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DOES MONETARY POLICY REINFORCE THE EFFECTS OF MACROPRUDENTIAL POLICY?

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Does Monetary Policy Reinforce the Effects of Macroprudential Policy

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Abstract:
This paper contributes to studying the interaction between monetary and macroprudential policies by examining whether the impact of macroprudential policy on credit and house price growth differs between the two key phases of monetary policy cycle, i.e. monetary policy tightening and loosening. The dataset covers 33 advanced and 33 emerging market countries in the period 1990 – 2019 in quarterly frequency. Using the GMM estimation method, the results show that tightening of monetary policy does on average reinforce the effects of macroprudential policy on credit and house prices. Furthermore, we show that this reinforcing effect works for some but not all types of macroprudential policy measures, and that the results differ between advanced countries and emerging markets.

JEL: E52, E58, G21, G28, E32
Keywords: Macroprudential Policy, Monetary Policy Cycle, Credit Growth, House Price Growth, Interaction of Policies

The opinions expressed here are ours and not necessarily those of the Czech National Bank.

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 macroprudential policy framework has been developed only recently and is still in progress, some policy questions remain yet unanswered, or the evidence is mixed, such as on the links between macroprudential and other macroeconomic policies (Aikman et al., 2016). Besides macroprudential policy, monetary policy has an effect on the financial sector and the economy as well. Currently, central banks worldwide are using both macroprudential and monetary policies; however, it is unclear how the interaction between these two policies works in practice, and which effects on the economy it has, e.g. whether these two policies reinforce each other's effects or rather weaken them.

The aim of this paper is to investigate the interaction between macroprudential and monetary policy, a topic that is under-researched in the current literature but is extremely important given that both policies are often conducted by the same authority and work through similar channels. We adopt a unique and innovative approach by evaluating the effectiveness of macroprudential policy across the two phases of a well-defined monetary policy cycle, i.e. monetary policy tightening and loosening. When conducting monetary policy, central banks increase or decrease monetary policy rates in a smooth way over several quarters or even years, creating a monetary policy cycle in which periods of monetary tightening are regularly alternating with periods of monetary loosening. The effectiveness of macroprudential policy is measured by its impact on what is typically called "intermediate targets," i.e. credit growth and house prices. Our paper explores whether there is a difference in the effectiveness of macroprudential policy in different phases of monetary policy cycle in advanced and emerging market economies and when using different macroprudential policy tools. This allows us to answer a question whether monetary policy reinforces the effects of macroprudential policy or not. We limit our focus to this direction of interaction, leaving the opposite one (whether macroprudential policy reinforces the effects of monetary policy or not) for future research.

The analysis is based on a sample of 66 countries all over the world (of which 33 advanced and 33 emerging market economies) for the period 1990 – 2019 using quarterly data. For all these countries, we are able to observe and measure a monetary policy cycle even if some of those do not conduct their own independent monetary policy. However, this is not a problem given our focus, it might actually be of an advantage as then the monetary policy can be considered exogeneous. Examples of such countries include countries that are part of the euro area, countries with their monetary policy pegged to other countries' or groups of countries' monetary policies (such as Denmark, or countries with fixed or strictly managed exchange rates); however, all countries in the sample have very regular monetary policy cycles with clear tightening and loosening periods. Credit and house price growth are used as dependent variables. Macroprudential policy data are based on the iMaPP database of Alam et al. (2019), while for monetary policy, we use data on monetary policy rates collected by the BIS or directly

from national sources. For countries that adopted quantitative easing between 2009 and 2019, we use a shadow interest rate estimated by Krippner (2012). Monetary policy cycles are identified using the BBQ algorithm for turning point analysis. The estimated models are estimated by a GMM method to avoid potential endogeneity and in addition to our main explanatory variables of interest – an index capturing macroprudential policy and the monetary policy rate - contain additional control variables such as real GDP growth, inflation rate, exchange rate, and crisis dummies. We also conduct the analysis separately for advanced and emerging markets, investigating if there is a difference between these two groups of countries, and also for different types of macroprudential policy measures.

The results show that on average, monetary policy reinforces the effects of macroprudential policy on both credit and house price growth across all type of countries. The reinforcing effect is visible for periods of monetary tightening rather than for monetary easing and is even more pronounced in the time period between 2005 and 2019. However, when looking at advanced and emerging markets separately, we get more mixed results. In advanced economies, macroprudential policy in general impacts credit and house price growth, but we have not found any reinforcing effect of monetary policy on credit or house prices. However, we see a lower impact of macroprudential tools on credit and house prices during monetary loosing, suggesting that indirectly, if a country is not in a monetary easing phase, the effects on credit and house prices are stronger (even if the regression has not picked this up directly). In emerging market economies, we do not find any effect of macroprudential policies on credit and house price growth, interestingly. Various types of macroprudential measures have different effects on credit and house price growth, depending on the monetary policy cycle phase. For example, borrower-based measures, reserve requirements, and measures labelled as "other" have a stronger impact on credit growth when applied during monetary policy tightening. In general, borrower-based measures, other measures, liquidity requirements, and provisioning have an effect on house price growth when monetary policy is tightening.

2 Literature review

Our paper relates to two main streams of existing literature. First, it contributes to the studies on effectiveness of macroprudential measures on the so-called "intermediate targets" of financial stability, i.e. credit growth and house prices. Araujo, et al. (2020), Cerutti, et al. (2017), Fendoğlu (2017) and Pochea & Nițoi (2021) belong to the first stream of literature to analyze the effect of prudential tools on credit and found that tightening of macroprudential policy tools have significant effect on credit. Araujo, et al. (2020) shows a weaker and imprecise effects of Loan-to-Value (LTV) and Debt-Service-to-Income (DSTI) on house prices than their effects on reduction of household credit. The analyses of Claessens, et al. (2013) and Kuttner & Shim (2016) suggest that Debt to Income (DTI) and LTV are effective in the limitation of credit growth. Cerutti, et al. (2020) shows the different sizes of the strength of the prudential tools in emerging market and advanced economies. Akinci & Olmstead-Rumsey (2018) find that provision requirements, LTV caps, risk weight on mortgages and other housing measures are efficient tools for reducing credit growth. 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 (Fendoğlu, 2017). Use of a combination of different macroprudential policy instruments is even more efficient in slowing down credit growth and the results suggest that macroprudential policy tools work as complements (Küçükbıçakcı et al., 2020). In Vietnam restriction on foreign currency loans reduces credit growth (Nguyen et al., 2021). The evidence for efficiency of ceiling credit growth rates for commercial banks is

mixed, as this measure seems to be effective only in the case of SIBs[1] and not small banks in Vietnam. Bank capital requirements are effective in slowing down credit growth in the analysis of Noss & Toffano (2016). Countercyclical provisions have a significant effect on reducing the effects of a credit crunch in Spain; however, the tool is unsuccessful in limiting the credit growth (Jiménez et al., 2017). In Uruguay tightening of credit requirements for banks has a significant effect on credit growth limitation (Dassatti Camors et al., 2019). Dynamic provisioning and countercyclical reserve requirements have a significant effect on reducing credit growth in Colombia, where macroprudential policies and monetary policy have worked as complements to reduce credit growth (Gómez et al., 2020).

A significant effects of interconnection limits and tax measures on the growth of house prices in emerging countries is shown in Cerutti, et al. (2020). Akinci & Olmstead-Rumsey (2018) and Kuttner & Shim (2016) show a significant effect of LTV and DSTI on house prices. In Central, Eastern and Southeastern Europe, Vandenbussche (2015) finds significant effect of capital adequacy ratio, maximum ratio of household loans to share capital, marginal reserve requirements (MRRs) on foreign funding, and MRRs linked to credit growth on house prices. In EU countries, macroprudential policy tools are generally effective in curbing credit and house prices (Poghosyan, 2020). However, the effect is delayed and reaches a peak after three years. The effects are found to be asymmetric in downturns and upturns. Kuttner & Shim (2016) find a significant effect of housing-related taxes on house prices.

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.

Second stream of literature to which our analysis contributes deals with the effect of monetary policy on financial stability and its intermediate targets, including the interaction between monetary and macroprudential policy. 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. However, Paul (2020a, 2020b) argues that higher policy rates may not reduce financial instability, as higher policy rates can increase market leverage of financial institutions and lead to the enlargement of assets that are the source of money market funds funding. 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.

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. A shift in the policy rate causes a change in the level of house prices in the opposite direction (Aspachs-Bracons & Rabanal, 2011; Musso et al. (2011). The size of the effect differs between the euro area and the rest of the countries. An insignificant impact of monetary policy on the house prices for the overall situation in the countries included is shown by Iacoviello & Minetti (2003). An impact of conventional and unconventional

[1] Systemically important banks.

monetary policy shocks on house prices is observed in eight OECD countries (Rahal, 2016), Scandinavian countries (Rosenberg, 2019) and between 1980 and 2014, also in some European countries (Nocera & Roma, 2018). Overall, the literature suggests that an increase in a policy rate has a negative effect on the level of house prices.

Whether the different results can be caused by spillovers between macroprudential and monetary policy, is a question that can be evaluated both from a theoretical and empirical point of view. One of the main conclusions of Martin et al. (2021) 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. Nier & Kang (2016) argue 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.

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 GFC 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. Bruno et al. (2017) and Altavilla et al. (2020) suggest that monetary and macroprudential policies work as complements. Gambacorta & Murcia (2020) also show that monetary policy and macroprudential policies reinforce each other and that tightening of the macroprudential tools tends to have a larger effect on credit growth during an economic upturn. In Israel the interaction between macroprudential and monetary policy is important; however, the interaction has an unclear effect on credit growth based on if the policies worked in the same direction or against each other (Benchimol et al., 2021).

Bussière et al. (2021) 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 the project summarized in Bussière et al. (2021), 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.

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., 2022). 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 (Jiang et al., 2019). The optimal combination of monetary and macroprudential policies may lead to stability of the real estate market according to a DSGE model (Pan & Zhang, 2020). In the existing literature, the debate if monetary policy reinforces the effects of macroprudential policy on house prices is still ongoing.

3 Data description and descriptive analysis

In our analysis, we use quarterly data for 66 countries; sample covers both emerging market (33) and advanced (33) economies from all over the world (for the list of countries, see Table A-*2*). Due to the data availability, 7 countries[2] are excluded from the house price analysis, meaning that the models for house price growth are based on a sample of 59 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 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 *8*).

Following the existing literature, credit 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 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 the private sector and depository corporations' domestic claims on the private sector are used as credit data. Credit data for bank credit to the 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 explanatory 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 influence the credit stock developments. Thus, exchange rate is included among the explanatory variables to control for this potential influence.

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 and data for housing prices from the OECD. Again, additional missing data were obtained directly from the central banks of the individual countries. Similarly

[2] These 7 countries are Argentina, Costa Rica, Jamaica, Kazakhstan, Nepal, Paraguay, and Ukraine.

as for the credit growth, the model includes inflation as a variable to account for the rise caused by the increase in the level of prices.

Figure 1: Dynamics of Credit Growth

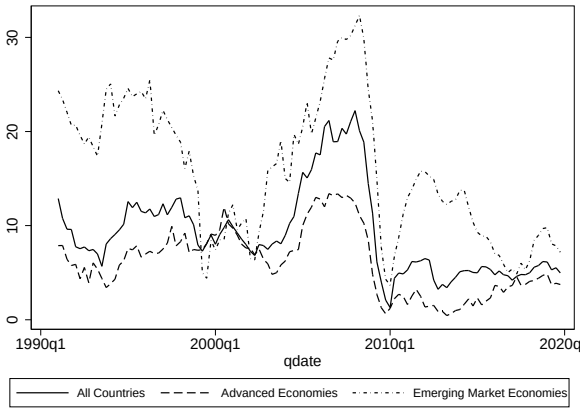
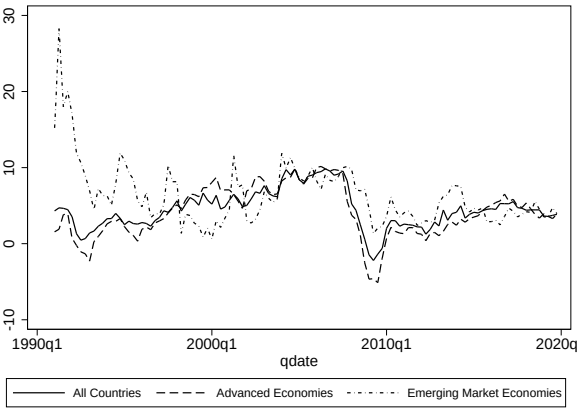


Figure 2: Dynamics of House Price Growth

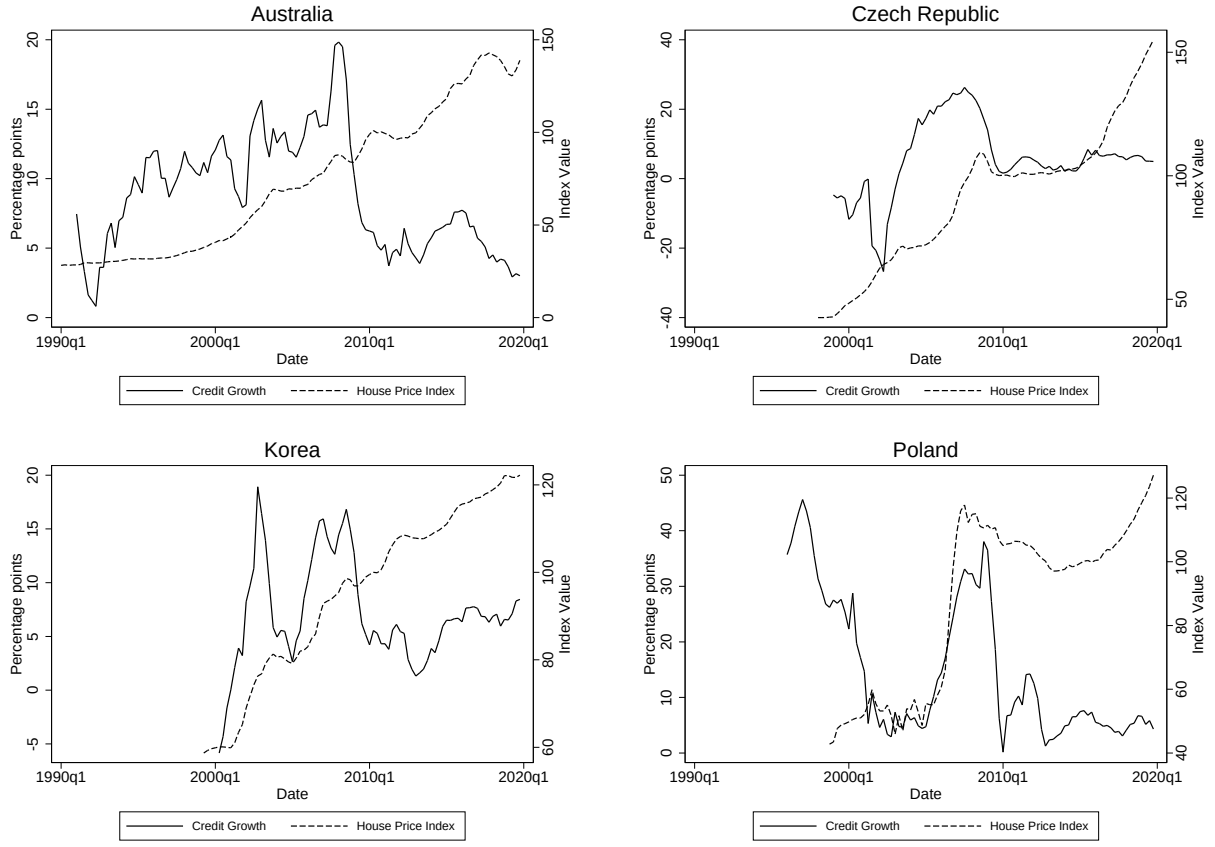


The dynamics of credit and house price growth are presented in Figure *1* and *Figure 2*. The figure shows median credit and house price growth across countries and its development over the period 1990 – 2019. Median credit growth in advanced economies is lower than median credit growth in emerging market economies most of the time, in line with the expectations due to catching up and financial deepening, although 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. 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 1990s and thus, the high median value is driven by the data from Asia. 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 GFC. After the fall of both variables connected to the GFC, a recovery has followed. However, in the periods after the GFC, the growth of credit and house prices in both advanced and emerging markets had a slower pace than in the 2000s.

To illustrate some specific developments, Figure *3* shows 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. A closer analysis of the development of house price index in a set of economies from our sample is based on Figure *3*. In all selected countries, house prices were strongly growing before the global financial crisis and the growth slowed down afterwards. In 2018 there was a fall in house prices, in Australia this cooling of the house price growth was a consequence of tighter macroprudential policy, to be more specific, tighter credit policies. The developments of house price index 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 2000s, 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.

Figure 3: Dynamics of Credit Growth and Developments of House Price Index



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). 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[3] categories like countercyclical capital buffers, capital conservation buffers, limits on leverage of banks, loan loss provisions, loan restrictions, etc.

[3] These 17 types of tools are more in detail described Table *A-3*.

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 a positive number, if it was loosening, the quarterly value is a negative number, 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. 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 groups of 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*.

The peaks and throughs of the monetary policy cycle were identified using the quarterly Bry-Boschan (BBQ) 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 loosening. The cycles were visually checked and adjusted, so the upturns and downturns correspond to the state of monetary policy based on the country's monetary policy reports and official communication. The calculated monetary policy cycles for some countries are presented in Figure *4*.[4] To evaluate if the monetary policy reinforces the effects of macroprudential policy, these variables are used to divide the sample into subsamples.

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, for the determination of monetary policy cycle, we have decided to use estimates of the shadow rates by Krippner (2012) for countries of the euro area,[5] Japan, the United Kingdom, and the United States. The development of the shadow rates is presented in Figure *5*.

In Figure *4*, to illustrate the results of the BBQ algorithm, the dynamics of monetary policy rate and identified monetary policy cycles in Australia, Czech Republic, Korea, and Poland are presented. The data for Australia show a long period of tightening monetary policy before the GFC. Monetary policy eased after the GFC 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 GFC, the third tightening period was a reaction to the growing recovered economy after the GFC, 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.

[4] Monetary policy cycles for the rest of countries are available upon request by the authors.

[5] The shadow rate for the euro area is used only for the period after 2007 or later when the countries were a part of the euro area; otherwise, monetary policy rate of their individual central bank is used. As is discussed in the previous paragraph, the cycles are adjusted. For example 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.

Within the sample period, three tightening phases are identified. The first one follows an introduction free-floating exchange rate of Polish Zloty. The first tightening phase was a reaction of the Czech National Bank (CNB) to the growth of the economy. The second period of monetary policy tightening aimed to bring inflation near to the inflation target.

Figure 4: Monetary Policy Rate and Monetary Policy Cycle

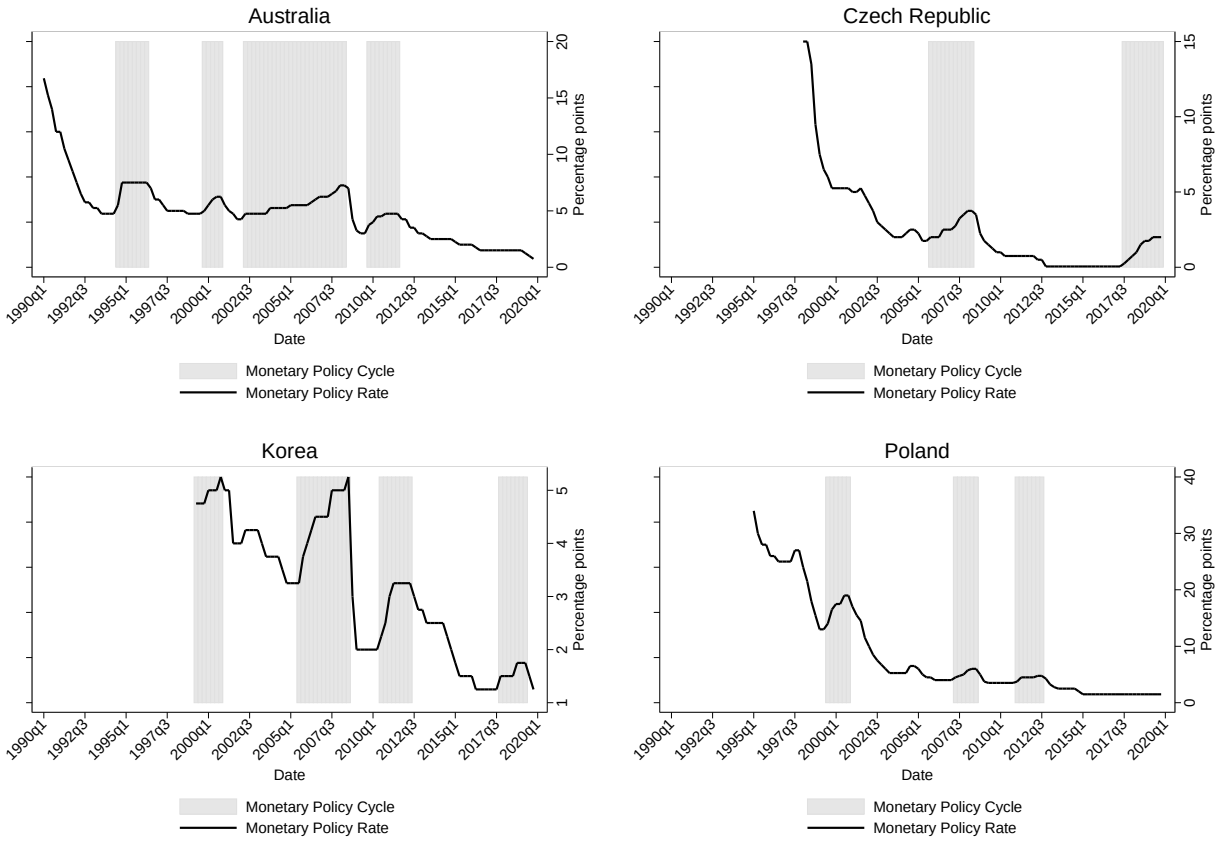
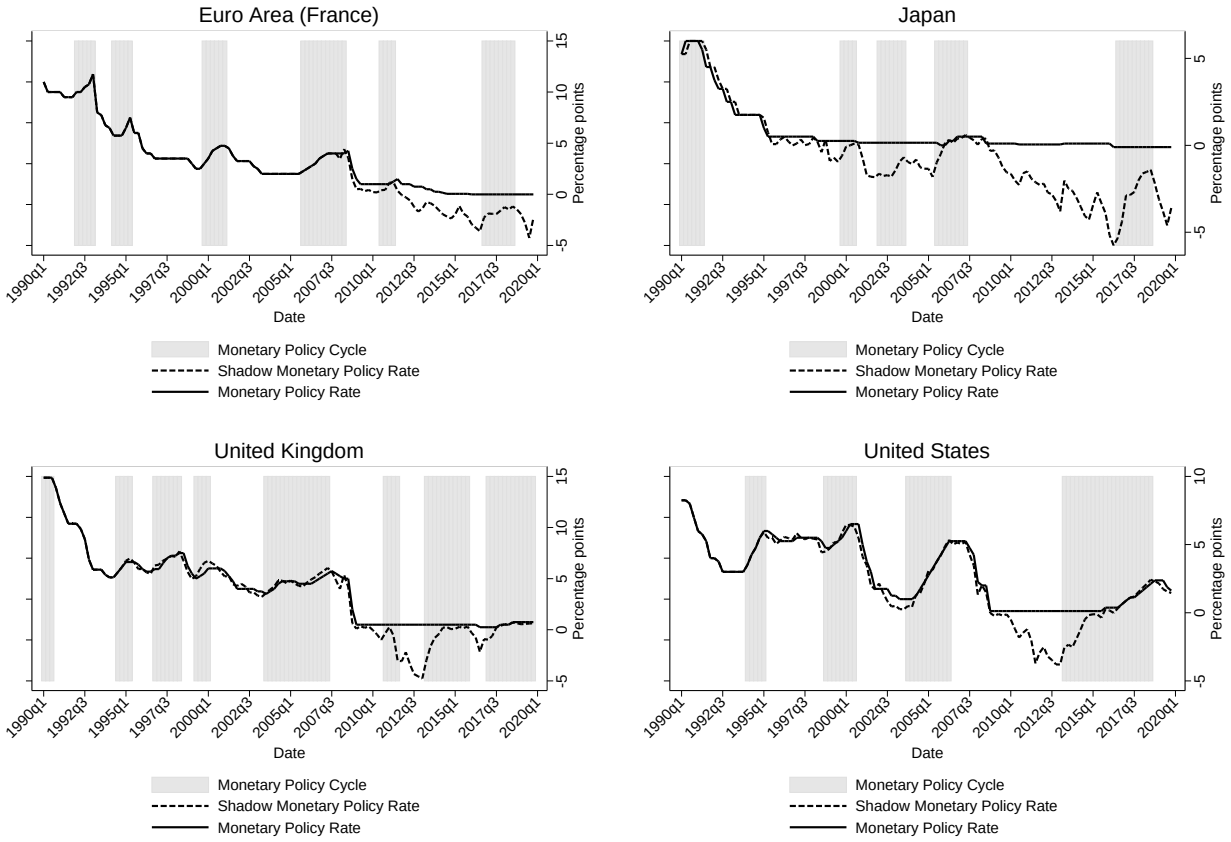


Figure *5* shows shadow monetary policy rates, nominal monetary policy rates and monetary policy cycles based on shadow monetary policy rates. In the shadow rate for the European Central Bank (ECB), a drop in 2014 captures the quantitative easing program of the ECB. Moreover, in 2014 the nominal monetary 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 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[6] is used as a control variable. The variable controls for FX effect on stock of credit and house prices[7] respectively. 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.

Figure 5: Shadow Monetary Policy Rate, Monetary Policy Rate, and Monetary Policy Cycle



During the last three decades macroprudential instruments have been used by countries all over the world. Asian countries have started to apply macroprudential tools already before the Asian financial crisis in 1997–98. Figure *6* illustrates the boom of the use of macroprudential instruments especially by emerging markets in the 2000s. Only after the GFC, 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.

[6] For the United States, the exchange rate against Euro is included in the variable.
[7] In some countries, especially emerging market countries, house prices are quoted in USD.

Figure *7* captures the development of average macroprudential policy index over the period 1990 – 2019 in the dataset. To show the overall increasing trend of the 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. Before 2013 the average macroprudential policy index in emerging market countries is most of the years higher than in advanced countries 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 *6*.

In Figure *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 measures 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 *9* 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 *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 *9* shows a similar amount of appearance as Figure *8*. Overall, more types of macroprudential policy measures have been implemented over time, especially after the GFC.

Figure 6: Number of countries using macroprudential policy tools

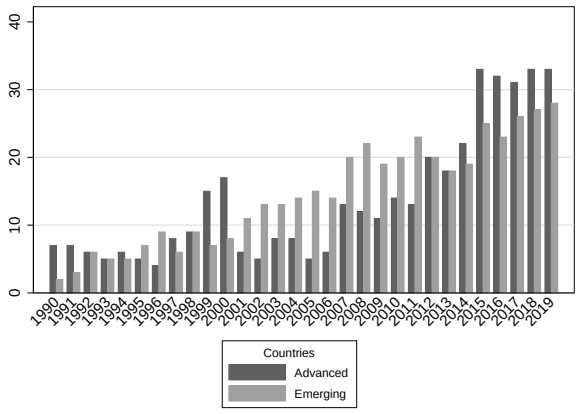


Figure 7: Development of Macroprudential Policy Index

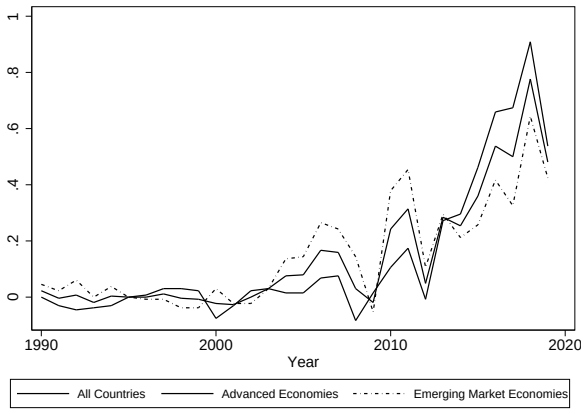


Figure 8: Frequency of use of individual macroprudential policy instruments

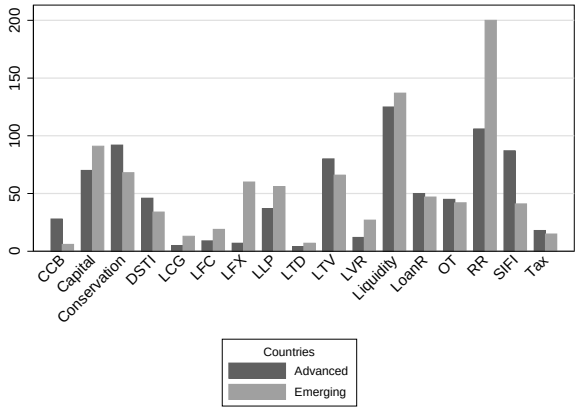


Figure 9: Frequency of use of individual macroprudential policy instruments after 2009

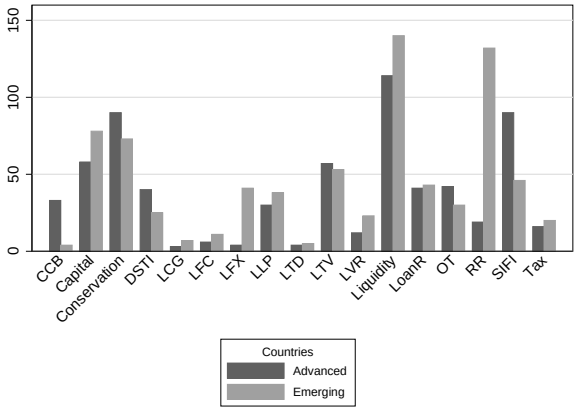


Figure 10: Use of Macroprudential Policy Tools

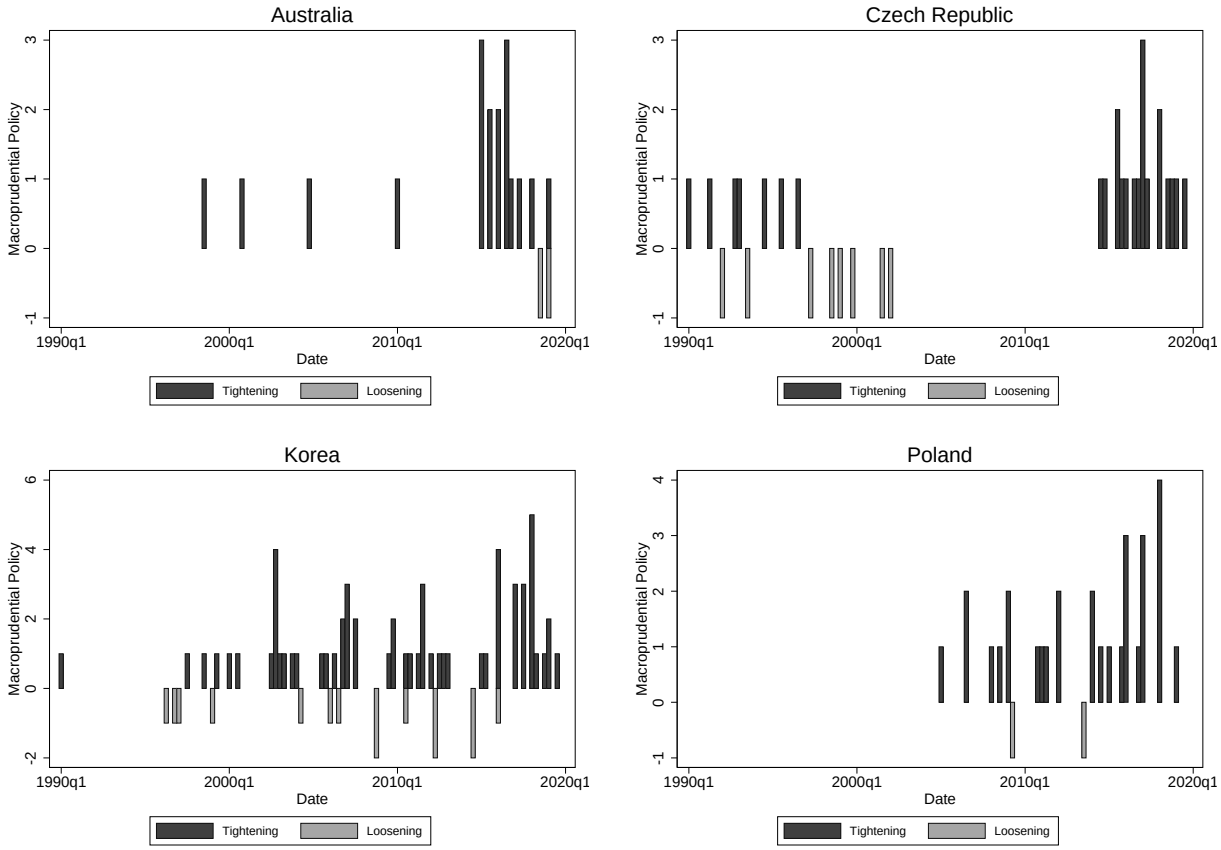


Figure *10* shows tightening and loosening of macroprudential policy tools in four selected countries. In this figure, tightening of a type of prudential instrument in a respective quarter is depicted as +1. On the other hand, loosening of a prudential tool is shown as -1. In Australia and Poland, within 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 related to the use of 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.

4 Methodology

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:

$$Y_{i,t} = Y_{i,t-1} + \beta_1 \times MacroPru_{i,t-1} + \beta_2 \times \Delta MonPolRate_{i,t-1} + \beta_3 \times GDPGrowth_{i,t-1} + \beta_4 \times Inflation\ Rate_{i,t} + \beta_5 \times \Delta Exchange\ Rate_{i,t} + \beta_6 \times Crisis_{i,t} + \alpha_{i,t} + \epsilon_{i,t}$$

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, 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, thus the decision was made to capture the effects of the macroprudential measures effectively. Δ*MonPolRate* 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 nominal terms, the inflation term is used in the equation to account for the effect of the change in the price level. Δ*ExchangeRate* stands for the year-on-year percentage change in the exchange rate of the domestic currency against the U.S. Dollar. 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. 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*[8] 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 stronger in the phase of the monetary policy tightening. Moreover, the equations have been also

[8] The *MonPolCycle* is not based on *MonPolRate* variable but instead on *MonPolRate_Shadow* variable. *MonPolRate_Shadow* captures unconventional monetary policy tools used in the euroarea, the U.S., the UK, and Japan. For other countries, the value is the same as in *MonPolRate* (it is a policy rate).

estimated for longer periods of tightening and 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.

Not all the types of macroprudential measures are taken with the aim to slow down the growth of the house prices and credit. Therefore, index as a representation of all the macroprudential measures taken (i.e. sum of the types of measures used) 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, variable *MacroPru* is substituted by the index of use of the various subgroup of instruments[9] obtained by a similar method as the original *MacroPru* variable.

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 increases 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

[9] List of subgroups is presented in Table *A-4*.

estimator, this approach has been taken in the estimation (Arellano & Bover, 1995). 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 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. In our model, 8 lags of dependent nad explanatory variables are added as the instrumental variables.

Arellano and Bond test results indicate that there is no higher-order serial correlation and the Sargan-Hansen test for the validity of the overidentifying restrictions confirms that all instruments are valid.

5 Results

5.1 Credit Growth

The estimation results start with credit growth as a dependent variable that appears more often in the existing literature. Table *1* presents the regression results based on the sample of all countries.[10] Tightening of macroprudential policy[11] has a significant negative effect on the credit growth, if we do not distinguish whether the monetary policy cycle is in phase of tightening or loosening. 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.

Table 1: Estimation of the model for credit growth for the full sample of 66 countries

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.909***	0.925***	0.959***	0.920***	0.988***
	(32.75)	(30.84)	(38.35)	(32.39)	(28.44)
L.MacroPru	-0.091*	-0.163*	-0.027	-0.124*	-0.020
	(-2.43)	(-2.39)	(-0.76)	(-2.25)	(-0.44)
L.GDPGrowth	0.085	0.057	0.099	0.046*	0.020
	(1.43)	(1.53)	(1.76)	(2.13)	(0.29)
InflationRate	0.092	0.063	0.003	0.053	0.040
	(1.32)	(0.96)	(0.05)	(0.80)	(0.53)

[10] The first column shows the model based on the whole sample of countries and does not distinguish between the phases of monetary policy cycle. 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 columns show the results for the subsamples, when 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 results section.

[11] The macroprudential index has a positive value if macroprudential measures are tightening and grows with the number of different macroprudential policy tools used.

L.diff_MonPolRate	-0.186**	-0.218**	-0.164	-0.214**	-0.128
	(-2.61)	(-2.83)	(-1.74)	(-3.23)	(-1.20)
diff_ExRate	-0.017	0.007	-0.009	0.001	-0.083*
	(-0.40)	(0.16)	(-0.43)	(0.03)	(-3.28)
crisis	-3.636***	-5.628**	-0.858	-4.951*	0.143
	(-3.35)	(-2.86)	(-0.63)	(-2.52)	(0.09)
Constant	0.462	0.761*	0.003	0.738*	0.162
	(1.90)	(2.27)	(0.01)	(2.36)	(0.60)
Observations	5447	1977	3470	1356	2804
J Test	0.31	0.64	0.40	0.77	0.20
AR(2)	0.36	0.97	0.99	0.30	0.94

t statistics in parentheses

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

If the monetary policy cycle was the previous quarter in the phase of tightening, the effect of the macroprudential policies is significant. The effect of the macroprudential policy is insignificant if the monetary policy was in the phase of loosening in the previous. 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 cycle is in the phase of tightening for the previous four quarters. 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). Year-on-year changes of monetary policy rate show that tightening of monetary policy rate has a slowing down effect on credit growth, further supporting the reinforcing effect of monetary policy on macroprudential policy. The significance of the credit growth from the previous quarter suggests that the trend in the growth of credit is persistent.

5.2 House Price Growth

Macroprudential policy aims also at slowing down the growth in the housing sector. Table *2* presents the estimation results for the whole sample of 59 countries (apart of the 7 countries mentioned earlier with no reliable house price data, and also the length of the time series is somewhat shorter than in the case of credit growth regressions due to data availability). The results for all countries from our sample show an insignificant effect of the combination of macroprudential policy instruments on house prices when we do not distinguish between the cycle phases of monetary policy. This result is in line with the research of Cerruti et al. (2017) and Araujo et al. (2020). Poghosyan (2020) shows by the impulse response analysis a significant effect of the macroprudential policy on housing prices after 3 years, which is a range out of our estimated effect. However, when monetary policy cycle is in the phase of tightening, macroprudential policy has a significant effect on house prices. The year-on-year loosening difference in the monetary policy rate has a positive effect on house price growth, the effect is insignificant when monetary policy is tightening. House price growth in the previous quarter 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 was in the previous quarter in the phase of tightening. These results support

the view that the monetary policy reinforces the effects of macroprudential policy on house price growth in all countries.

5.3 Advanced Economies

As was discussed before, there might be differences between advanced and emerging markets, the sample is divided into advanced and emerging market economies (Table A-2). Table 3 shows the estimation results of the relationship between macroprudential policy tools and credit growth in advanced economies. In the entire sample of advanced countries, the tightening of macroprudential policy has a negative significant effect on the credit growth. The effect is insignificant for the periods, where in the previous period or periods, the monetary policy cycle was in the phase of tightening. This is not in line with the estimations for the full sample covering both advanced and emerging markets. If monetary policy was in the previous four quarters in the phase of loosening, the effect of macroprudential policy is significant. This may be a consequence of too restrictive cut of the sample and also of the more broader use of macroprudential tools in advanced countries at times when monetary policy rate was at the zero lower bound, thus loosened monetary policy periods. From the control variables, lagged credit growth from the previous quarter has a positive significant effect, indicating persistence of credit development in a respective country. The effect of the year-on-year change of the policy rate is negative, suggesting that the change of the rate has an expected effect whether it is tightening or loosening.

Table 2: Estimation of the model for house price growth for the full sample of 59 countries

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.855***	0.860***	0.898***	0.848***	0.941***
	(16.36)	(25.28)	(22.96)	(26.32)	(25.25)
L.MacroPru	-0.025	-0.168*	0.046	-0.232*	0.068
	(-0.40)	(-1.98)	(0.76)	(-2.06)	(1.21)
L.GDPGrowth	-0.299*	0.098	-0.347*	0.252**	-0.393*
	(-2.49)	(1.68)	(-2.38)	(2.81)	(-2.16)
InflationRate	0.144	-0.103	0.103	-0.133	0.067
	(1.75)	(-1.33)	(1.46)	(-1.34)	(1.24)
L.diff_MonPolRate	-0.180*	-0.104	-0.227*	-0.159	-0.145*
	(-2.08)	(-0.66)	(-2.45)	(-1.00)	(-2.00)
diff_ExRate	-0.140**	0.051	-0.156**	0.055	-0.088*
	(-2.64)	(1.60)	(-2.93)	(1.68)	(-2.50)
crisis	-9.385***	-8.006	-6.112*	-9.173	-3.136
	(-2.59)	(-1.91)	(-2.22)	(-1.88)	(-1.69)
Constant	2.325**	1.202***	2.054***	0.894**	1.763**
	(2.79)	(3.34)	(3.62)	(3.04)	(3.25)
Observations	4695	1649	3046	1104	2474
J Test	0.26	0.33	0.31	0.23	0.28
AR(2)	0.13	0.16	0.29	0.30	0.38

t statistics in parentheses

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

Table 3: Estimation of the model for credit growth for the sample of advanced markets

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.944***	0.961***	0.940***	0.988***	0.966***
	(49.06)	(44.62)	(30.62)	(84.61)	(39.68)
L.MacroPru	-0.140*	-0.114	-0.074	-0.039	-0.112*
	(-2.50)	(-0.77)	(-1.02)	(-0.29)	(-2.48)
L.GDPGrowth	0.129*	0.124	0.193**	0.053	0.106
	(2.56)	(0.96)	(2.86)	(0.74)	(1.18)
InflationRate	-0.164	-0.116	-0.177	-0.427***	-0.099
	(-1.46)	(-0.56)	(-1.56)	(-3.57)	(-1.24)
L.diff_MonPolRate	-0.243**	-0.262	-0.141	-0.308	-0.057
	(-3.18)	(-1.02)	(-1.90)	(-0.73)	(-0.85)
diff_ExRate	-0.159*	-0.060	-0.091*	-0.066	-0.028
	(-2.13)	(-1.61)	(-2.36)	(-0.75)	(-0.99)
crisis	-2.655*	-2.666	-0.621	0.276	-1.934
	(-2.52)	(-0.61)	(-0.82)	(0.14)	(-1.89)
Constant	0.739***	0.334	0.369*	0.666	0.516*
	(3.86)	(0.56)	(2.46)	(0.84)	(2.16)
Observations	3023	1059	1964	707	1587
J Test	0.23	0.47	0.07	0.47	0.37
AR(2)	0.47	0.85	0.83	0.29	0.59

t statistics in parentheses

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

Table *4* presents the 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 take into account the phase of the monetary policy cycle. The effect is significant for the phases where the monetary policy cycle has been loosening in the previous one or four quarters. The effects of macroprudential policy are insignificant in the phases when monetary policy is tightening. This may be a consequence of a too restrictive cut of the sample, of the higher frequency of use of macroprudential tools after the GFC when monetary policy was mostly loosened (before the aftermath of the COVID19 crisis, which is a period that is not covered by our sample), and also not all types of macroprudential measures like capital ones are not aiming on housing sector. To evaluate the last thought, an analysis of individual subgroups of prudential tools is provided further in the paper. As for the control variables, lagged house price growth also has a positive significant effect that indicates some persistence of development in housing sector. Change in policy rate has an effect on house price development; the results show that especially when monetary policy is loosening, the lowering of policy rate further supports the pace of growth of house prices.

Table 4: Estimation of the model for house price growth for the sample of advanced markets

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.868***	0.938***	0.895***	1.006***	0.950***
	(27.64)	(15.62)	(23.05)	(22.76)	(22.23)
L.MacroPru	-0.252***	-0.215	-0.169*	-0.050	-0.182**
	(-3.69)	(-1.39)	(-2.09)	(-0.36)	(-2.64)
L.GDPGrowth	0.207***	0.087	0.130	0.134	-0.267*
	(3.35)	(0.75)	(1.37)	(1.25)	(-2.12)
InflationRate	-0.262*	-0.317	-0.309*	-0.606***	-0.303**
	(-2.16)	(-1.08)	(-2.38)	(-4.15)	(-2.86)
L.diff_MonPolRate	-0.600***	-0.303	-0.606***	-0.184	-0.573*
	(-3.82)	(-1.31)	(-3.77)	(-0.46)	(-2.39)
diff_ExRate	-0.056	0.059	-0.076*	0.060	-0.035
	(-1.92)	(1.95)	(-2.11)	(1.22)	(-0.58)
crisis	-5.540**	-6.903	-3.315	-0.552	-5.575*
	(-3.03)	(-1.11)	(-1.76)	(-0.18)	(-2.16)
Constant	1.210***	1.454*	1.088***	0.877	1.891***
	(3.49)	(2.14)	(3.55)	(1.52)	(4.00)
Observations	2978	1031	1947	678	1570
J Test	0.22	0.30	0.13	0.50	0.26
AR(2)	0.40	0.43	0.75	0.84	0.80

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 an insignificant combined effect on credit growth (Table 5) whether we distinguish between phases of monetary policy cycle or not. This result differs from the paper of Cerutti et al. (2017) where they compare the effects of macroprudential policies in advanced and emerging markets. In their analysis based on a significantly larger sample of countries and period until 2013, they found a difference in the strength of the effects in advanced and emerging markets, in both advanced and emerging markets their analysis finds a significant effect, in emerging markets the effect of macroprudential policy on credit is larger than in advanced economies. In our analysis, the data cover a longer period after the GFC where different macroprudential policy tools have been more frequently used by advanced countries than before GFC. Moreover, in our analysis is used a different definition of MPI than in 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, whereas in our analysis, MPI reflects tightening and loosening of the individual instruments. Both tightening and loosening of monetary policy rate have a significant effect on credit growth, in the case of loosening this does not hold when the monetary policy cycle is in the loosening

phase for at least four periods long. In all subsamples, the development of credit growth is highly influenced by the development in the previous quarter.

In comparison with advanced economies, the effects of macroprudential policy on credit growth are again insignificant in the phase of monetary policy tightening, thus, the results for both advanced and emerging markets are driven by a subsample of advanced and emerging economies and not by neither advanced nor emerging markets individually. From these results, monetary policy reinforcing effects of macroprudential policy cannot be observed for the subset of emerging markets for the index containing all macroprudential policies. Analysis for groups of macroprudential policy tools is done in the next part of the paper.

Table 5: Estimation of the model for credit growth for the sample of emerging markets

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	1.000***	1.047***	0.988***	1.029***	1.058***
	(27.60)	(17.80)	(17.22)	(15.38)	(24.01)
L.MacroPru	-0.094	-0.108	-0.061	-0.121	-0.015
	(-1.75)	(-1.06)	(-0.65)	(-0.97)	(-0.15)
L.GDPGrowth	0.080	0.043	0.085	0.042	-0.137
	(1.04)	(1.16)	(0.42)	(1.31)	(-1.20)
InflationRate	-0.060	-0.053	-0.022	-0.045	-0.028
	(-1.04)	(-1.14)	(-0.27)	(-0.94)	(-0.32)
L.diff_MonPolRate	-0.337*	-0.309**	-0.280*	-0.188*	-0.163
	(-2.37)	(-3.24)	(-2.48)	(-2.45)	(-0.83)
diff_ExRate	0.104	0.076***	0.057	0.030	-0.138*
	(1.26)	(3.66)	(1.65)	(1.80)	(-2.12)
crisis	-9.402***	-7.794***	-8.239	-7.533**	1.291
	(-3.77)	(-3.54)	(-1.53)	(-2.97)	(0.26)
Constant	-0.413	-0.957	-0.256	-0.762	0.527
	(-0.85)	(-0.89)	(-0.41)	(-0.81)	(1.05)
Observations	2424	918	1506	649	1217
J Test	0.25	0.51	0.10	0.51	0.31
AR(2)	0.96	0.74	0.98	0.88	0.55

t statistics in parentheses

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

Table 6: Estimation of the model for house price growth for the sample of emerging markets

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.993***	0.952***	1.026***	0.970***	1.050***
	(39.04)	(25.10)	(32.16)	(53.89)	(25.59)
L.MacroPru	0.111	0.038	0.120	-0.050	0.100
	(1.10)	(0.43)	(1.72)	(-0.77)	(1.03)
L.GDPGrowth	-0.273	-0.099	-0.176	-0.004	-0.159
	(-1.29)	(-1.56)	(-0.81)	(-0.12)	(-0.67)
InflationRate	0.092	0.104	-0.103	0.125	-0.114
	(0.97)	(1.17)	(-1.63)	(1.64)	(-1.95)
L.diff_MonPolRate	-0.072	-0.152	-0.105	-0.272	-0.009
	(-1.07)	(-1.07)	(-0.99)	(-1.60)	(-0.05)
diff_ExRate	-0.106*	-0.081	-0.038	0.004	-0.021
	(-2.11)	(-1.58)	(-1.11)	(0.20)	(-0.69)
crisis	-9.930	-2.542	-0.810	-9.191**	9.323
	(-1.42)	(-0.67)	(-0.12)	(-3.00)	(0.87)
Constant	1.383	0.444	1.082	-0.130	0.843
	(1.48)	(1.12)	(1.19)	(-0.39)	(0.98)
Observations	1717	618	1099	426	904
J Test	0.14	0.49	0.25	0.66	0.31
AR(2)	0.30	0.20	0.65	0.15	0.89

t statistics in parentheses

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

Table 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, the development of house prices cannot be explained by neither the growth of the economy, macroprudential nor monetary policies. Only the lagged house price growth shows the persistence of the development of housing sector in all subsamples. The insignificance of effects of all types of macroprudential policy measures in emerging markets on house prices is in line with the results of Cerutti et al. (2017). In advanced markets, if we consider all types of prudential measures in the index, macroprudential policy significantly influences house price development, which is not the case in emerging markets.

5.5 The effectiveness of the individual subgroups of macroprudential measures

In previous sections, the analysis is focused on the overall effect of a combination of all types of macroprudential policy instruments. However, not all the individual macroprudential measures target house price and credit growth. Therefore, the next part of the analysis focuses on the effect of different types or subgroups of macroprudential measures on credit and house price growth. The measures are grouped into 7 different subgroups: borrower-based, capital,

provisioning, limits on credit growth, liquidity requirements, reserve requirements, and general measures (which measures belong to individual groups are presented in Table A-*4*).

Estimated effects of different types of macroprudential policy measures on credit growth are presented in Table *7*. The table provides an overview of how the impact of various types of instruments differs within different phases of monetary policy cycle and whether these results are similar of different to the estimation of macroprudential policy index. Borrower-based measures, provisioning measures, reserve requirements, and measures labelled as other have a significant negative effect on credit growth, when these measures are tightening. When monetary policy was in the previous period in tightening phase, borrower-based measures, reserve requirements, and measures labelled as other have a significant effect on credit growth. When monetary policy cycle has been in the tightening phase all previous four quarters, capital measures, provisioning, and liquidity requirements have a negative significant effect on credit growth. Provisioning measures have a significant effect on credit growth when monetary policy is in the loosening phase. Obtained results show that for credit growth there holds that individual macroprudential instruments have a different effect on the dependent variable. Furthermore, the table shows that the tightening effects of some macroprudential measures are reinforced by tightening phase of monetary policy cycle and on the other hand, for other measures the results show a reinforcing effect of the loosening phase. This correspond to the results of the cumulative effect of all types of macroprudential measures, where the effect of MPI was significant in the phase of tightening of monetary policy cycle.[12]

In comparison with the existing literature, significant effects of various capital measures are also found by Vandenbussche (2015) nad Fendouglu (2017). Our results are in line with estimated effects of borrower-based measures; Akinci (2018), Claessens (2013), Kutnner (2016) and Lim (2011) show a significant effect of loan-to-value ratios on credit growth. An effect of liquidity measures on credit growth is shown in the analysis of Kuttner (2016). Akinci (2018) finds a significant effect of provision requirements on credit. The results do not prove the overall unusefulness and ineffectiveness of the other measures. As is discussed in Section 4, these results may be caused by the upward bias. Or these types of tools might be effective only in individual countries.

In Table A-6 and Table A-7 are presented results of the estimation of effects of 7 groups of prudential measures on credit growth in advanced and emerging market economies. In advanced economies, capital measures, provisioning, limits on credit growth, liquidity requirements, and other measures have a significant effect slowing down credit growth. When monetary policy cycle was in the previous quarter or quarters in the phase of tightening, liquidity requirements have a negative significant effect on credit growth. If monetary policy cycle is in the phase of loosening for at least the previous four quarters, borrower-based measures, capital measures, limits on credit growth, and other measures have an estimated negative significant effect on credit growth. These results correspond to the estimated combined effect of macroprudential policy measures in advanced economies. In emerging market economies, when monetary policy cycle is in the phase of tightening for at least four previous quarters, capital measures and liquidity requirements have a negative significant effect on credit growth. Provisioning have an estimated effect on credit growth, when monetary policy cycle was loosening in the previous quarter.

[12] Table 7 does not provide estimates of control variables, these are available upon request by the authors.

Table 7: Estimated effects of types of macroprudential instruments on credit growth in a full sample of countries

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	-0.633*	-1.118*	0.056	-0.384	-0.217
	(-2.34)	(-2.04)	(0.19)	(-0.50)	(-0.77)
L.CapitalM	-0.288	-0.663	-0.149	-0.677*	-0.096
	(-1.73)	(-1.87)	(-1.23)	(-2.01)	(-0.67)
L.Provisioning	-2.050*	-2.028	-1.726*	-1.427**	-1.469
	(-2.28)	(-1.79)	(-1.98)	(-2.83)	(-1.68)
L.LimitsOnCG	-0.600	-0.779	-0.055	-0.558	-0.260
	(-1.64)	(-1.54)	(-0.14)	(-0.55)	(-0.55)
L.LiquidityRequirements	-0.690	-1.359	-0.221	-2.057*	0.116
	(-1.63)	(-1.68)	(-0.70)	(-2.09)	(0.32)
L.ReserveRequirements	-0.295*	-0.462*	-0.077	-0.189	-0.074
	(-2.12)	(-2.14)	(-0.58)	(-0.92)	(-0.45)
L.Other	-1.857*	-1.140*	0.403	-0.631	0.421
	(-2.45)	(-2.08)	(0.64)	(-1.14)	(0.61)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of credit growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table *8* presents estimation results of 7 different groups of macroprudential instruments on house price growth. Provisioning and liquidity requirements have a negative significant effect on the development of house prices. On the other hand, the estimation suggests that reserve requirements leads to a slower growth of house prices. However, reserve requirements are not designed to aim on house price growth regulation. Thus, these reversed results are further supporting our idea that it is important to look not only on the cumulative effect of all macroprudential instruments, as some are aimed at regulating different parts of the markets. When we do not distinguish monetary policy cycle phase, liquidity requirements and provisioning have a significant negative effect on house price growth when these are tightening. If monetary policy cycle is in the phase of tightening, borrower-based measures, provisioning, liquidity requirements and other measures have an estimated negative effect on house prices. One must be careful with interpretation of these results - as already discussed before, not all of these measures are aiming on regulating housing market and thus, we cannot interpret the positive significant effect of reserve requirements and limits on credit growth within the monetary policy cycle loosening as a reversed effect of this macroprudential policy measure and a sign of unusefulness. Neither of these primarily aims to regulate house price growth. In case of borrower-based measures and other measures, two groups of measures aiming on regulating development on housing market, tightening monetary policy reinforces the tightening effects of these macroprudential measures. Supporting the theory that for house prices, monetary policy reinforces the effects of some instruments of macroprudential policy.

In comparison with the existing literature, we show an effect of borrower-based measures (both DSTI and LTV) on house price growth that is also estimated by Akinci (2018). Although in our estimation results, the effect seems to be significant in all countries only when monetary policy cycle is in the phase of tightening. This may be an explanation of weaker and imprecise effects of LTV on house prices estimated by Araujo (2020). Effect of tax measures (hidden in the "other" measures in our estimation) on house prices is also shown in Cerutti (2017) and Kuttner (2016).

Table 8: Estimated effects of types of macroprudential instruments on house price growth in a full sample of countries

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	0.237	-1.498*	0.726	-2.063*	0.661
	(0.55)	(-2.45)	(1.72)	(-2.35)	(1.66)
L.CapitalM	-0.385	-0.543	-0.088	-0.567	-0.050
	(-1.71)	(-1.87)	(-0.24)	(-1.41)	(-0.25)
L.Provisioning	-3.430*	-2.081*	-1.247	-1.863	-0.300
	(-2.31)	(-2.05)	(-0.54)	(-1.52)	(-0.25)
L.LimitsOnCG	0.140	-1.458	0.878	-1.337	1.324
	(0.13)	(-1.83)	(1.24)	(-1.29)	(1.93)
L.LiquidityRequirements	-1.157*	-2.041**	-0.103	-1.480*	0.018
	(-2.32)	(-3.00)	(-0.21)	(-2.41)	(0.04)
L.ReserveRequirements	0.528	0.044	0.465*	-0.381	0.584***
	(1.40)	(0.07)	(2.53)	(-1.22)	(2.71)
L.Other	-1.873	-2.151*	0.052	-2.208*	0.604
	(-1.80)	(-2.29)	(0.05)	(-2.18)	(0.78)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of house price growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table A-*8* and Table A-*9* present estimation results for the effects of 7 groups of macroprudential measures on house prices in advanced and emerging markets separately. In advanced economies, all 7 groups of macroprudential measures have a negative significant effect on house price growth, when we do not distinguish monetary policy cycle phase. If monetary policy was in previous period or periods in the phase of loosening, limits on credit growth, liquidity requirements, capital measures and provisioning have a negative significant effect on house price growth. In emerging market countries, the estimation shows in a few cases a positive significant effect of various groups of measures when monetary policy is in the loosening phase of the cycle. These results correspond to the results of the effects of MPI on house prices in advanced and emerging market economies.

6 Robustness Checks

As a first robustness check for time consistency of our results, the model is reestimated for a shorter time period 2005 – 2019. A wider range of macroprudential policy tools has been developed after the GFC and as we want to capture in the sample also some growing periods before the GFC, these are the reasons behind the choice of this specific shorter period. Estimation of the effects of macroprudential policy on credit growth[13] are consistent with the results for full length of the sample, effects of macroprudential policy are negative significant in times of monetary policy tightening and if we do not distinguish monetary policy cycle phases. Effects of prudential policy on house price growth[14] are estimated to be significant only in times when monetary policy is tightening, showing robustness for time of our house price growth estimation. In advanced economies, the effect of macroprudential policy on credit growth[15] is significant when monetary policy was in the previous quarter both tightening and loosening, where the estimated effect is stronger in the times of monetary policy tightening and the effect is also supported by an estimated negative effect of year-on-year tightening change of monetary policy rate. These results are different to the results of the whole sample and might be connected to the more frequent use of macroprudential policy in advanced countries in recent years as shown in Figure *6*. Estimated results for macroprudential policy and its effects on house price growth in advanced countries are consistent with the full-length sample, the effect of prudential policy instruments combined is significant when monetary policy cycle is in loosening phase. In emerging market economies, the effects of MPI on both credit and house price growth is estimated to be insignificant in all specifications. Estimation of the effects of 7 various groups of macroprudential instruments shows that for capital measures, liquidity requirements and reserve requirements, the effects on credit growth are estimated to be significant when monetary policy is tightening. Estimation of effects of various groups on house price growth shows the reinforcing effect of monetary policy on macroprudential policy also in the different strengths of the effects in times of loosening and tightening monetary cycle phases. The estimation is done for the effects of 7 subgroups of instruments on credit and house price growth in advanced and emerging market economies separately. The estimated effects show a reinforcing effect of monetary policy on macroprudential policy on credit growth in both advanced and emerging market economies. The estimated effects on house price growth in advanced economies are significant in times of monetary policy loosening, this holds for the groups which are not directly aiming at slowing down house price growth.

The estimated results of the various groups of macroprudential policy measures show that reserve requirements have an opposite effect on house prices than the rest of instruments, therefore, we opted for a robustness check in specification of macroprudential policy index, where only 16 types of measures are included and reserve requirements are excluded. The estimated effects show similarly to the original definition of MPI significant effect of macroprudential policy on credit and house price growth when monetary policy is tightening, thus, robustness of the results for all countries for definition of MPI.[16] In advanced countries, the estimated effect of macroprudential policy is insignificant on credit and is significant on house prices when we do not divide the sample based on the monetary policy cycle phase and when monetary policy is in the phase of loosening for at least 4 previous quarters. In emerging market economies, the effect of redefined macroprudential policy index on credit growth is

[13] For the estimation results see Table A-12 in Appendix.
[14] For the estimation results see Table A-13 in Appendix.
[15] Estimation results for this model and the rest of estimations mentioned in this paragraph are available upon request by the authors.
[16] For the estimation results see Table A-10 and Table A-11 in Appendix, the rest of estimations mentioned in this paragraph are available upon request by the authors.

significant when monetary policy cycle was in the phase of tightening the previous quarter. The effect on house price growth is insignificant in emerging market economies.

Third robustness check is a reestimation using an alternative methodology - fixed effects estimation method. This methodology may be biased by endogeneity, therefore we have opted for the GMM methodology as a robust method. Estimating the effects of macroprudential policy on credit growth and house price shows that the effects are insignificant in all specifications for all countries. Showing that the obtained results are not robust to the methodology chosen. In advanced countries, the effects of macroprudential policy on credit growth[17] are significant when monetary policy cycle is tightening. The estimated effect on credit in emerging market economies is insignificant. The effect on house prices is insignificant in both advanced and emerging market economies. The estimation of effects of 7 subgroups of macroprudential instruments show a significant effect of various groups on credit growth when monetary policy cycle is tightening. In case of house price growth, the reinforcing effect is estimated for liquidity requirements.

7 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 under-researched.

Our analysis is done by employing data for 66 countries over the period of 1990 – 2019. The models have been estimated for the macroprudential policy index as well as for the groups based on type of macroprudential measures. The robustness of the results has been tested by use of a different methodology, different specification of macroprudential policy index and for a shorter data period. The results are robust to different specification of MPI and shorter time period, however, the results are not robust to the methodology chosen. The results show that 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. In advanced economies, the macroprudential policy tools have a significant aggregated impact on credit and house prices. However, in advanced countries, the effect is insignificant when monetary policy cycle is tightening and is significant only when monetary policy is in the loosening phase. The effects of various groups of macroprudential policy instruments 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 credit growth, we have found a reinforcing effect for four subgroups of macroprudential policy tools and for house price growth, we have found a reinforcing effect for four groups of macroprudential measures.

[17] Results of these and the rest of estimations from this section are available upon request by the authors.

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. At the same time, however, given our mixed results when looking at various types of countries, measures, and time periods, further research in this area is required to detect a more robust links between the monetary and macroprudential policies.

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A 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 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) and updated version Laeven & Valencia (2020). Adjusted to quarterly data.
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.
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.
Shadow Monetary Policy 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 2008 - monetary policy rate from the websites of the individual central banks and the ECB. Japan, the UK, and the U.S.: Shadow rate calculated by Krippner (2012).

Table A-2: List of Countries

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

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

Note: The division of countries into Advanced and Emerging Market Economies is based on the IMF's World Economic Outlook 2022. The WEO classification may change over time.

Table A-3: 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.
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 clearcut.
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-4: Grouping of macroprudential policy instruments

Group of macroprudential policy instruments by type	**Abbreviation**	**Type of instrument in dataset of Alam et al. 2019**
Borrower-based measures	*BBM*	LTV, DSTI
Capital measures	*CapitalM*	CCB, Capital, Conservation, LVR, SIFI
Provisioning measures	*Provisioning*	LLP
Limits on credit growth	*LimitsOnCG*	LCG, LoanR, LFC
Liquidity requirements measures	*LiquidityRequirements*	Liquidity, LTD
Reserve requirements measures	*ReserveRequirements*	RR
Other measures	*Other*	Tax, LFX, Other

Table A-5: Summary Statistics

Variable	Mean	Median	Min	Max	Standard deviation
Credit Growth	10.27	7.18	-39.10	122.73	13.28
House Price Growth	5.44	4.52	-42.26	79.71	9.13
Diff_Mon.Pol.Rate	-.39	0	-75.83	49.79	3.05
GDP Growth	3.81	3.18	-83.01	276.70	6.84
Diff_Ex.Rate	2.62	.83	-33.82	455.83	17.20
InflationRate	3.87	2.54	-6.13	132.51	5.50
MacroPru	0.74	0	-9	14	1.84
BBM	0.09	0	-3	4	.49
CapitalM	0.32	0	-3	7	.77
Provisioning	0.05	0	-2	3	.26
LimitsOnCG	0.07	0	-5	4	.37
LiquidityRequirements	0.15	0	-3	4	.48
ReserveRequirements	-0.03	0	-8	10	.89
Other	0.09	0	-3	4	.40

Table A-6: Estimated effects of types of macroprudential instruments on credit growth in advanced countries

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	-0.491	-0.131	-0.344	0.513	-0.618*
	(-1.74)	(-0.21)	(-0.98)	(1.35)	(-2.54)
L.CapitalM	-0.376**	-0.791	-0.198	-0.225	-0.345*
	(-2.84)	(-1.49)	(-1.09)	(-1.02)	(-2.13)
L.Provisioning	-1.986*	-2.495	-1.295	0.642	-0.587
	(-2.40)	(-1.06)	(-1.66)	(0.48)	(-0.41)
L.LimitsOnCG	-1.261*	-0.0120	-0.750	0.648	-1.002*
	(-2.31)	(-0.01)	(-0.89)	(0.36)	(-2.23)
L.LiquidityRequirements	-0.912**	-2.920*	-0.488	-2.060*	-0.632
	(-2.63)	(-2.19)	(-1.08)	(-2.33)	(-1.64)
L.ReserveRequirements	-1.520	0.0688	-0.724	2.639	-0.907
	(-1.66)	(0.05)	(-0.95)	(1.92)	(-1.65)
L.Other	-2.798*	-0.0445	-0.660	0.943	-1.526**
	(-2.36)	(-0.04)	(-1.00)	(0.82)	(-2.62)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of credit growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table A-7: Estimated effects of types of macroprudential instruments on credit growth in emerging market countries

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	-0.634	-0.654	0.026	-2.122	0.010
	(-1.49)	(-0.84)	(0.04)	(-0.99)	(0.01)
L.CapitalM	-0.450	-0.704	-0.386	-1.147*	-0.048
	(-1.70)	(-1.37)	(-0.85)	(-2.05)	(-0.11)
L.Provisioning	-2.593	-1.556	-3.993***	-3.405	-0.913
	(-1.58)	(-0.77)	(-2.74)	(-0.81)	(-0.58)
L.LimitsOnCG	-0.798	-0.534	-0.779	-0.619	-0.202
	(-1.55)	(-0.71)	(-0.91)	(-0.58)	(-0.15)
L.LiquidityRequirements	-1.010	-1.219	-0.656	-2.031*	0.383
	(-1.91)	(-1.83)	(-0.88)	(-2.36)	(0.42)
L.ReserveRequirements	-0.197	-0.158	-0.347	-0.100	-0.149
	(-1.38)	(-0.70)	(-1.29)	(-0.54)	(-0.52)
L.Other	-1.554*	-1.171	-0.416	-1.025	-0.500
	(-1.99)	(-1.43)	(-0.39)	(-1.49)	(-0.34)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of credit growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table A-8: Estimated effects of types of macroprudential instruments on house price growth in advanced countries

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	-1.457**	-0.606	-0.980	-0.232	-0.817
	(-2.64)	(-0.89)	(-1.39)	(-0.59)	(-1.73)
L.CapitalM	-0.541***	-0.487	-0.359	-0.109	-0.514**
	(-3.56)	(-1.76)	(-1.90)	(-0.45)	(-2.76)
L.Provisioning	-3.472**	-0.950	-2.424*	-0.258	-2.515
	(-3.18)	(-1.25)	(-2.01)	(-0.29)	(-1.32)
L.LimitsOnCG	-2.535***	-0.381	-2.375*	1.053	-1.626**
	(-3.72)	(-0.48)	(-2.28)	(1.00)	(-2.80)
L.LiquidityRequirements	-1.481***	-1.169	-1.398*	-1.021	-1.022*
	(-3.28)	(-1.95)	(-2.28)	(-1.51)	(-2.54)
L.ReserveRequirements	-3.534*	-0.940	-2.163	0.594	-1.448
	(-2.27)	(-0.66)	(-1.57)	(0.40)	(-1.35)
L.Other	-3.612*	-1.324	-0.823	1.219	-1.760
	(-2.04)	(-1.07)	(-0.61)	(0.81)	(-1.55)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of credit growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table A-9: Estimated effects of types of macroprudential instruments on house price growth in emerging market countries

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.BBM	1.582	0.944	1.403*	-0.105	1.035
	(1.63)	(1.22)	(2.44)	(-0.22)	(1.61)
L.CapitalM	0.279	0.151	0.344	-0.183	0.238
	(0.89)	(0.37)	(1.49)	(-0.56)	(0.84)
L.Provisioning	2.102	1.589	0.052	-0.220	0.104
	(0.68)	(0.73)	(0.03)	(-0.16)	(0.07)
L.LimitsOnCG	1.127	0.254	1.560*	-0.281	1.908
	(1.30)	(0.47)	(2.32)	(-0.62)	(1.45)
L.LiquidityRequirements	-0.411	-0.950	0.055	-0.658	0.265
	(-0.66)	(-1.63)	(0.12)	(-1.06)	(0.49)
L.ReserveRequirements	0.355	0.127	0.380	-0.038	0.428*
	(1.32)	(0.65)	(1.85)	(-0.29)	(2.14)
L.Other	0.356	-0.068	0.796	-0.687	1.604
	(0.34)	(-0.11)	(0.67)	(-1.12)	(1.13)

Note: *The estimates are obtained using the GMM method, similarly to the previous estimations. As explanatory variables are used: lag of credit growth, GDP growth, inflation rate, difference in monetary policy rate, change in exchange rate, and crisis dummy. Each group of instruments is added separately to the baseline regression, but the coefficients are represented in the same column for compactness. The estimates of the rest of explanatory variables and the test results are available upon request by the authors.*

Table A-10: Estimation of the model with the alternative specification of MPI for credit growth for the full sample of 66 countries

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.911***	0.925***	0.959***	0.920***	0.988***
	(30.44)	(30.84)	(38.35)	(32.39)	(28.44)
L.MacroPru	-0.146*	-0.163*	-0.027	-0.124*	-0.020
	(-2.55)	(-2.39)	(-0.76)	(-2.25)	(-0.44)
L.GDPGrowth	0.063	0.057	0.099	0.046*	0.020
	(1.58)	(1.53)	(1.76)	(2.13)	(0.29)
InflationRate	0.095	0.063	0.003	0.053	0.040
	(1.41)	(0.96)	(0.05)	(0.80)	(0.53)
L.diff_MonPolRate	-0.176**	-0.218**	-0.164	-0.214**	-0.128
	(-2.61)	(-2.83)	(-1.74)	(-3.23)	(-1.20)
diff_ExRate	-0.024	0.007	-0.009	0.001	-0.083*
	(-0.66)	(0.16)	(-0.43)	(0.03)	(-3.28)
crisis	-3.755**	-5.628**	-0.858	-4.951*	0.143
	(-2.78)	(-2.86)	(-0.63)	(-2.52)	(0.09)
Constant	0.608*	0.761*	0.003	0.738*	0.162
	(2.14)	(2.27)	(0.01)	(2.36)	(0.60)
Observations	5447	1977	3470	1356	2804
J Test	0.26	0.64	0.40	0.77	0.20
AR(2)	0.43	0.97	0.99	0.30	0.94

t statistics in parentheses

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

Table A-11: Estimation of the model with the alternative specification of MPI for house price growth for the full sample of 59 countries

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.853***	0.857***	0.895***	0.843***	0.938***
	(31.45)	(23.84)	(33.93)	(25.06)	(35.15)
L.MacroPru	-0.130	-0.250*	-0.020	-0.258*	0.019
	(-1.26)	(-2.23)	(-0.07)	(-2.03)	(0.31)
L.GDPGrowth	-0.309*	0.090	-0.327	0.264**	-0.389**
	(-2.11)	(1.48)	(-1.50)	(2.65)	(-2.64)
InflationRate	0.131	-0.102	0.091	-0.138	0.062
	(1.35)	(-1.26)	(0.94)	(-1.33)	(1.18)
L.diff_MonPolRate	-0.174*	-0.112	-0.231*	-0.161	-0.138*
	(-2.09)	(-0.69)	(-2.41)	(-1.04)	(-1.97)
diff_ExRate	-0.127*	0.055	-0.151***	0.055	-0.085*
	(-2.35)	(1.74)	(-3.31)	(1.74)	(-2.73)
crisis	-10.11**	-8.602	-6.302	-9.300	-3.348
	(-2.91)	(-1.95)	(-1.94)	(-1.91)	(-1.82)
Constant	2.545***	1.368**	2.094***	0.898*	1.827***
	(3.33)	(3.29)	(3.63)	(2.36)	(3.76)
Observations	4695	1649	3046	1104	2474
J Test	0.27	0.27	0.37	0.24	0.28
AR(2)	0.13	0.16	0.33	0.29	0.38

t statistics in parentheses

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

Table A-12: Estimation of the model for credit growth for the full sample of 66 countries in the period 2005 - 2019

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.905***	0.882***	0.965***	0.898***	0.997***
	(28.09)	(32.16)	(40.73)	(42.26)	(42.84)
L.MacroPru	-0.097*	-0.262*	-0.010	-0.304*	-0.024
	(-2.00)	(-2.39)	(-0.23)	(-2.19)	(-0.47)
L.GDPGrowth	-0.010	-0.012	-0.048	0.002	0.101
	(-0.44)	(-0.72)	(-0.41)	(0.28)	(0.66)
InflationRate	0.190	0.377**	0.036	0.308*	-0.113
	(1.86)	(2.65)	(0.55)	(2.47)	(-1.05)
L.diff_MonPolRate	-0.290**	-0.319*	-0.243*	-0.259	-0.301*
	(-3.19)	(-2.08)	(-2.11)	(-1.52)	(-2.00)
diff_ExRate	-0.079	-0.126	-0.080	-0.114	-0.060
	(-1.67)	(-1.70)	(-1.93)	(-1.78)	(-1.18)
crisis	-7.060**	-16.78*	-3.868	-21.44**	0.228
	(-3.09)	(-2.52)	(-1.90)	(-2.98)	(0.12)
Constant	0.958***	1.205	0.685	1.245	0.062
	(3.01)	(1.48)	(1.38)	(1.53)	(0.16)
Observations	3803	1467	2336	1043	1881
J Test	0.13	0.23	0.50	0.10	0.23
AR(2)	0.82	0.79	0.48	0.41	0.31

t statistics in parentheses

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

Table A-13: Estimation of the model for house price growth for the full sample of 59 countries in the period 2005 - 2019

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.858***	0.839***	0.942***	0.789***	0.959***
	(26.15)	(25.28)	(13.05)	(23.94)	(16.82)
L.MacroPru	-0.049	-0.279**	0.014	-0.451***	0.083
	(-0.62)	(-3.23)	(0.17)	(-3.54)	(0.93)
L.GDPGrowth	-0.238	0.110	-0.843**	0.248**	-0.763**
	(-1.78)	(1.34)	(-2.64)	(3.18)	(-2.95)
InflationRate	0.024	-0.274**	0.248	-0.143	0.295*
	(0.23)	(-2.79)	(1.39)	(-1.41)	(1.99)
L.diff_MonPolRate	-0.230	0.190	-0.007	-0.023	0.237
	(-1.54)	(0.60)	(-0.03)	(-0.08)	(1.05)
diff_ExRate	-0.118**	0.016	-0.205**	0.032	-0.065
	(-2.76)	(0.68)	(-3.02)	(1.10)	(-1.05)
crisis	-9.734**	-14.54***	-11.19*	-22.11***	-4.140
	(-2.85)	(-3.38)	(-2.49)	(-3.69)	(-1.29)
Constant	2.423***	2.165***	3.936***	2.169***	2.630***
	(3.76)	(3.99)	(3.77)	(3.91)	(3.53)
Observations	3340	1252	2088	872	1690
J Test	0.24	0.29	0.28	0.27	0.28
AR(2)	0.09	0.14	0.12	0.31	0.11

t statistics in parentheses

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

Table A-14: Estimation of the model for credit growth and the full sample of 66 countries (fixed effects)

	Dependent variable: Credit Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.CreGrowth	0.919***	0.919***	0.898***	0.928***	0.901***
	(41.78)	(59.41)	(28.58)	(49.05)	(23.91)
L.MacroPru	-0.061	-0.109	-0.049	-0.057	-0.070
	(-1.29)	(-1.80)	(-0.90)	(-0.77)	(-1.38)
L.GDPGrowth	0.008**	0.006***	0.060	0.006***	0.046
	(3.25)	(5.19)	(1.59)	(4.03)	(1.32)
InflationRate	0.010	-0.029	0.056	-0.063	0.098
	(0.25)	(-0.47)	(0.85)	(-0.94)	(1.07)
L.diff_MonPolRate	-0.157***	-0.200*	-0.153***	-0.167	-0.148**
	(-3.90)	(-2.44)	(-3.40)	(-1.91)	(-2.65)
diff_ExRate	-0.009	-0.009	-0.002	-0.004	-0.001
	(-0.76)	(-0.60)	(-0.19)	(-0.26)	(-0.14)
crisis	-2.096***	-2.075**	-1.917***	-2.753***	-1.605***
	(-6.07)	(-3.23)	(-6.51)	(-3.72)	(-4.41)
Constant	0.847***	1.356***	0.560*	1.185**	0.595*
	(4.46)	(4.14)	(2.56)	(3.16)	(2.51)
Observations	5466	1991	3475	1367	2806

t statistics in parentheses

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

Table A-15: Estimation of the model for house price growth and full set of 59 countries (fixed effects)

	Dependent variable: House Price Growth				
		Monetary Policy Cycle Phase			
		Previous Quarter		Previous 4 Quarters	
		Tightening	Loosening	Tightening	Loosening
L.HPIGrowth	0.898***	0.879***	0.905***	0.890***	0.890***
	(47.41)	(30.12)	(38.56)	(43.08)	(35.64)
L.MacroPru	0.004	-0.038	-0.002	-0.025	-0.037
	(0.09)	(-0.72)	(-0.04)	(-0.35)	(-0.71)
L.GDPGrowth	0.001	0.011	-0.002	0.055	-0.007
	(0.03)	(0.25)	(-0.19)	(1.78)	(-0.54)
InflationRate	-0.123***	-0.176*	-0.106***	-0.250***	-0.091***
	(-4.73)	(-2.46)	(-3.64)	(-3.88)	(-5.42)
L.diff_MonPolRate	-0.166***	-0.113	-0.203**	-0.166	-0.175*
	(-3.55)	(-1.31)	(-2.88)	(-1.38)	(-2.61)
diff_ExRate	-0.012	-0.013	-0.016***	-0.011	-0.012**
	(-1.54)	(-1.63)	(-3.73)	(-1.24)	(-2.81)
crisis	-1.336***	-1.909***	-1.052**	-2.308***	-0.819*
	(-4.17)	(-4.23)	(-3.15)	(-5.57)	(-2.43)
Constant	0.929***	1.247***	0.829***	1.309***	0.951***
	(5.27)	(5.13)	(5.03)	(4.52)	(6.61)
Observations	4695	1657	3038	1112	2466

t statistics in parentheses

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

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