done for a smaller sample of countries. Thus, some measures taken in the larger sample are not included in the house price analysis. In the analysis for the macroprudential policy index on the whole sample in section 5.2, the effect of the index is insignificant, thus, the analysis aims to have a closer look on the effectiveness of the individual measures.

To compare the results on house prices with the existing literature is more challenging than in the case of credit growth, as the existing research on the effects of macroprudential policy on house prices is not that extensive. Tightening of conservation buffer has a negative significant effect on house price growth. In the results, the loan loss provisions significantly influence house price growth. In the existing articles, this measure seems to have an effect on credit growth (Akinci & Olmstead-Rumsey, 2018). Moreover, the loan restrictions seem to have a significant effect on house price growth, not only credit growth. In line with the existing literature (Akinci & Olmstead-Rumsey, 2018), the borrower-based measure of limits to the debt-service-to-income has a significant effect on house prices. Beside the significant effect on credit growth, liquidity measures have an effect on house price growth as well. Surprisingly, measures taken to mitigate risk at the systematically important institutions have a significant effect on slowing down house price growth. Last but not least, measures labeled as Other in the database of Alam *et al.* (2019) have a significant effect against house prices. In the literature, the effectiveness of tax mesures (Cerutti *et al.*, 2017; Kuttner & Shim, 2016) and LTV (Akinci & Olmstead-Rumsey, 2018) is proven. On the other hand, the results of Araujo *et al.* (2020) show a weaker and imprecise effect of LTV on house prices. The results provide a different picture than the estimation of the index of all macroprudential measures and indeed suggest that some macroprudential measures are effective in slowing down house price growth.

The rise in inflation rate and the crisis dummy variable have a negative effect on house price growth. The real GDP growth has a positive effect on the house price growth. The monetary policy rate does not seem to have a significant effect on house prices. These results are similar to the initial estimation of the overall index.

The estimation for the times of monetary policy tightening provides results that show a significant effect of only three types of macroprudential policy measures. These three types are limits on loan provisions, loan restrictions, and liquidity measures. In comparison with the estimation for the full sample, conservation buffer, loan restrictions, debt-service-to-income, SIFI measures, and measures labeled as Other are not significant. Moreover, for the limits on loan provisions and liquidity measures that are significant both in the full sample and this subsample, the effect in the subsample is lower than in the full sample. The opposite holds for the loan restrictions, thus, the evidence for monetary policy enforcing the effects of macroprudential policy is in this case mixed.

If the monetary policy is loosening in the previous quarter, capital conservation buffer, limits on loan loss provisions, liquidity measures, and reserve requirements have a significant effect on house price growth. The effect of loan loss provisions is larger while monetary policy is tightening than when it is loosening. This does not hold for capital conservation buffer and liquidity measures, however, this might be caused by the fact that the aim of capital requirements is not to slow down house price growth and the estimation results should be interpreted in this case rather as a correlation than a causality. The same holds for reserve requirements measures.

Advanced Economies

In advanced markets, nine types of macroprudential policies have a significant effect on house price growth. Results presented in Table A.22 show that the measures labeled as Other have again the largest effect. Widely used and by literature evaluated as efficient measures against house price growth, loan-to-value and debt-service-to-income have in the estimation a significant effect. As well, two capital measures, capital conservation buffer and other capital requirements have a significant effect in our estimation. Loan loss provisions and loan restrictions seem to be effective in influencing house price growth as well. The SIFI measures have a negative effect on house price growth in advanced markets.

Table A.22 shows the obtained results for the estimation in times of tightening the monetary policy. Tightening of capital conservation buffers, limits on leverage on banks, loan loss provisions, loan restrictions, loan-to-value instruments, tax measures, liquidity tools, measures taken to mitigate risk for SII, and Other measures have a negative significant effect on house price growth. These results are in line with the estimation of the effectiveness of macroprudential policy on house prices based on the index containing all types of measures. Moreover, the estimated effects are stronger in times of tightening than within the period of monetary policy loosening as none of the measures is significant in the times of loosening (Table A.22).

Emerging Market Economies

In emerging markets, none of the types of macroprudential measures has a significant effect on house prices, the situation does not even change for the times of monetary policy tightening (Table A.23). The results are similar to the ones obtained by Cerutti *et al.* (2017). In the subsample where the monetary policy was in the previous period in the phase of loosening, liquidity requirements have a significant effect on house prices. In comparison with the results obtained by the estimation of the index of all macroprudential policies, the effects of macroprudential policy are still inefficient; however, in some estimations, the growth in house prices is connected to real GDP growth.

5.6 Robustness checks

To evaluate the robustness of the estimation, some modifications of the original definition of macroprudential policy index and length of monetary policy tightening have been done. Another check is that the sample has been shortened to the period 2005-2019.

Definition of macroprudential policy index

In the existing literature the analysis is sometimes done only for the tightening measures as the effects are stronger than for loosening measures (Araujo *et al.*, 2020). Thus, the models for index of all macroprudential policies are reestimated with an alternative definition of macroprudential policy index, where only tightening measures are included. Thus, tightening measures are represented by 1 and otherwise the index is zero. Table A.8 presents estimation results for the full sample of countries. The tightening of macroprudential policies has a negative significant effect on credit growth. Moreover, the effect is stronger for the times when monetary policy cycle is tightening. The results are similar to the ones obtained for the initial definition of macroprudential index taking into account both tightening and loosening measures. The results are robust for advanced markets as well (Table A.9). For emerging markets, the index is insignificant for the full sample and the subsets of tightening and loosening monetary policy times (Table A.10). This suggests that the results of the original estimation show that the loosening macroprudential measures have a positive effect on credit growth.

In the estimation of the effects on house price growth, tightening of macroprudential measures is significant only in the times when monetary policy is tightening as well (Table A.11). Otherwise, the index of tightening of macroprudential policy seems to be inefficient in slowing down house prices. Thus, the original results from Table 5.2 are robust to a different definition of macroprudential policy index. Moreover, if monetary policy rate is rising, it contributes to house price growth. Table A.12 presents estimated results for advanced economies. Macroprudential policy tightening is efficient during the tightening phase of monetary policy cycle in curbing house price growth and in the full sample of advanced markets. In emerging markets (Table A.13), macroprudential policy index is inefficient in curbing the rise of house prices. Moreover, house price growth estimation again shows that its development is hardly to be explained by independent variables. The results for advanced and emerging market economies are thus also robust to a different definition of macroprudential policy index.

Monetary policy tightening and loosening

In our analysis, the results are presented for subsamples based on the phase of monetary policy cycle in previous quarter and the same phase in all previous four quarters, especially the last division of the sample may seem quite restrictive. Therefore, the results are reestimated for the same phase in previous two quarters and three quarters. Monetary policy cycles were calculated setting the minimum duration of phase to 4 quarters, thus, there is no need to try for example Q1: tightening - Q2: loosening - Q3: tightening combination.

Table A.14 presents the results, in first and second column, the results based on tightening the monetary policy cycle in the previous two and three quarters are presented. Columns (3) and (4) present the results for tightening phase of monetary policy in previous two and three quarters. If the subsamples are created based on the monetary policy tightening and loosening in the previous two quarters, the effect of macroprudential policies is stronger when it is supported by monetary policy tightening. Moreover, increasing of monetary policy rate has an additional negative significant effect on credit growth. If the results are based on the same phase of monetary policy cycle in the previous three periods, the effect of macroprudential policy index is stronger in the phase of monetary policy loosening. This relationship may be caused by loosening measures of macroprudential policy that are supported by loosening of monetary policy. Or it may be caused by the fact that in monetary policy tightening phase, the change of monetary policy rate is significant. At the same time, in monetary policy loosening phase, macroprudential policy is not significant. When the results are compared to the estimation of subsamples based on monetary policy cycle phase in previous four quarters, there the strength of the effect is similar in loosening and tightening phase, leading to a conclusion that for credit growth, the results are robust to dividing the sample based on the two previous quarters but not robust based on dividing the full sample of countries based on previous three quarters.

Table A.15 presents the results of this robustness check for house price growth. The columns of the table are structured similarly to the results for credit growth. Macroprudential policy has an impact on house price growth when monetary policy is in the phase of tightening and does not have a significant effect on house prices when monetary policy is loosening. Thus, the results for house prices are robust to the definition of the phase of monetary policy tightening and loosening.

Changing the data period to 2005 - 2019

The estimation results are also tested for robustness in time. The results are reestimated for the full sample of countries. Table A.16 shows the results for macroprudential policy and its effectiveness on credit growth. The estimated results show that macroprudential policy has a significant effect on credit growth in times of monetary policy tightening. The effect of macroprudential policy index is not significant in times of monetary policy loosening. The effect of crisis is stronger in this subsample, following the fact that in the shorter sample, the crisis periods play a more important role than in the sample covering also the 1990s. Thus, the results for the effectiveness of macroprudential policy index under monetary policy tightening on credit growth are robust to shorter sample period.

The estimated results for house prices are presented in Table A.17. Macroprudential policy index has a negative significant effect in the times of tightening of monetary policy and has an insignificant effect within monetary policy loosening phase. These results are similar to the original sample estimation, thus, the results for house prices are robust for changes in the length of the sample period.

5.7 Evaluation of hypotheses

Section 4.4 proposes three hypotheses based on economic theory and the existing literature on effects of macroprudential policy on credit growth and growth of house prices. The following section discusses the results for each hypothesis.

Hypothesis #1 Monetary policy reinforces the effects of macroprudential policy. The evidence based on our estimated results supports the hypothesis that tightening of monetary policy reinforces the effects of macroprudential policy on both credit and house price growth. The results for individual macroprudential measures also support this hypothesis. For credit growth, the results are robust for both advanced and emerging market economies. The results for advanced markets for house price growth support this hypothesis. On the other hand, the effects of macroprudential policies on house prices in emerging markets are insignificant. The results are consistent across the different definition of macroprudential policy index and monetary policy phases and a shorter period of data.

Hypothesis #2: The effects of the macroprudential policies in emerging market economies are larger than in advanced economies.
The results display a mixed evidence for the comparison of the size of effects in advanced and emerging market economies. For credit growth, not taking into account the phase of monetary policy, the effect of macroprudential policy index is larger in emerging markets than in advanced markets. The results are even robust for individual macroprudential measures. However, the effects of macroprudential policy tools on house prices in emerging markets are insignificant. This insignificance of results is robust for individual macroprudential measures, time period, and definition of macroprudential policy index. The effects are on the other hand significant for advanced economies. Cerutti *et al.* (2017) support the hypothesis based on estimatated results for credit growth.

Hypothesis #3: The effects of macroprudential policies differ for individual macroprudential instruments.

The estimated results show that various macroprudential measures are effective on curbing house price growth and credit growth. The effectiveness and size of effects differ across the dependent variable as well as across advanced and emerging market economies. The effectiveness of the individual measures on credit growth and house price growth differs for the individual countries also in the existing literature (Araujo *et al.*, 2020; Cerutti *et al.*, 2017; Akinci & Olmstead-Rumsey, 2018; Vandenbussche *et al.*, 2015; Poghosyan, 2020; Fendoğlu, 2017; Küçükbıçakcı *et al.*, 2020; Claessens *et al.*, 2013; Lim *et al.*, 2011; Nguyen *et al.*, 2021; Kuttner & Shim, 2016).

Chapter 6

Conclusions

The global financial crisis has revealed a need to expand the mandate of authorities responsible for macroeconomic management and complement the traditional price stability objective with a new objective of financial stability and an appropriate policy toolkit for financial stability. The macroprudential policy aims at mitigating the accumulation of systemic risk in the financial system and broader economy. The policymakers usually focus on two intermediate targets, credit and house prices as it has been shown that excessive growth of credit and asset prices typically leads to accumulation of systemic risk, increasing the probability of financial crisis. In both advanced and emerging market countries, one can observe a rising frequency of use of macroprudential tools in recent years. However, despite growing literature, the evidence on the effectiveness of macroprudential policies, especially on house prices, is still relatively scarce. Moreover, there is still an ongoing discussion about the effectiveness of individual measures. While important for the conduct on effectiveness of macroprudential policies, interaction with monetary policy is underresearched.

The aim of this thesis is to evaluate the effectiveness of macroprudential policies in curbing credit and house price growth, taking into account the monetary policy cycle. The thesis evaluates if the monetary policy reinforces the effects of macroprudential policy on credit and house price growth. Moreover, the thesis focuses also on the effect of individual macroprudential policies on house price and credit growth and the differences in effectiveness across advanced and emerging market economies. Based on economic theory and existing literature, three hypotheses have been formulated, presuming that the effects of macroprudential policies are reinforced by monetary policy, different sizes of the effects of macroprudential policy in advanced and emerging market economies, and various effects of individual macroprudential policy instruments.

The hypotheses have been evaluated by employing data for 72 countries over the period of 1990-2019. The models have been estimated for the macroprudential policy index including all types of macroprudential policy instruments as well as for the individual types. The robustness of the results has been tested by different definitions of macroprudential policy index and monetary policy phases and for a shorter data period.

The results are as follows: (1) Macroprudential policy is more effective in curbing the rise of credit and house prices when the monetary policy is tightening, thus supporting the view that monetary policy is reinforcing the effects of macroprudential policy. This holds for the individual measures as well as for the combined effect of macroprudential policies. The results are mainly driven by advanced economies. (2) In advanced economies, the macroprudential policy tools have a significant aggregated impact on house prices, especially in the times when monetary policy is tightening. The effect is insignificant when applied monetary policy is loosening. (3) The effects of various macroprudential policies are different. Some of them are effective at slowing down house prices, and others at impeding credit growth, depending on the monetary policy cycle phase. For example, capital instruments, liquidity instruments, and loan restriction have stronger impact when monetary policy tightens. The size of the effect also differs between the individual measures and the effects of individual measures differ in size in diverse phases of monetary policy cycle.

These findings present several policy implications for coordinating macroprudential and monetary policies. Despite the fact that monetary and macroprudential policies are conducted in many countries by one institution, the central bank, the policymakers often set one policy without sufficiently taking into account the effects of the other one. The results of our analysis should highlight the importance of taking into account the monetary policy cycle phase when implementing macroprudential measures.

Given the scarcity of research on the effects of interaction between macroprudential and monetary policies, there is still room for further research. For example, the monetary policy cycle could be based on a policy rate adjusted for inflation in order to capture the phases when nominal monetary policy rate remains at the same level and inflation increases. The state of monetary policy can be also represented by monetary conditions index based on short-term interest rate and real effective exchange rate. The databases capturing the use and changes of macroprudential policy tools also grow and become more precise, allowing to better capture the effects of macroprudential policy on credit and house price growth.

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Appendix A

Tables

Table A.1: List of variables and their sources

Variable	Description and Source
Credit growth	Year-on-year percentage change of BIS Bank Credit to private non-financial sector. Where the BIS data were not available: IMF Depository Corporations Domestic Claims on Private Sector. Billions of Domestic Currency. Quarterly data.
MacroPru and data for individual instruments	Sum of index created by measures applied based on Integrated Macroprudential Policy Database constructed by Alam *et al.* (2019). Monthly data.
Mon.Pol.Rate	BIS Central Bank Policy Rates. Where not available: IFS Monetary Policy-Related Interest Rate. For the countries of the euro area: after entering euro area - Shadow rate calculated by Krippner based on paper from 2012 (Krippner, 2012); before entering euro area - monetary policy rate from the websites of the individual central banks. Japan, the UK, and the U.S.: Shadow rate calculated by Krippner (2012). For prolonging the time series, data from the central banks of the individual countries have been used.
HPI growth	Year-on-year percentage change of BIS Nominal residential property prices. Index 2010=100. Where BIS data were not available: OECD Nominal house prices. Index 2015 = 100. Where not available: Data from the central banks of the individual countries.
Ex.Rate	End of period of the exchange rate of the domestic currency against the U.S.Dollar. Data source: Bank for International Settlements. Quarterly data.
Crisis	Dummy variable for Systemic Bank Crisis from the database of Laeven & Valencia (2012).
GDP Growth	Year-on-year percentage change of Real Gross Domestic Product. Data source: IMF International Financial Statistics. Quarterly data in millions of domestic currency. Base year differs from country to country. If not available: yearly data or calculated from the nominal data downloaded from the IMF IFS.

Table A.2: List of variables and their sources (continued)

Variable	Description and Source
Inflation Rate	Year-on-year percentage change of the Consumer price index of all items taken from the IMF International Financial Statistics. Index 2010 = 100. Quarterly data.
FDI-to-GDP	Ratio of average of the previous four quarters of the Direct Investment, net incurrence of liabilities, and the average of the previous four quarters of the nominal Gross Domestic Product. Source of the data: IMF.
PI-to-GDP	Ratio of average of the previous four quarters of the Portfolio investment, net Incurrence of liabilities, and the average of the previous four quarters of the nominal Gross Domestic Product. Source of the data: IMF.
Other-to-GDP	Ratio of average of the previous four quarters of the Other investment, net Incurrence of liabilities, and the average of the previous four quarters of the nominal Gross Domestic Product. Source of the data: IMF.

Table A.3: List of Countries

Advanced	Emerging
Austria	Albania
Australia	Armenia
Belgium	Argentina*
Canada	Brazil
Cyprus	Chile
Czech Republic	China
Denmark	Colombia
Estonia	Costa Rica*
Finland	Croatia
France	Georgia
Germany	Ghana*
Greece	Hungary
Iceland	Indonesia
Ireland	India
Israel	Jamaica*
Italy	Kazakhstan
Japan	Macedonia
Korea	Malaysia
Latvia	Mauritius*
Lithuania	Mexico
Luxembourg	Moldova
Malta	Mongolia
Netherlands	Nepal*
New Zealand	Nigeria*
Norway	Paraguay*
Portugal	Peru
Slovak Republic	Philippines
Slovenia	Poland
Spain	Romania
Sweden	Russia
Switzerland	Saudi Arabia*
United Kingdom	Senegal*
United States	Serbia
	South Africa
	Sri Lanka
	Thailand
	Turkey
	Trinidad and Tobago
	Ukraine

* Due to the data availability, this country is excluded from the house price analysis.

Table A.4: Results of the tests

Breusch-Pagan Test		
	Chi-squared	p-value
Credit Growth OLS model	10227.81	0.00
House Price Growth OLS model	858.55	0.00
Woolfridge Test		
	Statistic	p-value
Credit Growth OLS model	F(1, 71) = 42.839	0.00
House Price Growth OLS model	F(1, 59) = 209.541	0.00
Modified Wald Test		
	Chi-squared	p-value
Credit Growth FE model	2.9e+05	0.00
House Price Growth FE model	59805.22	0.00
Pesaran Test		
	Statistic	p-value
Credit Growth FE model	44.694	0.00
House Price Growth FE model	17.382	0.00

Table A.5: Definitions of Macroprudential Policy Tools included in the analysis

Tool	Definition
CCB	A requirement for banks to maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
Conservation	Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
Capital	Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in their sheets respectively and thus not included here.
LVR	A limit on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures (e.g., Basel III leverage ratio).
LLP	Loan loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g. housing loans).
LCG	Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit, and penalties for high credit growth.
LoanR	Loan restrictions, that are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans), lender characteristics (e.g., mortgage banks), and other factors.
LFC	Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
LTV	Limits to the loan-to-value ratios, applied to residential and commercial mortgages but also applicable to other secured loans, such as for automobiles. Other aspects of the LTV regulation are also covered, such as "speed limits" (i.e., a regulation on the percent of new loans that can go above certain LTV limits).
DSTI	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt service payments or the size of a loan relative to income (e.g., household income, net operating income of the company).
Tax	Taxes and levies applied to specified transactions, assets, or liabilities, which include stamp duties, and capital gain taxes.

Table A.6: Definitions of Macroprudential Policy Tools included in the analysis (continued)

Tool	Definition
Liquidity	Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
LTD	Limits to the loan-to-deposit (LTD) ratio and penalties for high LTD ratios.
LFX	Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.
RR	Reserve requirements (domestic or foreign currency) for macroprudential purposes. Please note that this category may currently include those for monetary policy as distinguishing those for macroprudential or monetary policy purposes is often not clear-cut.
SIFI	Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which includes capital and liquidity surcharges.
Other	Macroprudential measures not captured in the above categories—e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

Note: The definitions are taken from iMaPP database created by Alam *et al.* (2019).

Table A.7: Summary Statistics by groups

Monetary Policy Cycle	Mean	Median	Min	Max	Standard deviation
		Full sample			
Full sample	.751	0	-8	12	1.662
Tightening in previous period	.948	0	-5	10	1.747
Loosening in previous period	.602	0	-8	12	1.577
Long-term tightening	.937	0	-5	10	1.745
Long-term loosening	.618	0	-8	12	1.558
		Advanced Economies			
Full sample	.695	0	-5	10	1.547
Tightening in previous period	.833	0	-5	10	1.677
Loosening in previous period	.598	0	-4	7	1.439
Long-term tightening	.814	0	-5	10	1.685
Long-term loosening	.613	0	-4	7	1.378
		Emerging Market Economies			
Full sample	.815	0	-8	12	1.765
Tightening in previous period	1.059	0	-4	10	1.806
Loosening in previous period	.606	0	-8	12	1.713
Long-term tightening	1.053	0	-4	9	1.794
Long-term loosening	.623	0	-8	12	1.739

Table A.8: Estimation of the model for credit growth for full sample of countries with alternative definition of macroprudential index

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.962***	0.933***	0.984***	0.929***	0.921***
	(48.42)	(38.32)	(37.12)	(29.64)	(27.90)
L.MacroPru_T	-0.116*	-0.174**	-0.060	-0.210*	-0.186*
	(-2.39)	(-2.77)	(-0.76)	(-2.42)	(-2.02)
L.GDPGrowth	0.111**	0.093	0.113***	0.075	0.129***
	(3.20)	(1.55)	(4.81)	(1.05)	(4.82)
L.InflationRate	-0.066	-0.009	-0.103	0.017	0.095
	(-1.17)	(-0.15)	(-1.04)	(0.29)	(1.29)
L.MonPolRate	-0.212***	-0.269**	-0.219*	-0.244***	-0.128
	(-3.34)	(-2.92)	(-2.25)	(-4.60)	(-1.52)
Exrate	0.042*	0.032*	0.017	0.002	-0.004
	(2.57)	(2.44)	(0.53)	(0.05)	(-0.09)
Crisis	-1.907***	-1.354	-1.743***	-2.534*	-1.476**
	(-4.07)	(-1.72)	(-4.25)	(-2.15)	(-3.05)
Constant	0.264*	0.798***	0.0002	0.981**	0.257
	(2.03)	(3.81)	(0.00)	(2.96)	(1.62)
Observations	5583	2604	2979	1929	2232

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.9: Estimation of the model for credit growth for advanced economies with alternative definition of macroprudential index

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.899***	0.887***	0.926***	0.859***	0.927***
	(33.86)	(16.62)	(64.42)	(13.43)	(41.01)
L.MacroPru_T	-0.255***	-0.223	-0.165**	-0.295	-0.172*
	(-3.57)	(-1.32)	(-3.08)	(-1.70)	(-2.34)
L.GDPGrowth	0.091	0.190	0.082	0.196	0.073*
	(1.30)	(1.48)	(1.92)	(0.96)	(2.06)
L.InflationRate	-0.006	0.060	-0.182**	0.288	-0.138
	(-0.07)	(0.22)	(-2.84)	(0.71)	(-1.81)
L.MonPolRate	-0.015	-0.03	-0.038	-0.021	-0.099
	(-0.37)	(-0.27)	(-0.59)	(-0.13)	(-1.07)
Exrate	0.005	0.046	-0.019	0.081	-0.039*
	(0.24)	(1.17)	(-1.57)	(1.56)	(-2.13)
Crisis	-3.546**	-2.346	-2.168**	-6.389	-2.220**
	(-2.77)	(-0.49)	(-3.03)	(-1.03)	(-2.80)
Constant	0.981**	0.751	0.733***	0.821	0.653***
	(3.13)	(1.30)	(4.00)	(1.21)	(3.50)
Observations	2847	1273	1574	927	1183

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.10: Estimation of the model for credit growth for emerging market economies with alternative definition of macroprudential index

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.807***	0.766***	0.861***	0.750***	0.925***
	(28.09)	(25.25)	(23.90)	(22.90)	(33.32)
MacroPru_T	-0.167	-0.241	-0.125	-0.277	-0.310**
	(-1.23)	(-1.43)	(-0.83)	(-1.53)	(-2.80)
L.GDPGrowth	0.164**	0.146*	0.155***	0.117*	0.0930*
	(2.86)	(2.02)	(4.07)	(2.03)	(2.19)
L.InflationRate	0.128*	0.173**	0.0735	0.199***	0.107
	(2.23)	(3.08)	(1.01)	(3.36)	(1.49)
L.MonPolRate	-0.297**	-0.300*	-0.382*	-0.164	0.147
	(-3.06)	(-2.37)	(-2.09)	(-1.55)	(0.55)
Exrate	0.091*	0.047	0.081	-0.026	-0.100
	(2.41)	(1.74)	(1.69)	(-0.54)	(-1.08)
Crisis	-15.930**	-8.508	-15.780	-9.955*	13.360
	(-3.19)	(-1.80)	(-1.70)	(-1.96)	(0.90)
Constant	1.710**	2.724**	0.750	3.273***	1.006*
	(2.87)	(2.80)	(1.55)	(4.14)	(2.14)
Observations	2736	1331	1405	1002	1049

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.11: Estimation of the model for house price growth for full sample of countries with alternative definition of macroprudential index

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.898***	0.917***	0.874***	0.935***	0.871***
	(76.60)	(35.75)	(33.80)	(38.17)	(32.23)
L.MacroPru_T	-0.069	-0.128**	-0.010	-0.124*	-0.041
	(-1.39)	(-2.74)	(-0.22)	(-2.08)	(-0.68)
L.GDPGrowth	0.080**	0.094	0.087*	0.132**	0.089*
	(3.16)	(1.88)	(2.44)	(2.97)	(2.23)
L.InflationRate	-0.105**	-0.083	-0.071*	-0.123**	-0.057
	(-2.80)	(-1.91)	(-2.18)	(-2.69)	(-1.77)
L.MonPolRate	-0.083	0.081	-0.222**	0.106	-0.187*
	(-1.36)	(0.58)	(-3.03)	(0.68)	(-2.25)
Exrate	0.019	0.063	-0.028	0.065	-0.021
	(0.53)	(1.59)	(-1.82)	(1.73)	(-1.22)
Crisis	-0.986***	-1.680**	-1.049*	-2.467*	-0.545
	(-3.40)	(-3.06)	(-2.05)	(-2.57)	(-1.06)
Constant	0.721***	0.427	0.623***	0.193	0.642**
	(4.86)	(1.79)	(4.01)	(0.84)	(2.96)
Observations	4512	2004	2508	1429	1882

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.12: Estimation of the model for house price growth for advanced economies with alternative definition of macroprudential index

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.911***	0.929***	0.875***	0.933***	0.875***
	(55.81)	(53.74)	(34.34)	(49.05)	(35.62)
L.MacroPru_T	-0.125*	-0.199***	0.029	-0.170**	-0.076
	(-2.31)	(-4.45)	(0.28)	(-3.24)	(-0.87)
L.GDPGrowth	0.070*	0.091	0.092*	0.149*	0.009
	(2.17)	(1.55)	(2.07)	(1.96)	(0.25)
L.InflationRate	-0.342**	-0.421***	-0.311**	-0.474***	-0.216*
	(-3.15)	(-3.83)	(-2.61)	(-5.33)	(-2.09)
L.MonPolRate	-0.135	-0.104	-0.119	-0.121	-0.081
	(-1.83)	(-0.94)	(-1.34)	(-0.95)	(-0.78)
Exrate	-0.049	-0.016	-0.094**	-0.001	-0.032
	(-1.96)	(-0.87)	(-2.80)	(-0.06)	(-0.98)
Crisis	-0.730	-1.204**	-0.374	-1.493*	-0.589
	(-1.71)	(-2.68)	(-0.79)	(-2.25)	(-1.14)
Constant	1.076**	1.204***	0.999**	1.064***	1.119**
	(3.15)	(3.52)	(2.79)	(3.80)	(3.16)
Observations	2785	1216	1569	870	1176

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.13: Estimation of the model for house price growth for emerging market economies with alternative definition of macroprudential index

		Dependent variable: House price growth			
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.886***	0.899***	0.869***	0.926***	0.881***
	(55.18)	(26.75)	(25.58)	(25.09)	(32.29)
L.MacroPru_T	-0.004	-0.016	-0.164	-0.040	-0.275
	(-0.02)	(-0.09)	(-1.36)	(-0.19)	(-1.53)
L.GDPGrowth	0.051	0.094	0.081*	0.120	0.074
	(1.47)	(1.78)	(2.04)	(1.88)	(0.95)
L.InflationRate	-0.069	0.063	-0.074	-0.011	-0.062
	(-1.79)	(1.27)	(-1.93)	(-0.11)	(-1.30)
L.MonPolRate	-0.076	0.082	-0.193	0.084	-0.056
	(-1.09)	(0.38)	(-1.58)	(0.38)	(-0.53)
Exrate	0.009	0.058*	-0.020	0.038	-0.018
	(0.29)	(2.19)	(-1.22)	(1.49)	(-0.77)
Crisis	-0.952	-4.087	-1.524	-2.358	-1.200
	(-0.68)	(-1.61)	(-1.25)	(-0.75)	(-0.66)
Constant	0.858	-0.400	1.067**	-0.308	1.376*
	(1.75)	(-0.64)	(3.03)	(-0.36)	(2.49)
Observations	1727	788	939	559	706

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.14: Estimation of the model for credit growth for different specification of length of monetary policy phase

	Dependent variable: Credit growth			
	Monetary Policy			
	Previous Quarter		Previous 4 Quarters	
	Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.909***	0.933***	0.967***	0.918***
	(38.07)	(35.60)	(40.88)	(39.76)
MacroPru	-0.167*	-0.142*	-0.116	-0.156*
	(-2.53)	(-2.00)	(-1.55)	(-2.17)
L.GDPGrowth	0.101	0.086	0.117***	0.129***
	(1.89)	(1.37)	(4.69)	(4.60)
L.InflationRate	0.004	-0.007	-0.021	0.086
	(0.07)	(-0.12)	(-0.27)	(1.60)
L.MonPolRate	-0.273**	-0.297***	-0.168	-0.105
	(-3.08)	(-3.82)	(-1.88)	(-1.32)
Exrate	0.036*	0.035**	0.006	-0.017
	(2.29)	(2.84)	(0.16)	(-0.49)
Crisis	-1.651	-2.026*	-1.731***	-1.702***
	(-1.85)	(-2.10)	(-4.32)	(-3.68)
Constant	0.981***	0.857***	0.008	0.235
	(3.48)	(3.60)	(0.06)	(1.62)
Observations	2376	2151	2716	2472

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.15: Estimation of the model for house price growth for different specification of length of monetary policy phase

	Dependent variable: House price growth			
	Monetary Policy			
	Previous Quarter		Previous 4 Quarters	
	Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.929***	0.932***	0.868***	0.876***
	(39.36)	(37.99)	(27.78)	(36.64)
MacroPru	-0.112*	-0.117*	-0.035	-0.024
	(-2.50)	(-2.26)	(-0.62)	(-0.44)
L.GDPGrowth	0.122*	0.118**	0.094*	0.084**
	(2.43)	(2.63)	(2.57)	(2.60)
L.InflationRate	-0.117**	-0.108*	-0.074*	-0.028
	(-2.58)	(-2.24)	(-2.09)	(-0.81)
L.MonPolRate	0.122	0.121	-0.218*	-0.188*
	(0.84)	(0.83)	(-2.49)	(-2.47)
Exrate	0.068	0.042	-0.026	-0.037*
	(1.68)	(1.61)	(-1.71)	(-2.07)
Crisis	-1.771**	-1.798*	-0.992	-0.448
	(-2.77)	(-2.56)	(-1.70)	(-0.94)
Constant	0.253	0.188	0.678***	0.590***
	(0.92)	(0.70)	(4.16)	(3.73)
Observations	1811	1619	2288	2084

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.16: Estimation of the model for credit growth for the sample period 2005 - 2019

	Dependent variable: Credit growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.965***	0.924***	0.974***	0.914***	0.953***
	(46.09)	(25.52)	(48.21)	(22.22)	(56.96)
L.MacroPru	-0.065	-0.189*	0.051	-0.246*	-0.069
	(-1.00)	(-2.09)	(0.74)	(-2.30)	(-1.05)
L.GDPGrowth	0.077*	0.090	0.072**	0.096	0.090***
	(2.22)	(1.16)	(2.69)	(1.26)	(4.49)
L.InflationRate	-0.026	-0.008	0.015	0.016	0.076
	(-0.41)	(-0.08)	(0.34)	(0.16)	(1.73)
L.MonPolRate	-0.113	-0.207	-0.099	-0.184	-0.089
	(-1.26)	(-1.47)	(-0.96)	(-1.33)	(-0.72)
Exrate	-0.017	0.017	-0.104*	0.011	-0.087
	(-0.37)	(0.65)	(-2.42)	(0.39)	(-1.68)
Crisis	-1.713**	-2.359	-1.201**	-4.221*	-0.964*
	(-3.01)	(-1.91)	(-3.10)	(-2.29)	(-2.54)
Constant	0.234	0.949**	0.131	1.103*	0.245
	(1.18)	(3.00)	(0.66)	(2.57)	(1.18)
Observations	4126	2007	2119	1544	1598

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.17: Estimation of the model for house price growth for the sample period 2005 - 2019

	Dependent variable: House price growth				
		Monetary Policy			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.883***	0.908***	0.863***	0.925***	0.861***
	(80.87)	(29.03)	(23.88)	(37.51)	(20.95)
L.MacroPru	-0.023	-0.116*	0.068	-0.150*	-0.004
	(-0.50)	(-2.32)	(1.13)	(-2.46)	(-0.05)
L.GDPGrowth	0.055	0.092	0.069	0.136*	0.097*
	(1.63)	(1.53)	(1.81)	(2.57)	(2.21)
L.InflationRate	-0.084*	-0.124*	-0.136***	-0.168**	-0.128*
	(-2.54)	(-2.49)	(-3.45)	(-2.95)	(-2.32)
L.MonPolRate	0.028	0.284	-0.206	0.357	-0.265*
	(0.25)	(1.77)	(-1.89)	(1.71)	(-2.09)
Exrate	-0.030	0.049	-0.124*	0.068*	-0.102
	(-0.63)	(1.40)	(-2.36)	(2.38)	(-1.49)
Crisis	-0.868***	-1.809*	-1.080*	-4.154**	-0.686
	(-3.41)	(-2.12)	(-2.14)	(-2.94)	(-1.10)
Constant	0.777***	0.427	1.046***	0.283	0.933**
	(4.24)	(1.83)	(3.62)	(0.98)	(3.02)
Observations	3387	1568	1819	1170	1374

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: *The Arellano and Bond test and Sargan-Hansen test results are available upon request by the author.*

Table A.18: Estimated effects of individual types of macroprudential policies on credit growth for a full sample of countries

Instrument type	Full sample	Tightening	Loosening
CCB	-5.175*	-7.177*	-2.454
	(-2.49)	(-2.21)	(-1.06)
Conservation	-1.296**	-1.959**	-0.669
	(-3.18)	(-3.14)	(-1.30)
Capital	-1.153*	-0.471	-0.604
	(-2.04)	(-0.51)	(-1.22)
LVR	-2.216	-2.467	-0.024
	(-0.78)	(-1.01)	(-0.01)
LLP	-0.882	-1.259	-0.704
	(-1.09)	(-1.26)	(-0.68)
LCG	-0.285	3.444	-1.900
	(-0.07)	(0.54)	(-0.69)
LoanR	-1.516*	-1.734*	-0.966
	(-2.13)	(-2.27)	(-1.19)
LFC	-1.715	-2.736	-1.242
	(-0.62)	(-1.05)	(-0.27)
LTV	-1.228*	-1.733	-0.839
	(-1.96)	(-1.94)	(-1.07)
DSTI	-1.372	-2.173	-1.403
	(-1.42)	(-1.69)	(-0.84)
Tax	-2.660	-4.091	-3.428
	(-1.39)	(-1.72)	(-1.08)
Liquidity	-1.121***	-1.261**	-0.992*
	(-3.70)	(-3.21)	(-2.45)
LTD	8.693	8.216	0.080
	(1.30)	(1.54)	(0.03)
LFX	2.319	1.376	8.384***
	(0.94)	(0.78)	(3.87)
RR	-0.276	-0.396	-0.302
	(-0.81)	(-0.94)	(-0.58)
SIFI	-1.446***	-2.375***	-0.670
	(-3.39)	(-3.59)	(-1.07)
OT	-2.168	-1.974	-1.660
	(-1.40)	(-1.36)	(-0.53)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of credit growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Table A.19: Estimated effects of individual types of macroprudential policies on credit growth for advanced economies

Instrument type	Full sample	Tightening	Loosening
CCB	-2.495*	-3.221	-0.795
	(-2.29)	(-1.46)	(-0.79)
Conservation	-1.717**	-1.167	-1.108**
	(-2.90)	(-1.65)	(-3.10)
Capital	-1.069	0.163	-0.509
	(-1.92)	(0.24)	(-1.22)
LVR	-0.303	-3.595	3.365
	(-0.16)	(-1.63)	(1.45)
LLP	-2.525**	-1.902*	-1.362*
	(-3.20)	(-2.15)	(-2.42)
LCG	-5.315	1.406	-7.516
	(-0.85)	(0.15)	(-0.88)
LoanR	-2.170*	-2.306	-0.961
	(-2.24)	(-1.30)	(-1.36)
LFC	-1.696	-2.195	-3.824
	(-1.42)	(-1.23)	(-0.84)
LTV	-1.629*	-2.006	-0.683*
	(-2.37)	(-1.36)	(-2.00)
DSTI	-1.472	-1.389	-1.559
	(-1.45)	(-0.97)	(-1.92)
Tax	-4.494	-6.757	-1.183
	(-1.69)	(-1.37)	(-0.89)
Liquidity	-1.262**	-1.170	-1.229***
	(-2.92)	(-1.74)	(-3.48)
LTD	-1.011	-65.69	4.914
	(-0.13)	(-0.59)	(1.13)
LFX	-0.541	-4.161	1.777
	(-0.18)	(-1.44)	(0.50)
RR	-1.604	-0.733	-0.470
	(-1.52)	(-0.58)	(-0.91)
SIFI	-1.724***	-1.410*	-1.001**
	(-3.79)	(-2.11)	(-3.11)
OT	-5.144*	-3.506	-2.418
	(-2.02)	(-1.10)	(-1.55)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of credit growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Table A.20: Estimated effects of individual types of macroprudential policies on credit growth for emerging market economies

Instrument type	Full sample	Tightening	Loosening
CCB	4.655	8.047	-2.148
	(0.39)	(0.42)	(-0.19)
Conservation	-3.786**	-4.319*	-1.810*
	(-2.93)	(-2.36)	(-2.30)
Capital	-2.168	-0.882	-1.394
	(-1.88)	(-0.51)	(-1.61)
LVR	-6.580	-9.101	-2.907
	(-1.69)	(-1.55)	(-0.64)
LLP	-0.337	-1.894	-1.487
	(-0.19)	(-0.75)	(-0.38)
LCG	-4.822	35.75	-3.798
	(-0.57)	(1.57)	(-0.67)
LoanR	-1.478	-1.461	-1.325
	(-1.14)	(-0.52)	(-0.70)
LFC	-6.629	-0.323	-2.630
	(-1.44)	(-0.05)	(-0.52)
LTV	-1.502	0.876	-1.136
	(-1.02)	(0.61)	(-0.89)
DSTI	-4.741	-3.268	-4.405
	(-1.70)	(-0.97)	(-1.92)
Tax	2.598	-2.746	5.241
	(0.34)	(-1.54)	(0.61)
Liquidity	-2.159**	-2.085	-2.366**
	(-3.02)	(-1.74)	(-3.21)
LTD	4.210	-8.560	-3.674
	(0.20)	(-0.73)	(-0.25)
LFX	3.630	2.866	6.895
	(1.40)	(1.17)	(1.89)
RR	-0.359	-0.727	-0.204
	(-0.71)	(-1.13)	(-0.28)
SIFI	-4.475**	-4.645	-1.917
	(-2.91)	(-1.94)	(-1.82)
OT	-7.360*	-6.542*	-3.005
	(-2.37)	(-2.13)	(-0.78)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of credit growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Table A.21: Estimated effects of individual types of macroprudential policies on house price growth for a full sample of countries

Instrument type	Full sample	Tightening	Loosening
CCB	-5.312	-1.962	-9.635
	(-1.82)	(-1.49)	(-1.90)
Conservation	-1.135*	-0.516	-1.389*
	(-2.43)	(-1.21)	(-2.52)
Capital	-0.620	-0.948	-0.122
	(-1.25)	(-1.10)	(-0.29)
LVR	-1.227	-2.943	0.873
	(-0.74)	(-1.86)	(0.45)
LLP	-2.312*	-1.689*	-2.731*
	(-2.30)	(-2.11)	(-2.16)
LCG	12.49	-5.204	18.31
	(1.71)	(-1.38)	(1.55)
LoanR	-1.213*	-1.500*	0.451
	(-2.04)	(-2.26)	(0.50)
LFC	-2.920	-7.230	29.000
	(-1.30)	(-1.80)	(1.78)
LTV	-0.681	-0.497	-0.006
	(-1.43)	(-1.24)	(-0.01)
DSTI	-2.580*	-1.515	-1.365
	(-2.26)	(-1.48)	(-1.08)
Tax	-3.512	-4.745	-0.426
	(-1.40)	(-1.83)	(-0.27)
Liquidity	-0.935**	-0.533*	-1.233*
	(-2.73)	(-2.05)	(-2.42)
LTD	-0.414	-4.827	0.172
	(-0.22)	(-1.06)	(0.07)
LFX	0.441	-0.574	0.163
	(0.29)	(-0.49)	(0.10)
RR	0.806	-0.473	3.539**
	(1.66)	(-1.36)	(2.69)
SIFI	-1.451**	-0.930	-1.039
	(-2.68)	(-1.74)	(-1.94)
OT	-2.123*	-0.824	-2.989
	(-2.39)	(-1.29)	(-1.72)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of house price growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Table A.22: Estimated effects of individual types of macroprudential policies on house price growth for advanced economies

Instrument type	Full sample	Tightening	Loosening
CCB	-1.362	-1.454	1.335
	(-1.02)	(-1.69)	(0.93)
Conservation	-0.976*	-1.323**	0.236
	(-2.21)	(-2.75)	(0.38)
Capital	-1.150*	-1.639	0.859
	(-1.99)	(-1.91)	(1.18)
LVR	-4.014	-4.339*	1.925
	(-1.70)	(-2.15)	(0.77)
LLP	-1.538**	-1.471**	-0.898
	(-2.91)	(-3.15)	(-1.25)
LCG	1.143	-3.630	-3.152
	(0.25)	(-0.79)	(-0.43)
LoanR	-1.600*	-1.575**	-1.228
	(-2.27)	(-2.75)	(-0.88)
LFC	-8.359	-2.029	-16.80
	(-1.38)	(-1.47)	(-1.21)
LTV	-1.108**	-1.076*	-0.609
	(-2.93)	(-2.19)	(-0.90)
DSTI	-1.902**	-1.490	-1.200
	(-3.14)	(-1.77)	(-1.42)
Tax	-1.291	-3.219**	2.897
	(-1.22)	(-2.66)	(1.01)
Liquidity	-1.011**	-1.234**	-0.256
	(-2.83)	(-2.81)	(-0.79)
LTD	-7.686	-11.740	-5.287
	(-1.05)	(-0.83)	(-1.03)
LFX	-2.331	-2.960	1.110
	(-0.48)	(-1.23)	(0.21)
RR	0.0994	0.164	0.407
	(0.20)	(0.20)	(0.86)
SIFI	-0.976*	-1.144**	0.243
	(-2.33)	(-2.66)	(0.39)
OT	-2.614*	-3.014*	-0.131
	(-2.23)	(-2.37)	(-0.14)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of house price growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Table A.23: Estimated effects of individual types of macroprudential policies on house price growth for emerging market economies

Instrument type	Full sample	Tightening	Loosening
CCB	-12.320	-6.936	-16.400
	(-1.89)	(-0.63)	(-1.77)
Conservation	-1.077	0.507	-0.975
	(-1.40)	(0.71)	(-0.93)
Capital	0.567	0.333	-0.448
	(0.33)	(0.23)	(-0.43)
LVR	-0.0528	1.128	-3.265
	(-0.03)	(0.42)	(-1.71)
LLP	-2.641	-0.646	-3.866
	(-1.26)	(-0.28)	(-1.62)
LCG	2.869	-7.582	2.844
	(1.20)	(-1.78)	(1.52)
LoanR	-0.921	-0.440	0.0259
	(-0.63)	(-0.69)	(0.03)
LFC	1.349	-4.251	1.035
	(0.33)	(-1.26)	(0.33)
LTV	-0.889	0.296	0.907
	(-0.74)	(0.47)	(1.09)
DSTI	-2.144	3.152	0.372
	(-0.62)	(1.30)	(0.25)
Tax	-0.506	0.679	0.150
	(-0.15)	(0.40)	(0.06)
Liquidity	-0.422	0.615	-1.525*
	(-0.54)	(1.13)	(-2.07)
LTD	3.775	-0.283	2.061
	(0.83)	(-0.18)	(0.59)
LFX	-0.327	0.332	-0.697
	(-0.21)	(0.24)	(-0.59)
RR	0.143	-0.194	0.780*
	(0.19)	(-1.09)	(2.56)
SIFI	-0.0409	0.781	-1.023
	(-0.03)	(0.57)	(-1.05)
OT	-0.952	1.172	-3.474
	(-0.90)	(0.57)	(-1.16)

Note: *The estimates are determined using GMM method. As independent variables in the model are used: lag of house price growth, GDP growth, change of inflation rate, change of monetary policy rate, change of exchange rate, and crisis dummy. Each instrument is added separately to the baseline regression, but their coefficients are represented in the same column for compactness. The estimates of the rest of independent variables and the test results are available upon request by the author.*

Appendix B

Figures

Figure B.1: Frequency of use of individual macroprudential policy instruments after 2009

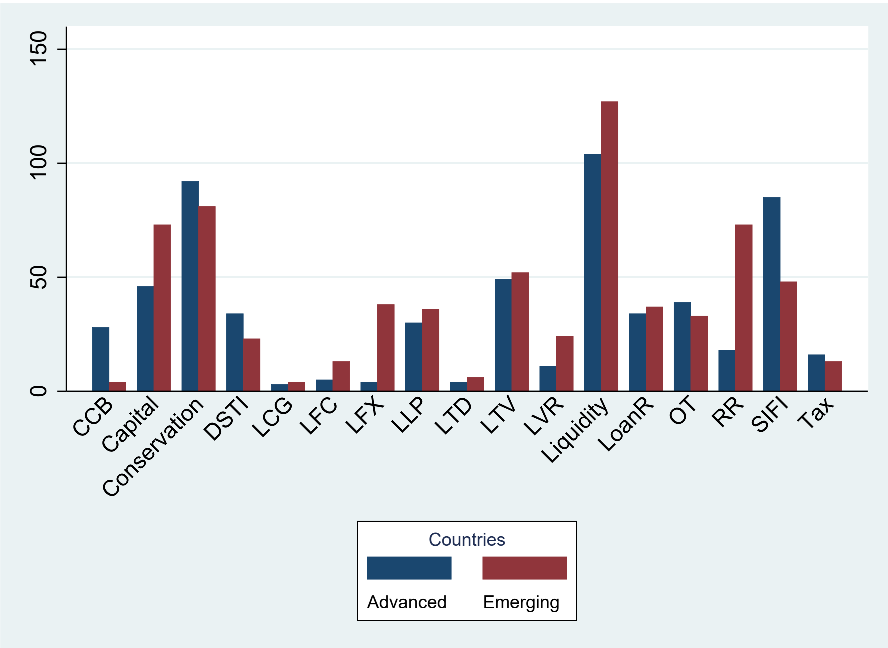


Figure B.2: Development of Macroprudential Policy Index taking into account only tightening of instruments

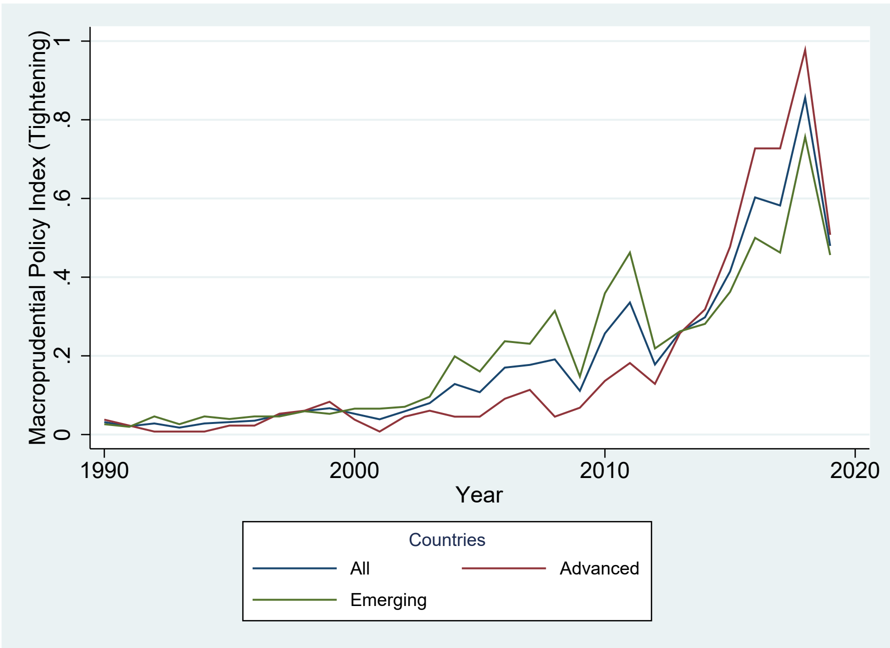
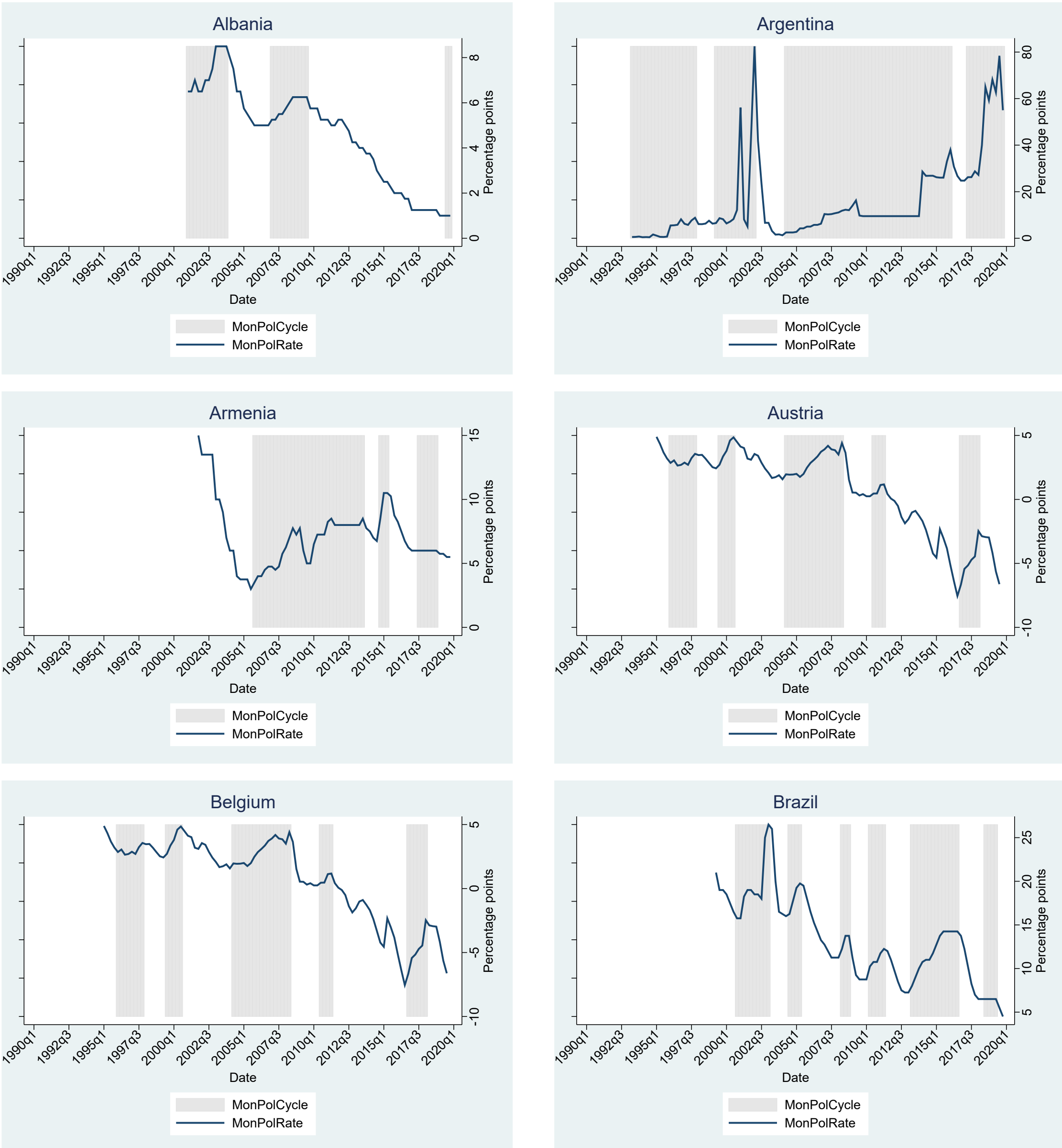


Figure B.3: Monetary Policy Rate and Monetary Policy Cycle



Note: *Monetary policy cycles presented in Figures B.3-B.13 are identified using BBQ method (Bry & Boschan, 1971)*

Figure B.4: Monetary Policy Rate and Monetary Policy Cycle

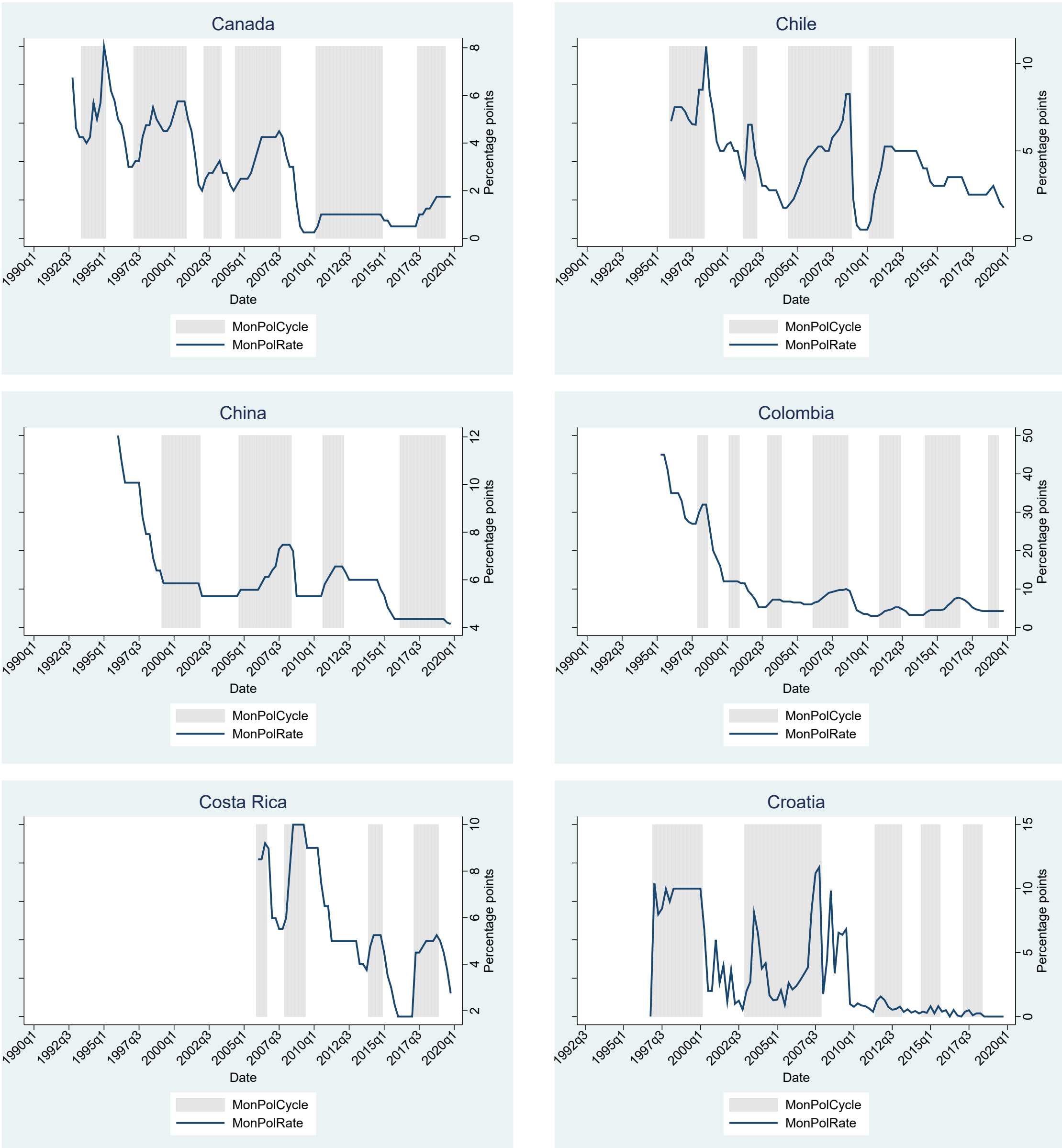


Figure B.5: Monetary Policy Rate and Monetary Policy Cycle

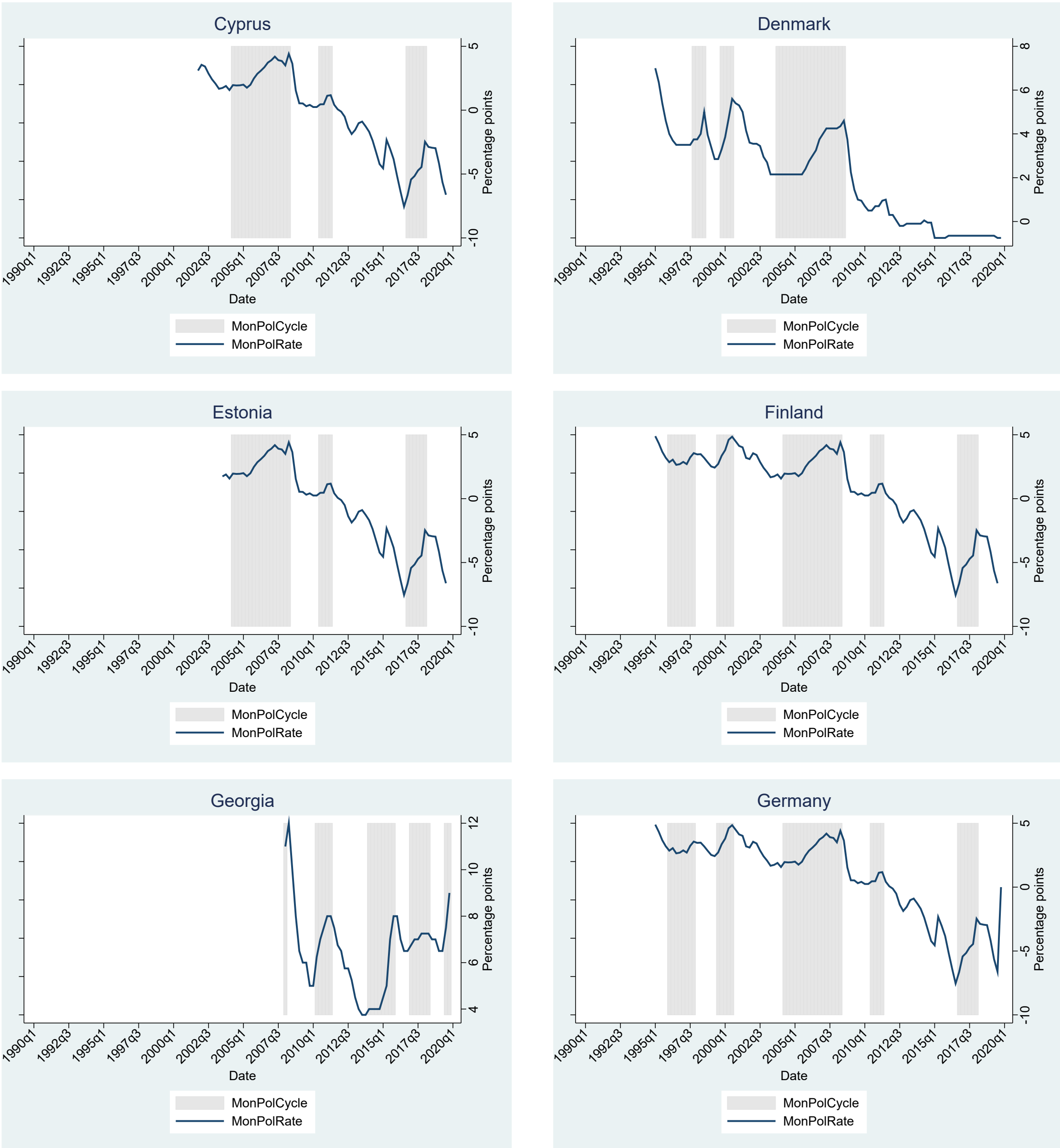


Figure B.6: Monetary Policy Rate and Monetary Policy Cycle

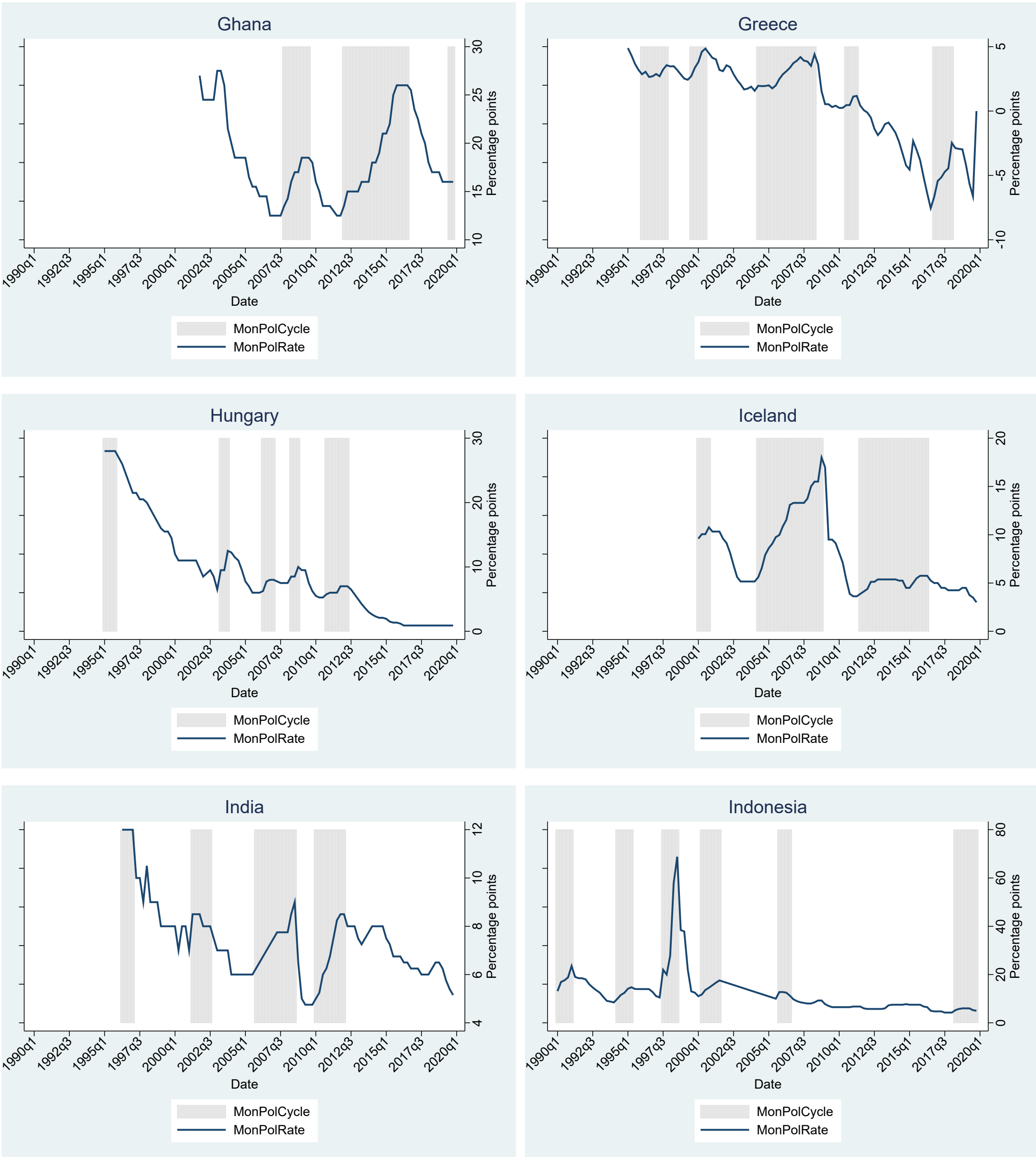


Figure B.7: Monetary Policy Rate and Monetary Policy Cycle

Figure B.8: Monetary Policy Rate and Monetary Policy Cycle

Figure B.9: Monetary Policy Rate and Monetary Policy Cycle

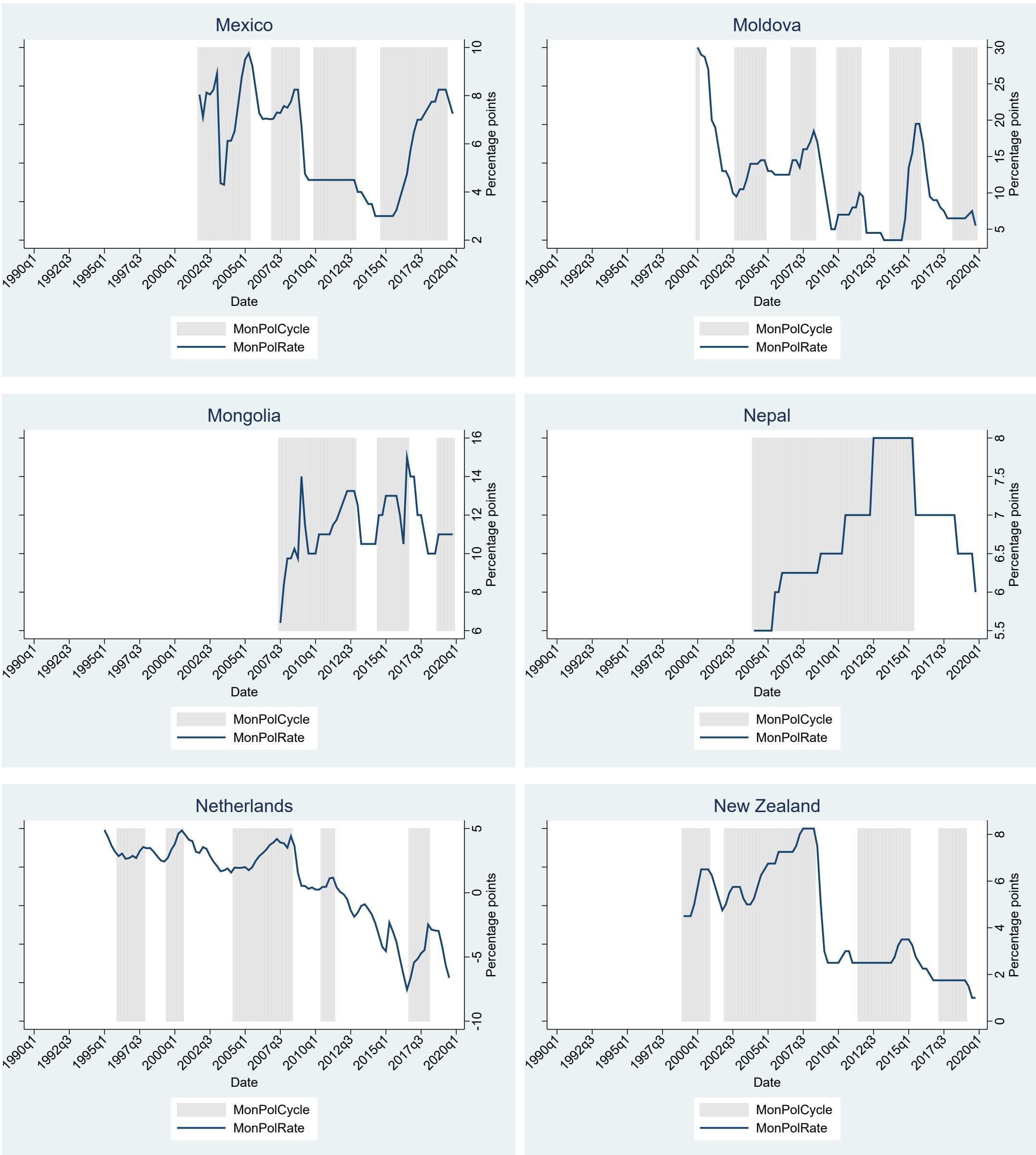


Figure B.10: Monetary Policy Rate and Monetary Policy Cycle

Figure B.11: Monetary Policy Rate and Monetary Policy Cycle

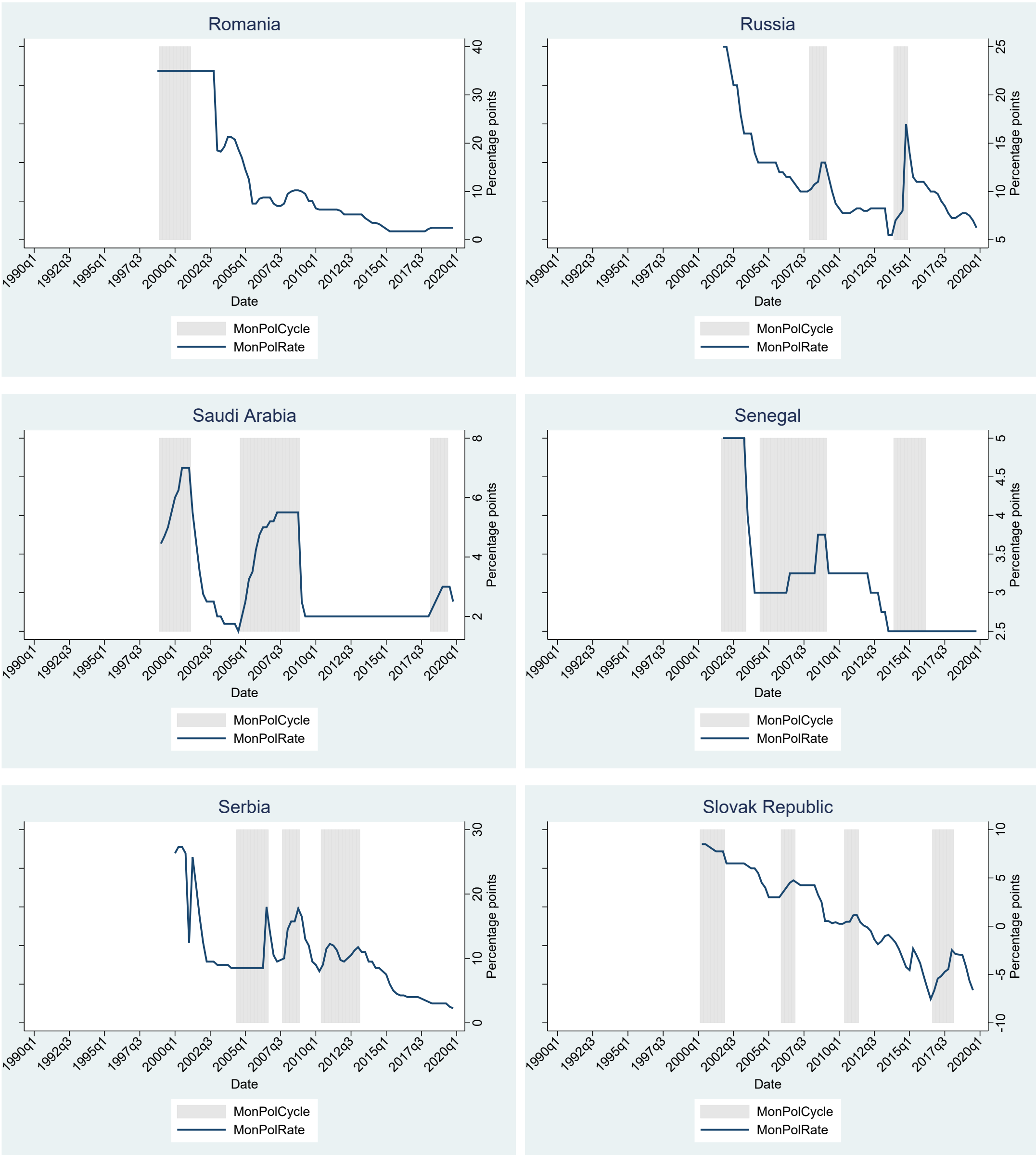


Figure B.12: Monetary Policy Rate and Monetary Policy Cycle

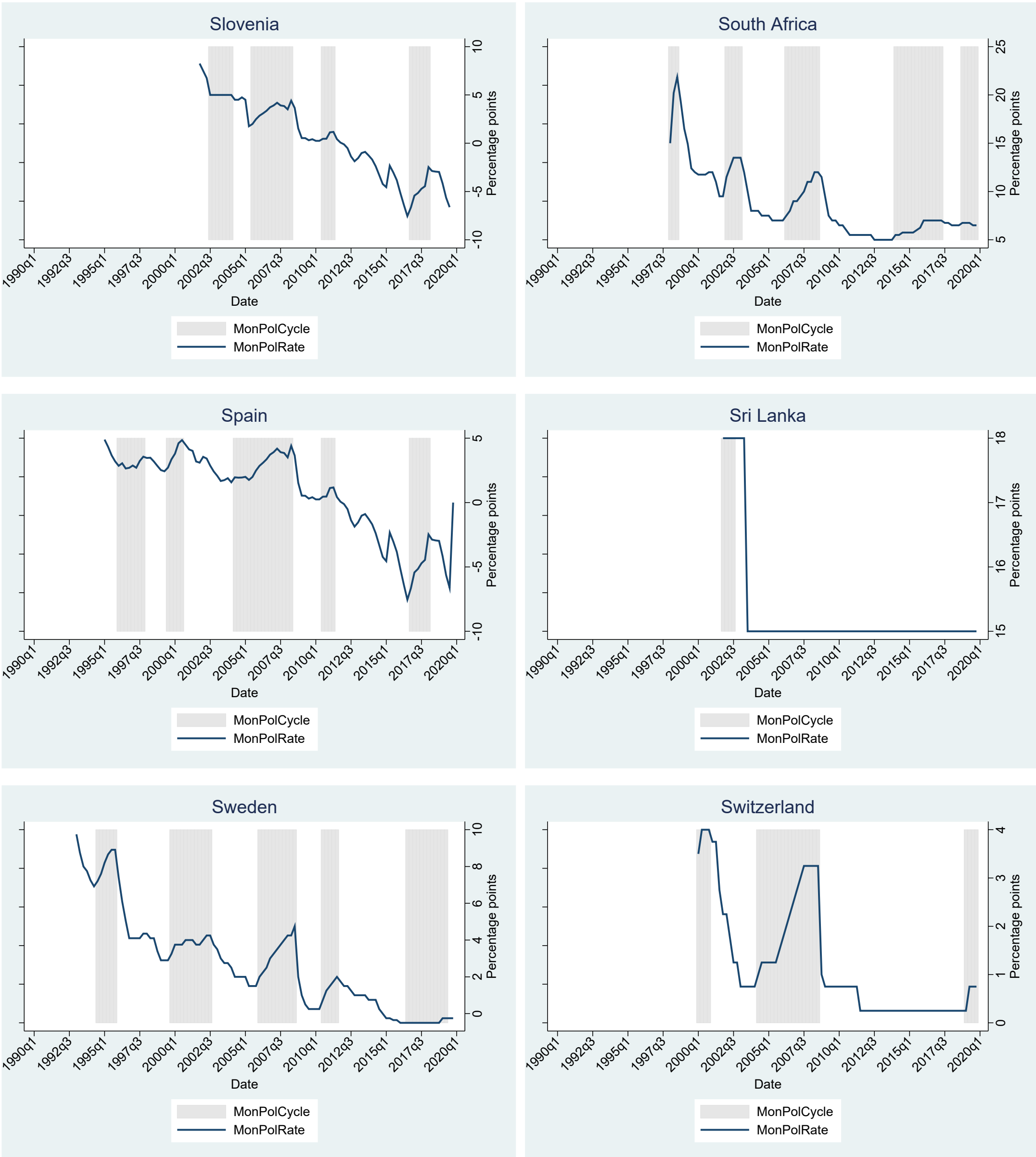


Figure B.13: Monetary Policy Rate and Monetary Policy Cycle