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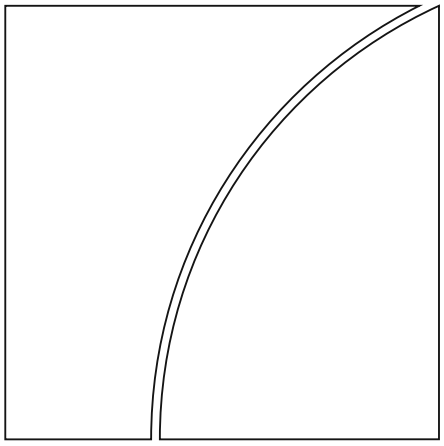

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Measuring the effectiveness of macroprudential policies using supervisory bank-level data

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Keywords: bank-level data, household credit, macroprudential policy, non-performing loans

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Foreword

One of the main challenges in implementing a new framework for financial stability is evaluating the effectiveness of macroprudential policies. Most of the evidence produced so far has been obtained from country- or bank-level data using publicly available sources at the annual frequency. The low granularity of the data makes it very difficult to clearly disentangle supply and demand effects and assess the effectiveness of the policies over time. Consequently, in 2018 the BIS initiated a research protocol project on "Measuring the effectiveness of macroprudential policies using supervisory bank-level data" with a quarterly frequency.

The project focused on the effectiveness of macroprudential policies on containing excessive household credit growth and bank risk using bank-level data. When analysing these effects, we control for bank-specific characteristics and macroeconomic variables. In a second step, the project evaluates whether the responses to a macroprudential shock differ for banks with different characteristics. Finally, the project also analyses how the effectiveness of macroprudential policies can be affected by monetary policy stance, the business cycle and the financial cycle. The quarterly frequency helps us to analyse the different steps in the transmission mechanisms. Carlos Cantú, Leonardo Gambacorta and Ilhyock Shim of the BIS were the project's research advisers.

Supervisory data are highly confidential. This means that it is not possible to merge the data into a single data set. The only possibility is to coordinate a common exercise and summarise the different results. The BIS sent a research protocol to the Asian Consultative Council (ACC) central banks in June 2018. Five ACC central banks agreed to join the exercise: the Reserve Bank of Australia (RBA), Bank Indonesia (BI), the Reserve Bank of New Zealand (RBNZ), Bangko Sentral ng Pilipinas (BSP) and the Bank of Thailand (BOT). Each central bank developed its own analysis, following the methodology from the protocol to enhance the comparability of the results. Preliminary results were presented in two Asian Research Network workshops held in New Zealand and Australia, respectively.[1] Taking into account the comments from the two workshops, the authors of the five country papers finalised them in September 2019. Results were summarised using meta-analysis techniques.

This volume is a collection consisting of the six papers. Here we provide a synopsis for time-constrained readers.

The first paper, by Carlos Cantú, Leonardo Gambacorta and Ilhyock Shim, summarises the results of the five country papers using a meta-analysis methodology. It finds that macroprudential policy actions taken by the five countries are largely effective in reducing excessive household credit growth, and that tightening actions have a stronger effect than easing actions. It also finds that macroprudential policy is effective in reducing bank risk as measured by the non-performing loan (NPL) ratio.

[1] The results of the analyses by the country teams of the RBA, BI and the RBNZ using the protocol for bank-level supervisory data were presented at the 12th Asian Research Network workshop held in Sydney, Australia, in June 2019. The results of the analyses by the country teams of BSP and the BOT, based on a similar protocol circulated in 2017 using loan-level and credit registry data, respectively, were presented at the 11th Asian Research Network workshop held in Wellington, New Zealand, in March 2018.

In the paper titled "Assessing the effects of housing policy measures on new lending in Australia", Corrine Dobson (RBA) shows first that two housing policy measures, announced in Australia in 2014 and 2017, reduced the flow of total new housing lending. In addition, she considers new loans to owner-occupiers and those to investors separately, and finds that these measures had a stronger effect on the growth of lending to investors, which was the policy's primary target.

The paper by Rani Wijayanti, Nur M Adhi P and Cicilia A Harun (BI) titled "Effectiveness of macroprudential policies and their interaction with monetary policy in Indonesia" shows that decreases (or increases) in the maximum loan-to-value (LTV) ratio and the macroprudential intermediation ratio [2] between 2010 and 2018 significantly reduced (or increased) household loan growth, and that such policy measures were more effective when real GDP growth was low or the credit-to-GDP gap was large. They also find that the use of such policy instruments effectively reduced the NPL ratio.

In their paper titled "The effectiveness of loan-to-value ratio policy and its interaction with monetary policy in New Zealand: an empirical analysis using supervisory bank-level data", Fang Yao and Bruce Lu (RBNZ) show that the LVR policy implemented in New Zealand between 2013 and 2016 reduced housing loan growth on average by 2 percentage points over the six months following each policy announcement. They also find evidence that the LVR policy has a statistically significant negative impact on the NPL ratio, although the economic magnitude is rather small.

The paper by Veronica B Bayangos and Jeremy De Jesus (BSP) titled "Have domestic prudential policies been effective? Insights from bank-level property loan data" examines the effects of domestic macroprudential policy in the Philippines over the sample period from March 2014 to December 2017. In particular, the authors consider the following six types of instrument: currency, capital-based, liquidity-based, asset side, reserve requirement and structural.[3] The paper finds that tightening macroprudential policies has a negative impact on real bank loan commitments to borrowers which lasts up to four quarters. It also shows a negative impact of tightening domestic macroprudential policy on the NPL ratio.

The final paper, titled "The impact of LTV policy on bank lending: evidence from Thailand", by Chantawit Tantasith, Nasha Ananchotikul, Chatlada Chotanakarn, Vorada Limjaroenrat and Runchana Pongsaparn (BOT) analyses the impact of three LTV measures in Thailand based on bank- and contract-level data provided by domestic commercial banks over the period 2004–18. They find that the policy effect does not manifest itself in the pace of credit growth at the bank level, but rather in the LTV distribution of newly issued loans. In particular, a loosening measure taken in 2009 prompted banks to increase the LTV ratio for the targeted loan sector, while tightening measures taken in 2011 and 2013 led to a more cautious LTV setting, reflecting the tightened credit standards the policy aimed to achieve.

[2] Since July 2018, the definition of the macroprudential intermediation ratio has been the ratio of the sum of loans extended and securities owned by a bank to the sum of deposits and securities issued by the bank. For the history of different definitions of this ratio, please see Table 1 in the BI's country paper in this volume.

[3] Structural or interconnectedness instruments aim to address vulnerabilities arising from interconnectedness between financial institutions and thus to limit contagion. They include interbank exposure limits and additional loss-absorbing capacity for systemically important banks. For details, please see Section 3.1 of the BSP's country paper in this volume.

How effective are macroprudential policies in Asia-Pacific? Evidence from a meta-analysis

Carlos Cantú, Leonardo Gambacorta and Ilhyock Shim[1]

Abstract

This paper evaluates the effectiveness of macroprudential policies in five Asia-Pacific countries (Australia, Indonesia, New Zealand, the Philippines and Thailand). We use supervisory bank-level data and apply a common empirical strategy. We find that macroprudential policies are effective in reducing excessive household credit growth. Additionally, a tightening in macroprudential policy has a stronger effect than an easing. We also find that banks' size and liquidity influence the effect of macroprudential policy on credit growth. Finally, macroprudential policy is effective in reducing bank risk as measured by the non-performing loan ratio.

Keywords: macroprudential policy, household credit, bank-level data, meta-analysis

JEL classifications: E51, E58 G18, G28

[1] Cantú: BIS, Carlos.Cantu@bis.org; Gambacorta: BIS and CEPR, Leonardo Gambacorta@bis.org; Shim: BIS, Ilhyock.Shim@bis.org. We are grateful for the comments provided by participants during the 2019 BIS Asian Research Network workshop. We especially thank the authors of the five country papers: Nur M Adhi P, Nasha Ananchotikul, Veronica B Bayangos, Chatlada Chotanakarn, Corrine Dobson, Cicilia A Harun, Jeremy De Jesus, Vorada Limjaroenrat, Bruce Lu, Runchana Pongsaparn, Chantawit Tantasith, Rani Wijayanti and Fang Yao. The views expressed in this paper are those of the authors and do not necessarily reflect those of the BIS.

1. Introduction

The Great Financial Crisis made clear that financial stability has a macroprudential or systemic dimension that cannot be ignored. Treating the financial system as merely the sum of its parts leads one to overlook the system's historical tendency to swing from a boom to a bust. Interestingly, it was in more advanced economies (AEs) that the macroprudential dimension had received less attention in the run-up to the crisis. Graph 1 shows that the use of macroprudential tools in AEs was quite limited before 2007 and increased only following the crisis. By contrast, emerging market economies (EMEs) have historically been more active in the use of macroprudential measures, and more willing to intervene in response to evidence of a build-up of imbalances and risks.

The implementation of a new macroprudential framework for financial stability raises a number of challenges for both AEs and EMEs. One is how to evaluate the effectiveness of macroprudential policies, especially when more than one tool is activated. Moreover, effectiveness should be analysed with respect to the specific goal macroprudential policies are designed to achieve; that is, to increase the resilience of the financial system or, more ambitiously, to tame financial booms and busts. At the moment, the evidence is mixed and more work is needed.

In Asia and the Pacific, central banks and regulatory authorities have implemented several asset side instruments to shield the economy against the risks of volatile credit cycles and tame the business cycle (Graph 2). Most of the evidence produced so far on the effectiveness of these policies in the Asia-Pacific region has been obtained using aggregate data or commercial databases such as BankScope. Limited use has been made of high-quality bank-level supervisory data, while evidence using credit registry data is even more scarce.

The objective of this paper is to study the effectiveness of macroprudential policies in the Asia-Pacific region, using supervisory bank-level data for the household sector.[2] Supervisory data are highly confidential. This means that it is not possible to merge the data into a single data set. The only possibility is to coordinate a common exercise and summarise the different results. To this end, the BIS coordinated the implementation of a common research protocol that established the modelling strategy and data definition (as far as data sources allow in terms of coverage, collection methods and definitions). In this way, it was possible to define a policy experiment by using the same baseline specifications and running similar tests.

The main focus of the research protocol was to establish the effects of macroprudential tools on household lending and on bank risk, the latter measured by the share of non-performing loans (NPLs) in total loans. In a second step, we evaluated whether the responses to a macroprudential shock differed for banks with different characteristics. Finally, we compiled and summarised the results by conducting a meta-analysis.

Our main results are the following. First, we find that macroprudential policies are effective in reducing excessive household credit growth. Second, bank characteristics are relevant when considering the strength of the transmission of macroprudential policies to credit. Third, there are asymmetric effects in the

[2] Countries that participated in the protocol exercise are Australia, Indonesia, New Zealand, the Philippines and Thailand.

implementation of macroprudential policy when we separate tightening from easing episodes. Finally, macroprudential policies are effective in reducing the build-up of bank risk, as measured by the NPL ratio.

The structure of the paper is as follows. In Section 2, we present a short literature review. Section 3 describes the empirical strategy implemented by each country team. Section 4 summarises the results obtained from the individual country teams by applying meta-analysis techniques. The last section concludes.

2. Literature review

Our paper contributes to the literature on the effects of macroprudential policies on credit. For instance, recent evidence suggests that debt service-to-income ratio rules and, to a lesser extent, loan-to-value ratio rules are more effective than capital requirements as tools for containing credit growth (Claessens et al (2013)). Indeed, the recent activation of the Basel III countercyclical capital buffer in Switzerland seems to have had little impact on pricing and credit extension (Basten and Koch (2015)). As clarified by the Basel III framework, the main objective of this buffer is to increase the resilience of the banking system. Restraining booms is perhaps no more than a welcome, possible side benefit (Drehmann and Gambacorta (2012)). Some instruments may work better in achieving the narrow aim of increasing financial system resilience rather than the broader aim of constraining the financial cycle.

An important feature of this paper is the use of supervisory data at the quarterly frequency. Gambacorta (2005) compares the results on the effectiveness of the bank lending channel in Italy using supervisory quarterly data with those using annual data obtained from BankScope, a publicly available data set. In particular, his analysis suggests that differences in the results are mainly due to a different quality of the data and to some extent to the annual frequency of the BankScope data. By using supervisory data in our paper, we aim to contribute to a better evaluation of the effectiveness of macroprudential measures.

Finally, our work is related to other research that conducts economic meta-analysis by pooling results from different countries. Regarding our first research question on the effectiveness of macroprudential policies, Gambacorta and Murcia (2019) present a meta-analysis based on credit registry data for five Latin American countries. Related to our second research question, Cantú et al (2019) study the role of bank characteristics on the transmission of shocks to credit supply in Latin America.

3. Empirical strategy

The first step is to evaluate the impact of a change in macroprudential tools on credit availability using a panel methodology. In particular, we estimate the impact on bank loans at the bank level using the following dynamic panel specification:

$$\Delta log\ Loans_{b,t} = \alpha_b + \sum_{j=1}^{k} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{k} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \vartheta X_{b,t-1} + \theta macrovars_{b,t} + \varepsilon_{b,t} \quad (1)$$

where $\Delta log\ Loans_{b,t}$ is the change in the logarithm of credit by bank *b* to households over quarter *t*, α_b are bank fixed effects, $X_{b,t-1}$ are bank-specific characteristics, and $macrovars_{b,t}$ are macroeconomic variables. The impact of a change in the macroprudential tool on credit supply is evaluated by means of $\sum_{j=0}^{k} \beta_j$, the main coefficients of interest. Residuals are clustered at the bank level. All variables are considered in real terms to eliminate inflationary effects in nominal variables.

The analysis focuses on ΔMaP_t, a dummy that takes the value of +1 if a macroprudential tool is tightened in a given quarter and −1 if it is eased. It takes the value of zero if no change occurs during that quarter.

We make two distinctions in the macroprudential policy variable. First, we differentiate between macroprudential measures depending on whether they are implemented to respond to cyclical conditions or to enhance resilience. We also consider two separate dummies: one for tightening actions and the other for easing actions. We can then verify asymmetric effects for each type of tool.[3]

Controls consist of macroeconomic variables and bank-specific characteristics. In particular, macroeconomic variables include changes in real GDP, changes in the monetary policy rate and the effective exchange rate. Bank-specific characteristics *X* includes four standard indicators: (i) size (log of total assets); (ii) liquidity ratio (cash and securities over total assets); (iii) capital ratio (Tier 1 capital to total assets); and (iv) funding composition (deposits over total liabilities).

3.1 Do responses to macroprudential shocks differ by type of bank?

The second step of the analysis evaluates the role of bank-specific characteristics in the transmission of macroprudential policy using the following equation:

$$\Delta log\ Loans_{b,t} = \alpha_b + \sum_{j=1}^{k} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{k} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \vartheta X_{b,t-1} + \sum_{j=0}^{k} \delta_j\, \Delta \mathrm{MaP}_{t-j} * X_{bt-1} + \theta macrovars_{b,t} + \varepsilon_{b,t} \quad (2)$$

The test is on the overall significance of $\sum_{j=0}^{k} \delta_j$. This approach builds on the bank lending channel literature. In order to discriminate between loan supply and loan demand movements, the literature has focused on cross-sectional differences between banks.[4] This strategy relies on the hypothesis that certain bank-specific characteristics influence only loan supply movements, while banks' loan demand is independent of these characteristics. Broadly speaking, this approach assumes that after a monetary tightening (macroprudential tightening in our case), the ability to buffer the policy's impact on loan portfolios is different for different banks. For example, small banks, which suffer a high degree of informational friction in financial markets, face a higher cost in raising non-secured deposits, and reduce their lending by more after a tightening in policy. Similarly, illiquid banks have less room to buffer the effect of a monetary tightening on lending simply by drawing down cash and securities.

[3] See, for example, Kuttner and Shim (2012).

[4] For a review of the literature on the distributional effects of the bank lending channel, see, amongst others, Gambacorta (2005).

3.2 Do responses to macroprudential policy vary over different monetary policy conditions?

We test this hypothesis by introducing additional interaction terms, which combine macroprudential dummies and monetary policy conditions *r* (ie real interest rate or monetary policy stance measured by the gap between the actual policy rate and the policy rate calculated from a version of the Taylor rule). In particular, we estimate the following equation:

$$\Delta log\ Loans_{b,t} = \alpha_b + \sum_{j=1}^{k} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{k} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \sum_{j=0}^{k} \varphi_j r_{t-j} + \sum_{j=0}^{k} \rho_j\, \Delta \mathrm{MaP}_{t-j} * r_{t-j} + \vartheta X_{b,t-1} + \theta macrovars_{b,t} + \varepsilon_{b,t} \quad (3)$$

The goal of this test is to verify the effectiveness of macroprudential tools when monetary policy pushes in the same or opposite direction (see Bruno et al (2017) for details). The test is on the overall significance of $\sum_{j=0}^{k} \rho_j$.

3.3 Do responses to macroprudential policy vary over the business or financial cycle?

We carry out an additional test by introducing interaction terms that combine macroprudential dummies and real GDP growth (or the credit-to-GDP gap):

$$\Delta log\ Loans_{b,t} = \alpha_b + \sum_{j=1}^{k} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{k} \beta_j\, \Delta MaP_{t-j} + \sum_{j=0}^{k} \varphi_j \Delta logGDP_{t-j} + \sum_{j=0}^{k} \rho_j\, \Delta MaP_{t-j} * \Delta logGDP_{t-j} + \vartheta X_{b,t-1} + \theta macrovars_{b,t} + \varepsilon_{b,t} \quad (4)$$

The goal of this test is to verify the possible presence of contemporaneous effects between real GDP/the credit-to-GDP gap and macroprudential tools: their impact may be stronger when real GDP growth is high or vice versa. The test is on the overall significance of $\sum_{j=0}^{k} \rho_j$.

3.4 Effects on bank risk (non-performing loans)

In general, the goal of macroprudential policies is to contain systemic risk that is by nature endogenous. By using macroprudential tools, policymakers aim to reduce banks' risk-taking and the probability of the occurrence of a financial crisis. We evaluate how macroprudential tools affect bank risk by estimating their effect on the ratio of banks' non-performing loans over total assets (NPL ratio).[5] To do so, we

[5] Measurement of systemic risk is, however, still rudimentary. While some concepts have been developed, it is difficult to compute such measures (for example, CoVaR, stress testing, and Shapley value measures).

consider the NPL ratio as the dependent variable in equations (1)–(4). For example, equation (1) becomes:[6]

$$\mathrm{NPL}_{b,t} = \alpha_b + \sum_{j=1}^{k} \gamma_j \,\mathrm{NPL}_{b,t-j} + \sum_{j=0}^{k} \beta_j \,\Delta\mathrm{MaP}_{t-j} + \vartheta X_{b,t-1} + \theta macro_{b,t} + \varepsilon_{b,t} \qquad (5)$$

where $NPL_{b,t}$ is a logit function of the ratio of gross NPLs to total loans. In particular, the logit function is given by $NPL_{b,t} = ln[\mathrm{NPL\ ratio}/(1 - \mathrm{NPL\ ratio})]$. Given the persistence of NPLs, we use a dynamic specification that includes a lagged value of the NPL as an explanatory variable. We use data on gross NPLs (including provisions) as the dependent variable, since this definition captures the overall quality of the loan portfolio (net NPLs reflect the realisation of loan defaults).

3.5 Endogeneity issues

One possible limitation of the empirical strategy is that, in principle, the situation of the banking sector (lending supply or bank risk) could also have an impact on macroprudential policy decisions. In order to mitigate such endogeneity problems, we use a dynamic generalised method of moments (GMM) panel methodology to obtain consistent estimates of the relationship between macroprudential policy and the dependent variables.[7] The use of this methodology is essential because in the presence of a lagged dependent variable with fixed effect, the ordinary least squares (OLS) method would produce inconsistent estimates. Thus, GMM reduces any endogeneity bias that may affect the estimation of other regression parameters. It also takes into account the heterogeneity of the data caused by unobservable factors affecting individual banks.

We use the instruments as defined by Blundell and Bond (1998). In particular, the exogenous variables, transformed in first differences, are instrumented by themselves, while the endogenous regressors (also transformed in first differences) are instrumented by their lags in levels.[8] As a final precaution, we consider all bank-specific characteristics lagged at t-1.

3.6 Meta-analysis techniques

We estimate the mean effect of macroprudential policy on household lending in the Asia-Pacific region by applying meta-analysis techniques. A meta-analysis is suitable for our study since the low number of observations (country studies) prevents us from applying minimum square techniques. We exploit the fact that by construction, all

[6] See Jiménez and Saurina (2006) and Chavan and Gambacorta (2019).

[7] This methodology was first described by Holtz-Eakin et al (1988) and Arellano and Bond (1991), and further developed by Blundell and Bond (1998).

[8] This approach has been applied to other areas of research in which the model was affected by possible endogeneity biases. For instance, Blundell and Bond (1998) use it to estimate a labour demand model, while Beck et al (2000) apply it to investigate the relation between financial development and economic growth.

studies have the same design and the coefficients are comparable between them. We can then compute a weighted average across the studies' individual estimates.[9]

The weights of the coefficients in the estimated mean effect are proportional to the two sources of variance in the studies. The first is the within-study sampling error and the second the between-study variance (that is, the level of variability of the estimated coefficients among the studies).

We present the results in two forms. First, for the effects of macroprudential policies on household lending and bank risk, we show the results by means of forest plots. In these graphs, the rows show the coefficients reported by each country (red dots) and their confidence interval (black line). The last row shows the estimated mean effect (blue dashed line) and its confidence interval (blue diamond). Second, for the rest of the exercises, we present tables showing the estimated mean effect and the estimated level of heterogeneity (I^2 statistics). This statistic is the percentage of the residual variation that is attributable to between-study heterogeneity.[10]

4. Results

Our main result is that macroprudential policies are effective in reducing growth in household credit (Graph 3). The estimated mean coefficient implies that, on average, an increase in the macroprudential index (ie a macroprudential tightening) reduces growth in real household credit by 4 percentage points in the subsequent quarters. The weights of each coefficient in the mean estimate are evenly distributed, which implies that there is no dominant study driving the results.

Next, we turn to the results on the role of bank characteristics in the transmission of macroprudential policies (Table 1). First, we find that, on average, large banks and banks with high liquidity are less sensitive to a macroprudential policy change.[11] As explained before, these banks are better able to raise additional funds when faced with a macroprudential shock. Second, banks with high capital are slightly more sensitive to changes in macroprudential policy. The result is only marginally significant. One explanation may be that, during the analysed period, bank capital levels were adjusted to adhere to Basel III capital requirements in conjunction with other tools. As banks shifted their capital composition, they tended to reduce their credit provision. Finally, the estimated level of heterogeneity (I^2 statistic) is higher than 85% for all the estimates in this block. This implies that there are important sources of heterogeneity between countries.

Our third set of results differentiates the effects of macroprudential policy depending on their objective (cyclical vs resilience) and the direction of change (tightening vs easing). First, as shown in Graph 2, most of the macroprudential policies implemented in Asia in 2017 responded to cyclical conditions. For our study, there

[9] See Gambacorta and Murcia (2019) and Cantú et al (2019) for a formal explanation on meta-analysis applied to economics.

[10] Although there can be no absolute rule for when heterogeneity becomes important, Harbord and Higgins (2008) tentatively suggest adjectives of low for I^2 values between 25 and 50%, moderate for 50–75% and high for values greater than 75%.

[11] The coefficient on the interaction term of macroprudential policy and deposits is positive but not significant.

are not enough observations to conduct a proper meta-analysis on the effect of macroprudential policies aimed at increasing banks' resilience. For the same reason, the results on the effects of the cyclical macroprudential policies were almost the same as the results using the aggregate index (Table 2). Second, we find that there are asymmetric effects in the implementation of macroprudential policies. In particular, a tightening in macroprudential policy has a stronger effect on credit growth than an easing; a tightening reduces growth in household credit on average by around 9 percentage points, whereas an easing increases it by around 7 percentage points (Table 1). It is important to consider this asymmetric effect when winding down macroprudential policies in the event of a credit crunch. In addition, we find no significant effect in the coefficients on the interaction term of bank characteristics and the two macroprudential indexes for tightening actions and easing actions, respectively. Finally, the coefficients on the interaction term of macroprudential policy and monetary policy, business cycle or credit cycle were also not significant (Table 4).

Finally, we show the results on the effect of macroprudential policies on bank risk, proxied by banks' share of NPLs in total loans (Table 3). First, we find that macroprudential policies are effective in reducing bank risk. In contrast to our previous results, we do not find a prominent role for bank-specific characteristics in the effect of macroprudential tools on bank risk. Second, as with our previous results, there are not enough observations to differentiate macroprudential policies aimed at building resilience from those that respond to cyclical conditions. Third, we find asymmetric effects of macroprudential policies on bank risk. In particular, a tightening in macroprudential policy has a stronger effect on bank risk than an easing. Finally, in Table 4 we find no significant effect of the interaction of macroprudential policy and economic conditions (monetary policy, business cycle or credit cycle).

5. Conclusions

Researchers have endeavoured to reach a consensus on the effect of macroprudential policies on credit growth. This paper presents the results of a joint project by five central banks in the Asia-Pacific region that evaluates the effectiveness of macroprudential policies with regard to household credit and bank risk. Each country team used confidential supervisory bank-level data and followed a common empirical specification. We then estimated the mean effects by applying meta-analysis techniques.

The results from the meta-analysis are intuitive and economically and statistically significant. First, we find that macroprudential policies are effective in reducing excessive growth of household credit. Second, large banks and banks with high liquidity ratios are less affected by macroprudential shocks. Third, there are asymmetric effects in the implementation of macroprudential policy; in particular, a tightening has a stronger effect than an easing. Finally, macroprudential policies are effective in reducing the build-up of risk as measured by banks' NPL ratios.

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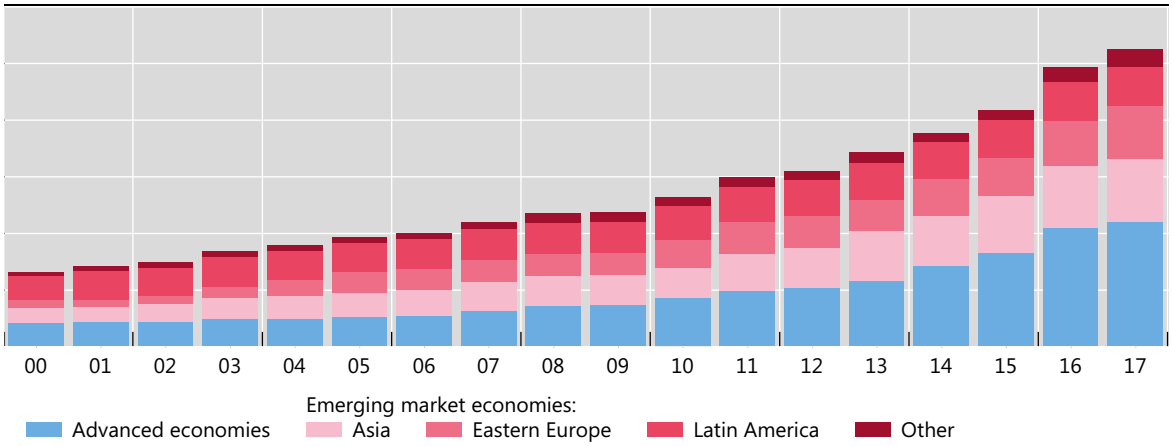
Graphs and tables

The use of macroprudential instruments increased after the Great Financial Crisis

Number of policy actions — Graph 1

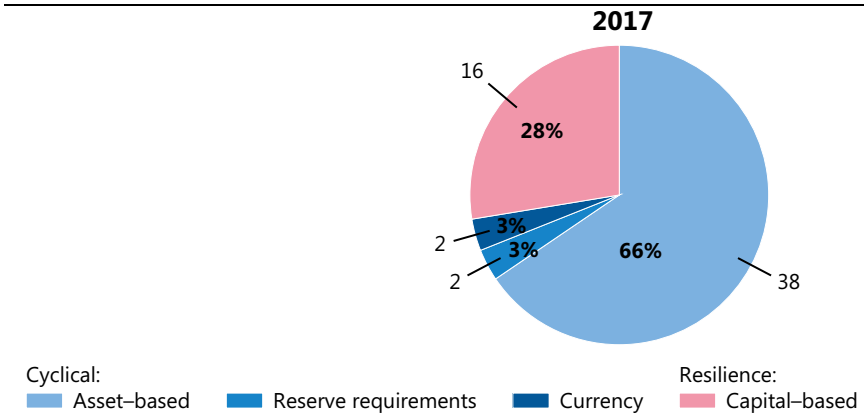


The sample covers macroprudential instruments adopted in 59 economies (27 advanced and 32 emerging market economies).

Source: Cerutti et al (2017).

In Asia-Pacific, most macroprudential tools available are asset-based instruments

Type of instrument — Graph 2

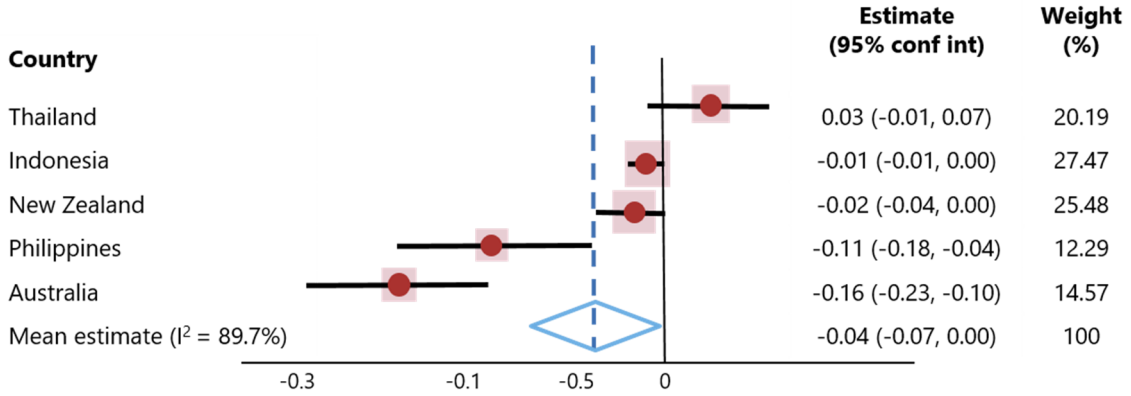


The sample covers macroprudential tools in place during 2017 for the following 14 Asia-Pacific economies: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippine, Saudi Arabia, Singapore, Thailand and the United Arab Emirates. Macroprudential tools for resilience include (a) capital-based instruments (countercyclical capital requirements, leverage restrictions, general or dynamic provisioning). Cyclical macroprudential tools include: (b) asset-based instruments (credit growth limits, maximum debt-service-to-income ratio, limits on banks' exposures to the housing sector as a maximum loan-to-value ratio); (c) changes in reserve requirements; and (d) currency instruments (variations in limits on foreign currency mismatches and on net open positions).

Source: Cerutti et al (2017).

Macroprudential policies are effective in reducing household credit growth

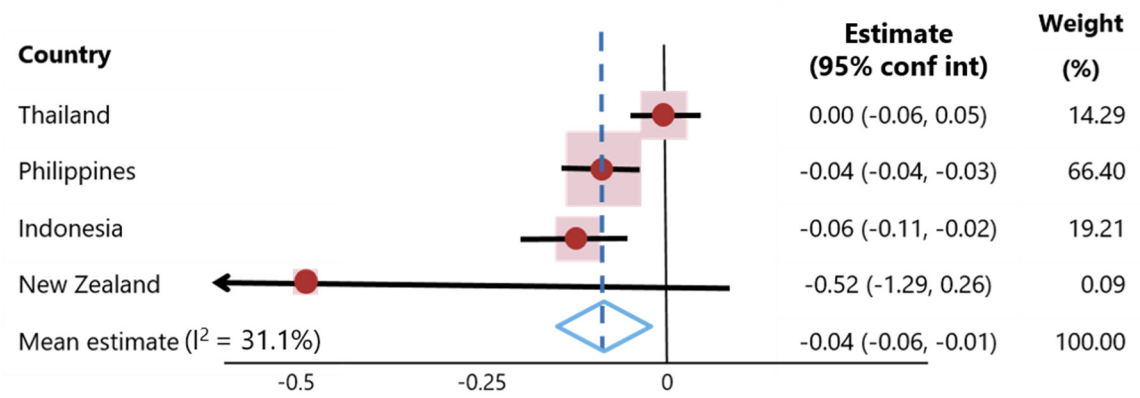
Graph 3



Results from a random-effects meta-analysis. The rows correspond to the coefficient obtained by each country (red dots). The size of the squares represents their weights in the estimated mean effect. The weight is calculated as the inverse of the estimate's standard error, as reported in the underlying study, plus the estimated between-study variance. The blue diamond represents the estimated 95% confidence interval of the estimated mean effect (dashed blue line).

Macroprudential policies are effective in reducing bank risk

Graph 4



Results from a random-effects meta-analysis. The rows correspond to the coefficient obtained by each country (red dots). The size of the squares represents their weights in the estimated mean effect. The weight is calculated as the inverse of the estimate's standard error, as reported in the underlying study, plus the estimated between-study variance. The blue diamond represents the estimated 95% confidence interval of the estimated mean effect (dashed blue line).

Effect of macroprudential policy on household credit and asymmetric effects

Table 1

	Mean effect	Percentage of heterogeneity (I^2) (0–100)	Observations
Macroprudential index	**–0.04****	89.74	5
Interaction with:			
Size	**0.11****	97.14	5
Capital	**–0.30***	87.14	5
Liquidity	**0.26*****	98.46	5
Deposits	0.15	95.06	5
Easing index	**0.07****	97.42	4
Interaction with:			
Size	0.00	0.00	4
Capital	–0.49	88.09	4
Liquidity	0.52	80.19	4
Deposits	–0.09	75.64	4
Tightening index	**–0.09****	98.53	5
Interaction with:			
Size	0.00	73.35	5
Capital	0.10	98.01	5
Liquidity	0.07	97.13	5
Deposits	0.10	90.86	5

Effect of macroprudential policy by objective

Table 2

	Mean effect index	Interaction with:				Observations
		Size	Capital	Liquidity	Deposits	
Household credit						
Cyclical	**–0.03****	**0.13****	**–0.29****	**0.39*****	**0.45*****	5
Resilience	–0.19	–0.01	0.59	0.33	–0.16	2
Non-performing loans:						
Cyclical	**–0.03*****	**0.14***	0.86	0.21	–0.15	4
Resilience	–0.01	0.07	0.00	0.01	–0.33	2

Results from a random-effects meta-analysis. The mean effect corresponds to the weighted average of coefficients reported in different estimations. The weights are calculated considering the sampling fluctuation of each effect size (standard error per reported coefficient) and estimated between-study variance. The I^2 statistic is the magnitude of the level of heterogeneity in effect sizes and is defined as the percentage of the residual variation attributable to between-study heterogeneity. Although there can be no absolute rule for when heterogeneity becomes important, Harbord and Higgins (2008) tentatively suggest adjectives of low for I^2 values between 25 and 50%, moderate for 50-75% and high for values greater than 75%. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Effect of macroprudential policy on bank risk and asymmetric effects

Table 3

	Mean effect	Percentage of heterogeneity (I^2) (0–100)	Observations
Macroprudential index	**–0.04*** **	31.1	4
Interaction with:			
Size	0.02	82.39	4
Capital	0.17	85.37	4
Liquidity	0.02	51.8	4
Deposits	–0.42	97.51	4
Easing index	**0.002** **	40.05	3
Interaction with:			
Size	0.0328	51.54	3
Capital	1.274	83.07	3
Liquidity	–1.7858	71.96	3
Deposits	0.3519	93.33	3
Tightening index	**–0.04***	65.93	4
Interaction with:			
Size	0.0464	97.92	4
Capital	0.4538	92.97	4
Liquidity	**0.80** **	96.35	4
Deposits	**0.28***	94.84	4

Interaction of macroprudential policy with other economic variables

Table 4

	Interaction with:			Observations
	Monetary policy	GDP	Credit	
Household credit growth	0.02	0.34	0.00	5
Non-performing loan ratio	–0.02	0.49	0.01	4

Results from a random-effects meta-analysis. The mean effect corresponds to the weighted average of coefficients reported in different estimations. The weights are calculated considering the sampling fluctuation of each effect size (standard error per reported coefficient) and estimated between-study variance. The I^2 statistic is the magnitude of the level of heterogeneity in effect sizes and is defined as the percentage of the residual variation attributable to between-study heterogeneity. Although there can be no absolute rule for when heterogeneity becomes important, Harbord and Higgins (2008) tentatively suggest adjectives of low for I^2 values between 25 and 50%, moderate for 50-75% and high for values greater than 75%. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Assessing the effects of housing policy measures on new lending in Australia

Corrine Dobson[1]

1. Introduction

In 2014, policymakers in Australia judged that the rapid increase in the share of housing lending to investors posed a growing risk to household balance sheets. At the time, housing prices were rising rapidly and there was a concern that investor activity could be amplifying the upswing in housing prices and construction activity, in turn raising the prospect of a sharp unwinding in the future. Moreover, strong growth in investor lending was occurring at a time when housing debt more broadly was rising considerably faster than incomes, off an already-high base. This was judged to pose a downside risk for economic activity because highly indebted households could sharply reduce their consumption in the event of falls in incomes or housing prices.

As a result, regulatory measures were implemented over several years which sought to address these risks. These measures targeted housing lending, rather than housing prices. The most high-profile and measurable of these policies were two benchmarks introduced by the Australian Prudential Regulation Authority (APRA): the first of these (announced in December 2014) sought to limit the rate of new investor lending growth and the second (announced in March 2017) to limit the share of new interest-only lending. Both benchmarks were applied at the institution level. This paper uses empirical methods to identify the effect of these two policy measures on new housing lending.

The approach follows that suggested by the Bank for International Settlements (BIS) for individual country teams to replicate across a range of Asia-Pacific countries (Cantú et al (2019)). It advocates the use of a bank-level dynamic panel regression to exploit bank-level variation, while controlling for bank-specific factors as well as macroeconomic factors that can affect banks' lending decisions. Dummy variables are used to identify the policy impact on new lending.

In addition to assessing the effect of the policies on the flow of total new housing lending, I replicate the procedure separately for loans to owner-occupiers and to investors. This breakdown of lending type is interesting because the policy measures implemented in Australia were motivated principally by the growth in lending to riskier lending types, such as investors, rather than owner-occupiers.

I find that the benchmarks had the effect of reducing the flow of new lending; this effect is statistically significant in some specifications. I also find that the

[1] The author would like to thank Nicholas Garvin at the Reserve Bank of Australia (RBA) for valuable assistance throughout this research. Thanks also to colleagues at the Bank for International Settlements for their guidance with respect to the project specification, notably Carlos Cantú and Ilhyock Shim, and to other colleagues at the RBA for their helpful comments. Views expressed in this paper are those of the author and not necessarily those of the RBA.

benchmarks had a much larger, negative and statistically significant effect on the growth rate of lending to investors, which was the type of lending explicitly targeted by the first benchmark.

2. The Australian housing policy measures

The Australian prudential regulator, APRA, has a mandate both to protect depositors in authorised deposit-taking institutions (ADIs) and to promote the stability of the financial system as a whole. As a result, APRA has long been alert to risks inherent in ADIs' mortgage lending activities. As explained in its recent *Information Paper* (APRA (2019)), between 2014 and 2018 APRA substantially increased the intensity of its prudential oversight of residential mortgage lending by ADIs. These prudential measures were taken in response to the heightened risk environment. Reflecting its mandate, APRA's actions were designed to both strengthen the resilience of lenders and promote the stability of the financial system overall. Specifically, the actions focused on improving lending standards and practices at individual ADIs, and reducing the share of higher-risk lending across the system.

Two specific policy measures introduced by APRA are the focus of analysis in this paper:

1. In December 2014, APRA announced that it would be scrutinising the lending practices of ADIs with strong growth in lending to property investors. Specifically, it announced that ADIs that continued to report growth over the year in investor lending above a threshold of 10% would face further supervisory action.
    - To reinforce this, APRA made a follow-up announcement a few months later reiterating its intentions and noting possible consequences for ADIs in instances where investor growth remained above the 10% threshold.
2. In March 2017, APRA announced another benchmark, this time on the share of new lending that could be on interest-only terms, which was set at 30% for each ADI. APRA also stated that ADIs should limit the share of interest-only lending with high loan-to-valuation ratios (LVRs) and scrutinise those loans with very high LVRs.

Over the same period, APRA continued its efforts to improve lending standards and practices, including by reviewing lenders' loan serviceability assessment practices, amending the Prudential Practice Guide, and announcing that it would more closely scrutinise higher-risk mortgage lending such as high loan-to-income loans, high LVR loans, interest-only loans and loans with very long repayment terms.

These measures (and others) are summarised in the RBA's 2018 *Financial Stability Review* (RBA (2018)). In its *Information Paper*, APRA (2019) explained that the objective of the benchmark policy measures was to develop a response that was targeted, efficient, relatively easy to implement, and able to be dialled up or down as needed. The housing policy measures proposed by APRA were discussed and endorsed by the Council of Financial Regulators (CFR) prior to implementation. The CFR is a non-statutory body designed to heighten collaboration between Australia's four primary financial regulators that have a role in promoting financial stability: the RBA, APRA, the Australian Securities and Investments Commission (ASIC) and the Australian Treasury.

In April 2018, APRA announced that the investor loan growth benchmark was no longer required given that other permanent measures to strengthen lending standards had been introduced. APRA confirmed that the threshold would no longer apply to an ADI from 1 July 2018 if the ADI had remained below the benchmark for the previous six months and could prove that it had measures in place to meet APRA's tighter lending standards. Similarly, in December 2018 APRA announced that ADIs no longer subject to the investor loan growth benchmark would also no longer be subject to the benchmark on interest-only lending from 1 January 2019.

3. Empirical methodology

As per the BIS methodological approach, I use a bank-level dynamic panel regression to exploit variation at the bank level, while controlling for bank-specific factors as well as macroeconomic factors that can affect banks' lending decisions. I include a dummy variable to identify the policy impact on new lending.[2] This model is estimated first by using total new housing loan approvals as the dependent variable. In addition, I rerun the model using two alternative dependent variables, specifically housing loans to investors and housing loans to owner-occupiers. Together, these two types of lending make up total housing lending.

The policy announcements are represented as common shocks across all ADIs. They are also considered to be exogenous to any individual ADI since the timing of the announcements and target level of the benchmarks were determined by external agents (the regulators) based on system-wide factors and macroeconomic considerations, rather than being driven by a single ADI. Hence, the policy identification mechanism is a dummy variable equal to 1 only in the quarter when a new prudential housing policy is announced; that is, in the December 2014 and March 2017 quarters. The dummy variable takes the value of 0 in all other quarters. However, each policy is allowed to influence the growth rate of new lending for the four quarters following the announcement, as specified by the four-quarter lags associated with the policy dummy variable. This specification allows the policy shocks to have direct, and individually measurable, effects in the quarters following the announcements, which informs us of the dynamics of the adjustment process undertaken by banks. In addition, the total effect of the policy measures in the four quarters after the announcements (that is, the sum of the four quarters) is also measured.

An extended specification includes the interaction of the policy variable with bank-specific characteristics. Finally, I test the hypothesis that the effectiveness of policy measures may vary depending on the stance of monetary policy and on the stage of the business cycle.

[2] For details on empirical specifications, refer to the paper by Cantú et al in this volume.

4. Data

The two main data sets used in this research come from banks' regulatory reporting forms submitted to APRA. Data are quarterly and cover the period from March 2008 to December 2018. The variable of interest, *new housing loans approved*, is only reported to APRA by ADIs with more than A$ 1 billion in total loan assets, so some very small ADIs are excluded from the analysis. A breakdown of new loans approved for the purpose of investment and those approved for owner-occupier housing is available from the same source. I focus on the quarterly change in the logarithm of new loans in real terms – that is, deflated by the consumer price index, published by the Australian Bureau of Statistics (ABS). ADIs with less than three years of data submitted over the sample period are dropped from the sample.

It is important to note that the dependent variable is loan *approvals* in each quarter. I do not use credit outstanding, as this stock measure is subject to potential policy-induced loan purpose switching among existing loans, which affects the data quality around the time of the policy measures. This issue is discussed by the RBA in its *Statement on Monetary Policy* (RBA (2018)). Loan approvals may not correspond exactly to the value of new credit extended in the quarter for at least two reasons. First, there may be timing differences in recording a loan approval versus the loan origination. Second, the value of loans approved does not account for loan repayments made, or for further drawdowns on credit made by existing borrowers. However, neither of these factors should be affected by the policy announcements.

The bank-level controls used are the four characteristics specified in the BIS cross-country analysis framework: size (total assets in log terms), capital ratio (the ratio of Tier 1 capital to total assets), deposit funding ratio (the share of deposits in total liabilities) and liquidity ratio (the ratio of highly liquid assets to total assets). These controls are chosen to account for bank-level factors that can affect banks' decisions to lend or their strategic decisions on lending growth rates.

In addition to bank decisions on lending, macroeconomic factors may affect the demand for credit and thus the growth rate of lending. To control for these factors, I use the following three macroeconomic controls suggested by the BIS protocol: the change in real quarterly gross domestic product (GDP), which measures economic growth; the quarterly change in the average level of the monetary policy interest rate, to account for changes in the stance of monetary policy and to some extent the baseline cost of borrowing; and the quarterly change in the real effective exchange rate (the trade-weighted index). Data on GDP are published by the ABS; the official monetary policy rate and the trade-weighted index (TWI) are published by the RBA. These macroeconomic factors are treated as being common to all lenders.

5. Discussion of results

Table 1 contains the key results for the preferred "baseline" model specification for total housing lending. Table 2 contains the results for the breakdown of lending to owner-occupiers and to investors. The policy impact in each of the four quarters after the policy announcements is presented separately, along with the sum of the four quarters for the overall size of the effect.

5.1 Impact of housing policies on lending

I find that the policy announcements were associated with a statistically significant decline in the rate of growth of total new housing lending over the year following the announcements; this is estimated to be equal to a reduction in the growth rate of new approvals of 0.16 percentage points in aggregate over the four quarters after each announcement (Table 1). This compares with the actual year-end growth rate in the total value of outstanding housing loans of around 6% at the time of each policy announcement.[3]

Importantly, I find that the decline is different for the two types of home lending (Table 2). Specifically, the results suggest that the decline in the growth rate of new loan approvals is substantially larger for loans to investors (Table 2, column 3), while there is no clear impact on owner-occupier loan approvals (Table 2, column 1). The decline in the growth rate of new investor approvals is estimated to be around 0.7 percentage points in aggregate over the four quarters following the policy announcements, which is more than four times the impact on total housing loans.[4] Investor loans outstanding were growing at a rate of around 16% in year-ended terms at the time of the first policy announcement, and at 4½% at the time of the second policy announcement.

The relatively larger impact on investor lending suggests that the policy measures were effective at reducing the growth in the lending types that were more directly targeted. The first policy targeted investor lending growth specifically, while the second targeted interest-only (IO) loans. IO loans can be to both investors and owner-occupiers. However, in Australia there are tax advantages to investors with IO loans and therefore a large share of investor loans are IO, while only a small share of owner-occupier loans are IO. Therefore, it is not surprising that the policy measures are found to have a more substantial impact on the growth of new investor loans than on owner-occupier loans. Nevertheless, it is an important finding that the policy measures were able to effectively target lending growth in particular housing lending segments, especially since similarly targeted measures have not been widely implemented globally.

Looking at the dynamics of the adjustment, the first quarter after the policy announcements is associated with a significant and negative effect on the growth of total new loans, as well as new owner-occupier and investor loans. This suggests that banks tend to respond immediately to such policies, according to the baseline specification. Interestingly, for investor loans only, the effectiveness of the policy measures in terms of the reduction in new lending growth seems to strengthen over time in the baseline specification, with the policy impact estimated to be larger for the third and fourth quarters after the announcements than for the first and second quarters.

This pattern may reflect the time taken for lending institutions to set up processes to reduce lending growth in the targeted segment. For example, in the quarter after the announcement was made, banks may have attempted to slow all

[3] According to data published by the ABS on housing lending; ABS catalogue number 5609.12.

[4] These figures abstract from dynamics captured in the lagged dependent variables, which have similar estimates across the different dependent variables. The interpretation of the policy effects is based on the baseline specification as there is no real economic interpretation of the policy effects on their own in the extended specification, which interacts the policy effect with bank characteristics.

types of lending while they sought ways to distinguish between lending types. Then, in subsequent quarters, institutions may have managed to slow new lending specifically in those targeted segments, which could have led to much larger declines in the growth rate of new lending in the targeted lending segments in the third and fourth quarters after the announcements, while other lending types were no longer constrained in the later quarters.

One of the observed ways that banks responded to the measures and actively sought to reduce demand for investor housing loans was by setting higher lending rates on their investor mortgage products relative to owner-occupier mortgages. However, consistent with the above dynamics, this differential pricing was only implemented with a six-month lag from the date of the first policy announcement. APRA also issued a follow-up statement six months after the first policy announcement which may have incited a stronger response from ADIs at this time. In contrast, differential mortgage pricing was applied by many ADIs immediately after the second policy announcement.

The methodology used in this paper identifies the *change* in policy setting as the policy shock that affects lending growth over the subsequent four quarters. However, it is possible that the effect of the policy measures was ongoing during the entire period that the benchmarks for lending growth remained in force. For example, the first policy measure was announced in December 2014 and remained in place until July 2018, while the second was announced in March 2017 and remained in place until the end of 2018. Of note, the second policy measure was announced when the first benchmark on investor credit growth was still in place. Therefore, further analysis may be required to ensure that the estimated effect of the second policy measure is not affected by its interaction with the first measure.

5.2 Interpretation of control factors

The approach and specification used in this paper assumes that bank-specific characteristics and macroeconomic factors can affect the supply of, or demand for, loans. Results from these regressions on Australian bank data imply that it is important to control for bank characteristics, as well as for macroeconomic factors, as these can affect the growth in new lending at a bank over time. In particular:

- The size of the bank is negatively associated with the growth rate of new lending in the following quarter, suggesting that banks with higher assets in a particular quarter are likely to have smaller percentage changes in loan growth in the following quarter. This could represent a loan growth rate management strategy of banks, or simply reflect a concave growth function.
- A bank's liquidity ratio is negatively associated with the growth rate of new lending in the following quarter, suggesting that banks tend to slow their lending growth after an increase in their liquidity ratio. This result raises the question of whether there remains some residual endogeneity; if a bank shifts towards holding more liquid assets, this would tend to involve a relative shift away from loans.
- The capital ratio is not a significant determinant of lending growth, while the funding ratio has a positive but insignificant impact on lending growth. These results suggest that banks' decisions on lending growth for the following quarter are not materially driven by their holdings of (higher-quality) capital or by their share of deposit funding. The former may be because during the period studied,

banks generally had sufficient Tier 1 capital to meet required minimums with a buffer, so that capital was not a constraint on lending. Capital ratios may have more of an effect on lending when they are more binding; that is, when a bank is closer to the regulatory minimum.

- Positive GDP growth is associated with a statistically significant increase in lending growth, while the relationship between changes in the RBA's policy target rate and changes in the growth rate of new lending is unclear depending on lending type and model specification. The RBA's policy target rate was declining over the entire sample, as monetary policy aimed to provide expansionary conditions over the period studied.
- The exchange rate is estimated to have no effect on lending growth. The lack of explanatory power of the TWI may reflect the domestic focus of mortgage lending and mortgage lenders and the use of hedging to remove exchange rate risk involved in debt funding.

One macroeconomic factor that is not explicitly controlled for in this model is housing price growth. It may be the case that housing price growth is a determinant, particularly for investors, of demand for property and hence bank finance at a particular time. Including a lag of this variable may increase the explanatory power of the model.

5.3 Role of interactions with bank characteristics

The extended specification including the interaction between the policy variable and bank-specific characteristics provides information on whether bank responses to the policy measures differ according to certain bank characteristics. I find that bank characteristics did affect how responsive banks were to the policies. Given that the policy actions in Australia were targeted at reducing the growth rate of particular lending types to a threshold limit, I expect that the bank characteristic most likely to affect the response to these policy actions would be the bank's lending growth rate prior to the policy announcement (rather than the bank's capital, funding or liquidity ratios). In contrast, if the policy action resulted in higher risk weights for mortgage lending, then I would expect that a bank's capital ratio might affect how responsive a particular bank is to the policy change.

Coefficients on the interaction terms should be interpreted as differences in the effect of the policy on a given bank (rather than across banks) as the relevant bank characteristic variable changes. I refrain from interpreting the policy effect on its own in the specifications that include the interaction terms, because it corresponds to a bank with zero assets, capital ratio, funding ratio and liquidity ratio. Generalised conclusions from the regressions including interactions with bank characteristics include:

- As a bank's size increases, it tends to reduce its lending growth rate by less after the policy announcements. This is most clearly the case for investor housing lending.
- As a bank's capital ratio increases, it tends to decrease lending growth to owner-occupiers by more after the policy announcement. However, the opposite is found for lending growth to investors.

- As a bank's deposit funding ratio increases, it tends to reduce lending growth rates by less in response to the announcements, with this effect more prominent for investor lending.
- As a bank's liquidity ratio increases, it tends to report larger decreases in lending growth rates.

When we focus on the effect of bank characteristics on the responsiveness to the policy measures of investor lending, which was the more targeted lending type, the overall conclusion is that an individual bank responded more to the policy changes when it was smaller (in terms of total assets), had a lower capital ratio, a lower funding ratio or a higher liquidity ratio. I find that the total effect of the bank characteristic interaction with the policy variable is statistically significant in the regressions for investor lending, but rarely for owner-occupier lending.

5.4 Interaction of housing policy with the monetary policy cycle and business cycle

Tables 3 and 4 in the Annex report results from the specifications considering the interaction of housing policy with the monetary policy cycle and business cycle. I find that neither the monetary policy cycle nor the business cycle has a significant effect on the policy response. This may reflect the relative lack of variation in these cycles in the year after the policy announcements. The monetary policy cycle was at all times in an easing phase, while the business cycle was at all times in an expansion phase. Moreover, following the first policy announcement the RBA cash rate was only adjusted four times, to be 1 percentage point lower by the end of 2018 compared with the end of 2014. Similarly, quarterly growth in GDP was quite steady during this period.

While the coefficients are not statistically significant, the signs of the coefficients suggest that bank responses to policy announcements would be stronger when monetary policy is being tightened or GDP growth is weaker. This tentatively suggests that macroprudential interventions may need to be calibrated more conservatively when monetary policy is being tightened at the same time or GDP growth is weakening. However, it would require further testing and refinement to produce robust conclusions for Australia.

6. Conclusions

This paper assesses the effects of regulatory measures implemented in Australia to address the growth of higher-risk types of housing lending. The specific measures considered in this paper are benchmarks on the rate of new investor lending growth and on the share of new interest-only lending. Following the approach suggested by the BIS, I use a bank-level dynamic panel regression to investigate the effects of these policies, controlling for bank-specific factors as well as macroeconomic factors that can affect lending supply and demand.

I find that the policy measures had a negative effect on the rate of growth in new lending and that this reduction in growth was larger for investor lending than for owner-occupier lending. As the policy measures implemented in Australia directly or indirectly targeted the growth of investor lending, the results suggest that the measures were effective. I also find that bank characteristics, such as the size of the institution and its deposit funding ratio, can affect banks' response to policy measures.

Findings from this paper are consistent with other published research finding that various types of macroprudential policy around the world have been effective in reducing credit growth and its associated risks.

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Annex: Tables

Table 1

Effects of housing lending policies on housing loan growth in Australia

Dependent variable: Quarterly change in total new housing loan approvals		
	Baseline specification	Interaction with bank characteristics
Policy effects		
Σ(four quarters)	*-0.16***	*-1.63***
quarter t+1	-0.06**	-0.85**
quarter t+2	-0.01	-0.40
quarter t+3	-0.04	-1.43***
quarter t+4	-0.05	1.06**
Sum Lending lags	-0.31***	-0.29***
Bank controls		
Size	-0.08*	-0.11**
Capital ratio	-0.00	0.00
Funding ratio	0.20	0.18
Liquidity ratio	-0.01**	-0.01***
Macroeconomic controls		
Cashrate	0.01	-0.01
GDP	0.07**	0.06**
TWI	0.00	-0.00
Interaction of policy variable with bank characteristics		
ΔPolicy x Size		
Σ(four quarters)		*0.05*
quarter t+1		0.03**
quarter t+2		0.02
quarter t+3		0.04***
quarter t+4		-0.04**
ΔPolicy x Capital ratio		
Σ(four quarters)		*-0.01*
quarter t+1		0.01
quarter t+2		-0.01***
quarter t+3		0.01**
quarter t+4		-0.01
ΔPolicy x Funding ratio		
Σ(four quarters)		*0.78****
quarter t+1		0.12
quarter t+2		0.26**
quarter t+3		0.34***
quarter t+4		0.06
ΔPolicy x Liquidity ratio		
Σ(four quarters)		*-0.03****
quarter t+1		0.00
quarter t+2		-0.01*
quarter t+3		-0.01*
quarter t+4		-0.02***
Seasonal dummies	Yes	Yes
Bank fixed effects	Yes	Yes
Sample period	2008Q1 – 2018Q4	2008Q1 – 2018Q4
ADIs	28	28
Observations	753	707

*, ** and *** represent statistical significance at the 10, 5 and 1 per cent level.

Table 2

Effects of housing lending policies on housing loan growth in Australia

	Dependent variable: Quarterly change in new **owner-occupier** loan approvals		Dependent variable: Quarterly change in new **investor** loan approvals	
	Baseline specification	Interaction with bank characteristics	Baseline specification	Interaction with bank characteristics
Policy effects				
Σ(four quarters)	*-0.02*	*-1.16*	*-0.70****	*-8.84****
quarter t+1	-0.04*	-0.67*	-0.14*	-3.15**
quarter t+2	0.01	-0.13	-0.16*	-2.28**
quarter t+3	0.01	-1.32***	-0.22***	-3.45***
quarter t+4	0.00	0.96	-0.22***	0.04
Sum Lending lags	-0.33***	-0.32***	-0.26***	-0.24***
Bank controls				
Size	-0.08	-0.12*	-0.00	0.01
Capital ratio	-0.00	-0.00	0.01	0.01
Funding ratio	0.17	0.16	0.25	0.12
Liquidity ratio	-0.01***	-0.01***	0.00	0.00
Macroeconomic controls				
Cashrate	-0.02	-0.05	0.07*	0.05
GDP	0.08***	0.07**	0.08*	0.06
TWI	0.00	0.00	-0.00	-0.00
Interaction of policy variable with bank characteristics				
ΔPolicy x Size				
Σ(four quarters)		*0.05*		*0.22***
quarter t+1		0.02**		0.03**
quarter t+2		0.01		0.02
quarter t+3		0.04***		0.04***
quarter t+4		-0.03		-0.04**
ΔPolicy x Capital ratio				
Σ(four quarters)		*-0.02****		*0.06****
quarter t+1		0.00		0.02**
quarter t+2		-0.01***		-0.00
quarter t+3		0.00		0.03***
quarter t+4		-0.01		0.01
ΔPolicy x Funding ratio				
Σ(four quarters)		0.51		*3.38****
quarter t+1		-0.05		1.22***
quarter t+2		0.21		0.78***
quarter t+3		0.29***		0.62***
quarter t+4		0.06		0.77
ΔPolicy x Liquidity ratio				
Σ(four quarters)		-0.01		*-0.09***
quarter t+1		0.00		0.00
quarter t+2		-0.01		-0.00
quarter t+3		0.00		-0.02*
quarter t+4		-0.01		-0.06***
Seasonal dummies	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Sample period	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4
ADIs	28	28	28	28
Observations	753	752	707	706

*, ** and *** represent statistical significance at the 10, 5 and 1 per cent level.

Table 3

Effects of housing lending policies on housing loan growth in Australia

Dependent variable: Quarterly change in total new housing loan approvals

	Baseline specification	Interaction with monetary policy cycle	Interaction with business cycle
Policy effects			
Σ(four quarters)	*-0.16***	*-0.13*	*-0.18***
quarter t+1	-0.06**	-0.04	-0.06**
quarter t+2	-0.01	-0.01	-0.02
quarter t+3	-0.04	-0.03	-0.05*
quarter t+4	-0.05	-0.04	-0.05
Sum Lending lags	-0.31***	-0.32***	-0.31***
Bank controls			
Size	-0.08*	-0.11**	-0.09*
Capital ratio	-0.00	-0.00	0.00
Funding ratio	0.20	0.16	0.19
Liquidity ratio	-0.01**	-0.01**	-0.01**
Macroeconomic controls			
Cashrate	0.01	-0.00	-0.02
GDP	0.07**	0.08**	0.08**
TWI	0.00	0.00	-0.00
Interaction with monetary policy cycle			
ΔPolicy x cashrate			
Σ(four quarters)		*-0.93*	
quarter t+2		-0.23	
quarter t+4		-0.71	
ΔCashrate			
Σ(four quarters)		*0.07*	
quarter t+1		0.02	
quarter t+2		0.01	
quarter t+3		0.01	
quarter t+4		0.02	
Interaction with business cycle			
ΔPolicy x ΔGDP			
Σ(four quarters)			*0.09*
quarter t+2			0.04
quarter t+4			0.06
ΔGDP			
Σ(four quarters)			*-0.06*
quarter t+1			-0.01
quarter t+2			-0.01
quarter t+3			-0.02
quarter t+4			-0.02
Seasonal dummies	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Sample period	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4
ADIs	28	28	28
Observations	753	753	753

*, ** and *** represent statistical significance at the 10, 5 and 1 per cent level.

Table 4

Effects of housing lending policies on housing loan growth in Australia

	Dependent variable: Quarterly change in new **owner-occupier** loan approvals			Dependent variable: Quarterly change in new **investor** loan approvals		
	Baseline specification	Interaction with monetary policy cycle	Interaction with business cycle	Baseline specification	Interaction with monetary policy cycle	Interaction with business cycle
Policy effects						
Σ(four quarters)	*-0.02*	*0.02*	*-0.03*	*-0.70****	*-0.70****	*-0.74****
quarter t+1	-0.04*	-0.03	-0.05	-0.14*	-0.13*	-0.16**
quarter t+2	0.01	0.01	0.01	-0.16*	-0.13*	-0.14*
quarter t+3	0.01	0.02	0.00	-0.22***	0.23***	-0.22***
quarter t+4	0.00	0.01	0.00	-0.22***	-0.21***	-0.21***
Sum Lending lags	-0.33***	-0.34***	-0.33***	-0.26***	-0.26***	-0.26***
Bank controls						
Size	-0.08	-0.11	-0.09*	-0.00	-0.02	-0.00
Capital ratio	-0.00	-0.00	-0.00	0.01	0.01	0.01
Funding ratio	0.17	0.12	0.17	0.25	0.24	0.24
Liquidity ratio	-0.01***	-0.01***	-0.01***	0.00	0.00	0.00
Macroeconomic controls						
Cashrate	-0.02	-0.03	-0.05	0.07*	0.17*	0.03
GDP	0.08***	0.08**	0.08***	0.08*	0.08*	0.07
TWI	0.00	0.00	0.00	-0.00	-0.00	-0.00
Interaction with monetary policy cycle						
ΔPolicy x cashrate						
Σ(four quarters)		*-0.90*			*-0.27*	
quarter t+2		-0.25			-0.03	
quarter t+4		-0.65			-0.24	
ΔCashrate						
Σ(four quarters)		*0.09*			*-0.04*	
quarter t+1		0.01			-0.10	
quarter t+2		0.00			0.06	
quarter t+3		0.04			-0.01	
quarter t+4		0.02			0.02	
Interaction with business cycle						
ΔPolicy x ΔGDP						
Σ(four quarters)			0.09			*0.02*
quarter t+2			0.02			0.01
quarter t+4			0.07			0.01
ΔGDP						
Σ(four quarters)			-0.05			*-0.11*
quarter t+1			-0.01			-0.06*
quarter t+2			-0.00			-0.02
quarter t+3			-0.03			0.00
quarter t+4			-0.02			-0.04
Seasonal dummies	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample period	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4	2008Q1 – 2018Q4
ADIs	28	28	28	28	28	28
Observations	753	753	753	752	752	752

*, ** and *** represent statistical significance at the 10, 5 and 1 per cent level.

Effectiveness of macroprudential policies and their interaction with monetary policy in Indonesia

Rani Wijayanti, Nur M Adhi P and Cicilia A Harun[1]

1. Introduction: macroprudential policy instruments in Indonesia

Indonesia has been using macroprudential policy instruments since 2011. Currently, there are four macroprudential instruments in Indonesia, namely, the maximum loan-to-value (LTV) ratio, the countercyclical capital buffer (CCB), the macroprudential intermediation ratio (MIR) and the macroprudential liquidity buffer (MPLB). However, this study is limited to examining the impact of the MIR and LTV ratio only. We do not take the CCB and MPLB into account for several reasons. First, the CCB is still being implemented with 0% charge of capital, hence we have not yet observed its impact on the banking system. Second, the MPLB was introduced only recently (in 2018), and thus the historical implementation data is insufficient for this research. A detailed explanation of the MIR and LTV ratio, their design, purpose and formula, and their historical reformulation is given in the following subsections.

1.1 Macroprudential intermediation ratio (MIR)

The MIR was implemented with a view to achieving the optimum level of bank intermediation, while maintaining a sufficient level of liquidity and bank prudentialism. It was introduced on 16 July 2018 for conventional banks and on 1 October 2018 for sharia banks. The MIR is actually a reformulation of a previously known macroprudential instrument called the loan-to-deposit ratio-based reserve requirement (LDR-based RR)[2] and later on the loan-to-funding ratio-based reserve requirement (LFR-based RR), which was first implemented in 2011. Therefore, although the MIR was just introduced recently, we have sufficient historical data for the exercise as we use the data for the LDR- and LFR-based RRs for the period before the implementation of the MIR. Despite the evolution of the instrument, the signals it conveys remain the same: it promotes balanced and high-quality intermediation.

The MIR instrument works by Bank Indonesia (BI) setting a certain range for the MIR that has to be met by banks. This specific range, or the intermediation level, is believed to be the optimum level of bank intermediation in the financial system given the macroeconomic and banking conditions and BI's policy to impose countercyclical measures. An additional RR is imposed on banks that are unable to meet the target range. This RR stands as a disincentive for banks that perform outside the MIR target. BI also has the option of setting the parameters of the disincentives. When BI's policy

[1] The views expressed are those of the authors and do not necessarily represent the views of Bank Indonesia, its Board of Governors or management.

[2] For theoretical background on the LDR-based RR, please refer to Satria et al (2015) and Gunadi and Harun (2011).

preference is to reduce risk appetite for banking intermediation, it can set the disincentive parameter higher for MIRs above the upper bound. Since the MIR was implemented, in order to enhance the prudentialism of banks, BI has charged a higher additional RR for banks which exceed the target compared to banks that have an MIR below the lower bound. However, the disincentive for having an MIR exceeding the upper bound is not applied when a bank has a higher capacity to absorb risks shown by sufficient capital; that is, a capital adequacy ratio (CAR) higher than 14%.

The optimum MIR range is regularly adjusted in consideration of macroeconomic and financial system conditions. If the financial system is overheating, BI would lower the MIR upper bound. Conversely, a slowdown in economic and credit growth would be followed by an increase in the MIR lower bound. Thus, any change in the MIR range target is expected to affect credit growth in the financial system. This instrument currently has a greater impact on bank intermediation than the CCB and CAR. This is because the CCB is still not active and most Indonesian banks have a significantly higher CAR than required. This implies that the CCB will not be binding even if it is activated.

In aggregate, the LDR-/LFR-based RR and MIR are achieved by banks. Graph 1 shows that banks in aggregate comply with the BI's intermediation target.

The formulas to calculate the MIR and its additional charge are as follows:

$$MIR = \frac{Loan + Securities\ Owned}{Deposit + Securities\ Issued} \text{ x } 100\%$$

$$\begin{aligned} &Additional\ RR\ for\ banks\ below\ targets \\ &= 0.1 \text{ x } MIR\ shortage \text{ x } third\ party\ fund \end{aligned}$$

$$\begin{aligned} Additional\ RR\ for\ banks &\text{ exceeding } targets \\ &= 0.2 \text{ x } MIR\ excess \text{ x } third\ party\ fund \end{aligned}$$

Table 1 shows how the MIR has been reformulated in the past.

1.2 Loan-to-value (LTV) ratio

The LTV ratio is the maximum ratio of the amount of a mortgage loan provided by a bank to the property price. Any increase in the LTV ratio denotes an easing of this instrument, as banks are allowed to lend a higher portion of the property price in the form of mortgage loans. On the other hand, a decrease in the LTV ratio signals a tightening of this instrument, as the proportion of the property price up to which banks can provide loans decreases.

This instrument was first introduced in Indonesia in June 2012 for conventional banks and in November 2012 for sharia banks, in order to dampen the excessive growth in mortgage loans back in 2011. During 2011, housing mortgage loan growth reached 40%, almost twice as high as overall bank loan growth. Therefore, the tightening of the LTV instrument was also intended to prevent a property market bust that could have materialised as a result of excessive mortgage loan growth. The first LTV measure successfully drove down housing mortgage loan growth. However, in the second half of 2013, mortgage loan growth began to accelerate again. Therefore, BI implemented further tightening in 2013 which was quite effective in slowing loan growth.

Against the backdrop of the slow growth in Indonesia's economy in 2015, the LTV rule was eased to boost the economy by increasing housing demand. This change resulted in a small increase in housing mortgage loans. Unfortunately, it did not have a significant effect on overall loan growth and economic growth. Thus, BI implemented a further relaxation of LTV requirements in 2016. This easing was followed by a slight growth in both housing and apartment loans. However, amidst the uncertainty of global and domestic economic conditions, this relaxation did not lead to the expected outcome of boosting the economy. Recently, BI implemented yet another relaxation of the LTV rule: in this case, banks were allowed to determine their own maximum LTV ratio. This easing helped to maintain the growth of housing and apartment loans. Amidst the economic recovery, this also boosted overall credit growth. Graph 2 shows the evolution of mortgage loan growth in Indonesia over the last eight years.

When implementing the LTV rules, BI differentiates the LTV ratio for different mortgage facilities. The more mortgage facilities owned by a borrower, the lower the maximum LTV ratio for the later facilities. For example, a borrower applying for a second mortgage facility will be subject to a lower maximum LTV ratio compared to the first facility. Furthermore, the third facility will be subject to an even lower maximum LTV ratio. This is set so as to mitigate any speculative motives in property purchases. BI also differentiates the LTV ratio for landed houses, apartments and office houses.[3] Furthermore, the LTV ratio applied to loans for purchasing landed houses and apartments can differ by size of housing unit (under 21m^2 , 22–70m^2, larger than 70m^2), with the smallest type subject to the most relaxed regulation. Finally, as an incentive, BI can apply a higher LTV ratio to banks with good credit risk performance.

The LTV ratio is expected to effectively control lending growth, specifically mortgage credit growth. An easing of the LTV limit is expected to increase credit growth. Conversely, any tightening would presumably result in a decrease of credit growth. We can also confidently say that fluctuations in mortgage lending growth can potentially affect overall lending growth. Although mortgage lending itself only accounts for 10% of overall lending value, market participants manage to capture the signals conveyed through the LTV policy on how the central bank assesses financial stability conditions.

The LTV policy is implemented with the awareness that the changes in the actual LTV ratio also affect credit risk. As an easing on the binding LTV limit means more credit is channelled to the economy, credit risk is also expected to increase. By contrast, a tightening of the maximum LTV ratio, which usually takes place during an economic boom, is expected to reduce credit risk. Therefore, an easing of the LTV policy is usually accompanied by additional regulation regarding the prudential aspect. For example, a bank's non-performing loan (NPL) ratio has to be under a certain level in order for it to enjoy the higher maximum LTV ratio.

[3] A "landed house" refers to any house that is not an apartment. An "office house" is a relatively small office building, which is also used as a home for the owner. Therefore, it is different from an office building.

2. Data and methodology

This paper uses quarterly panel data from 104 individual banks, covering a time period from Q1 2010 to Q1 2018. We look at the impact of BI's macroprudential policy on household credit growth and overall credit risk, which is measured by the NPL ratio.

We follow the empirical models suggested by the BIS protocol, which basically uses the generalised method of moments methodology, to deal with endogeneity issues. We run several models in order to gain a deeper understanding of the difference between the impact of an easing and a tightening of the instruments. Interaction terms are also included to obtain a better picture of how banks' characteristics, such as asset size, liquidity condition, capital condition and funding composition, affect the impact of the policy actions. We also capture the different impact of such policy actions along the different phases of the business cycle/financial cycle and on monetary conditions. Table 2 summarises the indicators we use, their definition and the transformation we apply.

3. Result and analysis

3.1 Macroprudential policy instruments' impact on household lending

In the first model, we try to examine the impact of our macroprudential policy measures on household lending growth. Table 3 shows that under both specifications (with and without the interaction terms), macroprudential policy instruments can control or limit the growth of household loans. When we add the interaction variables, we find that the macroprudential policy instruments have a larger impact on household loan growth than under the specification with no interaction term. However, the interaction term shows that this impact becomes smaller for banks which have larger assets, more substantial liquidity buffers and greater shares of deposits in their liabilities. We believe that banks with larger assets and more substantial liquidity buffers usually perform better in risk management terms. Furthermore, more substantial liquidity buffers and a larger share of deposits in funding also mean that banks have more room for intermediation. Therefore, the impact of our macroprudential policy instruments is lower for these banks. Nevertheless, further analysis can be conducted to track whether this impact is contributed to by the easing or tightening of instruments. Therefore, we run the second model to see the impact of easing and tightening instruments separately.

In Table 4, we find that the impact of tightening macroprudential policy instruments becomes larger in terms of reducing household loan growth after we introduce the interaction term. The tightening impact becomes bigger as banks' assets and share of deposits grow larger. However, the tightening impact becomes smaller for banks with larger liquidity buffers. This confirms the previous finding which implies that banks with ample liquidity buffers tend to have more room for intermediation, even in a tightening scenario. The coefficient on the dummy variable for easing macroprudential policy instruments is negative, which marks an increase in

loan growth.[4] However, the impact becomes insignificant as we introduce the interaction terms. The loosening impact again becomes significant and larger only for banks with ample liquidity buffers. Looking at these relatable findings, we can conclude that banks with better liquidity conditions have more room for intermediation and thus their lending growth either decreases less in response to tightening actions or increases more in response to easing actions than lending by banks with worse liquidity conditions does.

As policy mix is a pivotal part of central banks' decision-making, we look at the impact of macroprudential policy instruments with regard to the monetary stance. Table 5 shows that without the interaction term, the real policy rate has a negative and statistically significant effect on the growth of household loans, which is an expected result. However, the introduction of the interaction term of the change in macroprudential policy instruments and the real policy rate absorbs the effect and makes the coefficient on the real policy rate statistically insignificant. The impact of the macroprudential instrument alone is also weakened after the introduction of the interaction term, although it is still significant. The positive coefficient on the interaction term shows that when both monetary and macroprudential policies move in the same direction, they tend to increase household loan growth more than when these policies move in opposite directions. If we relate this result from using the interaction term to the results without the interaction term – ie that the tighter policy stance alone and the tightening macroprudential instruments alone significantly decrease household loan growth – we can confirm that our macroprudential policy measures and the monetary policy stance usually move in the same direction and thus reduce the decreasing impact of each policy. Moreover, our statistically significant and positive coefficient on the interaction term is likely to be driven by the periods when the monetary policy stance is loose *and* a macroprudential instrument is eased, not by the periods when monetary policy stance is tight *and* a macroprudential instrument is tightened.

We also investigate whether the implementation of our macroprudential policies in different phases of the business cycle and financial cycle will result in different impacts. In Table 6, we find that the impact of the business cycle becomes insignificant when we introduce an interaction term between the business cycle and macroprudential policy measures. The positive coefficient of this interaction term means that the effect of tightening (or easing) macroprudential measures on dampening (or stimulating) loan growth is weaker when real GDP growth is high. However, we see that the impact of macroprudential policy instruments becomes larger in reducing loan growth after we introduce the interaction term. Hence, we can conclude that tightening (or easing) macroprudential instruments is usually more effective in slowing down (or accelerating) household loan growth when real GDP growth is low. This implies that policymakers need to deploy macroprudential policy measures more actively when real GDP growth is high or more proactively before real GDP growth becomes too high.

Regarding the financial cycle, both specifications in Table 7 show no significant impact of the financial cycle on household lending growth. However, the impact of macroprudential policy instruments becomes insignificant after we introduce the interaction term. The negative coefficient of this interaction term means that the

[4] The easing index takes the value of −1 if monetary policy was eased during that quarter. A negative coefficient here implies an increase in credit growth.

effect of tightening (or easing) macroprudential measures on dampening (or stimulating) loan growth is stronger when the credit-to-GDP gap is large (ie during the financial cycle boom). In addition, we can infer that the negative sign of the interaction term captures the majority of the impact of macroprudential measures.

3.2 Macroprudential policy instruments' impact on credit risk

In relation to credit risk, we find that under both specifications (with or without the interaction term), the implementation of macroprudential policy instruments effectively reduces the NPL ratio (Table 8). This impact is even larger for banks with larger assets and a larger share of deposits in their liabilities. One possible reason for these banks to have a larger reduction in the NPL ratio is that larger banks usually have better risk mitigation and thus can fulfil the regulation more strictly. Consequently, they show larger reductions in credit risk.

In the model which differentiates between the tightening and easing instruments, we find a relevant outcome for tightening actions in the specification without an interaction term (Table 9). Tightening macroprudential instruments reduces the NPL ratio. Banks with higher regulatory capital, more substantial liquidity buffers, larger assets and a larger share of deposits in their liabilities tend to experience reductions in the NPL ratio. In both models, easing macroprudential instruments alone does not have a significant impact on the NPL ratio. Only banks with better liquidity conditions experience an increase in the NPL ratio. This may hold true as these banks have a higher chance of adopting risk-taking behaviour, due to their larger liquidity buffers.

In relation to monetary policy stance (Table 10), when we do not consider the interaction term, the tighter (or easier) monetary policy stance increases (or decreases) the NPL ratio, while a tightening (or easing) of the macroprudential measures lowers (or increases) the NPL ratio. When we consider the interaction term, the term has a positive and significant coefficient. This means that when both policies move in the same direction (either both tightening or both easing), the NPL ratio will increase. However, in the specification which includes the interaction term, the positive impact of monetary policy stance on the NPL ratio is reduced and insignificant. It implies that when the macroprudential policy instrument moves in the opposite direction to the monetary policy rate, the NPL ratio can be reduced.

The impact of the macroprudential policy instrument and the business cycle is larger in decreasing household loan growth when we include the interaction term (Table 11). The interpretation is similar to the findings from the household loan growth regressions. The positive and significant coefficient of this interaction term means that the impact of tightening (or easing) macroprudential measures on reducing (or increasing) the NPL ratio is smaller when real GDP growth is high. Similar findings can be derived in the model which includes the interaction of the macroprudential policy instrument and the financial cycle (Table 12). In particular, the positive and significant coefficient of this interaction term means that the impact of tightening (or easing) macroprudential measures on reducing (or increasing) the NPL ratio is smaller when the credit-to-GDP gap is high.

References

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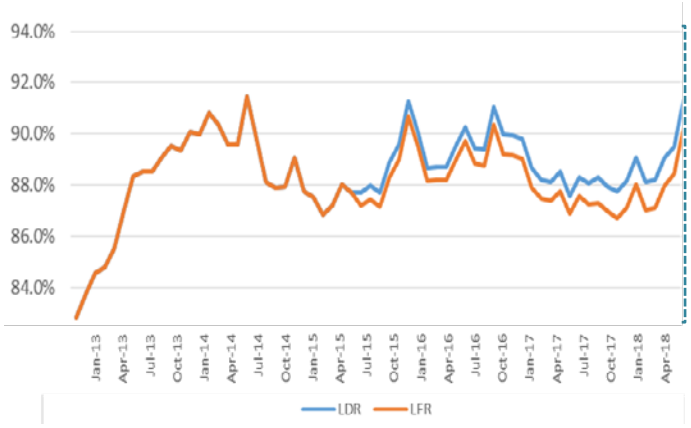
Satria, D, C Harun and A Taruna (2015): "The macro-prudential aspects of loan-to-deposit-ratio-linked reserve requirement", *Applied Economics*, vol 48, issue 1, August.

Annex: Graphs and tables

LDR and LFR

Graph 1

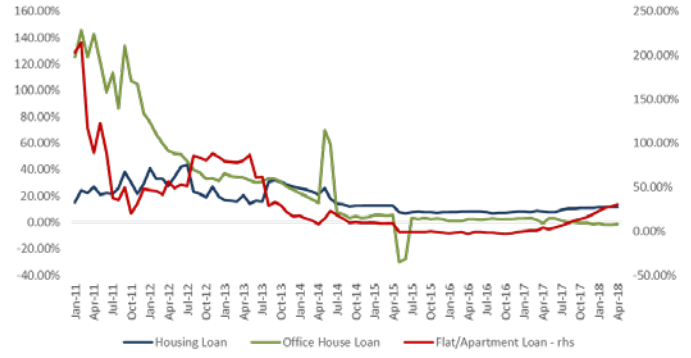


The graph shows that the aggregate level of LDR and LFR is within the target range.

Source: Monthly Bank Report to Bank Indonesia.

Mortgage loan growth

Graph 2



The graph shows the growth rate of each type of mortgage loans, which are housing loans, flat/apartment loans and office house loans.

Source: Monthly Bank Report to Bank Indonesia.

Historical change in loan to deposit-based reserve requirement, loan to funding-based reserve requirement and macroprudential intermediation ratio Table 1

Date	Instrument	Formula	Tightening (T) / Easing (E)	LDR/LFR/MIR target	Rationale for reformulation
Mar 2011	LDR-based RR	$\frac{Loan}{Deposit} \text{x } 100\%$	T	78–100%	-
Dec 2013	LDR-based RR		T	78–92%	Upper target lowered to limit credit growth in 2013.
Aug 2015	LFR-based RR	$\frac{Loan}{Deposit+Securities\ Issued} \text{x } 100\%$	E	78–92%	To boost slow credit growth, BI expands banks' source of funding. Thus, LDR is reformulated into the LFR, which includes both deposits and securities issuance as sources of funding. For banks with NPL ratio < 5%, the range is set at 78–94%.
Aug 2016	LFR-based RR		E	80–92%	BI aims to boost credit growth by increasing the lower bound of the LFR band to 80%.
Jul 2018	MIR	$\frac{Loan + Securities\ Owned}{Deposit + Securities\ Issued} \text{x} 100\%$	E	80–92%	BI includes securities owned (issued by non-financial corporations) as the numerator, to take into account a broader type of bank intermediation.

List of indicators Table 2

Variables	Explanation	Transformation
Dependent variables		
Household loan	Covers all unproductive loans, including mortgage loans, automotive loans, and uncollateralised loans.	Dlog
Credit risk (%)	Overall credit risk, calculated as the ratio of non-performing loans to total loans.	Logit function ln[NPL ratio/(1-NPL ratio)].
Independent variables		
Policy variables		
Dummy for macroprudential policy measures	1 denotes a tightening in policy; −1 an easing; and 0 no change.	
Dummy for tightening macroprudential policy measures	1 denotes a tightening in policy; and 0 otherwise.	
Dummy for easing macroprudential policy measures	−1 denotes an easing in policy; and 0 otherwise.	
Monetary policy condition	The real policy rate is calculated by dividing the BI Rate by the inflation rate.	delta
Bank characteristics variables		
Total assets	A bank's total assets	Log
Liquidity ratio (%)	The ratio of high-quality liquid assets (HQLA) to total assets. HQLA is measured using the definition of the liquidity coverage ratio.	-
Capital ratio (%)	Ratio of total bank capital to risk-weighted assets.	-
Deposits to total liabilities ratio (%)	Ratio of third-party funds to total liabilities. Measures banks' funding composition.	-
Macroeconomic control variables		
Real GDP	Calculated as the growth rate of constant price GDP.	Dlog
Policy rate (%)	BI Rate.	delta
REER	Real effective exchange rate data from the BIS, seasonally adjusted.	delta
Financial cycle	Gap of the credit-to-GDP ratio to its long-term trend. The trend is calculated using an HP filter.	-
Business cycle	Measured with the sequence of real GDP growth.	dlog

Impact of macroprudential policy instruments on household loan growth		Table 3
Variables	No interaction term	With interaction terms
Δln(Loans) (sum of k lags)	–0.238***	–0.225***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.005***	–0.094***
ΔMaP x ln(Total assets, t-1) (sum of contemporaneous and four lags)		0.562***
ΔMaP x Liquidity ratio(t-1) (sum of contemporaneous and four lags)		2.792***
ΔMaP x Capital ratio(t-1) (sum of contemporaneous and four lags)		–0.605***
ΔMaP x Deposits to total liabilities ratio(t-1) (sum of contemporaneous and four lags)		0.475**
Δln(Real GDP) (t)	0.414***	6.005***
ΔPolicy rate (t)	–0.639***	–2.806***
ΔReal effective exchange rate (t)	0.203***	0.040
ln(Total assets) (t-1)	–0.068***	–0.190***
Liquidity ratio (t-1)	0.049***	0.103***
Capital ratio (t-1)	0.045***	0.126***
Deposits to total liabilities ratio (t-1)	0.009***	0.085***
Number of banks	103	103
Observations	2,948	2,948
Serial correlation test	0.8351	0.1489
Hansen test	0.3849	0.075
Notes: (**) and (***) indicate statistically significant at 5% and 1% levels, respectively.		

Impact of tightening and easing macroprudential policy instruments on household loan growth

Table 4

Variables	No interaction term	With interaction terms
Δln(Loans) (sum of k lags)	–0.069***	0.256***
ΔMaP_easing (sum of contemporaneous and k lags) Dummy: −1,0	–0.232***	–0.060
ΔMaP_tightening (sum of contemporaneous and k lags) Dummy: +1,0	–0.049***	–0.190**
ΔMaP_easing x ln(Total assets, t-1) (sum of contemporaneous and k lags)		–0.781
ΔMaP_easing x Liquidity ratio(t-1) (sum of contemporaneous and k lags)		–5.192***
ΔMaP_easing x Capital ratio(t-1) (sum of contemporaneous and k lags)		2.133***
ΔMaP_easing x Deposits to total liabilities ratio(t-1) (sum of contemporaneous and k lags)		–0.720
ΔMaP_tightening x ln(Total assets, t-1) (sum of contemporaneous and k lags)		–0.286*
ΔMaP_tightening x Liquidity ratio(t-1) (sum of contemporaneous and k lags)		2.385***
ΔMaP_tightening x Capital ratio(t-1) (sum of contemporaneous and k lags)		0.308
ΔMaP_tightening x Deposits to total liabilities ratio(t-1) (sum of contemporaneous and k lags)		–1.919***
Δln(Real GDP) (t)	10.896***	3.024
ΔPolicy rate (t)	–0.452*	3.151
ΔReal effective exchange rate (t)	0.051**	0.190
ln(Total assets) (t-1)	–0.215***	–0.159***
Liquidity ratio (t-1)	0.106***	–1.209***
Capital ratio (t-1)	0.326***	0.032
Deposits to total liabilities ratio (t-1)	0.030*	0.185***
Number of banks	99	99
Observations	2,628	2,628
Serial correlation test	0.803	0.920
Hansen test	0.122	0.146

Notes: (*), (**) and (***) indicate statistically significant at 10%, 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on household loan growth with regard to monetary policy stance

Table 5

Variables	No interaction term	With interaction terms
Δln(Loans) (sum of k lags)	–1.095***	–0.802***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.059***	–0.030**
r (sum of contemporaneous and k lags)	–0.029***	–0.058
ΔMaP x *r* (sum of contemporaneous and k lags)		0.057**
Δln(Real GDP) (t)	4.814***	6.086**
ΔPolicy rate (t)	–0.009***	–0.022***
ΔReal effective exchange rate (t)	0.146***	–0.088
ln(Total assets) (t-1)	–0.111***	–0.084***
Liquidity ratio (t-1)	–0.017	–0.027
Capital ratio (t-1)	0.306***	0.151**
Deposits to total liabilities ratio (t-1)	0.017	0.016***
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	99	99
Observations	2,627	2,627
Serial correlation test	0.753	0.323
Hansen test	0.162	0.104

r: real policy rate as a proxy for monetary policy stance.

Notes: (**) and (***) indicate statistically significant at 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on household loan growth with regard to different phases of the business cycle

Table 6

Variables	No interaction term	With interaction terms
ΔIn(Loans) (sum of k lags)	–0.323***	–0.311***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.004**	–0.091***
ΔIn(GDP) (sum of contemporaneous and k lags)	3.858***	0.985
ΔMaP x ΔIn(GDP) (sum of contemporaneous and k lags)		6.868***
ΔIn(Real GDP) (t)	3.249***	3.196***
ΔPolicy rate (t)	–0.182**	–0.193
ΔReal effective exchange rate (t)	0.139***	0.123***
In(Total assets) (t-1)	–0.050***	–0.060***
Liquidity ratio (t-1)	–0.007	–0.009
Capital ratio (t-1)	0.083***	0.085***
Deposits to total liabilities ratio (t-1)	0.009***	0.011***
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	99	99
Observations	2,825	2,825
Serial correlation test	0.113	0.296
Hansen test	0.285	0.302

Notes: (**) and (***) indicate statistically significant at 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on household loan growth with regard to different phases of the financial cycle

Table 7

Variables	No interaction term	With interaction terms
ΔIn(Loans) (sum of k lags)	–0.622***	–0.988***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.016***	0.004
CreditGap (sum of contemporaneous and k lags)	0.001	0.001
ΔMaP x CreditGap (sum of contemporaneous and k lags)		–0.013***
ΔIn(Real GDP) (t)	0.879	2.318***
ΔPolicy rate (t)	0.411	0.222
ΔReal effective exchange rate (t)	0.036	0.011
In(Total assets) (t-1)	–0.080***	–0.094***
Liquidity ratio (t-1)	–0.013	–0.003
Capital ratio (t-1)	0.215***	0.339***
Deposits to total liabilities ratio (t-1)	0.018***	0.021***
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	99	99
Observations	2,726	2,726
Serial correlation test	0.595	0.642
Hansen test	0.173	0.340

Notes: (***) indicate statistically significant at 1% level.

Impact of macroprudential policy instruments on credit risk — Table 8

Variables	No interaction term	With interaction terms
NPL (sum of k lags)	0.765***	0.740***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.062***	–0.055***
ΔMaP x ln(Total assets, t-1) (sum of contemporaneous and k lags)		–0.169***
ΔMaP x Liquidity ratio(t-1) (sum of contemporaneous and k lags)		–0.454
ΔMaP x Capital ratio(t-1) (sum of contemporaneous and k lags)		0.127
ΔMaP x Deposits to total liabilities ratio(t-1) (sum of contemporaneous and k lags)		–2.189***
Δln(Real GDP) (t)	–3.149	–2.139
ΔPolicy rate (t)	–0.619	–0.937
ΔReal effective exchange rate (t)	0.283	0.337***
ln(Total assets) (t-1)	0.194***	0.282***
Liquidity ratio (t-1)	–0.142	0.076
Capital ratio (t-1)	0.436***	0.366**
Deposits to total liabilities ratio (t-1)	–0.031	–0.125**
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	101	101
Observations	2,931	2,931
Serial correlation test	0.210	0.935
Hansen test	0.087	0.260

Notes: (**) and (***) indicate statistically significant at 5% and 1% levels, respectively.

Impact of tightening and easing macroprudential policy instruments on credit risk

Table 9

Variables	No interaction term	With interaction terms
NPL (sum of k lags)	0.874***	0.626***
ΔMaP_easing (sum of contemporaneous and k lags) Dummy: −1,0	0.023	0.166
ΔMaP_tightening (sum of contemporaneous and k lags) Dummy: +1,0	–0.138***	–0.034*
ΔMaP_easing x ln(Total assets, t-1) (sum of contemporaneous and k lags)		0.061
ΔMaP_easing x Liquidity ratio(t-1) (sum of contemporaneous and k lags)		5.469***
ΔMaP_easing x Capital ratio(t-1) (sum of contemporaneous and k lags)		0.043
ΔMaP_easing x Deposits to total liabilities ratio (t-1) (sum of contemporaneous and k lags)		1.026
ΔMaP_tightening x ln(Total assets, t-1) (sum of contemporaneous and k lags)		0.439***
ΔMaP_tightening x Liquidity ratio(t-1) (sum of contemporaneous and k lags)		4.239***
ΔMaP_tightening x Capital ratio(t-1) (sum of contemporaneous and k lags)		1.313***
ΔMaP_tightening x Deposits to total liabilities ratio(t-1) (sum of contemporaneous and k lags)		1.359***
Δln(Real GDP) (t)	–13.997***	–2.563
ΔPolicy rate (t)	–1.926	–2.772
ΔReal effective exchange rate (t)	0.514**	0.344**
ln(Total assets) (t-1)	0.131***	0.162***
Liquidity ratio (t-1)	–0.218	–0.576***
Capital ratio (t-1)	0.360**	0.367**
Deposits to total liabilities ratio (t-1)	–0.001	–0.266***
Number of banks	101	98
Observations	2,932	2,914
Serial correlation test	0.8698	0.9999
Hansen test	0.1310	0.2106

Notes: (*), (**) and (***) indicate statistically significant at 10%, 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on credit risk with regard to monetary policy stance

Table 10

Variables	No interaction term	With interaction terms
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.069***	–0.097***
r (sum of contemporaneous and k lags)	0.091***	0.057
ΔMaP x *r* (sum of contemporaneous and k lags)		0.119***
Δln(Real GDP) (t)	–12.096***	–11.731***
ΔPolicy rate (t)	0.012	0.041**
ΔReal effective exchange rate (t)	–0.037	0.020
ln(Total assets) (t-1)	0.121***	0.123***
Liquidity ratio (t-1)	–0.069	–0.012
Capital ratio (t-1)	0.490***	0.496***
Deposits to total liabilities ratio (t-1)	–0.026	–0.009
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	98	98
Observations	2,724	2,724
Serial correlation test	0.910	0.859
Hansen test	0.229	0.254

Notes: (**) and (***) indicate statistically significant at 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on credit risk with regard to different phases of the business cycle

Table 11

Variables	No interaction term	With interaction terms
NPL (sum of k lags)	0.847***	0.841***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.037**	–0.277**
Δln(GDP) (sum of contemporaneous and k lags)	–12.553*	–13.930*
ΔMaP x Δln(GDP) (sum of contemporaneous and k lags)		18.051*
Δln(Real GDP) (t)	–13.451***	–14.609***
ΔPolicy rate (t)	–2.694**	–1.185
ΔReal effective exchange rate (t)	0.282**	0.449***
ln(Total assets) (t-1)	0.075***	0.072***
Liquidity ratio (t-1)	–0.095	–0.058
Capital ratio (t-1)	0.416***	0.459***
Deposits to total liabilities ratio (t-1)	0.001	0.002
Time period	Q2 2010–Q1 2018	Q2 2010–Q1 2018
Number of banks	98	98
Observations	2,724	2,724
Serial correlation test	0.951	0.960
Hansen test	0.264	0.296

Notes: (*), (**) and (***) indicate statistically significant at 10%, 5% and 1% levels, respectively.

Impact of macroprudential policy instruments on credit risk with regard to different phases of the financial cycle

Table 12

Variables	No interaction term	With interaction terms
NPL (sum of k lags)	0.241***	0.222***
ΔMaP (sum of contemporaneous and k lags) Dummy: −1,0,+1	–0.051***	–0.118***
CreditGap (sum of contemporaneous and k lags)	–0.097***	–0.104***
ΔMaP x CreditGap (sum of contemporaneous and k lags)		0.029***
Δln(Real GDP) (t)	–1.919	–0.605
ΔPolicy rate (t)	1.062	–0.680
ΔReal effective exchange rate (t)	–0.189*	0.124
ln(Total assets) (t-1)	–0.098**	–0.064
Liquidity ratio (t-1)	–0.054	–0.064
Capital ratio (t-1)	0.401***	0.394***
Deposits to total liabilities ratio (t-1)	0.079**	0.074**
Time period	Q1 2010–Q1 2018	Q1 2010–Q1 2018
Number of banks	98	98
Observations	2,917	2,917
Serial correlation test	0.105	0.128
Hansen test	0.229	0.267

Notes: (*), (**) and (***) indicate statistically significant at 10%, 5% and 1% levels, respectively.

The effectiveness of loan-to-value ratio policy and its interaction with monetary policy in New Zealand: an empirical analysis using supervisory bank-level data[1]

Fang Yao and Bruce Lu[2]

Abstract

In this paper, we quantify the effect of loan-to-value ratio (LVR) policy, as implemented in New Zealand between 2013 and 2016, in containing mortgage loan growth and credit risk at the bank level. We use the empirical strategy proposed by the BIS and find first that the effect of the LVR policy has, on average, a 2 percentage point negative impact on housing loan growth in the six months after implementation. Controlling for bank characteristics, we find that larger banks and more stably funded banks are less affected by the LVR policy. In addition, we also find evidence that the LVR policy has a statistically significant negative impact on the non-performing loan ratio, although the economic magnitude is rather small. These results suggest that the LVR policy achieved the intended effect of restricting risky lending and containing credit risk of small and less stably funded banks.

1. Introduction

Macroprudential policy is intended to reduce vulnerabilities in the banking and household sectors, which if left unchecked could worsen the impact of adverse shocks on the financial system and the real economy. This paper contributes to the growing body of empirical research on the effect of macroprudential policy internationally, by analysing the impact of loan-to-value ratio (LVR) restrictions in New Zealand. To fully capture the reaction of banks to such regulatory changes, we use a combination of prudential supervisory data and macroeconomic controls to construct a panel data set of banks, covering the period from 2010 to 2018.

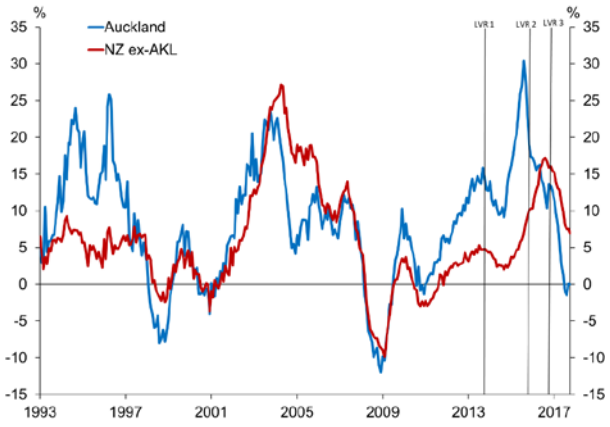
As shown in Figure 1, in response to financial stability risks associated with rapidly rising house prices, the Reserve Bank of New Zealand (RBNZ) implemented three rounds of restrictions on high-LVR lending between 2013 and 2016. The first round of LVR policy was imposed nationwide in October 2013, with the goal of helping to "slow the rate of housing-related credit growth and house price inflation, thereby reducing the risk of a substantial downward correction in house prices that would

[1] The authors would like to thank Ilhyock Shim, Carlos Cantú, Leonardo Gambacorta, Chris Bloor, Enzo Cassino, Ashley Dunstan and Christie Smith for their helpful comments and suggestions on this work. The views expressed in the paper do not necessarily reflect those of the Reserve Bank of New Zealand.

[2] Reserve Bank of New Zealand, 2 The Terrace, PO Box 2498, Wellington 6140, New Zealand. Phone: (64) 4 471 3696; email: Fang.Yao@rbnz.govt.nz and Bruce.Lu@rbnz.govt.nz.

damage the financial sector and the broader economy" (Wheeler (2013)). This policy had a notable effect on house price inflation in both Auckland and the rest of New Zealand for around six months. Subsequent rounds of LVR policy changes were implemented in November 2015 and October 2016, and were more focused on regions and borrower groups viewed as being of particular risk to financial stability.[3] A recent regulatory review by the Reserve Bank of its LVR policy shows that the policy has been effective in reducing house price inflation and credit growth, and in improving the resilience of the banking system (Lu (2019)).

House price inflation in Auckland and the rest of New Zealand Figure 1



Sources: RBNZ; REINZ.

In this paper we quantify the effect of LVR policy, as implemented in New Zealand between 2013 and 2016, in containing mortgage loan growth and credit risk at the bank level. We use the empirical strategy proposed by the BIS and find the following results. First, the LVR policy, on average, reduced housing loan growth by 2 percentage points over the two quarters following each policy announcement. Controlling for bank characteristics, we find that larger banks and more stably funded banks are less affected by the LVR policy. These results together show that LVR policy achieves the intended effect of restricting risky lending by small and less stably funded banks. Second, both the LVR policy and monetary policy have significant negative effects on mortgage lending growth. However, when they are used in the same direction, the policy effects are reinforced. Third, controlling for business and financial cycles, we find that both business cycle booms and growth of the credit-to-GDP gap weaken the LVR policy's effect on loan growth. This result suggests that the impact of the LVR policy is mitigated to a large extent by prior growth in buyers' existing housing equity in the upturn phase of the business cycle. In addition, we also study the effect of the LVR policy on non-performing loans (NPLs). We find evidence that the LVR policy has a significant negative impact on the NPL ratio, although the magnitude is rather small. The long-run elasticity of the NPL ratio with respect to the LVR policy is about a 0.16 percentage point reduction of the mean NPL ratio.

The remainder of the paper is organised as follows. Section 2 discusses our data and the methodology employed. Section 3 presents the empirical findings. Finally, we conclude and provide implications for future policy in Section 4.

[3] For more details on the LVR policy in New Zealand, see Armstrong et al (2019).

2. Data

The analysis in this paper uses supervisory data at the individual bank level, macroeconomic data, and regulatory data on macroprudential policy. We use a quarterly panel data set on 15 banks covering the period between the March quarters of 2010 and 2018.

Detailed supervisory data related to individual banks' balance sheets are confidential. Therefore, we do not disclose summary statistics on individual bank data. Within our supervisory data set, real housing credit, real consumer credit to households and the NPL ratio serve primarily as dependent variables for our analysis, while the remainder of the bank data serve as controls. In the suite of bank controls, the total asset size captures the scale of the bank, while the Tier 1 capital ratio, the liquidity ratio and the deposit-to-liability ratio capture the financial resilience of the bank. Not all supervisory data are available for the whole sample period, because not all the banks were operating for the entire sample period.

We use a number of macroeconomic variables as control variables to help isolate the impact of macroprudential policy changes on banks. These macroeconomic controls are summarised in Table 2 and are relatively intuitive. Among these, one of the less intuitive series is the credit-to-GDP gap, which expresses the deviation in the credit-to-GDP ratio from its long-term trend in percentage terms, and is intended to capture the stage of the financial credit cycle.

Finally, we have a set of policy dummies, including the signalling of macroprudential policy changes, the adjustment to macroprudential policy, and the adjustment to baseline capital requirements. For each series, the dummy takes a value of 1 if the Reserve Bank tightens the LVR policy in the quarter, or signals the imminent tightening of policy. The dummy takes the value of zero if there are no adjustments to policy or no signals, and –1 if the policy is loosened or is signalled to loosen.

We removed around half a dozen data points in banks' prudential indicators for analytical purposes, because we consider these to be outliers. We did not consider any macroeconomic data to be outliers. To qualify as an outlier under our method, a data point must satisfy three independent criteria. First, the data point must be the start of a time series or be adjacent to another outlier, which means that only the relatively early data points of a time series will be outliers. Second, the data point must be associated with an absolute percentage change that is over five times the average absolute percentage change in the series. Last, the value of the data point in level terms must be at least five times the average. The data pre-processing is necessary, especially for the data of small banks, which tend to be volatile immediately after they come into existence. Such volatility may reflect the fact that these lenders have not yet established a robust reporting system or lending strategy. Our methods help to deal with that issue, but also ensure that idiosyncratic shocks that have prudential effects will generally be reflected in the analysis.

3. Empirical results

In this section, we report our empirical results from the benchmark specifications.[4] First, we discuss findings on the effects of LVR restrictions on mortgage lending. Second, we summarise empirical results on bank credit risks.

3.1 Impact on mortgage lending to households

In Tables 2–3, we report empirical results regarding the effects of the LVR policy on the growth of mortgage lending. The dependent variable is the quarterly change in mortgage loans extended by bank b to households in real terms ($\Delta log\ Loans$). In Table 2, we run the benchmark regression and add interaction terms between the macroprudential policy indicator and bank characteristics variables to control for the differential effects on the type of banks. In column I, we find that the lagged terms of the dependent variable are highly significant, but not very persistent. The estimate (0.228) indicates that the effect of the LVR policy on mortgage lending is likely to die out in about two quarters. The coefficient on $\sum_{j=0}^{k} \beta_j \Delta MaP_{t-j}$ is the main estimate of interest. It summarises the overall policy effect on mortgage lending. As expected, the estimate suggests that the LVR policy, on average, reduces housing loan growth by 2 percentage points in the following two quarters. Among the macroeconomic variables, GDP growth appears to have a positive effect on loan growth, while the real interest rate has a negative effect.

In column II of Table 2, we further control for the types of bank by interacting the LVR indicator with the bank characteristics variables. We find that larger banks and more stably funded banks are less affected by the LVR policy. The former is measured by real total assets, the latter by the ratio of non-market funding over total liabilities. This finding confirms some of insights from the bank lending channel literature. In order to discriminate between loan supply and loan demand movements, the literature has focused on cross-sectional differences between banks.[5] This strategy relies on the hypothesis that certain bank-specific characteristics (for example, size, liquidity, the deposit-to-total funding ratio and capitalisation) influence only loan supply movements, while a bank's loan demand is independent of these characteristics. Broadly speaking, this approach assumes that after a macroprudential tightening, the ability to shield loan portfolios is different among banks. In particular, small or less capitalised banks, which suffer a high degree of informational friction in financial markets, face a higher cost of raising non-secured deposits and are more constrained in increasing their lending.

In column III of Table 2, we further investigate the asymmetric effects of macroprudential tools, which are documented by Kuttner and Shim (2012, 2016) and Bruno et al (2015). However, in New Zealand's context, we have only one loosening policy change so far. Therefore, the empirical findings in the first two columns of Table 2 are mainly driven by the tightening changes in the LVR. This is confirmed by the estimates in column III, where we separate negative from positive policy changes. Our

[4] For the detailed specification, refer to the paper by Cantú et al in this volume.

[5] For a review of the literature on the distributional effects of the bank lending channel, see, amongst others, Gambacorta (2005).

benchmark findings largely remain the same for policy tightening, while coefficients on loosening policy are insignificant.

Table 3 studies how is the effect of macroprudential tools affected by monetary policy conditions, and economic cycles. We can test this hypothesis by introducing additional interaction terms, which combine macroprudential dummies and monetary policy conditions *r* (real interest rate). The goal of this test is to verify the effectiveness of macroprudential tools when monetary policy pushes in the same or opposite direction (see Bruno et al (2015) for details). The test is on the overall significance of $\sum_{j=0}^{k} \rho_j$. The empirical finding in column (I) and (II) confirms that both the LVR policy and monetary policy have significant negative effects on mortgage lending growth. However, when they are used in the same direction, the policy effects are reinforced.

In column (III) - (VI), we ask whether the effects of macroprudential policies vary over the business or financial cycle. We test this hypothesis by introducing additional interaction terms which combine macroprudential dummies and real GDP growth (or GDP gap), as a measure of the business cycle; or the credit-to-GDP gap (the difference between the credit-to-GDP ratio and its trend),[6] as a measure of the financial cycle. The goal of this test is to verify the possible presence of endogeneity between real GDP and macroprudential tools: their effect may be higher when GDP is high or vice versa. The test is on the overall significance of the sum of interaction terms. Overall, we find that controlling for business cycles, the boom phase is found to weaken the LVR policy's effect on loan growth. The magnitude seems quite large compared to the effect of LVR policy. This result may suggest that the impact of the LVR policy is mitigated to a large extent by prior growth in buyers' existing housing equity, which tends to be correlated with the upturn phase of the business cycle. Controlling for financial cycles, on the other hand, shows that the LVR policy's effect is also weakened by the growth of the credit-to-GDP gap. The magnitude of the offsetting effect, however, is much smaller than the business cycle effect. This result is not surprising because, in New Zealand, GDP growth is highly correlated with house price growth. Housing cycles synchronise more with the business cycle than with credit cycles. Because the effect of the LVR policy crucially depends on how house prices develop during the policy impact periods, rising house prices during the business cycle boom phase help borrowers to evade LVR restrictions and therefore weaken the policy effect on bank lending.

3.2 Effects on bank risk (non-performing loans)

Ultimately, macroprudential policies are designed to contain systemic risk. By using macroprudential tools, policymakers aim to limit banks' risk-taking and the probability of the occurrence of a financial crisis. This means that, ideally, we should be interested in how macroprudential policies influence systemic risk. Measuring systemic risk is, however, difficult and still at an early stage. Alternatively, a compromise could be to evaluate how macroprudential tools have an impact on a specific measure of bank risk such as the ratio of NPLs over total assets.

[6] In line with the Basel III guidelines for the countercyclical capital buffer, credit-to-GDP gaps are derived as the deviations of the credit-to-GDP ratios from their one-sided (real-time) long-term trend. Trends are calculated using a one-sided Hodrick-Prescott filter with a smoothing factor (lambda) of 400,000, taking account only of information up to each point in time. For more details, see Drehmann (2013). These credit-to-GDP gap series are available from the BIS website and also upon request for many countries.

In Tables 4, we report empirical results regarding the effects of the LVR policy on NPLs. Overall, we find evidence that the LVR policy has a significant negative impact on the NPL ratio, although the magnitude is rather small (columns (I) and (II)). Given the logit transformation used in the regression equation, we have to convert the estimates into economic terms. Based on the estimates shown in Table 4, we calculate the long-run elasticity of NPLs with respect to the LVR policy to be about a 0.16 percentage point reduction of the mean NPL ratio.[7] In our sample, the mean of the LVR ratio is about 1%. Our estimate suggests that the LVR policy implemented in New Zealand will bring the long-run NPL ratio down to 0.84%. In columns (III)-(VI), we also find a significant role of the business cycle in dampening the effect of the LVR policy on the NPL ratio. A possible explanation of this result is that in the short run, recessions coincide with housing downturns, which causes both a loosening in the LVR policy and increasing NPLs.

4. Policy implications and conclusion

This paper contributes to the international policy debate on the effectiveness of macroprudential policies. We use New Zealand bank-level data to evaluate the effect of loan-to-value ratio (LVR) restrictions on mortgage loan growth and non-performing loans.

We draw a number of lessons based on our empirical results for the conduct of borrower-based macroprudential policy, including the LVR instrument. We do not generalise these implications to bank-based macroprudential tools, for example a countercyclical capital buffer.

Our finding that a tightening in the LVR restrictions does have a significant effect in restraining mortgage lending provides policymakers with greater confidence in the tool's effectiveness. There has been some uncertainty about whether there is a major restrictive impact of the LVR policy on mortgage credit, because a fall in borrower LVRs will reduce the minimum amount of capital banks need to hold against their mortgage assets under the capital requirement regime in New Zealand, an effect which permits banks to lend more. Our findings eliminate this uncertainty by showing that borrower-based policy can effectively dampen the credit cycle, and supports the conclusion of a recent New Zealand study (Bloor and Lu (2019)) that the LVR policy has improved the resilience of the banking system and reduced risky lending.

That said, the LVR restrictions may need to be tightened on a regular basis to maintain the policy's effectiveness during the upswing of the business and credit cycles. This is because, first, the impact of each LVR tightening on mortgage lending growth is temporary, largely limited to the two quarters after the policy change. Second, the LVR policy's effectiveness in restraining credit is weaker in the boom phase of an economic cycle, because house price inflation tends to be strong during this time and boost the housing equity of borrowers, increasing their access to credit.

[7] The long-run elasticity of NPLs with respect to LVR policy is given by the following equation: $\frac{\Delta NPL}{\overline{NPL}} = \frac{\theta}{1+\overline{NPL}}$, where $\theta = \frac{\sum_{j=0}^{k} \hat{\beta}_k}{\sum_{j=1}^{k} \hat{\gamma}_j}$, $\overline{NPL} = mean(NPL\ ratio)$ and $\widetilde{\overline{NPL}} = mean(NPL\ ratio/(1 - NPL\ ratio))$. For details, see Chavan and Gambacorta (2018).

Fortunately, the effect on the credit cycle of an LVR policy change would be reinforced by monetary policy moving in the same direction. This means that in a typical economic upswing associated with increasing credit demand, a tightening in monetary policy to address rising inflationary pressures can also be expected to support the LVR policy in dampening the credit cycle. However, in the less common case where the credit cycle and the inflation outlook move in opposite directions, monetary policy may come into tension with macroprudential policy, and decision-making by central bankers will need to consider such trade-offs.

Finally, the LVR policy should be complemented by a debt-service-to-income (DSTI) ratio tool if financial stability risks are high. Our results suggest that the LVR policy has a small impact in reducing the NPL ratio, possibly because the need to meet the LVR requirement has reduced the debt amount, and therefore the serviceability burdens of some borrowers. The main benefit of the LVR policy for bank resilience is in ensuring that borrowers can withstand a fall in house prices without negative equity, and that in the case of borrower distress, banks can recoup the full loan value in a mortgagee sale. The relatively small effect of the LVR policy on the NPL ratio suggests that, if vulnerabilities in the housing market are high, the LVR policy should be complemented with other macroprudential tools that more effectively reduce serviceability risks and the NPL ratio, such as a DSTI instrument. The combination of the two instruments would be more effective in boosting the resilience of both households and banks than either tool deployed alone.

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Annex: Tables

Summary of variables in the bank panel data set — Table 1

Variable	Purpose	Unit	Source
Housing mortgage lending	Dependent variable to model banks' willingness to lend	NZ$ m	Supervisory reporting
Consumer lending		NZ$ m	Supervisory reporting
Real asset size	Captures scale of banks	NZ$ m	Supervisory reporting
Tier 1 capital ratio	Captures resilience of banks	%	Supervisory reporting
Liquidity ratio		%	Supervisory reporting
Deposit to liabilities ratio		%	Supervisory reporting
NPL ratio	Captures bank asset quality	%	Supervisory reporting
Macroprudential tightening	Main independent variables for capturing the impact on banks of regulatory changes	Dummy	RBNZ
Macroprudential signalling		Dummy	RBNZ
Baseline capital tightening		Dummy	RBNZ
Production GDP	Macroeconomic controls for isolating the impact on banks of macroprudential policy	NZ$ m	Statistics NZ
Official cash rate		%	RBNZ
90-day bank bill rate		%	RBNZ
Trade-weighted real exchange rate		Index	RBNZ
Credit-to-GDP gap		%	RBNZ calculations

Effects of macroprudential policies on household loans: aggregate macroprudential index

Table 2

	Dependent variable: quarterly change in lending to households in real terms ($\Delta log\ Loans_{bt}$)		
	(I)	(II)	(III)
$\sum_{j=1}^{k} \gamma_j \Delta log\ Loans_{bt-j}$	0.228***	0.227**	0.231***
	(0.085)	(0.094)	(0.072)
$\sum_{j=0}^{k} \beta_j \Delta MaP_{t-j}$	–0.021**	–0.307*	
	(0.001)	(0.177)	
$\sum_{j=0}^{k} \beta_j \Delta MaP\_easy_{t-j}$			–0.012
			(0.011)
$\sum_{j=0}^{k} \beta_j \Delta MaP\_tight_{t-j}$			–0.020**
			(0.010)
$SIZE_{t-1}$	0.017	0.015	0.015
	(0.011)	(0.009)	(0.018)
LIQ_{t-1}	0.434	0.406	0.437***
	(0.292)	(0.275)	(0.125)
CAP_{t-1}	–0.099	–0.101	–0.103
	(0.221)	(0.256)	(0.186)
DEP_{t-1}	0.051	0.072	0.049
	(0.082)	(0.102)	(0.064)
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * SIZE_{t-1}$		0.021*	
		(0.011)	
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * LIQ_{t-1}$		–0.095	
		(0.142)	
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * CAP_{t-1}$		–0.690	
		(0.657)	
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * DEP_{t-1}$		0.278**	
		(0.136)	
$\Delta \log GDP_t$	0.685***	0.682***	0.725
	(0.179)	(0.193)	(0.477)
$\Delta\ i_t$	–0.000	–0.000	–0.000
	(0.002)	(0.002)	(0.003)
$\Delta\ REER_t$	–0.001	–0.001	–0.0004
	(0.001)	(0.001)	(0.655)
Observations	234	234	234
Serial correlation test[1]	0.182	0.144	0.182
Hansen test[2]	0.625	0.406	0.631

Sample period: Q1 2010–Q1 2018. Robust standard errors are reported in brackets. The symbols *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

[1] Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. [2] Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

Effects of macroprudential policies on household loans: monetary policy conditions and business (credit) cycles

Table 3

	Dependent variable: quarterly change in lending to households in real terms ($\Delta log\ Loans_{bt}$)					
	(I)	(II)	(III)	(IV)	(V)	(VI)
$\sum_{j=1}^{k} \gamma_j\ \Delta log\ Loans_{bt-j}$	0.287***	0.262***	0.224**	0.214**	0.232***	0.214***
	(0.094)	(0.009)	(0.082)	(0.117)	(0.095)	(0.085)
$\sum_{j=0}^{k} \beta_j\ \Delta MaP_{t-j}$	–0.027**	–0.026**	–0.028**	–0.028**	–0.021**	–0.018*
	(0.012)	(0.011)	(0.013)	(0.015)	(0.009)	(0.010)
$\sum_{j=0}^{k} \varphi_j r_{t-j}$	–0.003**	–0.001				
	(0.001)	(0.348)				
$\sum_{j=0}^{k} \rho_j\ \Delta MaP_{t-j} * r_{t-j}$	–0.013*	–0.022**				
	(0.007)	(0.009)				
$\sum_{j=0}^{k} \varphi_j \Delta log GDP_{t-j}$			0.336	0.370		
			(0.429)	(0.447)		
$\sum_{j=0}^{k} \rho_j\ \Delta \mathrm{MaP}_{t-j} * \Delta log GDP_{t-j}$			1.715**	1.692*		
			(0. 920)	(0.988)		
$\sum_{j=0}^{k} \varphi_j \mathrm{Credit} GAP_{t-j}$					0.001	–0.000
					(0.001)	(0.001)
$\sum_{j=0}^{k} \rho_j\ \Delta MaP_{t-j} * \mathrm{Credit} GAP_{t-j}$					0.013***	0.012***
					(0.002)	(0.003)
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Other macroeconomic controls	No	Yes	No	Yes	No	Yes
Observations	234	234	234	234	234	234
Serial correlation test[1]	0.166	0.154	0.214	0.208	0.228	0.227
Hansen test[2]	0.573	0.641	0.508	0.533	0.625	0.658

Sample period: Q1 2010–Q1 2018. Robust standard errors are reported in brackets. The symbols *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

1 Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. 2 Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

Effects of macroprudential policies on non-performing loans: Table 4

	Dependent variable: non-performing loan ratio (NPL_{bt})					
	(I)	(II)	(III)	(IV)	(V)	(VI)
$\sum_{j=1}^{k} \gamma_j \mathrm{NPL}_{b,t-j}$	0.696***	0.699***	0.683***	0.670***	0.698***	0.694***
	(0.048)	(0.045)	(0.058)	(0.056)	(0.048)	(0.052)
$SIZE_{t-1}$	–0.753**	-0.746**	–0.622	–1.108***	–0.772*	–0.832**
	(0.394)	(0.389)	(0.543)	(0.368)	(0.468)	(0.402)
LIQ_{t-1}	3.964**	3.959**	4.213***	4.562***	3.457***	3.503***
	(1.785)	(1.789)	(1.688)	(1.763)	(1.323)	(1.263)
CAP_{t-1}	7.027	7.738	6.209	5.464	7.863	7.645
	(6.027)	(6.042)	(5.963)	(5.821)	(6.583)	(6.674)
DEP_{t-1}	2.108	2.518	2.270	2.488	2.154	2.185
	(2.594)	(2.544)	(2.626)	(2.807)	(2.394)	(2.561)
$\sum_{j=0}^{k} \beta_j \Delta MaP_{t-j}$	–0.519	–4.784***	–0.570	–1.129**	–0.599*	–0.628
	(0.395)	(1.564)	(0.426)	(0.559)	(0.341)	(0.434)
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * SIZE_{t-1}$		0.226***				
		(0.079)				
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * LIQ_{t-1}$		1.385**				
		(0.665)				
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * CAP_{t-1}$		9.589***				
		(2.283)				
$\sum_{j=0}^{k} \delta_j \Delta MaP_{t-j} * DEP_{t-1}$		0.926				
		(0.751)				
$\sum_{j=0}^{k} \varphi_j \Delta logGDP_{t-j}$			–20.58	–26.34		
			(19.23)	(22.23)		
$\sum_{j=0}^{k} \rho_j \Delta \mathrm{MaP}_{t-j} * \Delta logGDP_{t-j}$			30.85	53.44**		
			(27. 92)	(28.91)		
$\sum_{j=0}^{k} \varphi_j \mathrm{Credit}GAP_{t-j}$					0.041	0.045
					(0.027)	(0.028)
$\sum_{j=0}^{k} \rho_j \Delta MaP_{t-j} * \mathrm{Credit}GAP_{t-j}$					–0.038	–0.034
					(0.121)	(0.136)
Macroeconomic controls	Yes	Yes	Yes	Yes	No	Yes
Observations	138	138	138	138	138	138
Serial correlation test[1]	0.033	0.030	0.031	0.031	0.026	0.028
Hansen test[2]	0.247	0.257	0.250	0.241	0.233	0.236

Sample period: Q1 2010–Q1 2018. Robust standard errors are reported in brackets. The symbols *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

1 Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. 2 Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

Have domestic prudential policies been effective? Insights from bank-level property loan data

Veronica B Bayangos and Jeremy De Jesus[1]

1. Introduction

This study examines the effectiveness of changes in domestic macroprudential policies in restraining the growth of real loan commitments by universal, commercial and thrift banks to the non-financial sector in the Philippines. In recent findings, the use of domestic prudential policies to promote financial stability and prevent the occurrence of financial crises, which in turn prevent output losses associated with macroeconomic and financial volatility and financial crises, has been highlighted. The use of macroprudential tools to promote financial stability has likewise allowed many central banks to keep monetary policy focused on its primary objective of maintaining price stability. This has helped enhance monetary policy's credibility in this area. In turn, central banks have recognised that financial stability policy interacts with and influences banking regulations as well as monetary policy actions, implying that central banks need to consider the extent of policy interactions.

Many studies have defined macroprudential policy as a set of measures that prevent or mitigate systemic risk, either over time or across institutions and markets. There are variations on the national/institutional definitions of what constitutes macroprudential policy, but these often centre around the following theme: the use of instruments or tools that either increase the resilience of the financial system or constrain systemic risks often associated with financial booms. This study covers a more comprehensive set of domestic macroprudential policies classified by instrument, such as instruments related to credit (or asset side instruments), to liquidity, which address the build-up of domestic and foreign currency liquidity risks associated with lending booms, to capital, to banks' liabilities (such as reserve requirements on domestic deposits and deposit substitutes), to the structural aspect or interconnectedness (Orsmond and Price (2016)), and to currency exposures (Bruno et al (2015)). The study then estimates the effectiveness of these policies in curbing the growth of real bank loan commitments to non-financial borrowers acquiring new residential properties using an unbalanced panel data regression for the period from 2014 to 2017.

In the Philippines, a detailed study on the effectiveness of prudential policies on the growth of bank credit is yet to be completed. Most studies in this area include the Philippines as part of bigger cross-country studies. In particular, the latest study by Bayangos (2017) finds that, after controlling for episodes of sterilisation of capital inflows across nine Asian emerging market economies for the period 2004–15, capital

[1] Veronica B Bayangos, Director, Supervisory Policy and Research Department, Bangko Sentral ng Pilipinas (email: vbayangos@bsp.gov.ph). Jeremy De Jesus, Bank Officer IV, Department of Economic Statistics, Bangko Sentral ng Pilipinas (email: jdejesus@bsp.gov.ph). We are grateful for comments by the participants in the 62nd ISI World Statistics Congress, which was held on 19 August 2019 in Kuala Lumpur, Malaysia. The usual institutional disclaimer applies.

inflow restrictions and domestic macroprudential policy measures are effective in curbing overall real bank and housing credit and real house prices. Moreover, monetary policy tightening complements domestic macroprudential policy tightening in restraining movements in real bank credit and real house prices.

This study is broadly related to a growing area of empirical research on financial stability. The empirical literature on the effectiveness of domestic macroprudential policies in dampening credit cycles across economies remains relevant since the Great Financial Crisis (GFC). In recent years, empirical evidence on the efficiency of macroprudential policies in restraining excessive credit growth has expanded to include bank-level and credit registry data. However, credit registry data in many countries, including the Philippines, are limited and confidential. This study uses bank-level data from residential property loan reports involving 101 universal/commercial banks (U/KBs) and thrift banks (TBs).

This study raises five main questions. First, are domestic prudential policies effective in restraining growth of bank loan commitments based on bank-level residential property loan data in the Philippines? Second, do responses to a domestic prudential shock differ by type of bank? Third, do responses to domestic prudential policies vary with monetary policy conditions? Fourth, do responses to domestic prudential policies vary over the business and financial cycles of the Philippines? And fifth, do responses to domestic prudential policies restrict bank riskiness? It should be noted that the third and fourth are additional questions which this paper explores.

This study has three possible contributions to make to the empirical literature. First, it updates Bayangos (2017), who documents a database of domestic prudential measures and changes in monetary policy stance for the Philippines to include changes in prudential limits from the first quarter of 2014 to the fourth quarter of 2017. Second, it develops a new database using data from the quarterly bank reports on the residential real estate price index (RREPI) for the same period. Third, the study uses these databases to examine the effectiveness of both tightening and easing of domestic prudential policies on the growth of real bank loan commitments and the overall quality of bank loan portfolios. It then examines the importance of monetary policy reactions to address changes in real bank loan commitments and in the quality of banks' loan portfolios and the interaction among different domestic prudential policy instruments. This study is the first to adopt this approach for the Philippine data. The rest of the study is organised as follows. Section 2 discusses major developments in the Philippine banking system following the GFC in 2008. Section 3 presents the baseline databases and empirical methodology, while Section 4 highlights the main findings of the paper. Section 5 concludes.

2. The Philippine banking system after the GFC

The aftermath of the GFC in 2008 has confirmed, once again, that globalisation brings increasing exposure to the volatility of international financial markets and to other external shocks. Globalisation exposes emerging market economies to large surges and volatility of capital flows, especially when these are routed through the financial system. An important task for monetary authorities is to stabilise the macroeconomy and financial system as well as to steer economic development in the face of such uncertainties.

In turn, the conduct of monetary policy under uncertainty has received significant attention during the last two decades or so. Discussions around this theme include the institutional design of monetary policy, strategies for operating in the markets and the monetary transmission mechanism. Among these areas, discussions on operational strategies in the markets have been crucial in recent years, with the implementation of flexible inflation targeting (IT) to preserve price stability.

In the Philippines, major components of these operational policies in the markets include reforms to the foreign exchange regulatory framework in 2007 and the formal shift in the monetary operations of Bangko Sentral ng Pilipinas (BSP) to an interest rate corridor (IRC) system in June 2016.

In 2007, BSP announced the implementation of a package of reforms in the foreign exchange (FX) regulatory framework to address the needs of a more globalised economy. Eleven waves of FX liberalisation reforms have been introduced since 2007. In November 2014, Republic Act (RA) No 10641 was approved and provided the legal basis for BSP to regulate and supervise the entry and operation of foreign banks in the country. Moreover, RA No 10574 was implemented to allow infusion of foreign equity into rural banks' capital.[2] The liberalisation of entry requirements for foreign banks is expected to contribute to promoting a more competitive banking environment. There are 29 foreign banks which have been approved and authorised to operate by BSP in the Philippines. In particular, BSP has approved 12 foreign bank applications (10 branches and two subsidiaries) since the implementation of RA No 10641.

The IRC is a system for guiding short-term market rates towards the BSP policy interest rate, which is the overnight reverse repurchase (RRP) rate. The primary aim of adopting the IRC is to improve the transmission of monetary policy. By helping ensure that money market rates move within a reasonably narrow range around the BSP policy rate, the IRC helps to enhance the link between the stance of BSP monetary policy and financial markets and, thereby, impact the real economy.

Domestic liquidity (M3) has expanded since 2007 following the surge in overseas remittances and capital flows. In particular, M3 grew by 65.9% from end-December 2004 to end-December 2007, and by 55.8% from end-December 2007 to end-December 2012. More recently, M3 grew by 68.1% from end-December 2013 to end-December 2018. However, year-on-year growth in M3 has dropped from 31.8% at end-December 2013 to 12.8% at end-December 2016 and further to 9.5% at end-December 2018. Nevertheless, M3 relative to nominal gross domestic product (GDP) climbed from 39.7% in 2004 to 48.9% in 2007, 49.7% in 2012 and 66.8% in 2018. When foreign currency deposits of residents are included, broader M3 (or M4) as a share of nominal GDP rose from 56.8% in 2004 to 57.0% in 2007, 59.2% in 2012 and 78.1% in 2018.

Meanwhile, the total resources of the financial system (including BSP) have also risen. The latest data show that total financial system resources grew by 52.3% from end-December 2013 to end-December 2018. The increase could be traced to the growth in loans, securities and other equities of banks.

[2] Under this law, non-Filipino citizens are allowed to own, acquire or purchase up to 60% of the voting stocks in a rural bank and become members of its Board of Directors.

Moreover, BSP pushed for a broad set of strategic reforms in the financial system to better promote financial stability, preserve the institutional safety and soundness of individual banks, and protect the public.[3] These included, first, the adoption of risk-based supervision to keep up with the growing complexity of the banking business. In turn, BSP gradually redirected its supervisory thrust on the measurement and management of banks' risk exposures. Second, driven by the emergence of complex banking groups and mixed conglomerates, BSP adopted consolidated supervision.

Against these developments, banks' business models in the Philippines have also evolved. The latest data show that the Philippine banking sector comprises 45 U/KBs, 54 TBs, and 472 rural and cooperative banks (R/CBs) with their combined assets approximating the size of the domestic economy. U/KBs are able to underwrite securities and take equity positions in manufacturing, agricultural and other enterprises. These banks are also encouraged to make equity investments, to promote longer-term lending and to inject competition into the financial system. By contrast, TBs and R/CBs, which are largely standalone banks, play a pivotal role in promoting inclusive development, especially in the countryside, by providing credit to the agriculture, forestry and fishing industries.

Moreover, more capital-based measures and disclosure standards have been implemented since 2008 due in part to the implementation of the Basel III requirements. BSP adopted the Basel III capital rules for U/KBs and their subsidiary banks on 1 January 2014. In particular, U/KBs were required to comply with the following new minimum capital ratios: 6.0% Common Equity Tier 1 (CET1), 7.5% Tier 1, and 10.0% total capital adequacy ratios (CARs). BSP also adopted the capital conservation buffer (CCB) of 2.5% effective 1 January 2014, the leverage ratio of 5% effective 31 July 2018 and the framework on the countercyclical capital buffer on 6 December 2018. However, simpler standards were applied to TBs and R/CBs that are not subsidiaries of commercial banks. Finally, BSP adopted the international framework for dealing with domestic systemically important banks (D-SIBs), requiring staggered implementation of higher capital buffers starting on 1 January 2017 and moving towards full compliance by 1 January 2019.[4] As a result, the latest data in 2019 show that banks' capitalisation has continued to build up, with capital ratios well above the minimum thresholds set by BSP (10%) and the Bank for International Settlements (8%).

These measures were complemented by an increase in the risk weight on non-deliverable forward (NDF) transactions in 2013, and the conduct of a real estate stress test (REST) on banks' real estate exposures starting from 2014. Moreover, in 2014 BSP approved the adoption of major enhancements to the regulations governing credit risk-taking activities of banks and non-banks with quasi-banking functions (B/NBQBs). Basically, the amendments strengthened credit risk management in these financial institutions in line with global best practices and the Basel Core Principles for Effective Banking Supervision. In 2015, BSP approved the enhancements to the reporting requirements for banks on motor vehicle loans and salary loans.

Meanwhile, liquidity standards were adopted to mitigate systemic risk. To promote short-term resiliency of the liquidity risk profile of banks, a liquidity coverage

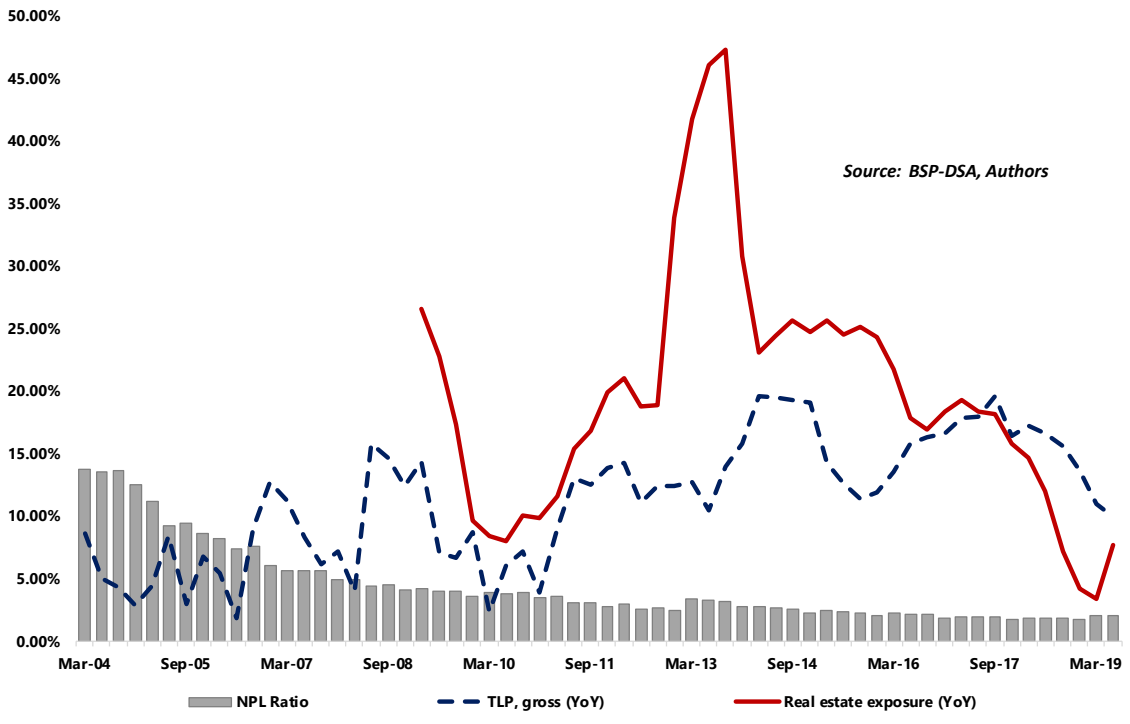
[3] These efforts are generally guided by the *Core Principles for Effective Banking Supervision* issued by the Basel Committee on Banking Supervision (BCBS).

[4] The framework on D-SIBs was recently enhanced, with staggered implementation of capital buffers by 1 January 2022.

ratio (LCR) rule was issued in March 2016. A net stable funding ratio (NSFR) rule was issued in June 2018 to promote resiliency over the longer term by creating additional incentives for banks to fund their activities from more stable sources. In March 2019, standalone TBs, R/CBs and NBQBs were required to submit minimum liquidity ratio (MLR) reports.

The significant increase in the financial system's resources was driven by a rapid expansion in banks' total loan portfolio starting at end-June 2011 (Figure 1). Year-on-year growth of banks' total loan portfolio climbed from 13.0% at end-June 2011 to 19.5% at end-March 2014 and further to 19.6% at end-September 2017, before it dropped to 10.1% at end-June 2019. Meanwhile, consumer loan growth rose from 12.4% at end-September 2010, reached its peak at end-March 2015, dropped to 20.6% at end-September 2016 and went further down to 11.7% at end-June 2019. Real estate loans continued to drive the expansion in real estate exposure of banks, taking up 85.4% of the expansion. Year-on-year growth of banks' real estate exposure reached its peak at 47.3% at end-September 2013. This growth dropped to 21.8% at end-March 2016 and further to 7.7% at end-June 2019.

Figure 1. Growth of Outstanding Bank Loans, Bank Real Estate Exposure and NPL Ratio



As banks continue to adhere to sound credit underwriting standards set by BSP through the issuance of Guidelines on Sound Credit Risk Management Practices in October 2014, loan quality remains satisfactory, with the NPL ratio of banks roughly around 2.1% during the past five years (Figure 1). Likewise, the banking system has also continued to set aside adequate provisioning for credit losses, with the NPL coverage ratio still above 100%. The NPL definition was also aligned with international standards as BSP adopted Philippine Financial Reporting Standard (PFRS) 9 starting on 1 January 2018 that prescribed the use of an expected credit loss model.

Liquidity is a strength of Philippine banks. The banking system maintains sufficient buffers to meet liquidity and funding requirements as the LCR is way above

BSP's current regulatory threshold of 100%. In particular, banks hold sufficient high-quality liquid assets (HQLAs) that can be easily converted into cash to service liquidity requirements over a 30-day stress period.

Banks have also taken advantage of the growing and deepening domestic capital markets, opting to increase their issuances of fixed income securities, including bonds and long-term negotiable certificates of deposit (LTNCDs) to better manage their funding costs. This increase can be attributed to the enhanced rules for the issuance of bonds and commercial papers.

3. Baseline databases and empirical methodology

3.1 Data

This study compiles and constructs three unique sets of databases for the Philippines on bank-level loan commitment, domestic prudential policies and monetary policy actions.

Measure of bank-level loan commitment

This database compiles the volume or number of loans granted for purchases of new residential properties, the average acquisition cost of the property, the appraised value of the residential unit, the appraised value of the lot, the location of these properties, the type of residential property – classified into single-detached, duplex, apartments and condominiums – from 101 banks. The focus of this database is the compilation of the average acquisition cost of residential property as an indicator of the commitment of banks to grant loans based on the acquisition cost of the property. The data are generated from the quarterly report submitted by U/KBs and TBs on all residential real estate loans (RRELs) granted for the generation of the RREPI for the Philippines.

Database on domestic prudential policies

This database includes all the domestic prudential measures adopted by BSP, classified by instrument. For example, *capital-related measures* aim to strengthen banks' ability to absorb risks by adjusting their capital and provisioning requirements. These measures include Basel III capital requirements, adjustments in specific risk weights and provisioning requirements. *Liquidity-related instruments* address the build-up of domestic and foreign currency liquidity risks associated with lending booms. These instruments include the LCR and intraday liquidity requirements. *Structural* or *interconnectedness instruments* aim to address vulnerabilities from interconnectedness and limit contagion. These include interbank exposure limits and additional loss-absorbing capacity for systemically important banks. *Asset-related measures* (or *credit-related instruments*) place restrictions or caps on the amount that can be lent by banks such as the maximum loan-to-value (LTV) ratio and administrative measures in relation to credit or credit growth. *Reserve requirements* are imposed against bank deposits and deposit substitutes. Finally, *currency-related instruments* place limits on net open currency positions and foreign currency lending by banks. The first category captures the measures that are intended to preserve the resilience of the banking system. These include capital- and liquidity-based measures as well as structural or interconnectedness measures. The second category includes

those measures that are expected to address excessive cyclical swings. These include asset side instruments, reserve requirements on banks and currency-related instruments. These two categories are then aggregated to capture both the measures designed to promote banking system resilience and those designed to contain excessive cyclical movements.

Moreover, each policy action in the database is classified into either a tightening or loosening measure. Such a classification is used to verify the extent of asymmetric effects of tightening and loosening measures. This study follows the approach adopted by Kuttner and Shim (2013) and McDonald (2015) in estimating the magnitude of the effectiveness of each instrument. A one-year window (or a four-quarter effect) is used to account for the most appropriate lag effects in the implementation of a tightening or loosening of domestic macroprudential policy. A separate index is constructed for each type of prudential instrument. The idea is that a macroprudential policy tightening dummy variable takes the value of +1 if a prudential instrument is tightened during a quarter, and 0 otherwise. For loosening measures, a macroprudential policy loosening dummy variable takes the value of +1 if a prudential instrument is loosened during a quarter, and 0 otherwise. The database includes a measure of the intensity of implementation of prudential policy by considering the number of times a policy is implemented. The average of these measures is also used.

The study compiles data on the use of domestic prudential instruments. The database shows that the most frequently used macroprudential measures from 2002 to the fourth quarter of 2017 were currency instruments (41.8% of the total), followed by capital-based instruments (29.5%), liquidity-based instruments (13.1%), asset side instruments (6.1%), and interconnectedness instruments (1.2%). During the same period, a total of 108 tightening measures and 102 loosening measures were recorded. Thirty-four measures were classified as being neutral, largely pertaining to changes in reporting requirements. On balance, BSP implemented more tightening than loosening measures. In particular, a majority of the tightening measures were capital- and liquidity-related measures for Basel III compliance, while most of the loosening measures were currency-related measures implemented in connection with the liberalisation of BSP's FX framework starting in 2007. Similarly, there were more measures relying on resilience-based instruments (56.3% of the total) than on cyclical-based instruments (43.7%) from the first quarter of 2014 to the fourth quarter of 2017. Of the total measures adopted, 44.3% were tightening measures, 41.8% loosening measures and 13.9% neutral measures.

Measures of monetary policy actions

This database compiles and updates monetary policy actions by BSP based on the Bayangos (2017) database to include Term Deposit Facility (TDF) rates under the IRC system introduced in June 2016. From this database, we construct two indexes of tightening and loosening policy actions, respectively. Similar to the previous specifications for macroprudential measures, for each change in the central bank official policy rate, a monetary policy tightening dummy variable takes the value of +1 if a hike in policy rate is accompanied by a rise in TDF rates (hence the monetary policy stance is tight) and 0 otherwise. A monetary policy loosening dummy variable takes the value of +1 when the reduction in policy rate is accompanied by a drop in TDF rates (hence the monetary policy stance is loose) and 0 otherwise. The database also includes a measure of the intensity of monetary policy actions by considering

the number of times a policy is implemented. The average of these measures is also used.

Vector of controls

This data set includes macro-financial indicators and bank-specific characteristics used in the study. These include changes in real GDP, inflation, real overseas Filipino remittances, the monetary policy rate, the TDF rate, the bank lending rate, the neutral interest rate, the output gap, the bank credit-to-GDP ratio gap, the nominal peso-dollar rate and real effective exchange rates. The bank-specific characteristics in the data set include the size of a bank (or total resources in real terms), the liquidity ratio defined as liquid assets relative to total assets, capital ratios including the total CAR and the ratio of Common Equity Tier 1 to total assets, funding composition using outstanding deposits relative to total liabilities, the profitability of banks using real net interest income, and the quality of bank loans measured by the NPL ratio, non-performing asset ratio and non-performing coverage ratio.

3.2 Empirical analysis

The empirical analysis includes two parts. The first part estimates the impact of each prudential tool or measure on bank lending to household borrowers and on bank risk-taking activities measured by banks' NPL ratios. The second looks at the impact of prudential tools on monetary policy conditions and financial cycles. While the first part takes the baseline specification proposed by the BIS, the second takes the following specifications.[5]

Do responses to macroprudential policies vary with monetary policy conditions?

In this specification, additional interaction terms are introduced which combine macroprudential policy indicators and monetary policy actions (measured by the neutral interest rate (NRR) based on the Taylor rule).[6] This is seen in equation (1) as

$$\begin{aligned}\Delta logLoans_{b,t} = \; & a_b + \sum_{j=1}^{k} \gamma_j \Delta logLoans_{b,t-j} + \sum_{j=1}^{k} \beta_j \, \Delta MaP_{t-j} + \\ & \sum_{j=0}^{k} \vartheta_j \, r_{t-j} + \sum_{j=1}^{k} \rho_j \, \Delta MaP_{t-j} \; * \; r_{t-j} \; + \sigma X_{b,t-1} + \\ & \theta macrovars_{b,t} + \varepsilon_{b,t}\end{aligned} \tag{1}$$

Following Bruno et al (2017), equation (1) estimates the effectiveness of macroprudential tools when changes in monetary policy push in the same or opposite direction.[7] The test is on the overall significance of $\sum_{j=1}^{k} \rho_j$.

Do responses to macroprudential policies vary over business and financial cycles?

[5] For the detailed baseline specification, refer to the article by Cantú et al in this volume.

[6] The neutral interest rate (NRR) is derived as NRR = (10-year average of real one-year secondary rates) − ((real one-year secondary rates − real five-year secondary rates) − (real one-year secondary average − real five-year secondary average)).

[7] In the estimation of $\sum_{j=0}^{k} \vartheta_j \, r_{t-j}$, the contemporaneous impact is considered.

In this specification, additional interaction terms are included which combine macroprudential policy indicators and real GDP growth (measured by the output gap or the difference between actual real GDP growth and the average output gap from four approaches).[8] This is seen in equation (2) as

$$\begin{aligned}\Delta logLoans_{b,t} = \; & a_b + \sum_{j=1}^{k} \gamma_j \Delta logLoans_{b,t-j} + \sum_{j=1}^{k} \beta_j \, \Delta MaP_{t-j} + \\ & \sum_{j=0}^{k} \vartheta_j \, \Delta logGDP_{t-j} + \sum_{j=1}^{k} \mu_j \, \Delta MaP_{t-j} \; * \; \Delta logGDP_{t-j} \; + \\ & \sigma X_{b,t-1} + \theta macrovars_{b,t} + \varepsilon_{b,t}\end{aligned} \tag{2}$$

The goal of this exercise is to determine the possible presence of endogeneity between the output gap and macroprudential tools. For example, the effects of these tools may be higher when the output gap has widened or vice versa. The test is on the overall significance of $\sum_{j=1}^{k} \mu_j$. In this study, a measure of the financial cycle using the credit-to-GDP gap or the difference between the actual credit-to-GDP ratio and its trend is used in the regression model.[9] In the empirical analysis, this study also considers separate consumer loans-to-GDP ratios for U/KBs and TBs.

Estimation method

In this study for the Philippines, the parameters in the models are estimated using unbalanced panel generalised method of moments (GMM) approach, which is a more appropriate empirical methodology to address the endogeneity between real bank loan commitments and NPLs with bank-specific characteristics and macroeconomic indicators. To handle cross section fixed effects, data are transformed into first difference. Moreover, residuals are clustered by banks.

Robustness checks

Diagnostic tests are used to check for normality of residuals across equations at 1%, 5% and 10% levels of significance. The results are broadly robust against normality tests and different specifications of dependent and independent variables. The residual tests show that all estimated coefficients are significant and that the instruments used are not correlated with the residuals (using a Hansen test). The standard errors of regression are robust and the errors in the first difference regression exhibit no second-order serial correlation (using a serial correlation test).

4. Results

The regression results reported in Tables 1–4 reveal important findings. First, a tightening of domestic prudential instruments, in particular those tightening measures that are meant to preserve banking system resilience, is effective in curbing growth of real bank loan commitments to borrowers for acquiring new residential

[8] (1) production function approach, (2) structural vector autoregression (SVAR), (3) macroeconomic unobserved components model (MUCM), and (4) Hodrick-Prescott (HP) filter.

[9] Credit-to-GDP gaps are derived, in line with the Basel III guidelines for the countercyclical capital buffer, as the deviations of the credit-to-GDP ratios from their (real-time) long-term trend. The consumer loans-to-GDP ratio was also used in the estimation.

properties. The results show that tightening macroprudential policies has a direct negative impact that can last up to four quarters on real bank loan commitments to borrowers based on the real acquisition cost of new properties from March 2014 to December 2017. Importantly, the results reveal that the impact of tightening domestic macroprudential policies varies with both business and financial cycles. Overall, these results confirm other studies' findings that prudential policy tightenings are likely to be effective.

However, looking at the relationship between the index of macroprudential policies and the gap between the actual total CAR and the requirement of 10%, we note that the relationship between the two is negative in all specifications. This relationship consistently holds even when we use the ratio of Common Equity Tier 1 to total assets. This is also consistent with Layaoen and Domantay-Mailig (2018),[10] who find that following the adoption of Basel III regulations, most U/KBs and their subsidiary TBs in the Philippines have become more risk-sensitive. In general, these banks adjust their regulatory capital ratios through changes in the level of capital (ie, capital stock, additional paid-in capital, retained earnings and undivided profits). In addition, U/KBs and their subsidiary TBs have less pressure to adjust their risk-weighted exposures but are more inclined to maintain a reasonable balance between changes in the size of assets and capital.

Moreover, banks' funding costs[11] in general dropped from March 2014 to December 2017, while the gap of the total CAR and the 10% regulatory threshold has broadly climbed and settled at an average of 5.5 percentage points. There was a slight uptick in banks' funding costs following the rise in BSP's overnight policy rate in 2018. Such a negative relationship between bank funding costs and higher capital requirements implies that higher capital requirements could increase investors' confidence in the banking sector, by supporting banks' resilience as well as their ability to increase lending.

In a second important finding, this study highlights the bigger negative impact of tightening prudential measures on real bank loan commitments to maintain resilience of U/KBs than that of TBs, an indication of the presence of a bank lending channel.

Third, real bank loan commitments to household borrowers are driven by bank deposits (relative to total liabilities), the liquidity position and capital adequacy (gap relative to the regulatory threshold). Moreover, monetary policy tightening complements prudential policy tightening in restraining the growth of real bank loan commitments.

Meanwhile, a real exchange rate appreciation reacts to tightening of prudential measures. This finding is significant at the 5% level and across specifications of real effective exchange rates.[12] In particular, the real effective exchange rate rose by 5.6% year-on-year in 2015 but dropped by 3.6% in 2016 and further by 4.2% in 2017. In

[10] Layaoen and Domantay-Mailig (2018) examine U/KBs' motives for maintaining "excess" capital using quarterly panel data for 34 U/KBs (including 14 foreign banks) in the Philippines from December 2012 to June 2017.

[11] Defined as the ratio of annualised interest expense and average interest-bearing liabilities.

[12] In the exercise, the following three measures of real effective exchange rate (REER) were used: the overall REER (Trading Partners Index), the Trading Partners Index – Advanced Countries (TPI-A) and the Trading Partners Index – Developing Countries (TPI-D).

the earlier literature, a local currency appreciation typically leads to a decline in net exports and, consequently a fall in real output. In recent empirical studies, however, a currency appreciation is often associated with buoyant economic activity and rapid credit growth following the growing influence of global financing conditions. An appreciation of the local currency can lead to the perception that risks have decreased, encouraging borrowers to increase their leverage and, in turn, their vulnerability to subsequent shocks. Such a phenomenon has become known as the risk-taking channel of currency appreciation.[13]

Fourth, in general, restricting prudential measures limits risk-taking activities by banks. The results show a negative impact of tightening domestic macroprudential measures on the ratio of NPLs to total loans. It should be noted that as part of BSP's continued assessment of the quality of the total bank portfolio and bank exposures to the real estate sector, supervising BSP departments concerned are closely monitoring actions taken by banks to manage their exposure to the real estate sector effectively. This finding is consistent with the behaviour of the NPL coverage ratio, which has improved for both U/KBs and TBs since end-December 2016.

Meanwhile, the results reveal that the impact of both the business cycle (output gap) and financial cycle (credit-to-GDP ratio) on the movements of the NPL ratio is positive and significant. However, when prudential measures are adopted, the impact on the NPL ratio becomes negative.

In general, the results indicate that despite the relative rise in the size of bank loan portfolios, banks have become more risk-sensitive in their lending behaviour as the quality of loans (measured by the NPL ratio and NPL coverage ratio) has remained relatively stable amid adverse shocks to the macroeconomic environment.[14] Simply put, banks have not just lent more, but lent to capable borrowers as well.

5. Conclusion

This study examines the effectiveness of changes in a comprehensive measure of domestic prudential policies in restraining the growth of real loan commitments of U/KBs and TBs to borrowers for new purchases of residential property and the riskiness of these banks' loan portfolios using a panel data regression from the first quarter of 2014 to the fourth quarter of 2017. There are improvements that the study intends to pursue moving forward. From the technical point of view, the study intends to explore the use of ageing of NPLs of U/KBs and TBs in assessing the extent of risk-taking activities by banks and to examine the impact of domestic macroprudential policies on net interest margins of banks. Moreover, the study aims to use difference-in-differences analysis to check the robustness of the results and to assess the effects of domestic macroprudential policies on the supply of loans in greater detail.

The use of credit registry data will be a future research area to assess the impact of domestic macroprudential policies on household and firm credit risk. Matching firm balance sheet information with credit registry data could help us to fill this gap.

[13] See Bruno and Shin (2015a,b) and Cerutti et al (2014) with special focus on the banking sector, and Sobrun and Turner (2015) and Feyen et al (2015) for an extension to bond markets.

[14] See Cachuela (2018), who reports impulse response functions from a panel VAR using bank-level data on 53 banks (36 U/KBs and 17 TBs) covering the period from the first quarter of 2012 to the fourth quarter of 2017.

The approval into law of the creation of a Credit Information System on 31 October 2008, known as Republic Act No 9510, "An act establishing the Credit Information System and for other purposes" and the establishment of the Credit Information Corporation (CIC) to address the need for a comprehensive, centralised and reliable credit information system is indeed a significant development. The main purpose of the CIC is to strengthen the submission of basic credit data, both positive and negative credit information in the entire data subject provided by submitting entities.

Nevertheless, the study's findings have important policy implications. First, the finding that tightening domestic macroprudential policies is effective in reducing the growth of real bank loan commitments underscores the critical role for structural policies to enhance the capacity of the economy to cope with volatility, along with improved regulation and supervision of the financial sector.

Second, given the influence of a real effective exchange rate appreciation in driving growth in real loan commitments, there is a need for more in-depth understanding of exchange rate dynamics, their impact on the economy and the effectiveness of policy instruments, in both the short and longer term, as well as the risk-taking channel of currency appreciation.

Third, an important point to consider is the role of domestic macroprudential measures in cross-border issues. The cross-border effects of prudential measures can be both positive and negative. The positive effect concerns the public good aspect of financial stability, wherein actions enhancing financial stability in one country also benefit others. Policies that prevent the build-up of systemic risk in one jurisdiction may reduce the probability of crises that subsequently spread elsewhere.

Finally, the finding that tightening of domestic macroprudential policies restricts risk-taking activities by banks underscores the role of bank supervision and the resulting macroprudential policy in managing risks to banking sector stability in the Philippines. Importantly, BSP, cognisant that a "one size fits all" framework is not appropriate for all banks, adheres to the principle of proportionality in the adoption and application of certain prudential regulations.

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Annex: Tables

Table 1

Dep var:	ΔIn(Loans)		NPL	
	(1)	(2)	(3)	(4)
Lag Dep Var	–0.360***	–0.424***	0.583***	0.603***
ΔMaP Dummy: −1, 0, +1	–0.108***	–0.050*	–0.036***	–0.028***
ΔMaP x ln(Total assets, t-1)		–0.272		0.050**
ΔMaP x Liquidity ratio (t-1)		–0.006***		–0.011***
ΔMaP x Capital ratio (t-1)		–0.451*		–0.128***
ΔMaP x Deposit ratio (t-1)		–0.588**		0.213***
ΔReal effective exchange rate (t)	0.323*	0.158**	–0.443***	–0.437***
Liquidity ratio (t-1)	0.093	0.047	–0.036***	–0.184***
Capital ratio (t-1)	–0.157*	0.047	–0.049***	0.105***
Deposit ratio (t-1)	–0.649	0.047	–0.185***	–0.567***
Time period	Q1 2014–Q4 2017			
Number of banks	56	56	56	56
Residual clustered by	bank-level			
Observations	530	530	530	530
Bank fixed effects	Y	Y	Y	Y
R-squared	0.336	0.389	0.879	0.889
Adjusted R-squared	0.302	0.357	0.783	0.799

*, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively.

Table 2

Dep var:	Δln(Loans)		NPL	
	(1)	(2)	(3)	(4)
Lag Dep Var	–0.439***	–0.447***	–0.572***	–0.112*
ΔMaP_cyc Dummy: −1, 0, +1	–0.266*	0.193*	–0.026***	–0.087***
ΔMaP_res Dummy: −1, 0, +1	–0.350***	–0.642*	–0.009***	–0.009***
ΔMaP_cyc x ln(Total assets, t-1)		–0.392		0.042
ΔMaP_cyc x Liquidity ratio (t-1)		–0.246***		–0.081***
ΔMaP_cyc x Capital ratio (t-1)		–0.287***		–0.401***
ΔMaP_cyc x Deposit ratio (t-1)		0.788		–0.012***
ΔMaP_res x ln(Total assets, t-1)				0.101***
ΔMaP_res x Liquidity ratio (t-1)		–0.294*		0.009***
ΔMaP_res x Capital ratio (t-1)		–0.817*		–0.005
ΔMaP_res x Deposit ratio (t-1)		–0.165**		–0.017***
ΔReal effective exchange rate (t)	0.323*	0.250	0.087***	0.035***
Liquidity ratio (t-1)	–0.090*	0.417*	–0.133***	–0.001*
Capital ratio (t-1)	–0.409**	–0.225***	0.170***	0.170***
Deposit ratio (t-1)	–0.175**	0.540*	–0.574***	–0.007
Time period	Q1 2014–Q4 2017			
Number of banks	56	56	56	56
Residual clustered by	bank-level			
Observations	530	530	530	530
Bank fixed effects	Y	Y	Y	Y
R-squared	0.311	0.322	0.657	0.781
Adjusted R-squared	0.3	0.2989	0.611	0.7

*, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively.

Table 3

Dep var:	ΔIn(Loans)		NPL	
	(1)	(2)	(3)	(4)
Lag Dep Var	–0.629***	–0.341**	0.017***	0.024***
ΔMaP_eas Dummy: +1, 0	0.650	0.156**	0.002***	0.033***
ΔMaP_tigh Dummy: +1, 0	–0.285**	–0.017***	–0.008***	–0.014***
ΔMaP_eas x ln(Total assets, t-1)		–0.1698		–0.014
ΔMaP_eas x Liquidity ratio (t-1)		0.156**		0.005***
ΔMaP_eas x Capital ratio (t-1)		0.639**		0.134***
ΔMaP_eas x Deposit ratio (t-1)		–0.473**		–0.016***
ΔMaP_tigh x ln(Total assets, t-1)		–0.126**		–0.202**
ΔMaP_tigh x Liquidity ratio (t-1)		–0.221**		–0.036***
ΔMaP_tigh x Capital ratio (t-1)		–0.203**		–0.234***
ΔMaP_tigh x Deposit ratio (t-1)		0.127**		–0.139***
ΔReal effective exchange rate (t)	0.032***	0.054***	0.027**	0.002*
Liquidity ratio (t-1)	–0.175***	–0.664**	–0.037***	–0.019***
Capital ratio (t-1)	0.063**	–0.414***	0.306***	0.234***
Deposit ratio (t-1)	–0.134***	0.114*	–0.144***	–0.087***
Time period	Q1 2014-Q4 2017			
Number of banks	56	56	56	56
Residual clustered by	bank-level			
Observations	530	530	530	530
Bank fixed effects	Y	Y	Y	Y
R-squared	0.331	0.343	0.823	0.912
Adjusted R-squared	0.322	0.339	0.8	0.867

*, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively.

Table 4

Eco var:	*r*				Δln(GDP)				Credit gap			
Dep var:	Δln(Loans)		NPL		Δln(Loans)		NPL		Δln(Loans)		NPL	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Lag Dep Var	–0.443***	–0.423***	–0.455***	–0.406***	–0.446***	–0.421***	0.598***	0.012***	0.225**	0.315***	0.097*	0.772**
ΔMaP Dummy: −1, 0, +1	–0.054**	0.880	–0.539***	–0.694***	–0.213*	–0.452***	0.007***	–0.009***	–0.002***	–0.166**	–0.010***	–0.872**
Eco Var	0.257**	0.374	–0.144**	0.132	–0.087**	–0.027	0.002***	–0.134***	0.147**	0.242***	0.304**	0.329***
ΔMaP x Eco Var	–0.699**	0.003**	–0.044***	–0.068*	–0.036**	–0.001*	0.353*	–0.339**	–0.626***	–0.111***	–0.359***	–0.136**
ΔREER (t)		0.249***		0.132***		0.096*		0.151***		0.268***		0.353**
Liquidity ratio (t-1)	0.482**	0.850***	0.125*	0.365	–0.042***	0.311*	–0.057***	–0.034***	–0.066***	0.144***	–0.118***	0.198*
Capital ratio (t-1)	0.223***	0.297*	0.364**	–0.119**	–0.633***	0.182	0.363***	0.635***	0.801***	–0.254**	0.503***	–0.251**
Deposit ratio (t-1)	–0.510*	–0.010	–0.119*	0.576**	–0.004***	–0.053*	–0.124***	–0.06***	–0.224***	0.116**	–0.003***	0.101**
Time period	Q1 2014-Q4 2017											
Number of banks	56	56	56	56	56	56	56	56	56	56	56	56
Residual clustered by	bank-level											
Observations	530	530	530	530	560	560	530	530	530	530	530	530
Bank fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.478	0.521	0.31	0.409	0.339	0.451	0.899	0.939	0.911	0.923	0.889	0.854
Adjusted R-squared	0.432	0.472	0.282	0.389	0.311	0.426	0.812	0.898	0.834	0.899	0.845	0.823

The independent term for *r* is Δ*r*. *, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively.

The impact of LTV policy on bank lending: evidence from Thailand[1]

Chantawit Tantasith, Nasha Ananchotikul, Chatlada Chotanakarn, Vorada Limjaroenrat and Runchana Pongsaparn

1. Introduction

The Great Financial Crisis (GFC) in 2008–09 highlighted the importance of safeguarding financial stability and the need to carefully assess and contain systemic risks. At the Bank of Thailand (BOT), financial stability issues have been an integral part of policymaking over the past decade. To increase the resiliency of the financial system and contain the build-up of systemic vulnerabilities, macroprudential policy (MaP) measures have been employed on several occasions. Chief among them are measures on housing credit in the form of loan-to-value (LTV) measures.

The main objective of the LTV measures implemented in Thailand is to ensure that banks are sufficiently prudent in their lending standard to safeguard individual banks' solvency and the stability of the whole financial system. Meanwhile, a potential impact on loan growth can be seen rather as a secondary objective with no explicit policy targets. In 2003, the first measure on LTV ratios was implemented to mitigate a build-up of risks and pre-empt potential speculation in the high-value housing segment, by imposing a strict LTV limit of 70%. Later, in 2009, this measure was relaxed to support a recovery in the property market. Subsequently, LTV tightening measures on low-value mortgage loans were enforced in 2011 and 2013 to signal potential vulnerabilities in these housing segments.

This paper assesses the impact of LTV measures implemented in the housing sector in Thailand in 2009, 2011 and 2013. The analysis will be based on the bank-level and contract-level data provided by all domestic commercial banks in Thailand during the period from Q1 2004 to Q1 2018. We follow the empirical strategy as described in the meta-analysis section introduced in the first paper of this volume, as well as an alternative specification – focusing on the change in the bank loans' LTV distribution – that yields interesting results in the case of Thailand.

The empirical results suggest that the LTV measures were effective in influencing bank risk-taking behaviour, after having controlled for bank and borrower characteristics as well as macroeconomic conditions. Importantly, the effects manifest in terms of a reshaping of the LTV distribution within the loan sector where the LTV measure was applied, while the evidence of an impact on credit growth at the bank level has been muted. The loosening measure in 2009 prompted banks to increase

[1] This country paper draws on our full paper (Tantasith et al (2018)). We would like to thank Piti Disyatat, Sakkapop Panyanukul, Maethinee Hemrit, Atipong Saikaew, Sra Chuenchoksan, Rungporn Roengpitya, participants at the 11th Annual Workshop of the Asian Research Network, Auckland, New Zealand, and participants at the Thai Housing Finance Association's annual workshop for their comments and suggestions. We also thank Leonardo Gambacorta and Ilhyock Shim of the Bank for International Settlements (BIS) for their guidance and support throughout this project. All errors are ours. The views expressed in this paper are those of the authors and do not necessarily represent those of the Bank of Thailand.

the LTV ratio for the targeted loan sector, while the tightening measures taken in 2011 and 2013 led to a more cautious LTV setting, reflecting the tightened credit standard the policy aimed to achieve. In addition, the size of adjustment varies across banks of different attributes, with stronger responses from large and small banks compared with medium-sized banks. The differential response among banks is consistent across the three LTV measures under investigation. Our results overall suggest that certain macroprudential policies can attain a target-specific outcome, but with a differential impact across players. This underlines the need to carefully identify specific areas of risks building up as well as to understand the underlying factors that may give rise to diverging responses in designing a policy measure.

2. Macroprudential policy in Thailand

The MaP measures implemented in Thailand to date have been primarily related to the housing sector. Several MaP measures have been used by the BOT since 2000. Chief among them are LTV measures. In the case of LTV measures, four instances are evident, with varying degrees of restraints and target groups. The first LTV measure was implemented in 2003, when a cap on the LTV ratio of 70% was imposed on high-value mortgages (at and above THB 10 million) as a pre-emptive measure against a potential build-up of risks in the high-end property market. Later, in 2009, the BOT increased the LTV limit of high-value mortgages to 80% and, instead of a strict limit, introduced higher risk-weighted capital charges on high-value mortgages. This measure was intended to provide a further boost to the property market following the GFC after the concern over the property market had already subsided. Following signs of potential speculative activities in the low-value property segment, the higher risk-weighted capital charge on low-value mortgages (below THB 10 million) was implemented in 2011 for high-rise property (eg apartment buildings) and in 2013 for low-rise property (eg houses). The LTV tightening measure on low-rise property was initially scheduled for implementation in January 2012 but later postponed to January 2013 due to severe flooding at end-2011.[2]

Other MaP measures have also been implemented. Among them are maximum credit limits on credit cards and personal loans. Concerns over credit card usage and personal loans, which can have important implications for household debt, as well as industry-wide consumer protection issues prompted the BOT to mandate financial institutions to take borrowers' ability to repay debt into account and tighten related regulations in 2004 and 2005. These regulations include setting a minimum income for credit card holders of at least THB 15,000 per month and a combined credit limit for every credit card provider to five times average monthly income. In addition, the 2004 regulation also stipulated that the minimum monthly payment be raised from 5% to 10%. A similar overall credit limit was also applied to personal loans. Later, in 2017, the BOT tightened the regulations on credit cards and personal loans further

[2] In October 2018, the BOT introduced another LTV measure aiming to enhance financial institutions' credit underwriting standards and to serve as a preventive measure to contain systemic risks after spotting signs of credit standard loosening amidst intensified competition in the mortgage loan market. The measure imposed an LTV cap between 70 and 100% of the collateral value depending on the value of the property and whether the borrower was a first-time home buyer, and also revised a guideline on LTV calculation (see BOT (2019) for more details). However, our study does not cover the impact of this latest round of LTV measures.

due to concerns over potential spillovers from the high level of household debt. Table 1 provides details on the housing-related and consumer credit measures.

Implementation of macroprudential measures in Thailand (2003–17) Table 1

Year	Details
LTV-based measures	
2003	Strict 70% LTV limit on **high-value mortgages** (greater than or equal to THB 10 million).
2009	For **high-value mortgages** (greater than or equal to THB 10 million): LTV limit increased from 70% to 80%, risk-weighted capital charge of 75% for loans with LTV ratio greater than 80% (risk-weighted capital charge of 35% for loans with LTV ratio below or equal to the 80% limit).
2011	For **high-rise property** with a value below or equal to THB 10 million: risk-weighted capital charge of 75% for loans with LTV ratio greater than 90% (risk-weighted charge of 35% otherwise).
2013	For **low-rise property** with a value below or equal to THB 10 million: risk-weighted capital charge of 75% for loans with LTV ratio greater than 95% (risk-weighted charge of 35% otherwise).
2018	Strict LTV limit between 70 and 100% (100% for first-time home buyers) for property valued less than THB 10 million, and between 70 and 80% for property valued higher than THB 10 million.
Non-housing-related measures	
2004	**Credit card measures:** (1) minimum monthly payment increased from 5% to 10%; (2) minimum income of THB 15,000 per month for credit card holders; (3) limit on combined credit line of no greater than five times the borrower's average monthly income; and (4) requiring cancellation of a credit card after three months of non-payment on a positive outstanding balance.
2005	**Personal loan measure:** overall credit limits set to no greater than five times average monthly income.
2017	**Credit card measure:** credit line limit for credit card holders with monthly income lower than THB 50,000 baht lowered from five to 1.5 times average monthly income (if cardholder's monthly income is less than THB 30,000) and to three times monthly income (if cardholder's monthly income is between THB 30,000 and 50,000). **Personal loan measure:** credit line limit for borrowers with monthly income lower than THB 30,000 lowered to 1.5 times average monthly income, with the number of providers not to exceed three companies. **D-SIBs capital surcharge:** adoption of a supervisory framework for D-SIBs, requiring them to maintain an additional 1% of Common Equity Tier 1 above the current minimum requirement (starting at 0.5% in 2019 and increasing to 1% in 2020).

Apart from LTV and consumer credit measures, the BOT has also implemented other forms of MaP.[3] In 2017, the BOT announced the adoption of a supervisory framework for domestic systemically important banks (D-SIBs) – requiring them to maintain an additional 1% of Common Equity Tier 1 above the current minimum requirement. The new requirement will be phased in, starting at 0.5% in 2019 and increasing to 1% in 2020.

[3] Other regulations that may affect bank lending behaviour include the BOT's requirement in 2012 for commercial banks to provide additional provisioning on higher-risk loans to ensure a sufficient cushion during difficult times.

3. Data and stylised facts

Two main data sets used in the empirical investigation are: 1) banks' balance sheet and loan portfolio data, available from 2004 onwards; and 2) a mortgage loan database (MGL), available from 2007 onwards. Both data sets constitute supervisory data reported to the Bank of Thailand by all Thai commercial banks and subsidiaries and branches of foreign banks operating in Thailand. Due to the limited time coverage, our analysis will only examine the effectiveness of three LTV measures, introduced in 2009, 2011 and 2013 respectively.[4] As a reminder, the 2009 measure was a loosening MaP applied to high-value (**HV**) mortgages (equal to or above THB 10 million), while the 2011 and 2013 measures were tightening MaPs applied to high-rise low-value (**HR-LV**) and low-rise low-value (**LR-LV**) mortgages, respectively.

The combination of bank balance sheet and MGL data enables clear separation of mortgages corresponding to the nature of the LTV measures and allows us to examine the behaviour of different banks. The bank-level balance sheet data offer a comprehensive view of banks' loan portfolios and allow us to explore how different banks' characteristics may influence the *supply* of mortgage loans. The banks are grouped by asset size into large, medium and small, which often also reflect other key characteristics as well as the business model common within each size group.[5] However, this data set — though it can be disaggregated into loan types — may not be granular enough to capture smaller subsections of each type of loan or the demand side of loan characteristics. This is where the second set of data, namely the mortgage loan data (MGL), comes in to fill this gap. The MGL database contains contract-level mortgage loans newly issued in each period with details on the characteristics of mortgage borrowers, loan characteristics and collateral characteristics. MGL, therefore, allows us to explore the specific sectors of loans in line with the policy's target, as well as the factors that may influence the *demand* side of mortgages, including borrowers' occupations and the value and type of properties. More details on the data sources and coverage are provided in Appendix A of our full paper (Tantasith et al (2018)).

Focusing on the data before and after the implementation of the three LTV measures in 2009, 2011 and 2013, some interesting stylised facts emerge. We observe that the implementation of each LTV measure was associated with a change in the distribution of mortgage loans' LTV ratios. The implementation of the LTV measures has a significant impact on the distribution of the LTV ratio at both the contract level (Figure 1) and bank level (Figure 2). Figure 1 shows the contract-level LTV distribution for all new mortgage loans. Following the loosening policy for high-value properties in 2009, the share of loans with an LTV ratio above 70% substantially increased, while the tightening policy for low-value homes (both high-rise and low-rise) in 2011 and 2013 led to a decrease in the LTV distribution above the policy thresholds, ie 90% and 95%, respectively.

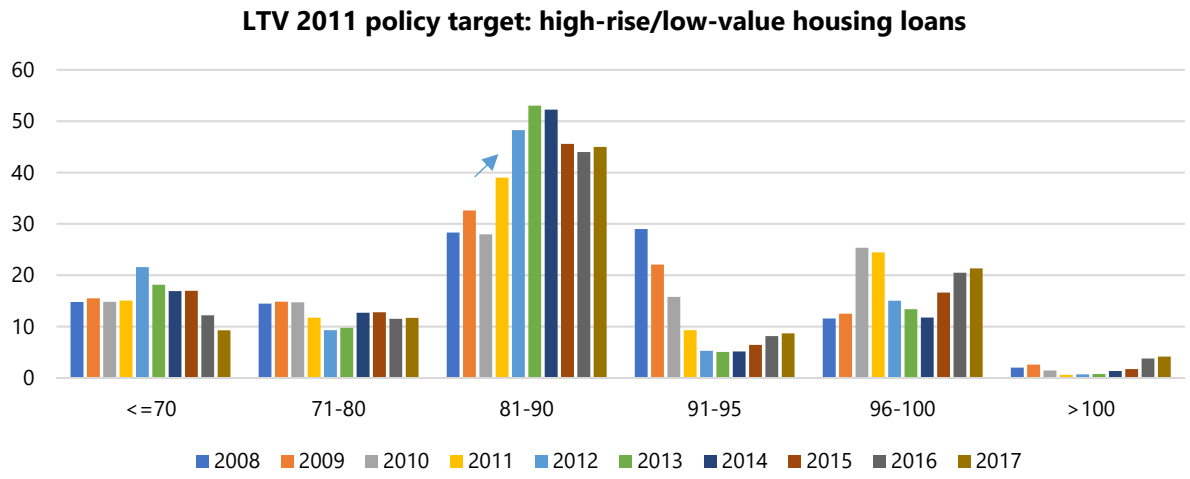
[4] Since the data are only available from 2004 onwards, we cannot test the effects of the 2003 LTV measure and the 2004 credit card measure. Also, the 2017 credit card measure was implemented only recently, hence does not allow enough time lags to systematically evaluate its effects.

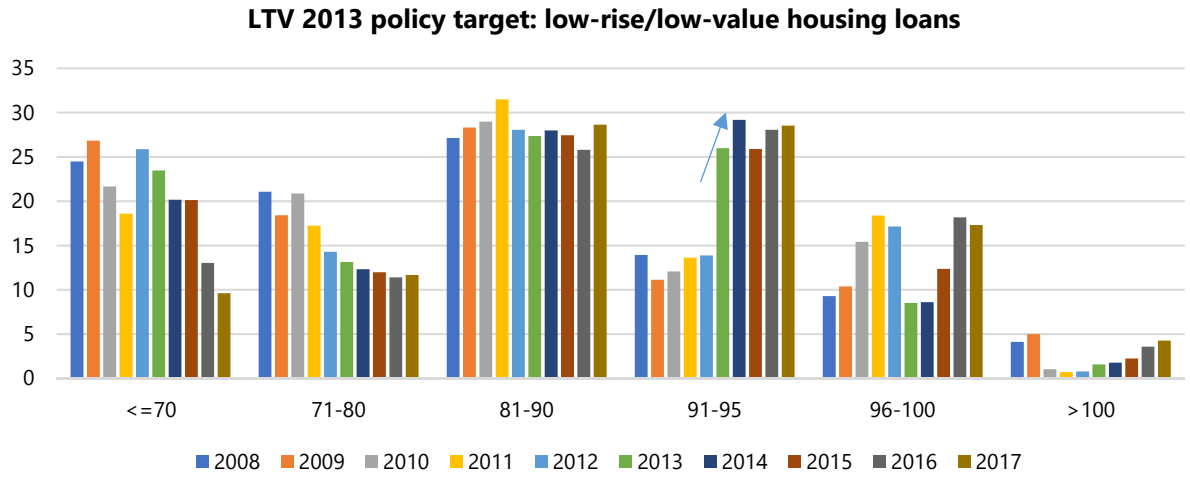
[5] There are a total of 19 banks in our sample, comprising five large banks, three medium-sized banks and 11 small banks including foreign subsidiaries. The top five banks by asset size command more than 70% of the total loan market in the Thai economy, reflecting a high degree of concentration in the Thai loan market and the high market power of the large banks. Small banks typically focus on niche markets and have a relatively small housing loan share. Descriptive statistics on bank balance sheet characteristics by bank size group can be found in Appendix A3 of Tantasith et al (2018).

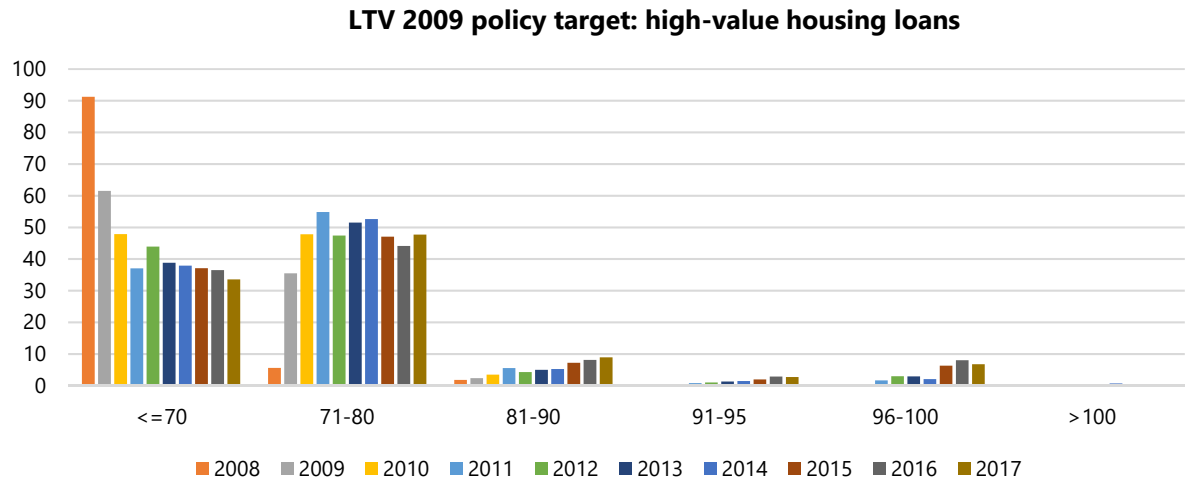
Distribution of the LTV ratio (share of housing loans by level of LTV ratio)

In per cent

Figure 1







Source: Bank of Thailand, authors' calculation

Average bank-level share of new loans above the LTV threshold in each period, by loan amount and by number of contracts

Figure 2

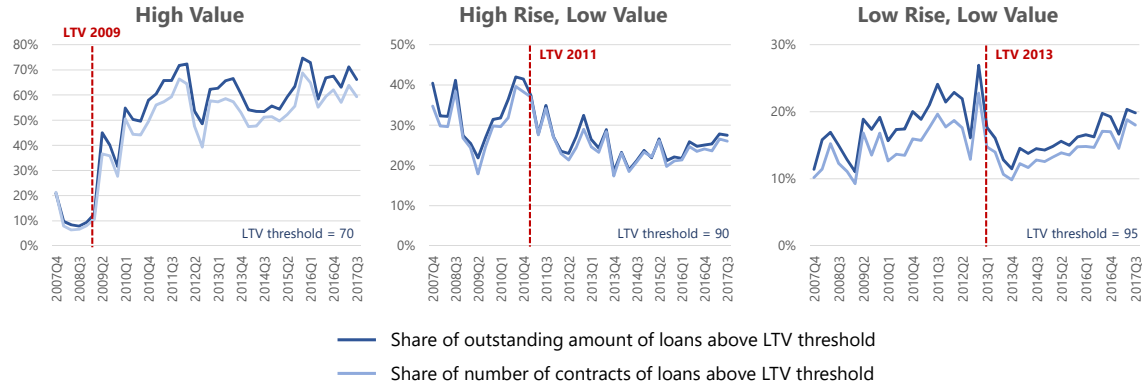


Figure 2 constructs the average bank-level share of new loans by loan amount and by number of contracts above LTV thresholds in each period. The fact that average bank-level shares of loans above the policy thresholds increased after the policy loosening in 2009, and decreased after the policy tightening of 2011 and 2013, provides preliminary evidence of policy effectiveness.

4. Empirical strategy

We perform regression analyses to assess the impact of Thailand's LTV policies following the common empirical methodology.[6] The second set of regression analyses then tests whether the implementation of LTV policies has induced a shift in the composition of loans below and above the policy thresholds. Details on regression specifications are as follows.

4.1 Bank-level loan growth regressions

Here we briefly explain Thailand-specific variables included in the standard regressions. In addition to the standard macroeconomic control variables, we include dummy variables for the 2009 GFC and for the 2011 nationwide floods to allow for a temporary shift in bank lending behaviour induced by the aggregate shocks to the economy.

For this exercise, we employ the bank-level loan data extracted from bank balance sheet information. One advantage of using this data set is that – unlike the contract-level MGL data, which reports only the amount of housing loans for *new* contracts made within a period (ie flow variable) – the bank balance sheet data report the outstanding amount of each type of loan in each period (ie stock variable) that can be used to compute loan growth. A key disadvantage of this data set, however, is that we observe only *total* housing loans held by each bank, and cannot separate them into the specific type corresponding to the LTV targeted housing sector.

[6] For the detailed specification, refer to the article by Cantú et al in this volume.

4.2 Bank-level threshold effects of LTV measures

Next we study the impact of macroprudential policy in terms of changes in the distribution of new loans around the LTV threshold. As motivated by what we observe in the data section, we test whether a change in the LTV measure has effectively influenced a shift in the LTV composition of new loans around the policy threshold value. The specification is essentially the same as equation (1) in the BIS protocol except that the dependent variable is now the share of bank loans (in the targeted housing sector) above the threshold specific to each macroprudential measure:

$$\Delta Share\ above\ threshold_{bt} = const + \sum_{j=1}^{k} \gamma_j \Delta Share\ above\ threshold_{bt-j} + \sum_{j=0}^{k} \beta_j \Delta MaP\_LTV_{t-j} + \theta Controls_{bt} + \varepsilon_{bt}$$

where the dependent variable is the quarterly change in the proportion of new housing loans (that bank *b* extends to borrowers at time *t*) that are above the LTV threshold. The policy variable ΔMaP_LTV_{t-j} indicates a change in the LTV limit. The bank-level MGL data are used for this exercise, with the housing loan portfolio being divided into three main types of mortgages according to the property type: high-value (HV) for the 2019 LTV measure, high-rise/low-value (HR-LV) for the 2011 LTV measure, and low-rise/low-value (LR-LV) for the 2013 LTV measure. We evaluate the effectiveness of each LTV policy separately, focusing on the targeted housing sector before and after the implementation of the policy. If a particular LTV policy is effective, tightening (easing) in the policy stance should result in β_j being statistically significantly negative (positive). This would imply that banks adjusted the targeted loan portfolio by reducing the share of loans above the given LTV threshold, which was the intention of the LTV measure.

5. Discussion of results

Overall, we find that in the case of Thailand, the impact of past macroprudential policy on loan growth appears to have been muted. As shown in Table 2, we cannot detect a statistically significant impact of macroprudential measures on credit growth at the bank level. The sum of the coefficients on the four lags of MaP index ($\sum_{j=0}^{k} \beta_j \Delta MaP_{t-j}$) in the case of consumer loans is found to be positive, which is counterintuitive. This possibly reflects the fact that the periods when macroprudential policy was tightened were usually associated with high rates of loan growth in Thailand.

Interestingly, we find evidence that banks adjusted the LTV distribution of newly issued loans up to four quarters after the LTV measures were introduced. For brevity, we present here the results from the alternative specification only for the 2011 LTV measure.[7] As shown in Table 3 (first column), the share of new loans with LTV above 90% decreased by 13 percentage points, 12 percentage points and 9 percentage points respectively in the quarters after the 2011 measure became effective. Similar results were observed in the case of the LTV measures taken in 2009 and 2013. This suggests that banks responded to the LTV measures by reshaping the LTV distribution rather than by changing the rate of loan growth. This could possibly be due to the fact that most banks set their loan growth targets on a yearly basis, and they might

[7] Refer to the full paper (Tantasith et al (2018)) for all other results, including an investigation on heterogeneous responses by different types of banks.

choose to stick with predetermined targets even in the presence of changes in macroprudential policy. Another likely explanation is that due to data limitations, we only observe credit growth at the bank level for total housing loans. Banks might change the composition of loans across the housing loan subsectors, away from the LTV-targeted loans. But this cannot be detected as the data structure does not allow for a calculation of credit growth for each housing loan subsector. As the impact on credit growth remains inconclusive, this leaves room for future research.

In the context of Thailand, an important question remains whether it is the "actual rule" of the measures or the "signalling" element of the policy that is the main factor driving changes in banks' LTV setting decisions. Since the past LTV measures in the case of Thailand did not apply a strict limit, the policy rule can influence banks' lending only through an increase in capital costs. Whether this capital surcharge creates a burden on banks to the extent that it materially changes their lending decisions remains debatable. As shown in Figure 3, the levels of capital that Thai banks of all sizes maintain have been consistently and considerably above the minimum levels required by the capital requirement threshold of 8.5%. Under the LTV measures' risk-weighted rule, banks might become more cautious in setting the LTV ratio to retain the same capital position. Alternatively, since the measures did not impose a strict limit and since the capital ratio is apparently not a binding constraint for most banks in Thailand, banks may feel no need to adjust the LTV standard, especially if competition in the housing loan market is fierce and they wish to maintain their market share in such conditions. Meanwhile, the signal that the BOT sends to banks about concerns over the real estate sector can be an important factor in their lending decisions. Through public statements and moral suasion, the BOT has established various platforms to communicate with banks should there be specific loan sectors warranting close monitoring. If the signalling channel works effectively, banks will change their risk assessment, leading to adjustment in their lending behaviour even without hard policy rules. The answer to the question of which mechanism has actually led banks to adjust their lending behaviour would ultimately depend on the assessment of the policy impact on bank costs, the optimal levels of capital, and banks' risk-taking attitude, which may in turn depend on the level of market competition as well as the effectiveness of the central bank's moral suasion.

Effects of MaP measures on consumer loans

Table 2

	Dependent variable: quarterly change in outstanding consumer loans ($\Delta \log Loans$)					
	(1)			(2)		
	Coeff		Std err	Coeff		Std err
$\sum_{i-1}^{4} \Delta \log Loans_{t-j}$	0.528	***	0.046	–0.036	***	0.009
$SIZE_{t-1}$	–0.036	***	0.009	–0.176		0.098
LIQ_{t-1}	–0.190	*	0.090	–0.420	***	0.103
CAP_{t-1}	–0.428	***	0.102	–0.030		0.027
DEP_{t-1}	–0.029		0.025	0.528	***	0.046
$\sum_{j=0}^{4} \Delta MaP_{t-j}$	0.023		0.019	0.163		0.142
$\sum_{j=0}^{4} \Delta MaP_{t-j}$ x $SIZE_{t-1}$				–0.011		0.012
$\sum_{j=0}^{4} \Delta MaP_{t-j}$ x CAP_{t-1}				–0.251		0.439
$\sum_{j=0}^{4} \Delta MaP_{t-j}$ x LIQ_{t-1}				–0.010		0.321
$\sum_{j=0}^{4} \Delta MaP_{t-j}$ x DEP_{t-1}				–0.046		0.126
Macroeconomic controls	Yes			Yes		
Policy controls	Yes			Yes		
Fixed effect	Yes			Yes		
Sample period	Q1 2004 – Q1 2018			Q1 2004 – Q1 2018		
Banks	17 (domestic)			17 (domestic)		
Observations	766			766		
Overall R-squared	0.179			0.195		
Within R-squared	0.303			0.341		
Between R-squared	0.216			0.200		

The symbols *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

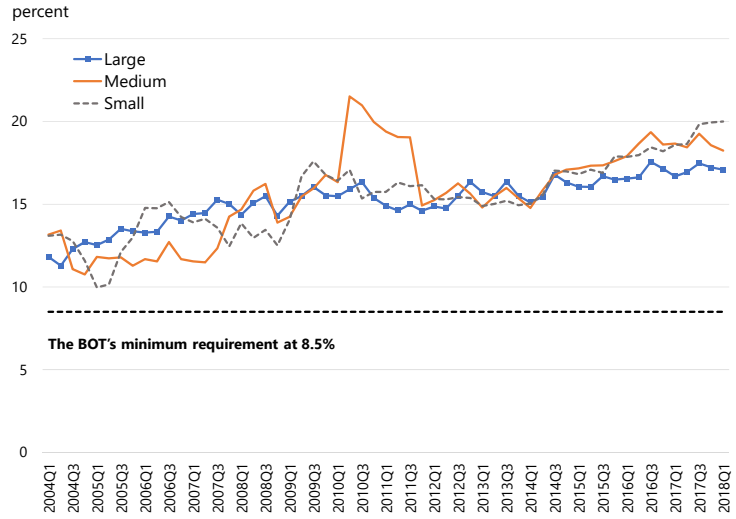
Effects of 2011 LTV policies on the LTV distribution of HR-LV loans

Table 3

	Dependent variable: quarterly change in share of loans with LTV above 90% (Δ share)					
	(1)			(2)		
	Coeff		Std err	Coeff		Std err
Δ share_LTV_above90 $_{t-1}$	–0.146	**	0.055	–0.142	*	0.056
Δ share_LTV_above90 $_{t-2}$	–0.142	**	0.054	–0.154	**	0.055
Δ share_LTV_above90 $_{t-3}$	0.072		0.051	0.049		0.051
Δ share_LTV_above90 $_{t-4}$	0.000		0.043	–0.002		0.044
Δ MAP_LTV_2011 $_{t}$	–13.456	***	3.545	–12.499	*	5.453
Δ MAP_LTV_2011 $_{t-1}$	–12.975	***	3.539	–14.343	**	5.522
Δ MAP_LTV_2011 $_{t-2}$	–9.444	**	3.313	–23.652	***	6.357
Δ MAP_LTV_2011 $_{t-3}$	–1.263		3.515	3.722		6.505
Δ MAP_LTV_2011 $_{t-4}$	–6.434		3.974	–12.808		6.798
LARGE	0.714		1.178	0.497		1.268
MEDIUM	2.351		1.322	1.357		1.397
Δ MAP_LTV_2011 $_{t}$ x LARGE				–4.119		6.698
Δ MAP_LTV_2011 $_{t}$ x MEDIUM				4.426		8.047
Δ MAP_LTV_2011 $_{t-1}$ x LARGE				1.186		6.419
Δ MAP_LTV_2011 $_{t-1}$ x MEDIUM				4.258		8.050
Δ MAP_LTV_2011 $_{t-2}$ x LARGE				14.824	*	7.347
Δ MAP_LTV_2011 $_{t-2}$ x MEDIUM				26.845	**	8.771
Δ MAP_LTV_2011 $_{t-3}$ x LARGE				–7.985		7.381
Δ MAP_LTV_2011 $_{t-3}$ x MEDIUM				–4.002		8.880
Δ MAP_LTV_2011 $_{t-4}$ x LARGE				5.815		7.391
Δ MAP_LTV_2011 $_{t-4}$ x MEDIUM				13.316		8.866
Macroeconomic controls	Yes			Yes		
Policy controls	Yes			Yes		
Fixed effect	No			No		
Sample period	Q4 2007 – Q3 2017			Q4 2007 – Q3 2017		
Banks	18 (domestic)			18 (domestic)		
Observations	326			326		
Overall R-squared	0.145			0.184		
Within R-squared	0.137			0.177		
Between R-squared	0.354			0.397		

The symbols *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.
The results are robust to inclusion of a fixed effect.

Capital position of Thai banks (BIS ratio) Figure 3



Since 2004, Thai banks have been required to maintain the BIS ratio above 8.5%, higher than the minimum requirement of 8%. The jump in the BIS ratio of medium-sized banks in 2010 is due to a bank merger.

Source: Bank of Thailand.

6. Conclusion

This paper assesses the impact of macroprudential policy implemented in Thailand. Given the data available, we study the impact of the LTV measures introduced in 2009, 2011 and 2013. The ultimate goal of the LTV measures is to improve financial resilience by ensuring that banks maintain sufficiently prudent lending standards, while the impact on credit growth is considered a secondary objective. The three LTV measures targeted different segments of the property market using different features, varying from a strict cap to risk-weighted capital charges.

On the whole, both the stylised facts and the results from regressions confirm the influence of the LTV measures on banks' lending behaviour. However, in the case of Thailand the effect is not manifested in changes to the pace of credit growth at the bank level, but rather in the LTV distribution of newly issued loans. Following the LTV measures, banks responded by adjusting their LTV setting consistent with the policy's objective. The loosening measure in 2009 prompted banks to increase the LTV ratio for the targeted loan sector, while the tightening measures in 2011 and 2013 led to a more cautious LTV setting, reflecting the tightened credit standards the policy aimed to achieve.

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