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by

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The Impact of LTV policy on Bank Lending: Evidence from Disaggregate Housing Loan Data[1]

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Abstract

How did the Loan-to-Value (LTV) measures aimed at increasing resilience of the banking system affect banks' lending? This paper utilizes bank-level and contract-level data of housing credit in Thailand spanning from 2004 to 2017, and applies the panel data and probit approaches in evaluating the impact of LTV measures introduced in 2009, 2011 and 2013 on the housing loans. We find that the LTV measures had an impact on banks' risk-taking behavior in ways consistent with the policy's objectives. The effects manifest in a reshaping of LTV distribution of the targeted loan sector rather than a credit growth slowdown at the bank level. In addition, the size of adjustment varies across different types of banks, with stronger response from large and small banks compared with medium banks. Overall, our results suggest that certain macroprudential policies can achieve target-specific outcome, but with differential impact across banks. Nevertheless, questions remain regarding the channels through which LTV measures impact bank lending and factors underlying diverging response among banks.

JEL Classification codes: E58; C55

Keywords: Macroprudential policy; Bank lending; Thailand

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I. Introduction

The Global Financial Crisis in 2008-2009 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 its policymaking over the past decade. To increase the resiliency of the financial system and contain the build-up of systemic vulnerabilities,[2] macroprudential policy (MaP) measures have been employed on several occasions.

The use of MaP measures is one of the three main interlinked building blocks of financial stability work at the BOT. These building blocks are "early detection" (surveillance and risk assessment), "swift policy response" (MaP and other related policies), and "well-contained impact" (availability of financial safety net). According to IMF (2013), an integration of surveillance work and the design of MaP measures is crucial.[3] Often times, the implementation of MaP measures was based on detection of risk buildup in particular sectors.

In the case of Thailand, several MaP measures have been implemented, chief among them are measures on housing credit in the form of loan-to-value (LTV) measures. The main objective of the LTV measures is to ensure that banks are sufficiently prudent in their lending standard to safeguard individual banks' solvency and stability of the whole financial system. Meanwhile, potential impact on loan growth can be rather seen a secondary objective with no explicit policy targets. In 2003, the first measure on LTV ratios was implemented to mitigate risk build-up and pre-empt potential speculation in the high-valued housing segment, by imposing a strict LTV limit of 70 percent. Later in 2009, this measure was relaxed to support slowdown in the property market. Subsequently, the tightening LTV measures on low-valued 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 the domestic commercial banks in Thailand during 2004Q1 to 2018Q1. We rely on two econometric approaches—that is, a dynamic panel data and a probit model estimate—in studying the adjustments of banks' loan portfolio and credit growth after the LTV measures were implemented. We also investigate whether there is evidence of heterogeneity in the policy responses by banks with different characteristics. It should be noted that this paper abstracts away from discussing whether it is more appropriate to use monetary policy or MaP to address financial stability issues. Rather, it takes monetary policy stance as given as part of macroeconomic and policy indicators.

The empirical results suggest that the LTV measures were effective in influencing bank risk-taking behavior, having controlled for bank and borrower characteristics as well as macroeconomic conditions. Importantly, the effects manifest in terms of a reshaping of LTV distribution within the loan sector where the LTV measure was applied, but the evidence of impact on credit growth at the bank level has been muted. The loosening measure in 2009 prompted banks to increase LTV for the targeted loan sector, while the tightening measures in 2011 and 2013 led to a more cautious LTV setting, reflecting a tightened credit standard that the policy aims to achieve. In addition, the size of adjustment varies across banks of different attributes, with stronger response from large and small banks compared with medium banks. The

[2] These are the objectives of macroprudential policy (among others), according to the Bank for International Settlements (BIS), the Financial Stability Board (FSB), and the International Monetary Fund (IMF) (2016).

[3] According to IMF (2013), macroprudential policy cannot rely on rules, but must be based on a continuous assessment of evolving risks.

differential response among banks is consistent across the three LTV measures under investigation. Our results overall suggest that certain macroprudential policies can attain target-specific outcome, but with differential impact across players. This underlines the need to carefully identify specific areas of risk buildup as well as to understand underlying factors that may give rise to diverging responses in designing a policy measure.

The paper is structured as follows. The next section provides general literature review on the conceptual framework pertaining the implementation of MaP and the empirical work on the assessment of MaP effectiveness. The section that follows will focus on MaP in Thailand and provides details on the use of MaP measures and the existing empirical work on MaP effectiveness specific to Thailand. Having provided the background, the details on the assessment of the MaP impact will be discussed starting with the data and methodology before moving on to empirical results and interpretation. The paper then concludes and draws on policy implication from the findings.

II. Literature Review on Macroprudential Policies: Objectives, Nature and Effectiveness[4]

2.1 Objectives of MaP

MaP have been viewed as a supplement to prudential regulatory and supervisory arrangements, *i.e.* microprudential policies, which solely focus on individual institutions. Microprudential policies set the same standards across regulated entities without taking into account the impact of an institution's failure on the financial system and the overall financial system's condition over time. According to Borio (2014), since the ultimate objective of MaP is to preserve *overall* financial stability, they could address these issues by focusing on the whole financial system and set standards with respect to both the systemic footprint of individual institutions ('cross-sectional') and the evolution of system-wide risk ('time-dimensional'). Consequently, the objectives of macroprudential policy can be divided into two categories: 1) to increase the resilience of the financial system (to build banks' financial resiliency against future negative shocks), and more ambitiously 2) to constrain financial booms (to limit banks' excessive credit expansion).

While the objectives of macroprudential policies are clear in principle, in practice, complications arise from the lack of commonly agreed definition of 'financial stability' and 'systemic risk'. There are no commonly held notions of 'financial stability', towards which macroprudential policy should be aimed and 'systemic risk' which is the main variable that the policy aims to influence. The lack of common definition of financial stability follows from the lack of agreement over the notion of 'systemic risk'. For example, De Bandt and Hartmann (2000) defines system risk as the risk of experiencing systemic events where institutions affected in the second round or later actually fail as a consequence of the initial shock, although they have been fundamentally solvent ex-ante. Meanwhile, Perotti and Suarez (2011) interpret systemic risk as propagation risk, when shocks spread beyond their direct economic impact, resulting in diffused distress and disruption of the real economy. The different definitions of systemic risk are reflected in a spectrum of definitions on 'financial stability' as appeared in central banks' and/or regulators' mandates. For instance, according to the Bank of England, financial stability is the consistent supply of the vital services that the real economy demands from the financial system (which comprises financial institutions, markets and market infrastructures), while the ECB defines financial stability as a condition in which the financial system–

[4] This section mainly draws on Tantasith (2017) and an internal work by Financial Stability Unit, Bank of Thailand.

intermediaries, markets, and market infrastructures—can withstand shocks without major disruption in financial intermediation and in the effective allocation of savings to productive investment.

2.2 Nature of MaP

The different interpretation of financial stability and systemic risks have implications on the conduct of macroprudential policy following the different dimensions of risks. Based on the literature (see for example, IMF (2014)) and international experiences, MaP measures can be divided into four main groups in line with the nature of risks: 1) MaP to address risk buildup from economic activities (time-dimensional) 2) MaP to address potential spillover risks from the financial system structure (cross-sectional) 3) MaP to address potential risks from inappropriate Asset-Liability Management (ALM) and 4) MaP to address excessive financial market volatility, potentially leading to instability of the overall financial system. Table 1 summarizes MaP measures according to the nature or the source of risks.

MaP have been increasingly utilized by both advanced and developing countries, especially the credit-related measures. According to BIS-FSB-IMF (2016), there has been a clear upward trend in the use of MaP across different types of countries, and credit-related MaP measures especially Loan-to-Value (LTV) and Loan-to-Income (LTI) have been more popular.

Table 1. Risk factors and corresponding MaP measures

Risk factors	Risk dimensions		Example of MaP measures
Risk buildup from economic activities	Credit side	Broad-based tools	Dynamic provisioning requirements, countercyclical capital buffer, (time-varying) leverage ratio cap, caps on credit growth
		Sectoral tools	Loan-to-value ratios, debt-service ratios, debt-to-income ratios, sectoral capital requirements, exposure limits
Spillover risks from the financial system structure	Structural side	Systemically Important Financial Institutions (SIFIs)	Capital surcharge on Domestic/Global Systemically Important Banks (D-SIBs/G-SIBs)
Risks from inappropriate Asset-Liability Management	Liquidity	- Liquidity mismatch - Maturity mismatch - Currency mismatch	Loan to deposit ratio, reserve requirements, levy on non-core funding, limit on net open FX position
Risks from excessive financial market volatility	Financial market stability	- Impact from excess volatility in the financial market	Capital flows management measures for MaP purposes, regulations on investment and leverage

2.3 Literature review on the effectiveness of MaP

Assessment on the effectiveness of MaP yields mixed results, both from individual-country cases and cross-country analysis. Among the country-specific studies, Aguirre and Repetto (2016) found both the introduction and tightening of a capital requirement and changes in limits on foreign currency of financial institutions effective in altering the credit cycles and changing the behavior of non-performing loans in Argentina. In the case of Brazil, de Araujo et al. (2016) found a tightening in reserve requirements had a negative effect on credit. Gomez et al. (2017) examined the implementation of a counter-cyclical reserve

requirement and a dynamic provisioning scheme for commercial loans effective in stabilizing credit growth and bank risk taking in the case of Colombia. The study on Peru by Levin et al. (2016) found the introduction of conditional reserve requirements on foreign currency liabilities effective in reducing foreign-currency denominated loans. Meanwhile, Basten and Koch (2015) found that the activation of Basel III countercyclical capital buffers in risk-weighted domestic residential mortgages had limited impact on credit in Switzerland.

For the cross-country panel studies, Kuttner and Shim (2016) used a dynamic panel regression of 57 countries to evaluate the effectiveness of various MaP measures in influencing credit growth as well as house prices. The study found that only DSTI (debt service to income) measure could slow down credit growth while no MaP measures could dampen the dynamics of house prices unlike tax measures. Cerutti, Claessens and Laeven (2015) conducted a dynamic panel regression on 119 countries based on the IMF's Global Macroprudential Policy Instruments (GMPI) database and found LTV and Debt-To-Income (DTI) measures effective in slowing down both credit growth and house prices. In addition, MaP measures tend to be more effective among emerging market economies compared to their advanced counterparts. According to the paper, this was potentially because emerging markets relied more on MaP measures compared to their advanced counterparts, at the same time, more developed financial systems in advanced economies could provide more alternative sources of finance – rendering MaP measures less effective. A recent study by Akinci, Olmstead-Rumsey (2017) based on a dynamic panel regression of 57 countries found that housing-related MaP measures were effective in dampening credit growth and house prices.

III. Macroprudential Policy in Thailand[5]

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

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 may have important implications on household debts, as well as industry-wide consumer protection issues prompted the BOT to mandate financial institutions to take borrowers' ability to repay debts into account and tighten related regulations in 2004 and 2005. These regulations include setting a minimum income for credit card holders to at least 15,000 THB per month and a combined credit limit for every credit card provider to no greater

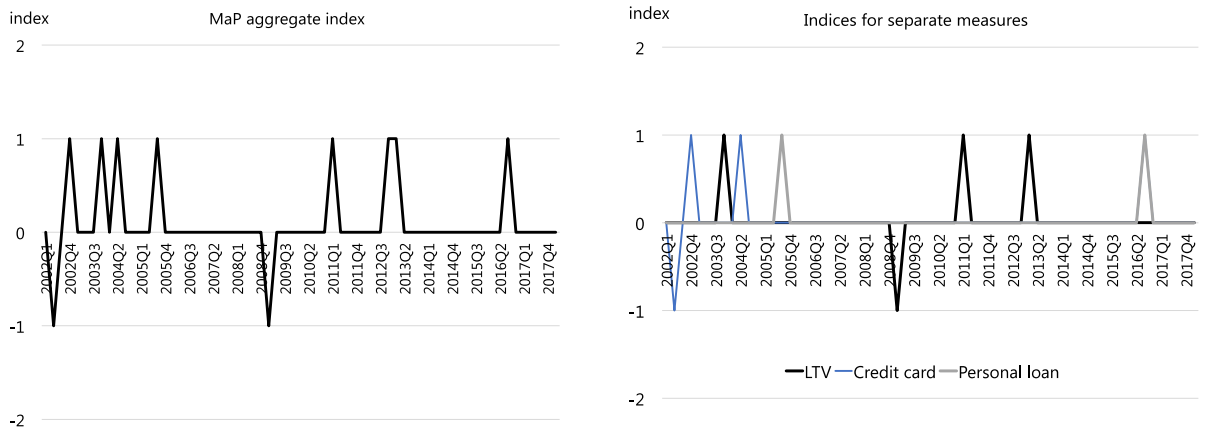
[5] The section draws on Pongsaparn et al. (2017) and BIS (2017)

than five times the average monthly income. In addition, the regulation also stipulated that the minimum monthly payment be raised from 5 to 10 percent. Similar measure on overall credit limit was also applied to personal loans. Later in 2017, the BOT tightened the regulations on credit card and personal loans further due to concerns over potential spillovers from the high level of household debt. The details on housing-related and consumer-credit measures appears in Table 2.

Apart from LTV and consumer credit measures, the BOT also implemented other forms of MaP[6]. In 2017, the BOT announced the adoption of supervisory framework for D-SIBs - requiring D-SIBs to maintain additional 1 percent of common equity tier 1 from the current minimum requirement. The new requirement will be phased in starting at 0.5 percent in 2019 and 1 percent in 2020.

The empirical work on the effectiveness of MaP measures in the case of Thailand found evidence of the impact on housing credit growth from LTV measures at the aggregate level. Pongsaparn et al. (2017) constructed LTV and tax measure indices to reflect different stance of MaP and other policies that might have affected activity in the housing sector.[7] These indices were then included in the set of driving factors behind housing credit growth as part of the regression-based model, following an approach by Akinci and Olmstead-Rumsey (2017). LTV was found to be effective in slowing down housing credit growth, and the counterfactual exercise suggested that the magnitude of LTV's impact was in line with international experiences and did not derail long-term credit growth. However, the study was based on aggregate-level data on housing credit, which did not allow an investigation into the target-specific loan sectors as well as how banks or borrowers with different characteristics may be affected or behave differently in response to the measures. This paper, therefore, attempts to fill this gap. Based on Pongsaparn et al. (2017), we apply the method of constructing indices for the aggregate, housing, credit card and personal loan measures as shown in Figure 1.

Figure 1. MaP indices



Source: Authors' calculation

Note: +1 refers to policy tightening; -1 refers to policy easing; and 0 if there are no changes in MaP stance

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

[7] Housing-related tax measures include tax deduction from property buying and a reduction in special business tax on property transactions implemented during 2002-2003 and 2008-2010. This quasi-fiscal measure was aimed to stimulate the activity in the housing sector as part of the government's economic stimulus package.

Table 2. Implementation of macroprudential measures in Thailand

Year	Details
LTV-based measures	
2003	Imposing a 70% LTV strict limit on **high-valued mortgages** (greater than or equal to 10 million baht)
2009	Only for **high-valued mortgages** (greater than or equal to 10 million baht): increasing the LTV limit from 70% to 80% and imposing risk weighted capital charge of 75% for loans with LTV greater than 80% (risk weighted capital charge of 35% for loans with LTV below or equal to the 80% limit)
2011	Only for **high-rise property** with value below or equal to 10 million baht: imposing risk-weighted capital charge of 75% for loans with LTV greater than 90% (risk-weighted charge of 35% otherwise)
2013	Only for **low-rise property** with value below or equal to 10 million baht: imposing risk-weighted capital charge of 75% for loans with LTV greater than 95% (risk-weighted charge of 35% otherwise)
Non-housing-related measures	
2004	**Credit card measure:** (1) increasing the minimum monthly payment from 5% to 10% (2) setting the minimum income of 15,000 baht per month to credit-card holders (3) setting a limit on combined credit line to no greater than five times the average monthly income of a borrower and (4) requiring the cancellation of a credit card after three months of nonpayment on positive outstanding balance.
2005	**Personal loan measure:** setting overall credit limits to no greater than five times the average monthly income
2017	**Credit card measure:** lowering a credit line limit for credit card holders with monthly income lower than 50,000 baht per month - from 5 to 1.5 times the average monthly income times (if card holders' monthly income is less than 30,000 baht per month) and to 3 times (if card holders' monthly income is between 30,000 – 50,000 baht per month) **Personal loan measure:** lowering a credit line limit for personal loan borrowers with monthly income lower than 30,000 baht per month - to 1.5 times the average monthly income with restrictions on the number of personal loan providers not to exceed three companies. **D-SIBs capital surcharge:** announcing the adoption of supervisory framework for D-SIBs, requiring D-SIBs to maintain additional 1% of common equity tier 1 from the current minimum requirement (starting at 0.5% in 2019 and 1% in 2020).

IV. Data and Stylized Facts

This sub-section describes briefly the data used and provides some stylized facts on mortgage loans and LTV ratios to set stage for empirical investigation. Two main datasets used in the empirical investigation are 1) the banks' balance sheet and loan portfolio, available from 2004 onwards and 2) mortgage loan database (MGL), available from 2007 onwards. Both datasets are 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.[8] As a reminder, the 2009 measure was a loosening MaP applied to high-value mortgages (equal or above 10 million THB) or **HV**, 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 nature of LTV measures and allows us to examine behavior of different banks. The bank-level balance sheet data offers a comprehensive view of banks' loan portfolio and allows us to explore how different banks' characteristics may influence the 'supply' of mortgage loans. The banks are grouped by asset sizes into large, medium and small, which often times also reflect other key characteristics as well as business model common within the size groups.[9] However, this dataset—though it can be disaggregated into loan types—may not be granular enough to capture smaller subsections of each type of loans nor 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 as well as collateral characteristics. MGL, therefore, allows us to explore the specific sectors of loan in line with the policy's target, as well as the factors that may influence the 'demand' side of mortgages including borrowers' occupations, the value and type of properties. More details on the data sources and coverage are provided in Appendix A.

Some interesting stylized facts emerge, suggestive of policy effectiveness. Focusing on the data before and after the implementation of the three LTV measures in 2009, 2011 and 2013, the following patterns are observed:

Stylized fact 1. The implementation of each LTV measure was associated with the change in the distribution of mortgage loans' LTV ratios – in line with one of the measures' intended outcome. The implementation of the LTV measures has significant impact on the distribution of LTV both at the contract level (Figure 2) and at the bank level (Figure 3). Figure 2 shows the distribution of the contract-level LTV distribution of all new mortgage loans. Following the loosening policy for high-valued properties in 2009, shares of loans with LTV above 70 percent substantially increased, while the tightening policy for low-valued home (both high-rise and low-rise) in 2011 and 2013 led to a decrease in the LTV distribution above the policy thresholds, i.e. 90 and 95 percent, respectively.

Figure 3 constructs the average bank-level share of new loans by loan amount and by the 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.

Stylized fact 2. Different types of banks respond to LTV measures somewhat differently (bank heterogeneity). To evaluate whether the impact of macroprudential policy is consistent across different

[8] Since the data is only available from 2004 onwards, we cannot test the effects of the LTV measure introduced in 2003 and the credit card measure in 2004. Also, the 2017 credit card measure has been implemented only recently and hence has not allowed enough time lags to systematically evaluate its effects.

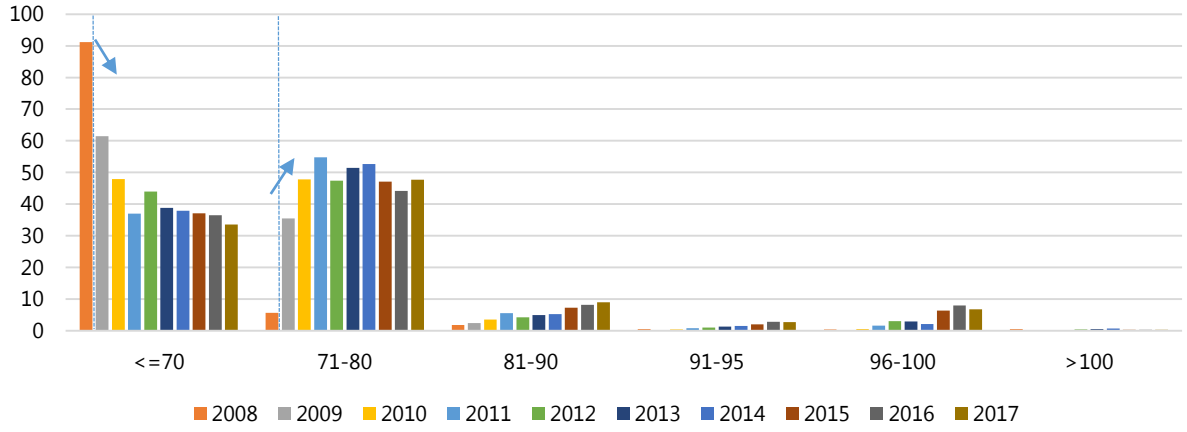
[9] There are a total of 19 banks in our sample, comprised of 5 large banks, 3 medium banks and 11 small banks including foreign subsidiaries. The top 5 banks by asset size command more than 70 percent of total loan market share in the Thai economy, reflecting a high degree of concentration of the Thai loan market and the high market power of the large banks. Small banks typically focus on niche markets and have relatively small housing loan share. Descriptive statistics on bank balance sheet characteristics by bank size group can be found in Appendix A3.

groups of banks, Figure 4 shows an average of bank-level share of new mortgage loans and number of contracts above LTV thresholds in each period, categorized by bank size. While banks' adjustment of loan portfolio in response to the loosening policy in 2009 was similar across the board, heterogeneous responses were observed after the tightening episode of 2011 and 2013. Both large and small banks decreased the share of loans above the policy thresholds after the implementation of the LTV measures. Medium banks, on the contrary, increased the proportion of mortgage loans with LTV above the threshold against the tightening LTV measures. This stylized fact suggests the existence of heterogeneity in bank behavior that is to be explored further in the main regression analysis.

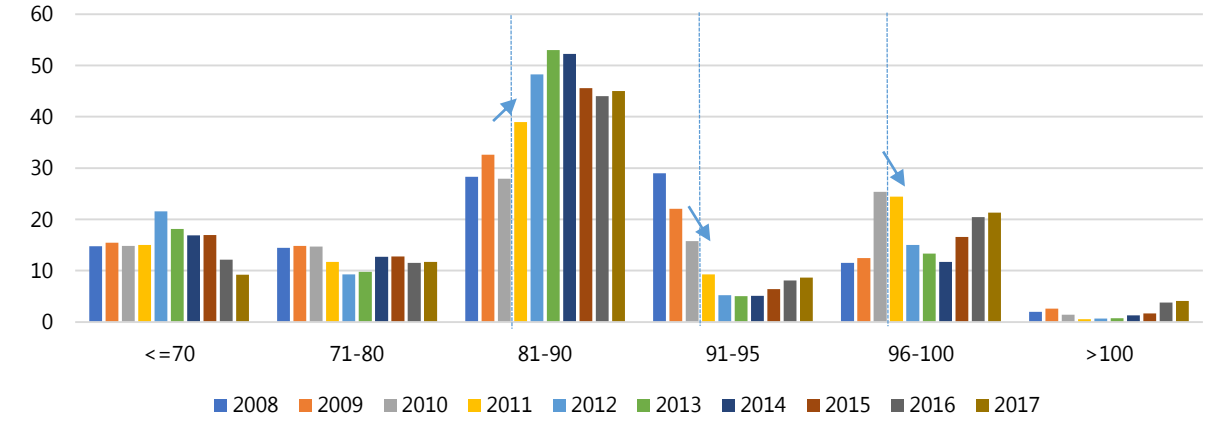
Stylized fact 3. The LTV and LTI ratios of issued loans also depend on the characteristics of borrowers (borrower heterogeneity). In addition to heterogeneity across bank sizes, we also compare LTV and LTI (loan-to-income) ratios across some borrower characteristics, here borrower's occupation. Figure 5 plots the share of loans with LTV above the threshold for the salary-based borrowers (including government officers, state enterprise officers and corporate employees) and for the non-salary-based group (including business owners, freelance, and housewives). For low-value property, the share of loans with LTV above threshold is clearly higher for borrowers with the salary-based incomes than the non-salary income group. Figure 6 plots the distribution of LTI for these two groups and shows that salary-based borrowers tend to have higher LTI ratios on average compared to the non-salary group with relatively skewed distribution towards lower LTI ratios. This indicates that, holding everything else equal, borrowers with salary-based income are perceived to have a more stable source of income and tend to be treated more favorably by banks in terms of higher LTV and LTI ratios. We also find other loan characteristics including the number of (co)borrowers and location of the property to be important determinants of the LTV ratio. We will thus include these as control variables when it comes to contract-level regressions.

Figure 2. Distribution of LTV ratios
(share of housing loans by levels of LTV)

LTV 2009 Target: High-Value Housing Loans



LTV 2011 Target: High-Rise/Low-Value Housing Loans



LTV 2013 Target: Low-Rise/Low-Value Housing Loans

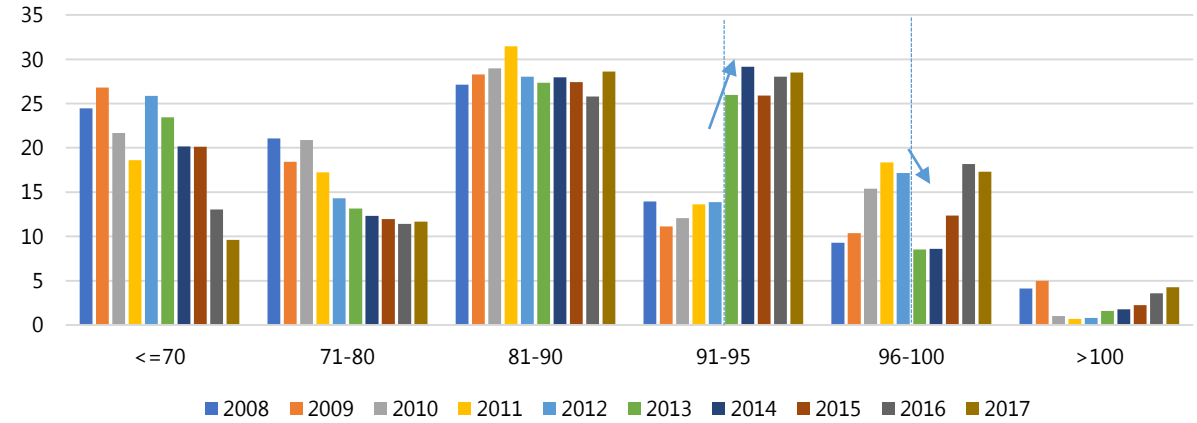


Figure 3. Average bank-level share of new loans above LTV threshold in each period, by loan amount and by number of contracts

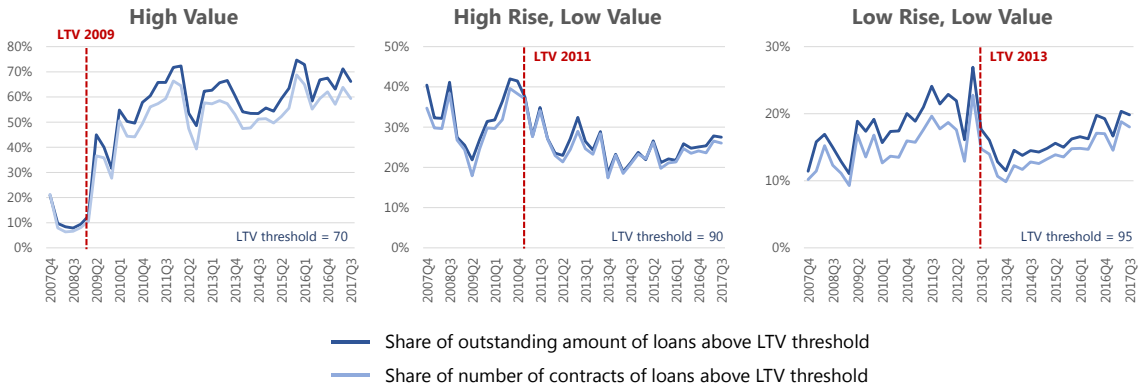


Figure 4. Average bank-level share of new loan amount above LTV threshold in each period, by bank size

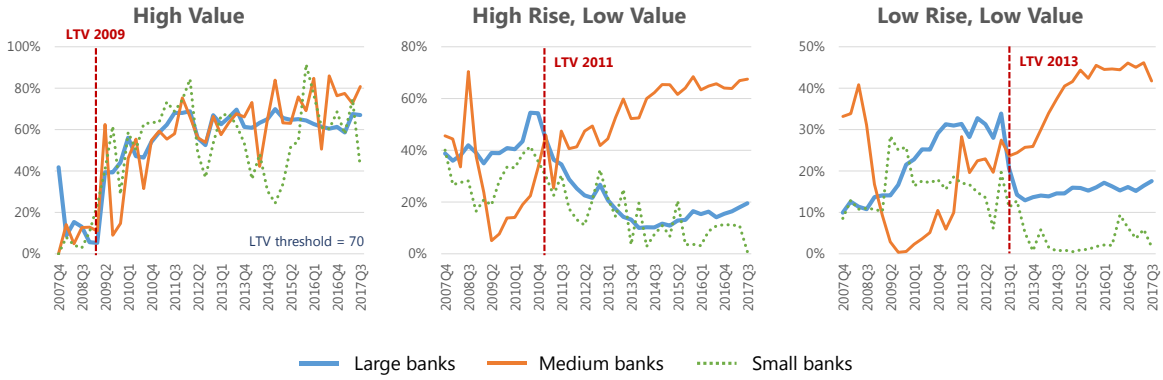


Figure 5. Share of LTV above the threshold, by borrower's income type

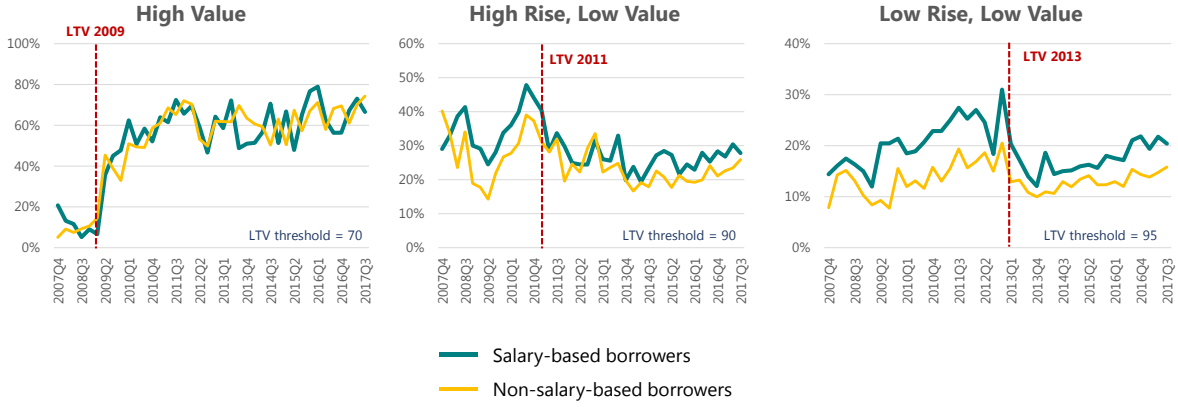
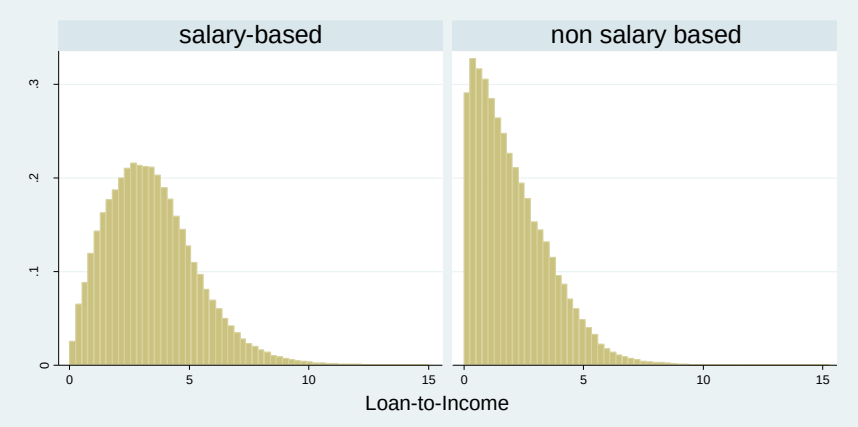


Figure 6. Loan-to-Income distribution, by borrower's income type



V. Empirical Methodology

In this section, we perform regression analyses to assess the impact of Thailand's macroprudential policies at the bank level and the loan contract level. The main variables of interest are rates of growth in credit and distribution of LTV of policy's target loan. Following a standard methodology, we first evaluate the effect of a change in macroprudential tools on credit availability to households in the housing, credit card, and personal loan sectors, using a dynamic panel data model. The second set of regression analyses test whether the implementation of macroprudential policies has induced a shift in the composition of loans below and above the policy thresholds. The last empirical exercise fully utilizes the granularity of the contract-level data and employs a probit model to test the impact of the macroprudential measures from the borrowers' perspective. Details on regression specifications are as follows.

5.1 Bank-Level Loan Growth Regressions

We estimate the effect of a change in macroprudential policy on loan growth at the bank level using a dynamic panel approach. The baseline specification is as follows:[10]

$$\Delta \log Loans_{bt} = const + \alpha_b + \sum_{j=1}^{k} \gamma_j \Delta \log Loans_{bt-j} + \sum_{j=0}^{k} \beta_j \Delta MaP_{t-j} + \theta Controls_{bt} + \varepsilon_{bt} \quad (1)$$

where $\Delta \log Loans_{bt}$ is the loan growth rate calculated as a quarterly change in log of outstanding loan amount of bank b over quarter t. α_b are bank fixed effects. ΔMaP_{t-j} is a dummy variable that takes a value of +1 if a macroprudential tool is tightened in a given quarter, -1 if it is eased, and 0 if no changes occur during that quarter. $\sum_{j=0}^{k} \beta_j$ are our main coefficients of interest which capture the impact of a change in the macroprudential tool on credit growth. We test an aggregate index[11] of all measures on total loans extended to households, and test each macroprudential measure separately on the corresponding types of loans that the measure aims to target.

$Controls_{bt}$ consists of bank characteristics, macroeconomic variables and dummy variables capturing related government policy. Bank-specific characteristics include bank size (*SIZE*: log of real total assets),

[10] This methodology follows the baseline specification described in the BIS protocol (Gambacorta, 2018). We also perform regression exercises under other model specifications according to the protocol. All results are presented in the Appendix B.

[11] The indices used for regression exercises are shown in Figure 1

liquidity ratio (*LIQ:* cash and securities over total assets), capital ratio (*CAP*: Tier 1 capital to total assets) and funding composition (*DEP:* the share of deposits to total liabilities), all in their first lag. Macro controls include quarterly change in real GDP, change in the real monetary policy rate, change in the effective real exchange rate, as well as credit-to-GDP gap (in percent). Dummy variables for the 2009 Global Financial Crisis and for the 2011 nationwide floods are also included in the macro controls to allow for a temporary shift in the bank lending behavior induced by the aggregate shocks to the economy. All variables in levels are expressed in real terms, deflated by the CPI inflation. The number of lags (*k*) for the dependent variable and ΔMaP_{t-j} is 4 to allow changes in macroprudential policy to have an effect up to 4 quarters.

For this exercise, we employ the bank-level loan data extracted from bank balance sheet information. One advantage of using this dataset is that—unlike the MGL data which reports only the amount of housing loans for *new* contract made within a period (i.e. flow variable)—the bank balance sheet data reports outstanding amount of each type of loans in each period (i.e. stock variable) that can be used to compute loan growth. A key disadvantage of this dataset, however, is that we observe only *total* housing loans held by each bank, and cannot separate them into the specific type corresponding to the targeted housing sector. The main results from this exercise are reported in Table 3 and Table 4.

5.2 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 stylized facts, 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 (1) 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. The specification is:

$$\Delta Share\ above\ threshold_{bt} = const + \sum_{j=1}^{k} \gamma_j \Delta Share\ above\ threshold_{bt-j} + \sum_{j=0}^{k} \beta_j \Delta MaP\_LTV_{t-j} + \theta Controls_{bt} + \varepsilon_{bt} \quad (2)$$

where the dependent variable is the quarterly change in proportion of the amount 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 a LTV measure. The bank-level MGL data is 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 LTV 2009 measure, High Rise-Low Value (HR-LV) for the LTV 2011 measure, and Low Rise-Low Value (LR-LV) for the LTV 2013 measure. We evaluate the effectiveness of each LTV policy separately and the focus is on the targeted housing sector before and after the implementation of the policy.

We are also interested in assessing differential impact of the policy measures on banks of different attributes. The bank size dummies (*LARGE* and *MEDIUM*) are introduced to the baseline specification and interacted with the policy variables. Grouping banks in this way encapsulates important attributes and business models of Thai banks. As we will show in Section 6, banks of different sizes reveal differential responses to changes in LTV measures. Other variables broadly follow those described in (1). Details of the variables and summary statistics are provided in Appendix A. The number of lags (k) remains 4.

Considering equation (2), the coefficient of interest is β_j. If a particular LTV policy is effective, tightening (easing) in the policy stance should result in β_j being statistically significantly negative (positive). It 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. We will also focus on the estimated coefficients of the interaction terms with bank size dummies to compare differential impact across different bank attributes. The main results from this exercise are reported in Table 5 – Table 7.

5.3 Contract-Level Probit Model

Lastly, we estimate a probit model which enables us to fully exploit the granularity of the contract-level MGL data. For each new loan contract being made, we aim to test whether the implementation of the LTV measures effectively changed the probability that the loan was granted with an LTV above the threshold, controlling for characteristics of banks and borrowers and other macroeconomic conditions. The probit model is in the following form:

$$P\ (Y = 1 \mid X) = \Phi(L) \tag{3}$$

where Y is the event that LTV ratio of a new loan is greater than the threshold set by each LTV measure. X indicates whether an observation corresponds to the policy's target loan, and whether time belongs to pre- or post-policy intervention period. Φ is the cumulative distribution function of normal distribution which underlies the probit model. We construct a binary dependent variable by assigning the value of 1 to new-loan observations that have LTV greater than the threshold level, and 0 otherwise. *L* contains a similar set of variables as in the previous regression models with an addition of a set of contract-level characteristics. These include borrowers' occupation (salary-based vs. non-salary-based), the number of borrowers under the contract, and the area where the property is located (Bangkok vs. elsewhere).

A key benefit the probit model adds to the regression exercises is that it gives each contract an equal weight regardless of loan amount granted. Under (2), the dependent variable measures the proportion of loans with LTV above the policy thresholds. Since the variable's construction is based on *loan amount*, it might be driven by some contracts that carry large amount of loans. The probit model is not subject to this limitation as information for every loan contract is summarized in a binary dependent variable indicating whether LTV is above the policy threshold. We thus use the probit model to confirm the results obtained from (2). The main result from the probit model is shown in Table 8.

Overall, these regression exercises allow us to evaluate policy effectiveness of Thailand's macroprudential policy thoroughly using different sets of loan data. The granularity of the data we use offers at least three benefits. First, the contract-level MGL data enables us to construct a dependent variable (share of loan above LTV thresholds), thus offering a new perspective in assessing the policy impact on bank lending behavior in addition to the commonly used loan growth. Second, given that macroprudential policy has a narrow focus on the loan sectors they aim to influence, using the aggregate data we might not be able to detect the true effect of MaP or get misleading results due to loan developments outside of MaP influence. Lastly, the approach enables us to capture potential heterogeneity in policy impact on different loan types as well as heterogeneity in policy responses by banks with varying characteristics, which can help guide future policy direction.

VI. Discussion of Results

Based on the estimated results, we summarize our findings as follow.

<u>Finding 1.</u> The impact of macroprudential policy on loan growth was muted at the bank level. Instead, banks responded to the LTV measures by reshaping LTV distribution of housing loans.

As presented in Table 3 (consumer loans) and Table 4 (housing loans), we cannot detect the statistically significant impact of macroprudential measures on credit growth at the bank level, both for the aggregate MaP index and for individual measures. We would expect the coefficient on the MaP index to be negative if the tightening of the measures were effective in slowing down credit growth. Rather, as shown in Table 3, 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, possibly reflecting the fact that the periods when macroprudential policy was tightened were usually associated with high rates of loan growth. This coefficient for Table 4 in the case of housing loans follows the same interpretation. As for credit card and personal loan measures, we cannot find statistically significant coefficients pointing to the impact of the policy on credit growth[12] (Table B1 and Table B2 in Appendix B). Combined with other results obtained from different specifications (Appendix B), this leads to a conclusion that the impact of macroprudential policy is not manifested in terms of credit growth at the bank level.

On the contrary, we find evidence that banks adjusted the LTV distribution of newly issued loans up to 4 quarters after the LTV measures were effective. As Table 5 (first column) illustrates, within one period after the BOT increased the maximum LTV for HV housing loans from 70 percent to 80 percent, we observed a 33 ppt increase in the share of loans with LTV above 70 percent, implying that the previous LTV strict limit at 70 percent may have been binding for banks. This limit was long imposed since 2003 in response to signs of instability in the real estate sector. The policy remained in place even after the concerns had subsided. Thus, policy relaxation may have prompted banks to adjust their LTV upwards in a sizable magnitude. The tightening policies in 2011 and 2013 also led to banks' LTV adjustment in line with the policy's objective. In Table 6 (first column), share of new loans with LTV above 90 percent decreased by 13 ppt, 12 ppt and 9 ppt in the subsequent quarters since the LTV 2011 measure became effective. For the LTV 2013 measure, we detected a contemporaneous effect of a 8 ppt decrease in share of loans with LTV above 95 percent (Table 7; first column)

The results from the probit model confirm this finding (Table 8). After the LTV 2009 measure became effective, the probability that banks would offer loans with LTV higher than 70 percent significantly increased by about 44 percent (Column 2). For LTV 2011 and LTV 2013, tightening stance led to a lower probability that banks would extend loans with LTV above the given thresholds, by 17 percent (Column 4) and 14 percent (Column 6), respectively.

Based on this finding, two questions arise. First, what caused banks to adjust the LTV distribution of newly issued loans in response to LTV policies? Second, why are the impact of the LTV measures *not* manifested in credit growth?

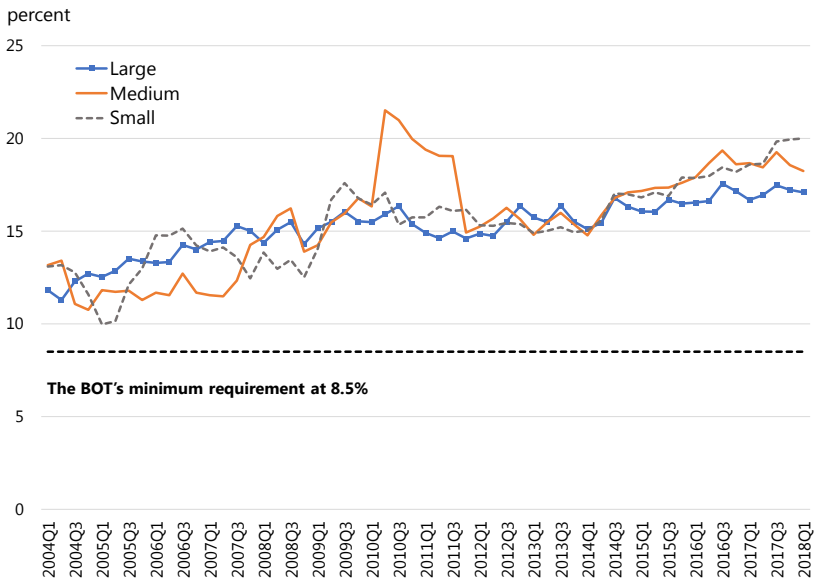
As for the first question, there are two aspects of macroprudential policy which can lead to a change in bank lending behavior—namely, policy rules and signaling. Policy rules refer to the incentive scheme designed by policymakers to influence banks' lending decision. Before the policy relaxation

[12] In the case of personal loan and credit card measures, while the impact on the total outstanding consumer loans may not be statistically significant, a study by Chuenchoksan (forthcoming) suggests that the personal loan measure has a significant impact on "new flows of personal loans". However, these new flows are relatively small compared to the overall outstanding amount.

in 2009, the rule stated that banks were strictly prohibited from extending HV housing loans with LTV above 70. The following LTV measures gave banks more room to maneuver by allowing banks to set LTV above the policy thresholds, but with additional capital surcharge. In turn, the signaling element refers to the central bank's attempt to send signal to credit providers that a particular loan sector is worth taking special caution during loan decision. These two aspects reinforce each other and usually come together as a policy package. Nevertheless, their relative contribution to policy impact varies, depending on banks' balance sheet conditions, level of competition in the banking sector, the central bank's credibility and other surrounding environment.

Under the context of Thailand, an important question remains whether it is the actual rule of the measures or signaling that is the main factor driving changes in banks' LTV setting decisions. Since the LTV measures 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 burden for banks to the extent that it materially changes banks' lending decision remains debatable. As shown in Figure 7, 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 percent. Under the LTV measures' risk-weighted rule, banks might become more cautious in setting LTV to retain the same capital position. Alternatively, since the measures did not impose a strict limit and since 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 the competition in the housing loan market was fierce and banks wished to maintain their market share in such market. Meanwhile, the signal that the BOT sends to banks about concerns over the real estate sector can be an important factor banks incorporate in their lending decision. Through public statement and moral suasions, the BOT has established various platforms in order to communicate with banks should there are specific loan sectors warranting close monitoring. If the signaling channel works effectively, banks would change their risk assessment, leading to adjustment in their lending behavior, even without hard policy rules. The answer as to which mechanism actually led banks to adjust their lending behavior, would thus 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 central bank's moral suasion.

Figure 7. Capital position of Thai banks (the BIS ratio)



Source: the BOT
Note: (1) Since 2004, Thai banks are required by law to maintain the BIS ratio (capital/risk- weighted assets) above 8.5 percent, higher that the Basel's minimum requirement of 8 percent
(2) The jump in the BIS ratio of medium banks in 2010 is due to a bank merger

The second question asks why *credit growth* did not respond to the LTV measures even if credit growth is the most common policy outcome in the literature. A plausible reason is that banks may not necessarily adjust the total volume of loans, but rebalance the LTV distribution of the targeted loans instead. Most banks have set their loan growth targets to achieve on a yearly basis, and they might choose to stick with predetermined targets even in the presence of changes in macroprudential policy. Another likely explanation is that due to data limitation, 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 given the data structure that 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.

<u>Finding 2.</u> Banks of all types reshaped LTV distribution in line with policy expectation. Nevertheless, the size of adjustment differs among banks with different attributes.

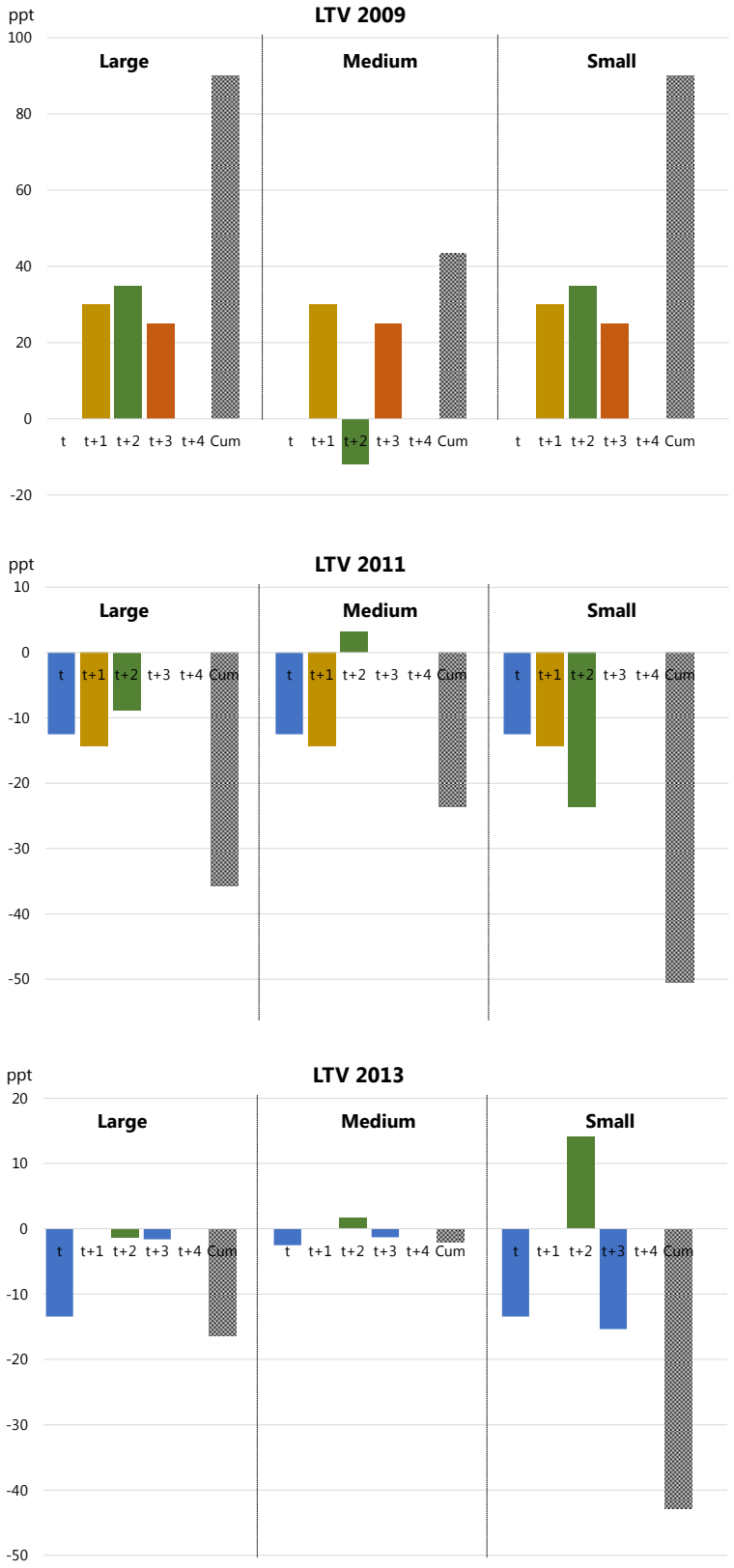
So far we have focused on the average response of banks to changes in macroprudential measures. To investigate whether banks with different characteristics exhibit differing response pattern, dummy variables capturing bank sizes were interacted with the policy variables. The results are reported in the second column of Table 5 through Table 7, which are summarized in Figure 8. Banks across different attributes adjusted their LTV setting behavior consistent with the policy's objectives. The adjustment started to take effect in the contemporaneous quarter when the measures became effective (period t), and became more pronounced in the subsequent periods until the impact started to wane or disappeared in period t+3. Nevertheless, the size of adjustment differs among banks, with the greatest impact observed among small banks, followed by large and medium banks respectively.

This disparity among banks is consistent across the three LTV measures, and is confirmed by the results obtained from the probit model[13] (Table 8: column 2, 4 and 6)

What are the factors behind the observed differential response among banks? We offer three plausible reasons. The most obvious is the fact that the LTV measures did not impose strict LTV limit, but instead apply the more lenient risk-weighted approach. Even in the presence of LTV measures, banks maintain a complete control over LTV setting, provided that they are willing to accept additional capital surcharge. This type of policy rule creates more room for differential response among banks, compared to the case of strict LTV ceiling. The second reason is the different business models between large and medium banks. The medium banks' greater willingness to accept capital costs—as reflected in the smaller overall response to the measure—many potentially imply their competitive stance and their business opportunity to expand their customer base as large banks retrenched from lending to higher-LTV borrowers. In the case of small banks, their penetration in the housing loan market is relatively low, thus the LTV measures may be less relevant for their overall businesses. Lastly, according to some anecdotal evidence, real estate developers potentially play a part in influencing banks' lending decision by directing customers to specific banks that offer higher LTV on mortgage loans. Amid high competition in the housing loan market and the pressure for banks to reach loan targets, some banks might choose to grant loans with higher LTV to retain relationship with real estate developers.

[13] In addition to the dynamic panel model, the probit model shows that banks that carry more weights of housing loans as a share of their total lending tend to adjust more strongly to the LTV measures, implying greater sensitivity to the policy as exposure increases. This makes sense given that the overall cost incurred from capital surcharge for banks with higher exposure to the housing loans would be substantially greater than banks with small housing loan portfolio, hence caused these highly-exposed banks to react more strongly to the housing LTV measures.

Figure 8. Impact of LTV measures on LTV distribution by types of banks



Source: Authors' calculation

Note: Each bar represents the change in the share of housing loans in respective housing segments, consequent of a LTV measure implemented at time t. Cum is the sum of the impact at time t up to and including time t+4.

Table 3. Effects of MaP policies on consumer loans

	Dependent variable: Quarterly change in outstanding of consumer loans $(\Delta \log Loans)$					
	(1)			(2)		
	coeff		Std err	coeff		Std err
$\sum_{j=1}^{4} \Delta \log Loans_{t-j}$	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	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
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		

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

Table 4. Effects of LTV policies on housing loans

	Dependent variable: Quarterly change in outstanding of housing loans ($\Delta \log Housing\_Loans$)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
$\sum_{j=1}^{4} \Delta \log Housing\_Loans_{t-j}$	0.716	***	0.036	0.719	***	0.036
SIZE $_{t-1}$	-0.008		0.008	-0.005		0.009
LIQ $_{t-1}$	-0.109		0.077	-0.116		0.078
CAP $_{t-1}$	-0.093		0.086	-0.090		0.085
DEP $_{t-1}$	0.027		0.023	0.032		0.024
$\sum_{j=0}^{4} \Delta MaP\_LTV_{t-j}$	-0.033		0.026	-0.199		0.148
$\sum_{j=0}^{4} \Delta MaP\_LTV_{t-j}$ x $SIZE_{t-1}$				0.019		0.014
$\sum_{j=0}^{4} \Delta MaP\_LTV_{t-j}$ x LIQ_{t-1}				0.388		0.531
$\sum_{j=0}^{4} \Delta MaP\_LTV_{t-j}$ x CAP_{t-1}				0.310		0.399
$\sum_{j=0}^{4} \Delta MaP\_LTV_{t-j}$ x DEP_{t-1}				-0.065		0.133
Macroeconomic controls	yes			yes		
Policy controls	yes			yes		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	696			696		
Overall R-Squared	0.501			0.544		
Within R-Squared	0.419			0.451		
Between R-Squared	0.865			0.923		

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

Table 5. Effects of LTV 2009 policies on LTV distribution of HV loans

	Dependent variable: Quarterly change in share of loans with LTV above 70 (Δ share)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δ share_LTV_above70 $_{t-1}$	0.283	***	0.058	0.283	***	0.058
Δ share_LTV_above70 $_{t-2}$	0.199	***	0.059	0.190	**	0.060
Δ share_LTV_above70 $_{t-3}$	-0.042		0.058	-0.036		0.059
Δ share_LTV_above70 $_{t-4}$	0.298	***	0.054	0.312	***	0.054
Δ MAP_LTV_2009 $_{t}$	1.242		9.948	19.058		14.073
Δ MAP_LTV_2009 $_{t-1}$	26.647	***	7.667	30.077	*	12.582
Δ MAP_LTV_2009 $_{t-2}$	18.050	*	7.420	34.786	**	12.419
Δ MAP_LTV_2009 $_{t-3}$	15.107	*	7.593	25.045	*	12.560
Δ MAP_LTV_2009 $_{t-4}$	18.942	*	7.678	12.151		12.571
LARGE	0.011		2.131	0.732		2.243
MEDIUM	-2.880		2.944	-0.241		3.085
Δ MAP_LTV_2009 $_{t}$ x LARGE				-21.669		14.496
Δ MAP_LTV_2009 $_{t}$ x MEDIUM				-38.110		20.581
Δ MAP_LTV_2009 $_{t-1}$ x LARGE				-2.367		14.525
Δ MAP_LTV_2009 $_{t-1}$ x MEDIUM				-13.776		20.609
Δ MAP_LTV_2009 $_{t-2}$ x LARGE				-17.257		14.521
Δ MAP_LTV_2009 $_{t-2}$ x MEDIUM				-46.585	*	20.632
Δ MAP_LTV_2009 $_{t-3}$ x LARGE				-12.558		14.539
Δ MAP_LTV_2009 $_{t-3}$ x MEDIUM				-14.934		20.718
Δ MAP_LTV_2009 $_{t-4}$ x LARGE				16.463		14.545
Δ MAP_LTV_2009 $_{t-4}$ x MEDIUM				-14.511		20.606
Macroeconomic controls	yes			yes		
Government policy controls	yes			yes		
Fixed effect	no			no		
Sample Period	2007:q4 - 2017:q3			2007:q4 - 2017:q3		
Banks	18 (domestic)			18 (domestic)		
Observations	315			315		
Overall R-Squared	0.513			0.534		
Within R-Squared	0.444			0.461		
Between R-Squared	0.293			0.323		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) The results are robust to inclusion of fixed effect

Table 6. Effects of LTV 2011 policies on LTV distribution of HR-LV loans

	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	2007:q4 - 2017:q3			2007:q4 - 2017:q3		
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		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) The results are robust to inclusion of fixed effect

Table 7. Effects of LTV 2013 policies on LTV distribution of LR-LV loans

	Dependent variable: Quarterly change in share of loans with LTV above 95 (Δ share)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δ share_LTV_above95 $_{t-1}$	-0.113	*	0.050	-0.125	*	0.052
Δ share_LTV_above95 $_{t-2}$	0.060		0.054	0.036		0.056
Δ share_LTV_above95 $_{t-3}$	-0.103	*	0.048	-0.087		0.049
Δ share_LTV_above95 $_{t-4}$	0.040		0.041	0.047		0.041
Δ MAP_LTV_2013 $_{t}$	-8.968	***	2.043	-13.438	**	4.366
Δ MAP_LTV_2013 $_{t-1}$	-3.274		2.087	-0.017		4.402
Δ MAP_LTV_2013 $_{t-2}$	-2.726		2.128	-14.111	**	4.315
Δ MAP_LTV_2013 $_{t-3}$	-4.243	*	2.059	-15.341	***	4.289
Δ MAP_LTV_2013 $_{t-4}$	2.192		2.147	2.092		4.294
LARGE	1.478		0.887	0.749		0.939
MEDIUM	2.454	*	1.020	0.888		1.079
Δ MAP_LTV_2013 $_{t}$ x LARGE				2.113		4.927
Δ MAP_LTV_2013 $_{t}$ x MEDIUM				10.918	*	5.309
Δ MAP_LTV_2013 $_{t-1}$ x LARGE				-6.151		4.887
Δ MAP_LTV_2013 $_{t-1}$ x MEDIUM				0.088		5.312
Δ MAP_LTV_2013 $_{t-2}$ x LARGE				12.737	**	4.847
Δ MAP_LTV_2013 $_{t-2}$ x MEDIUM				15.839	**	5.256
Δ MAP_LTV_2013 $_{t-3}$ x LARGE				13.735	**	4.845
Δ MAP_LTV_2013 $_{t-3}$ x MEDIUM				14.062	**	5.298
Δ MAP_LTV_2013 $_{t-4}$ x LARGE				-1.469		4.989
Δ MAP_LTV_2013 $_{t-4}$ x MEDIUM				2.153		5.300
Macroeconomic controls	yes			yes		
Government policy controls	yes			yes		
Fixed effect	no			no		
Sample Period	2007:q4 - 2017:q3			2007:q4 - 2017:q3		
Banks	18 (domestic)			18 (domestic)		
Observations	284			284		
Overall R-Squared	0.196			0.275		
Within R-Squared	0.187			0.272		
Between R-Squared	0.776			0.450		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) The results are robust to inclusion of fixed effect

Table 8. Effects of LTV policy on loan portfolio using probit model

	(1)	(2)	(3)	(4)	(5)	(6)
Target loan subsample:	**High Value**		**Low Value - High Rise**		**Low Value - Low Rise**	
Dep Var: Dummy subject to threshold	**LTV above 70**		**LTV above 90**		**LTV above 95**	
Salary-based income dummy	-0.054***	-0.068***	0.094***	0.070***	0.111***	0.099***
	(-7.433)	(-9.302)	(47.322)	(37.600)	(115.502)	(103.128)
Number of (co-)borrowers	-0.008	-0.006	0.006***	0.018***	0.001	0.006***
	(-1.429)	(-1.006)	(2.871)	(9.351)	(0.775)	(7.864)
Bangkok area dummy	0.056***	0.046***	0.113***	0.068***	0.088***	0.079***
	(7.256)	(5.916)	(46.192)	(29.558)	(99.037)	(90.034)
Crisis dummy	-0.201***	-0.198***	-0.044***	-0.051***	-0.028***	-0.031***
	(-10.951)	(-10.829)	(-10.112)	(-12.892)	(-12.180)	(-13.978)
Flood dummy	0.080***	0.078***	-0.018***	-0.049***	0.022***	0.021***
	(5.004)	(4.873)	(-4.086)	(-11.978)	(10.532)	(10.346)
LTV 2009	**0.513*** **	**0.443*** **	-0.007	0.000	0.031***	0.026***
	(26.288)	**(9.472)**	(-1.490)	(0.000)	(15.543)	(13.683)
LTV 2011	0.040***	0.036***	**-0.127*** **	**-0.177*** **	0.025***	0.032***
	(3.185)	(2.929)	**(-38.641)**	**(-31.556)**	(15.916)	(20.970)
LTV 2013	0.055***	0.053***	-0.012***	-0.054***	**-0.038*** **	**-0.147*** **
	(6.049)	(5.851)	(-4.475)	(-22.621)	**(-33.180)**	**(-42.633)**
LARGE		-0.016		-0.089***		-0.047***
		(-0.329)		(-23.946)		(-28.457)
MEDIUM		0.049		-0.136***		-0.057***
		(0.669)		(-25.190)		(-23.495)
High housing-loan share		-0.149***		-0.064***		-0.048***
		(-3.489)		(-18.262)		(-39.523)
LTV 2009 x LARGE		**-0.004**				
		(-0.081)				
LTV 2009 x MEDIUM		**-0.002**				
		(-0.027)				
LTV 2009 x High housing-loan share		**0.221*** **				
		(5.127)				
LTV 2011 x LARGE				**0.022*** **		
				(4.000)		
LTV 2011 x MEDIUM				**0.442*** **		
				(65.481)		
LTV 2011 x High housing-loan share				**-0.017*** **		
				(-4.173)		
LTV 2013 x LARGE						**0.087*** **
						(26.475)
LTV 2013 x MEDIUM						**0.272*** **
						(71.717)
LTV 2013 x High housing-loan share						**-0.035*** **
						(-19.975)
Sample period			2007:q4 - 2017:q3			
Banks			18 (domestic)			
Observations	21,230	21,230	272,777	272,777	654,244	654,244

Notes: (1) The table reports average marginal effect
(2) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(3) Numbers in parentheses is z-statistics

VII. Conclusion and Policy Implications

This paper assesses the impact of macroprudential policy implemented in Thailand. Due to data availability, 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 standard, while the impact on credit growth is considered as 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.

Leveraging on the contract-level mortgage-loan data, we offer novelty in evaluating the policy impact on the rebalancing of LTV in banks' loan portfolios, in addition to the rate of credit growth commonly used in the literature. The granularity of data also allows us to separate the loan sectors according to each LTV measure' specific targets and examine behavior of different banks – the practice that is not feasible under aggregate loan data. We employ the dynamic panel approach and the probit model to assess the impact that the LTV measures potentially have on banks' LTV setting and credit growth.

On a whole, both stylized facts and results from regression-based empirical investigation confirm the influence of the LTV measures on banks' lending behavior. However, the effect is not manifested in the changes of 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 LTV for the targeted loan sector, while the tightening measures in 2011 and 2013 led to a more cautious LTV setting, reflecting a tightened credit standard that the policy aims to achieve. The analysis also shows differential reactions by different groups of banks, where we observe stronger LTV adjustment by large banks while medium banks appeared to be less responsive. This is likely due to the competitive stance of different banks and the nature of the policy's rule that does not impose a strict limit, which allows banks with greater willingness to take on more risk to do so as long as long as they are willing to bear the additional costs of capital surcharge under by the LTV measures.

Lessons can be drawn for future policy design. First, it is crucial to clearly and carefully identify the intended group or sector of policy target, which calls for a thorough and in-depth risk assessment to help pin point the exact areas of risk build-up. Although there is no clear evidence of spillovers of the policies examined in this study, potential leakages (such as a switch of bank lending to other types of loans to outside the policy parameters) or other unintended consequences should be taken into consideration in designing a sector-specific MaP measure. In addition, it might be useful to specify the policy's targeted variables upfront to help monitoring impact and the effectiveness of the policy. Secondly, policy design needs to take into account the heterogeneity—in balance sheet characteristics and the business model–among different types of banks that may potentially give rise to diverging reactions of banks following the policy implementation. The detailed features and parameters need to be calibrated carefully in order to ensure that the measures are binding enough to be effective or sending the right signal to achieve the intended outcome overall. Lastly, policymakers should take into consideration the relative contribution of the 'rule' and 'signaling' aspects of the MaP, which might vary across time. Greater understanding of the channels through which the MaP influences banks' lending behavior and ultimately activities in the real sector would lead to the most effective policy design in controlling systemic risk.

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Appendix A. Data Description

Data sources

This Appendix describes two main datasets that are used in this study: namely (I) banks' balance sheet and loan portfolio and (II) Mortgage Loan Database (MGL)

1. Banks' balance sheet and loan portfolio data

Bank-balance sheet and loan portfolio data contain bank-level data for all Thai commercial banks. The data is reported on a quarterly frequency, spanning from 2004Q1 to 2017Q3. The information collected from individual banks comprises the operational structure, loan portfolio composition and lending characteristic of all commercial banks. We include only Thai domestic banks to be consistent with the coverage of banks in the MGL dataset.

Bank-balance sheet data contains each Thai commercial bank's assets, liabilities and equities as well as key financial ratios. The size of total assets of banks determines its peer group (large, medium, or small). With the exception of one bank, all banks belong to the same peer groups throughout the period under study. Meanwhile, banks' loan portfolio data contains outstanding amount of loans, classified into (I) corporate loan and (II) consumer loan consisting of mortgage loan (for low-rise and high-rise properties), automobile loan, credit-card loan, and personal loan. For the purpose of this study, we focus mainly on mortgage loan to evaluate the impact of LTV measures on growth of mortgage loans.

Banks' loan portfolios by type of loans are reported below in Figure A1. As shown, mortgage loan accounts for the largest share of consumer loan across all bank sizes. We ignore the commercial real estate loans (shown as '*other mortgage*' in Figure A1) which is unaffected by the LTV measures.

2. Mortgage Loan Database (MGL)

MGL data contains contract-level new mortgage loans issued by all Thai commercial banks. The data is reported on a monthly frequency from 2007M12 to 2017M8. It contains detailed characteristics of mortgage borrowers, loan characteristics, and collateral characteristics (high-rise/low rise properties). Figure A2 reports borrowing objectives of MGL data. As shown, the majority of the loans is for the purpose of buying new homes. For the purpose of the study, we only use mortgages loans for the objectives of buying new and second-hand homes which are subject to the LTV measures, and ignore loans for other purposes.

We report below coverage of the data in Table A1 separating into three types according to the implemented housing-related macroprudential policy: (I) mortgage contract of properties with values above or equal to 10 million baht **(High-Valued Houses: HV)**, (II) mortgage contract of high-rise properties with values below 10 million **(High Rise - Low Valued Houses: HR-LV)**, (III) mortgage contract of low-rise properties with value below 10 million baht **(Low rise - Low Valued Houses: LR-LV).** Mortgage loan for LR-LV properties accounts for the largest share of the new mortgage loan while the mortgage for HV properties is smallest both in terms of loan amount and a number of contracts. Figure A3 displays the market share by large, medium and small banks in different housing sectors, indicating that over 70 percent of the housing loans are undertaken by large banks.

Figure A1. Loan portfolio composition of the Thai commercial banks by bank size (as of 2018Q1)

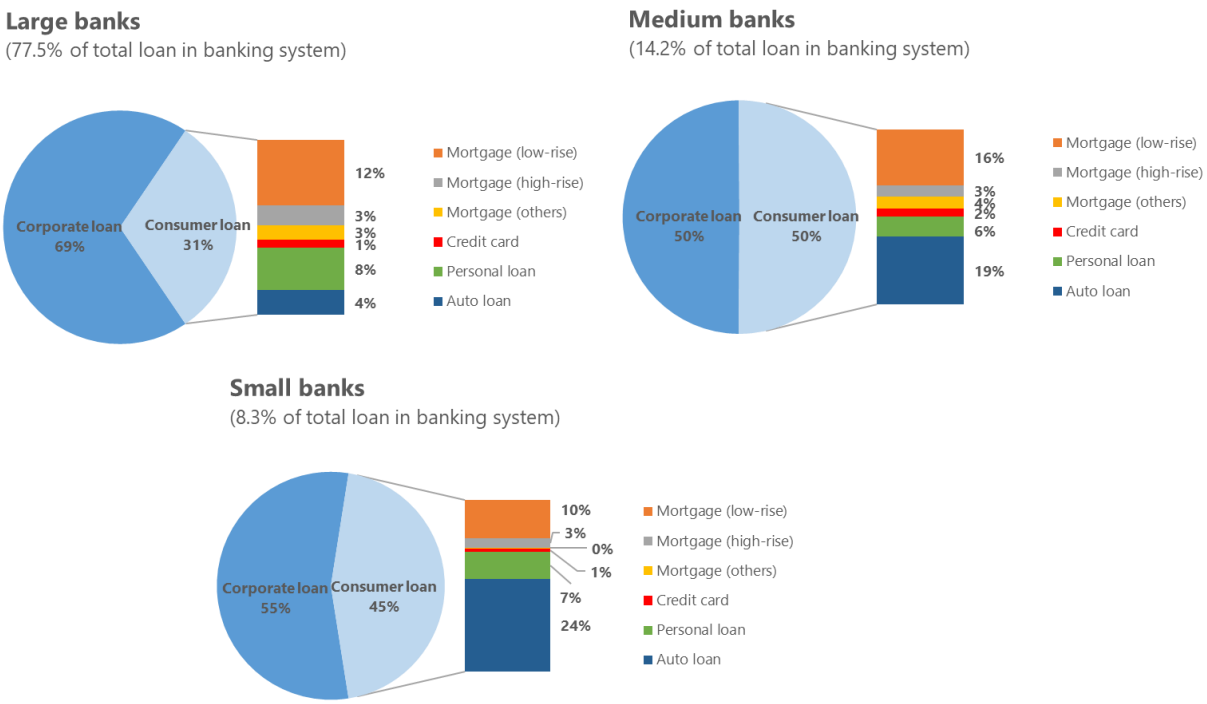

Figure A2. Mortgage loan data coverage by objective (as of 2017Q3)

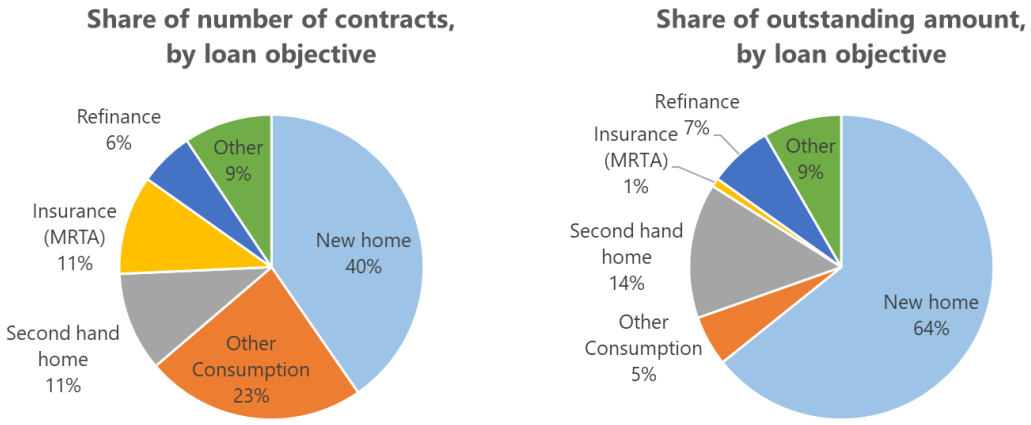

Table A1. Number of mortgage loans by type of properties, 2007-2017

(only new and second-hand home purchases)

	High value properties	High rise, Low value properties	Low rise, Low value properties	Total
Number of contracts	27,413	278,723	686,616	**992,752**
% Share	3%	28%	69%	**100%**
Amount	29,738	52,620	146,230	**228,588**
% Share	14%	25%	61%	**100%**

Figure A3: Market share by bank size, average 2004-2017

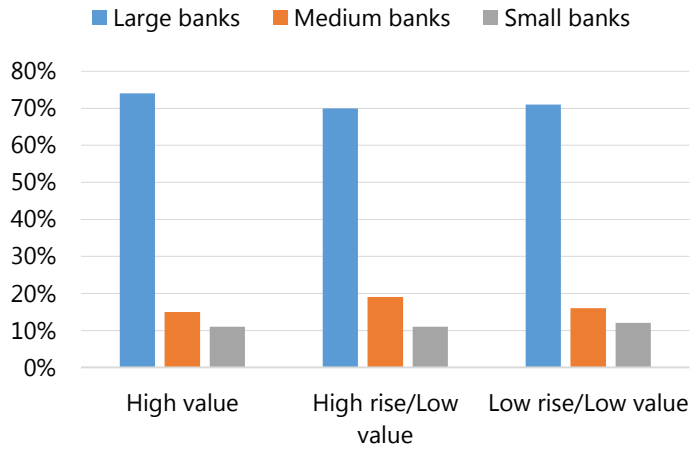

Table A2. Contract-level mortgage loan data by types of properties

Mortgage loans for High-Value Properties						
	Observations	Mean	Median	p25	p75	S.D.
Contract size	21,230	11,000,000	9,870,000	8,000,000	13,000,000	6,408,735
House Price	21,230	16,500,000	14,000,000	11,700,000	18,000,000	8,274,125
Income	21,230	1,014,796	367,000	212,959	701,842	6,280,231
LTV	21,230	67.21	74.25	59.26	80.00	21.35
LTI	21,230	2.75	2.29	1.17	3.71	2.76

Mortgage loans for High Rise-Low Value Properties						
	Observations	Mean	Median	p25	p75	S.D.
Contract size	272,777	1,954,305	1,600,000	1,058,000	2,415,000	1,416,305
House Price	272,777	2,406,418	1,900,000	1,356,500	2,900,000	1,632,368
Income	272,777	165,929	63,950	37,020	122,900	1,334,551
LTV	272,777	82.40	89.77	79.25	92.65	28.61
LTI	272,777	2.43	2.08	1.05	3.47	1.78

Mortgage loans for Low Rise-Low Value Properties						
	Observations	Mean	Median	p25	p75	S.D.
Contract size	654,245	2,360,624	2,000,000	1,200,000	3,063,700	1,637,104
House Price	654,245	2,955,073	2,500,000	1,630,000	3,800,000	1,822,192
Income	654,245	168,854	60,193	36,585	114,000	1,017,598
LTV	654,245	81.77	87.95	74.48	94.96	45.34
LTI	654,245	2.96	2.78	1.42	4.17	2.00

Table A3. Bank balance sheet characteristics by bank size

	Large Banks			
Unit : million THB	Observations	Mean	Median	S.D.
Total asset	275	1,616,111	1,535,126	674,388
Total liability	275	1,454,794	1,374,210	596,974
Leverage ratio	275	1.108	1.110	0.022
Liquidity ratio	275	0.019	0.018	0.005
Funding composition ratio	275	3.178	16.353	0.176
BIS ratio	275	15.104	15.200	1.964
ROA	275	1.337	1.324	0.595
Share of mortgage loan	275	0.166	0.145	0.063

	Medium Banks			
Unit : million THB	Observations	Mean	Median	S.D.
Total asset	165	518,061	463,804	269,886
Total liability	165	470,093	413,769	245,385
Leverage ratio	165	1.106	1.104	0.029
Liquidity ratio	165	0.013	0.013	0.005
Funding composition ratio	165	17.001	8.994	31.101
BIS ratio	165	16.547	16.800	3.801
ROA	165	0.624	0.781	0.947
Share of mortgage loan	165	0.186	0.144	0.117

	Small Banks			
Unit : million THB	Observations	Mean	Median	S.D.
Total asset	345	152,748	150,705	93,046
Total liability	345	136,038	132,377	84,948
Leverage ratio	345	1.140	1.120	0.081
Liquidity ratio	345	0.007	0.005	0.005
Funding composition ratio	308	0.278	4.861	0.009
BIS ratio	345	17.566	15.200	11.611
ROA	345	0.647	0.834	1.663
Share of mortgage loan	345	0.162	0.055	0.200

Table A4. Summary statistics for the variables used in regression

Variables	Description	Source	min	p25	median	mean	p75	max
Dependent variables								
Δ log loans	Change in natural logarithm of outstanding consumer loans in real term	Bank balance sheet	-0.37	-0.01	0.02	0.03	0.05	0.60
Δ log housing_loans	Change in natural logarithm of outstanding housing loans in real term	Bank balance sheet	-0.21	-0.02	0.01	0.02	0.04	0.43
Δ log CC_loans	Change in natural logarithm of outstanding credit card loans in real term	Bank balance sheet	-0.31	-0.02	0.02	0.06	0.07	1.30
Δ log PL_loans	Change in natural logarithm of outstanding personal loans in real term	Bank balance sheet	-0.61	-0.04	0.01	0.02	0.06	0.87
Δ share_LTV_above70	Change in share of loans with LTV above 70; share of loans with LTV above 70 = the total amount of newly issued loans with LTV above 70/total amount of loans extended during that period; cover only High Valued loans (target of LTV 2009 measure)	MGL	-92.31	-6.74	1.11	2.46	9.93	88.21
Δ share_LTV_above90	Change in share of loans with LTV above 90; share of loans with LTV above 90 = the total amount of newly issued loans with LTV above 90/total amount of loans extended during that period; cover only High-rise/Low-Valued loans (target of LTV 2011 measure)	MGL	-80.29	-4.25	0.32	0.00	4.69	77.07
Δ share_LTV_above95	Change in share of loans with LTV above 95; share of loans with LTV above 95 = the total amount of newly issued loans with LTV above 95/total amount of loans extended during that period; cover only Low-rise/Low-Valued loans (target of LTV 2013 measure)	MGL	-58.30	-2.55	0.23	0.24	3.20	64.29
NPL	The logit function of NPL ratio of consumer loans NPL = ln(NPL ratio/(1-NPL ratio))	Bank balance sheet	-9.00	-5.26	-4.60	-4.87	-4.18	-2.91
Policy dummies								
Δ MaP	1 if MaP is tightened; -1 if MaP is eased; 0 if no changes in MaP	Authors' calculation	-1.00	0.00	0.00	0.09	0.00	1.00
Δ MaP_cyc	1 if MaP aimed at cyclical purpose is tightened; -1 if eased; 0 if no changes	Authors' calculation	-1.00	0.00	0.00	0.07	0.00	1.00
Δ MaP_res	1 if MaP aimed at resiliency is tightened; -1 if eased; 0 if no changes	Authors' calculation	0.00	0.00	0.00	0.02	0.00	1.00
Δ MaP_tight	1 if tightening measure becomes effective; 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.11	0.00	1.00
Δ MaP_loose	1 if easing measure becomes effective; 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.02	0.00	1.00
Δ MaP_LTV	1 if LTV-based MaP is tightened; -1 if eased; 0 if no changes	Authors' calculation	-1.00	0.00	0.00	0.02	0.00	1.00
Δ MaP_CC	1 if credit-card related MaP measure is tightened; -1 if eased; 0 if no changes	Authors' calculation	0.00	0.00	0.00	0.04	0.00	1.00
Δ MaP_PL	1 if personal-loan related MaP measure is tightened; -1 if eased; 0 if no changes	Authors' calculation	0.00	0.00	0.00	0.04	0.00	1.00
Δ MaP_LTV2009	1 in 2009Q1 and 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.02	0.00	1.00
Δ MaP_LTV2011	1 in 2011Q1 and 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.02	0.00	1.00
Δ MaP_LTV2013	1 in 2013Q1 and 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.02	0.00	1.00
TAX	1 if related TAX measures on housing loan is tightened; -1 if eased; 0 if no changes	Authors' calculation	-1.00	0.00	0.00	0.02	0.00	1.00

Table A4. Summary statistics for the variables used in regression (continued)

Variables	Description	Source	min	p25	median	mean	p75	max
Bank Characteristics								
SIZE	total assets in real term	Bank balance sheet	3.30	7.07	8.00	7.98	9.31	10.32
LIQ	liquidity ratio = cash and short-term investment/total assets	Bank balance sheet	0.00	0.04	0.06	0.06	0.08	0.22
CAP	capital ratio = capital/total assets	Bank balance sheet	0.01	0.10	0.12	0.13	0.14	0.39
DEP	funding composition ratio = deposits/total liabilities	Bank balance sheet	0.19	0.67	0.78	0.74	0.85	0.98
LARGE	1 if a bank is categorized as large and 0 otherwise	Bank balance sheet	0.00	0.00	0.00	0.31	1.00	1.00
MEDIUM	1 if a bank is categorized as medium and 0 otherwise	Bank balance sheet	0.00	0.00	0.00	0.19	0.00	1.00
high housing-loan share	1 if a bank's share of outstanding housing loan to total assets is greater than 75th percentile of the whole dataset	Bank balance sheet	0.00	0.00	0.00	0.21	0.00	1.00
Borrower Characteristics								
Salary-based income dummy	1 if a borrower earns income by salary and 0 otherwise	MGL	0.00	0.00	1.00	0.65	1.00	1.00
Number of (co-) borrowers	a number of borrower(s) specified in a loan contract	MGL	0.00	1.00	1.00	1.28	2.00	9.00
Bangkok area dummy	1 if a property is situated in Bangkok metropolis and 0 otherwise	MGL	0.00	0.00	1.00	0.62	1.00	1.00
Macroeconomic control								
Δ rgdp	Change in real GDP	NESDB; BOT	-0.07	-0.02	0.01	0.01	0.04	0.12
Δ REER	Change in real effective exchange rate	BOT	-0.06	-0.01	0.01	0.00	0.02	0.09
real rate	Real policy interest rate = Policy interest rate - 1 year ahead inflation expectations from consensus forecast	BOT; consensus forecast	-1.70	-0.77	-0.44	-0.34	0.05	1.75
Δ real rate	Change in real policy interest rate	BOT; consensus forecast	-1.74	-0.22	0.02	0.02	0.29	1.25
credit gap	The difference between the credit-to-GDP ratio and its trend (in percen term)	BIS	-41.00	-28.20	-6.70	-7.95	10.30	16.10
flood dummy	1 during 2012Q4 - 2013Q1 when the national wide flood affected the Thai economy and 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.04	0.00	1.00
crisis dummy	1 from 2009Q1 - 2009Q3 when the Thai economy contracted due to the GFC and 0 otherwise	Authors' calculation	0.00	0.00	0.00	0.05	0.00	1.00

Note: (1) The table reports statistics from data sets used in the regression which are subject to winsorization
(2) All changes are on quarterly basis (3) Real terms (except real rate) are created by dividing the nominal amount by the CPI index

Appendix B. Additional regression results

Table B1 and **Table B2** report results obtained under (1), using credit card loan and personal loans as dependent variables. The associated MaP_{t-j} variable measures changes in credit card measure and personal loan measure respectively. The first column reports the baseline result and the second column reports results obtained from interacting MaP_{t-j} with bank-characteristics variables to capture differential response among banks.

$$\Delta \log Loans_{bt} = const + \alpha_b + \sum_{j=1}^{4} \gamma_j \Delta \log Loans_{bt-j} + \sum_{j=0}^{4} \beta_j \Delta MaP_{t-j} + \theta Controls_{bt} + \varepsilon_{bt} \quad (1)$$

The rest of Appendix B reports results following specifications outlined in Gambarcota (2018). All specifications are extended from the baseline equation (1) with details as follows.

Table B3 and **Table B4** examine whether loan growth exhibit differential response between MaP tools aimed at increasing resilience (MaP_res_{t-j}) and ones with countercyclical purpose (MaP_cyc_{t-j}) ,and between tightening and loosening episodes (MaP_tight_{t-j} and MaP_loose_{t-j}). The first column reports average response among banks; the second column reports results based on the interaction between MaP variable and bank characteristics.

Table B5, Table B6 and **Table B7** investigate whether responses to macroprudential policies vary over monetary policy conditions (2), the business cycle (3) and financial cycle (4). The specifications are:

$$\Delta log\ Loans_{b,t} = const + \alpha_b + \sum_{j=1}^{4} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{4} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \sum_{j=0}^{4} \varphi_j r_{t-j} + \sum_{j=0}^{4} \rho_j\, \Delta \mathrm{MaP}_{t-j} * r_{t-j} + \theta control_{b,t} + \varepsilon_{b,t} \quad (2)$$

$$\Delta log\ Loans_{b,t} = const + \alpha_b + \sum_{j=1}^{4} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{4} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \sum_{j=0}^{4} \varphi_j \Delta log GDP_{t-j} + \sum_{j=0}^{4} \rho_j\, \Delta \mathrm{MaP}_{t-j} * \Delta log GDP_{t-j} + \theta control_{b,t} + \varepsilon_{b,t} \quad (3)$$

$$\Delta log\ Loans_{b,t} = const + \alpha_b + \sum_{j=1}^{4} \gamma_j\, \Delta log\ Loans_{b,t-j} + \sum_{j=0}^{4} \beta_j\, \Delta \mathrm{MaP}_{t-j} + \sum_{j=0}^{4} \varphi_j creditgap_{t-j} + \sum_{j=0}^{4} \rho_j\, \Delta \mathrm{MaP}_{t-j} * creditgap_{t-j} + \theta control_{b,t} + \varepsilon_{b,t} \quad (4)$$

where r_{t-j} is the real interest rate (policy interest rate deducted by one-year ahead inflation expectation by consensus forecast), $\Delta log GDP_{t-j}$ is the change in natural logarithm of real GDP and $creditgap_{t-j}$ is the difference between the credit-to-GDP ratio and its trend (in percent). Other variables follow the same notation as explained in section on methodology. For **Table B5 – Table B7**, the difference between the first column and the second column is the presence of macroeconomic controls.

Apart from effect on loan growth, another aim of using macruprudential tool is to limit bank risk-taking and the probability of the occurrence of a financial crisis. We are interested in how macroprudential policies influence a bank's contribution to system-wide risk. As measurement of systemic risk is still rudimentary, a compromise could be to evaluate how macroprudential tools have an impact on specific measures of bank risk as non-performing loans over total assets. We can evaluate how changes in macroprudential tools affect non-performing loans using the dynamic panel

regression in the same fashion as (1), with a change in the dependent variable from loan growth to NPL variable. The main specification, analogous to (1), is:

$$\mathrm{NPL}_{b,t} = const + \alpha_b + \sum_{j=1}^{4} \gamma_j \, \mathrm{NPL}_{b,t-j} + \sum_{j=0}^{4} \beta_j \, \Delta\mathrm{MaP}_{t-j} + \theta control_{b,t} + \varepsilon_{b,t} \quad (5)$$

where NPL_{bt} is a logit function of the ratio of gross NPL to total consumer loans. The logit function is $\mathrm{NPL}_{b,t} = \ln[\mathrm{NPL\ ratio}/(1 - \mathrm{NPL\ ratio})]$. Other variables are the same as indicated before. The baseline specification (5) is extended exactly the same way as (1) is. **Tables 8** to **Table 13** report results of such specifications.

Overall, for the case of Thailand, we do not detect any statistically significant and economically intuitive relationship from the above tables. Nevertheless, we document the results in this appendix as a part of the BIS's cross-country study on using micro-level data to assess effectiveness of macroprudential policy, and also as a reference for future studies on this topic.

Table B1. Effects of credit card measures on credit card loans

	Dependent variable: Quarterly change in outstanding of credit card loans (Δ log CC_loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog CC_Loans $_{t-1}$	-0.166	**	0.051	-0.182	***	0.053
Δlog CC_Loans $_{t-2}$	0.003		0.049	-0.010		0.051
Δlog CC_Loans $_{t-3}$	0.019		0.045	0.015		0.046
Δlog CC_Loans $_{t-4}$	0.213	***	0.039	0.215	***	0.040
ΔMaP_CC $_{t}$	0.005		0.052	0.918		0.625
ΔMaP_CC $_{t-1}$	-0.056		0.053	-0.773		0.643
ΔMaP_CC $_{t-2}$	-0.125	*	0.051	0.035		0.549
ΔMaP_CC $_{t-3}$	-0.044		0.051	-0.122		0.529
ΔMaP_CC $_{t-4}$	0.003		0.031	0.057		0.333
SIZE $_{t-1}$	-0.058		0.033	-0.051		0.035
LIQ $_{t-1}$	-0.146		0.170	-0.100		0.189
CAP $_{t-1}$	0.421		0.301	0.806	*	0.350
DEP $_{t-1}$	-0.223	**	0.075	-0.214	**	0.079
ΔMaP_CC $_{t}$ x SIZE $_{t-1}$				-0.009		0.038
ΔMaP_CC $_{t-1}$ x SIZE $_{t-1}$				0.014		0.039
ΔMaP_CC $_{t-2}$ x SIZE $_{t-1}$				-0.027		0.044
ΔMaP_CC $_{t-3}$ x SIZE $_{t-1}$				-0.020		0.062
ΔMaP_CC $_{t-4}$ x SIZE $_{t-1}$				-0.029		0.033
ΔMaP_CC $_{t}$ x LIQ $_{t-1}$				-1.731		1.464
ΔMaP_CC $_{t-1}$ x LIQ $_{t-1}$				0.583		1.382
ΔMaP_CC $_{t-2}$ x LIQ $_{t-1}$				0.714		1.188
ΔMaP_CC $_{t-3}$ x LIQ $_{t-1}$				0.550		1.292
ΔMaP_CC $_{t-4}$ x LIQ $_{t-1}$				0.355		0.960
ΔMaP_CC $_{t}$ x CAP $_{t-1}$				-3.891		2.185
ΔMaP_CC $_{t-1}$ x CAP $_{t-1}$				1.866		2.084
ΔMaP_CC $_{t-2}$ x CAP $_{t-1}$				-1.076		1.435
ΔMaP_CC $_{t-3}$ x CAP $_{t-1}$				-0.772		1.314
ΔMaP_CC $_{t-4}$ x CAP $_{t-1}$				-1.345		0.884
ΔMaP_CC $_{t}$ x DEP $_{t-1}$				-0.241		0.423
ΔMaP_CC $_{t-1}$ x DEP $_{t-1}$				0.336		0.515
ΔMaP_CC $_{t-2}$ x DEP $_{t-1}$				0.217		0.592
ΔMaP_CC $_{t-3}$ x DEP $_{t-1}$				0.387		0.630
ΔMaP_CC $_{t-4}$ x DEP $_{t-1}$				0.399		0.429
Macroeconomic controls	yes			yes		
Policy controls	yes			yes		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	366			366		
Overall R-Squared	0.295			0.335		
Within R-Squared	0.543			0.563		
Between R-Squared	0.337			0.317		

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

Table B2. Effects of personal loan measures on regulated personal loans

	Dependent variable: Quarterly change in outstanding of personal loans (Δlog PL_Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog PL_Loans $_{t-1}$	0.370	***	0.046	0.360	***	0.047
Δlog PL_Loans $_{t-2}$	0.152	**	0.048	0.150	**	0.049
Δlog PL_Loans $_{t-3}$	-0.022		0.044	-0.019		0.046
Δlog PL_Loans $_{t-4}$	0.054		0.037	0.054		0.039
SIZE $_{t-1}$	0.074	**	0.023	0.073	**	0.025
LIQ $_{t-1}$	0.257	*	0.127	0.302	*	0.134
CAP $_{t-1}$	1.317	***	0.236	1.338	***	0.247
DEP $_{t-1}$	-0.078		0.057	-0.070		0.061
ΔMaP_PL $_{t}$	-0.023		0.025	0.112		0.363
ΔMaP_PL $_{t-1}$	-0.033		0.025	0.048		0.379
ΔMaP_PL $_{t-2}$	-0.038		0.025	0.130		0.381
ΔMaP_PL $_{t-3}$	-0.031		0.025	0.059		0.605
ΔMaP_PL $_{t-4}$	-0.035		0.028	-0.052		0.299
ΔMaP_PL $_{t}$ x SIZE $_{t-1}$				-0.018		0.018
ΔMaP_PL $_{t-1}$ x SIZE $_{t-1}$				-0.012		0.018
ΔMaP_PL $_{t-2}$ x SIZE $_{t-1}$				-0.005		0.019
ΔMaP_PL $_{t-3}$ x SIZE $_{t-1}$				-0.010		0.025
ΔMaP_PL $_{t-4}$ x SIZE $_{t-1}$				0.006		0.018
ΔMaP_PL $_{t}$ x LIQ $_{t-1}$				-0.593		1.025
ΔMaP_PL $_{t-1}$ x LIQ $_{t-1}$				-0.150		1.118
ΔMaP_PL $_{t-2}$ x LIQ $_{t-1}$				-0.235		1.041
ΔMaP_PL $_{t-3}$ x LIQ $_{t-1}$				0.153		1.230
ΔMaP_PL $_{t-4}$ x LIQ $_{t-1}$				-0.744		0.770
ΔMaP_PL $_{t}$ x CAP $_{t-1}$				0.537		1.341
ΔMaP_PL $_{t-1}$ x CAP $_{t-1}$				0.261		1.324
ΔMaP_PL $_{t-2}$ x CAP $_{t-1}$				-0.348		1.181
ΔMaP_PL $_{t-3}$ x CAP $_{t-1}$				-0.608		1.635
ΔMaP_PL $_{t-4}$ x CAP $_{t-1}$				-0.445		1.129
ΔMaP_PL $_{t}$ x DEP $_{t-1}$				-0.007		0.246
ΔMaP_PL $_{t-1}$ x DEP $_{t-1}$				-0.006		0.282
ΔMaP_PL $_{t-2}$ x DEP $_{t-1}$				-0.079		0.313
ΔMaP_PL $_{t-3}$ x DEP $_{t-1}$				0.083		0.421
ΔMaP_PL $_{t-4}$ x DEP $_{t-1}$				0.051		0.210
Macroeconomic controls	yes			yes		
Policy controls	yes			yes		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	484			484		
Overall R-Squared	0.227			0.237		
Within R-Squared	0.432			0.440		
Between R-Squared	0.142			0.145		

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

Table B3. Effects of MaP policies on consumer loans (Cyclical vs Resilience MaP tools)

	Dependent variable: Quarterly change in outstanding of consumer loans (Δlog Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog Loans $_{t-1}$	0.281	***	0.037	0.278	***	0.037
Δlog Loans $_{t-2}$	0.097	*	0.040	0.073		0.041
Δlog Loans $_{t-3}$	0.178	***	0.038	0.209	***	0.040
Δlog Loans $_{t-4}$	-0.035		0.036	-0.048		0.037
SIZE $_{t-1}$	-0.040	***	0.010	-0.040	***	0.010
LIQ $_{t-1}$	-0.175		0.091	-0.168		0.098
CAP $_{t-1}$	-0.452	***	0.103	-0.437	***	0.104
DEP $_{t-1}$	-0.035		0.025	-0.030		0.028
ΔMaP_cyc $_{t}$	0.005		0.011	0.165	*	0.073
ΔMaP_cyc $_{t-1}$	0.016		0.010	0.094		0.073
ΔMaP_cyc $_{t-2}$	-0.009		0.010	0.010		0.071
ΔMaP_cyc $_{t-3}$	0.028	*	0.011	-0.051		0.076
ΔMaP_cyc $_{t-4}$	0.011		0.008	0.010		0.062
ΔMaP_res $_{t}$	-0.008		0.019	-0.005		0.205
ΔMaP_res $_{t-1}$	-0.015		0.021	0.067		0.231
ΔMaP_res $_{t-2}$	0.012		0.020	-0.234		0.231
ΔMaP_res $_{t-3}$	0.007		0.021	0.077		0.242
ΔMaP_res $_{t-4}$	-0.035		0.022	-0.125		0.217
ΔMaP_cyc $_{t-1}$ x LIQ $_{t-1}$				-0.536	*	0.261
ΔMaP_cyc $_{t}$ x CAP $_{t-1}$				-0.441	*	0.177
ΔMaP_cyc $_{t-1}$ x CAP $_{t-1}$				-0.416	*	0.163
ΔMaP_cyc $_{t-3}$ x CAP $_{t-1}$				0.320	*	0.162
ΔMaP_cyc $_{t-4}$ x CAP $_{t-1}$				0.292	*	0.139
ΔMaP_cyc $_{t-1}$ x DEP $_{t-1}$				0.134	*	0.061
ΔMaP_res $_{t-2}$ x CAP $_{t-1}$				1.533	**	0.472
ΔMaP_cyc $_{t-1}$ x LIQ $_{t-1}$				-0.536	*	0.261
Macroeconomic controls	yes			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	766			766		
Overall R-Squared	0.165			0.196		
Within R-Squared	0.311			0.372		
Between R-Squared	0.195			0.174		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) For the interaction terms between MaP and bank characteristics, only statistically significant coefficients are reported

Table B4. Effects of MaP policies on consumer loans (Tightening and Loosening episodes)

	Dependent variable: Quarterly change in outstanding of consumer loans (Δlog Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog Loans $_{t-1}$	0.278	***	0.037	0.272	***	0.037
Δlog Loans $_{t-2}$	0.095	*	0.040	0.103	*	0.040
Δlog Loans $_{t-3}$	0.183	***	0.038	0.183	***	0.038
Δlog Loans $_{t-4}$	-0.031		0.036	-0.031		0.037
SIZE $_{t-1}$	-0.037	***	0.009	-0.037	***	0.010
LIQ $_{t-1}$	-0.196	*	0.091	-0.140		0.113
CAP $_{t-1}$	-0.429	***	0.103	-0.369	***	0.110
DEP $_{t-1}$	-0.029		0.025	-0.024		0.030
ΔMaP_loose $_{t}$	0.004		0.020	0.037		0.142
ΔMaP_loose $_{t-1}$	-0.019		0.017	0.038		0.144
ΔMaP_loose $_{t-2}$	-0.009		0.017	0.051		0.140
ΔMaP_loose $_{t-3}$	-0.016		0.017	-0.048		0.138
ΔMaP_loose $_{t-4}$	-0.018		0.018	0.026		0.135
ΔMaP_tight $_{t}$	-0.003		0.009	0.193	*	0.077
ΔMaP_tight $_{t-1}$	0.016		0.009	0.118		0.077
ΔMaP_tight $_{t-2}$	-0.011		0.009	0.003		0.076
ΔMaP_tight $_{t-3}$	0.014		0.010	-0.064		0.081
ΔMaP_tight $_{t-4}$	0.000		0.009	0.037		0.073
ΔMaP_loose $_{t-4}$ x CAP $_{t-1}$				-0.736	**	0.283
ΔMaP_tight $_{t-1}$ x SIZE $_{t-1}$				-0.014	*	0.006
ΔMaP_tight $_{t-1}$ x LIQ $_{t-1}$				-0.536	*	0.233
ΔMaP_tight $_{t}$ x DEP $_{t-1}$				-0.142	*	0.063
ΔMaP_tight $_{t-1}$ x DEP $_{t-1}$				0.126	*	0.059
Macroeconomic controls	yes			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	766			766		
Overall R-Squared	0.214			0.239		
Within R-Squared	0.284			0.324		
Between R-Squared	0.338			0.316		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) For the interaction terms between MaP and bank characteristics, only statistically significant coefficients are reported

Table B5. Effects of MaP policies on consumer loans (MaP and monetary policy conditions)

	Dependent variable: Quarterly change in outstanding of consumer loans (Δlog Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog Loans $_{t-1}$	0.287	***	0.037	0.274	***	0.037
Δlog Loans $_{t-2}$	0.109	**	0.039	0.097	*	0.040
Δlog Loans $_{t-3}$	0.179	***	0.038	0.182	***	0.038
Δlog Loans $_{t-4}$	-0.026		0.035	-0.027		0.036
SIZE $_{t-1}$	-0.017	**	0.006	-0.041	***	0.010
LIQ $_{t-1}$	-0.088		0.085	-0.169		0.090
CAP $_{t-1}$	-0.281	**	0.092	-0.411	***	0.104
DEP $_{t-1}$	-0.040		0.024	-0.046		0.026
ΔMaP $_{t}$	0.021		0.011	0.021		0.012
ΔMaP $_{t-1}$	0.040	***	0.011	0.042	***	0.012
ΔMaP $_{t-2}$	-0.013		0.011	-0.013		0.012
ΔMaP $_{t-3}$	0.014		0.011	0.018		0.012
ΔMaP $_{t-4}$	0.005		0.011	0.002		0.011
realrate $_{t}$	-0.001		0.007	0.000		0.009
realrate $_{t-1}$	-0.004		0.008	-0.002		0.009
realrate $_{t-2}$	-0.002		0.007	-0.002		0.009
realrate $_{t-3}$	0.012		0.009	0.010		0.009
realrate $_{t-4}$	-0.007		0.007	-0.004		0.009
MaP $_{t}$ x realrate $_{t}$	0.031	*	0.015	0.041	*	0.016
MaP $_{t-1}$ x realrate $_{t-1}$	0.037	*	0.015	0.048	**	0.017
MaP $_{t-2}$ x realrate $_{t-2}$	-0.022		0.014	-0.011		0.016
MaP $_{t-3}$ x realrate $_{t-3}$	0.014		0.014	0.015		0.015
MaP $_{t-4}$ x realrate $_{t-4}$	-0.002		0.012	-0.006		0.013
Macroeconomic controls	no			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	796			766		
Overall R-Squared	0.287			0.169		
Within R-Squared	0.304			0.323		
Between R-Squared	0.423			0.193		

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

Table B6. Effects of MaP policies on consumer loans (MaP and the business cycle)

	Dependent variable: Quarterly change in outstanding of consumer loans (Δlog Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog Loans $_{t-1}$	0.283	***	0.037	0.280	***	0.037
Δlog Loans $_{t-2}$	0.102	*	0.040	0.100	*	0.040
Δlog Loans $_{t-3}$	0.182	***	0.038	0.179	***	0.038
Δlog Loans $_{t-4}$	-0.032		0.036	-0.033		0.036
SIZE $_{t-1}$	-0.023	***	0.007	-0.039	***	0.010
LIQ $_{t-1}$	-0.108		0.086	-0.176		0.090
CAP $_{t-1}$	-0.311	***	0.093	-0.411	***	0.103
DEP $_{t-1}$	-0.049	*	0.025	-0.043		0.026
ΔMaP $_{t}$	0.024		0.015	0.014		0.017
ΔMaP $_{t-1}$	0.051	***	0.013	0.049	***	0.015
ΔMaP $_{t-2}$	-0.013		0.014	-0.010		0.018
ΔMaP $_{t-3}$	0.021		0.014	0.021		0.017
ΔMaP $_{t-4}$	0.011		0.010	0.012		0.010
Δrgdp $_{t}$	0.196		0.139	0.189		0.148
Δrgdp $_{t-1}$	0.057		0.140	-0.052		0.191
Δrgdp $_{t-2}$	-0.174		0.116	-0.161		0.132
Δrgdp $_{t-3}$	-0.081		0.122	-0.043		0.134
Δrgdp $_{t-4}$	-0.136		0.132	-0.061		0.138
ΔMaP $_{t}$ x Δrgdp $_{t}$	-0.445		0.368	-0.310		0.394
ΔMaP $_{t-1}$ x Δrgdp $_{t-1}$	-1.026	**	0.344	-1.045	**	0.379
ΔMaP $_{t-2}$ x Δrgdp $_{t-2}$	0.150		0.376	-0.052		0.427
ΔMaP $_{t-3}$ x Δrgdp $_{t-3}$	-0.129		0.391	-0.201		0.568
ΔMaP $_{t-4}$ x Δrgdp $_{t-4}$	-0.325		0.334	-0.436		0.414
Macroeconomic controls	no			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	781			766		
Overall R-Squared	0.251			0.173		
Within R-Squared	0.306			0.316		
Between R-Squared	0.324			0.201		

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

Table B7. Effects of MaP policies on consumer loans (MaP and the financial cycle)

	Dependent variable: Quarterly change in outstanding of consumer loans (Δlog Loans)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
Δlog Loans $_{t-1}$	0.274	***	0.037	0.268	***	0.037
Δlog Loans $_{t-2}$	0.113	**	0.040	0.104	**	0.040
Δlog Loans $_{t-3}$	0.180	***	0.038	0.187	***	0.038
Δlog Loans $_{t-4}$	-0.033		0.036	-0.033		0.036
SIZE $_{t-1}$	-0.041	***	0.010	-0.042	***	0.010
LIQ $_{t-1}$	-0.165		0.089	-0.163		0.090
CAP $_{t-1}$	-0.425	***	0.106	-0.420	***	0.106
DEP $_{t-1}$	-0.049		0.026	-0.056	*	0.027
ΔMaP $_{t}$	0.001		0.008	0.003		0.009
ΔMaP $_{t-1}$	0.005		0.008	0.012		0.009
ΔMaP $_{t-2}$	0.004		0.008	0.007		0.009
ΔMaP $_{t-3}$	0.002		0.008	0.008		0.009
ΔMaP $_{t-4}$	0.012		0.008	0.011		0.008
creditgap $_{t}$	-0.001		0.003	-0.002		0.003
creditgap $_{t-1}$	-0.003		0.004	-0.001		0.005
creditgap $_{t-2}$	0.006		0.004	0.003		0.005
creditgap $_{t-3}$	-0.000		0.004	0.002		0.004
creditgap $_{t-4}$	-0.001		0.002	-0.001		0.002
ΔMaP $_{t}$ x creditgap $_{t}$	-0.001	*	0.001	-0.002	**	0.001
ΔMaP $_{t-1}$ x creditgap $_{t-1}$	-0.001	**	0.001	-0.002	**	0.001
ΔMaP $_{t-2}$ x creditgap $_{t-2}$	0.001	*	0.001	0.001		0.001
ΔMaP $_{t-3}$ x creditgap $_{t-3}$	-0.000		0.000	-0.000		0.001
ΔMaP $_{t-4}$ x creditgap $_{t-4}$	0.001		0.000	0.000		0.000
Macroeconomic controls	no			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	766			766		
Overall R-Squared	0.170			0.168		
Within R-Squared	0.324			0.332		
Between R-Squared	0.196			0.186		

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

Table B8. Effects of MaP policy on non-performing loans (aggregate MaP index)

	Dependent variable: Non performing loan ratio (NPL)			
	(1)		(2)	
	coeff	Std err	coeff	Std err
NPL $_{t-1}$	0.911 ***	0.037	0.892 ***	0.038
NPL $_{t-2}$	0.070	0.047	0.113 *	0.048
NPL $_{t-3}$	-0.062	0.041	-0.077	0.043
NPL $_{t-4}$	0.004	0.030	-0.005	0.031
SIZE $_{t-1}$	0.015	0.025	0.012	0.025
LIQ $_{t-1}$	0.190	0.223	0.291	0.246
CAP $_{t-1}$	-0.111	0.261	-0.032	0.272
DEP $_{t-1}$	0.054	0.065	0.058	0.071
ΔMaP $_{t}$	-0.035	0.020	-0.137	0.166
ΔMaP $_{t-1}$	0.009	0.020	-0.115	0.162
ΔMaP $_{t-2}$	-0.015	0.020	-0.010	0.158
ΔMaP $_{t-3}$	0.018	0.019	0.373 *	0.158
ΔMaP $_{t-4}$	0.023	0.018	0.176	0.151
ΔMaP $_{t}$ x SIZE $_{t-1}$			0.042 **	0.014
ΔMaP $_{t-1}$ x SIZE $_{t-1}$			-0.019	0.014
ΔMaP $_{t-2}$ x SIZE $_{t-1}$			-0.011	0.015
ΔMaP $_{t-3}$ x SIZE $_{t-1}$			0.003	0.014
ΔMaP $_{t-4}$ x SIZE $_{t-1}$			0.004	0.014
ΔMaP $_{t}$ x LIQ $_{t-1}$			-0.699	0.491
ΔMaP $_{t-1}$ x LIQ $_{t-1}$			1.296 *	0.517
ΔMaP $_{t-2}$ x LIQ $_{t-1}$			-0.057	0.554
ΔMaP $_{t-3}$ x LIQ $_{t-1}$			-0.830	0.514
ΔMaP $_{t-4}$ x LIQ $_{t-1}$			-0.593	0.530
ΔMaP $_{t}$ x CAP $_{t-1}$			0.037	0.491
ΔMaP $_{t-1}$ x CAP $_{t-1}$			0.872 *	0.423
ΔMaP $_{t-2}$ x CAP $_{t-1}$			-0.206	0.438
ΔMaP $_{t-3}$ x CAP $_{t-1}$			-1.290 **	0.415
ΔMaP $_{t-4}$ x CAP $_{t-1}$			-0.581	0.413
ΔMaP $_{t}$ x DEP $_{t-1}$			-0.274	0.148
ΔMaP $_{t-1}$ x DEP $_{t-1}$			0.128	0.137
ΔMaP $_{t-2}$ x DEP $_{t-1}$			0.156	0.129
ΔMaP $_{t-3}$ x DEP $_{t-1}$			-0.221	0.131
ΔMaP $_{t-4}$ x DEP $_{t-1}$			-0.102	0.129
Macroeconomic controls	yes		yes	
Policy controls	no		no	
Fixed effect	yes		yes	
Sample Period	2004:q1 - 2018:q1		2004:q1 - 2018:q1	
Banks	17 (domestic)		17 (domestic)	
Observations	750		750	
Overall R-Squared	0.972		0.974	
Within R-Squared	0.915		0.920	
Between R-Squared	0.997		0.997	

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

Table B9. Effects of MaP policies on non-performing loans (Cyclical vs Resilience MaP tools)

	Dependent variable: Non performing loan ratio (NPL)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
NPL $_{t-1}$	0.911	***	0.037	0.908	***	0.038
NPL $_{t-2}$	0.070		0.047	0.111	*	0.048
NPL $_{t-3}$	-0.062		0.041	-0.093	*	0.043
NPL $_{t-4}$	0.004		0.030	0.001		0.031
SIZE $_{t-1}$	0.016		0.026	0.013		0.025
LIQ $_{t-1}$	0.204		0.225	0.304		0.246
CAP $_{t-1}$	-0.105		0.267	-0.049		0.275
DEP $_{t-1}$	0.055		0.066	0.067		0.073
ΔMaP_cyc $_{t}$	-0.028		0.027	-0.053		0.189
ΔMaP_cyc $_{t-1}$	0.006		0.026	-0.235		0.184
ΔMaP_cyc $_{t-2}$	-0.014		0.026	-0.007		0.179
ΔMaP_cyc $_{t-3}$	0.012		0.026	0.407	*	0.178
ΔMaP_cyc $_{t-4}$	0.018		0.020	0.142		0.158
ΔMaP_res $_{t}$	-0.068		0.046	-0.231		0.511
ΔMaP_res $_{t-1}$	0.013		0.053	-0.154		0.590
ΔMaP_res $_{t-2}$	-0.012		0.051	0.446		0.598
ΔMaP_res $_{t-3}$	0.018		0.052	-0.233		0.728
ΔMaP_res $_{t-4}$	0.050		0.055	-0.063		0.633
ΔMaP_cyc $_{t-1}$ x LIQ $_{t-1}$				1.831	**	0.655
ΔMaP_cyc $_{t-1}$ x CAP $_{t-1}$				1.174	**	0.445
ΔMaP_cyc $_{t-3}$ x CAP $_{t-1}$				-1.348	**	0.432
ΔMaP_res $_{t}$ x SIZE $_{t-1}$				0.146	***	0.033
ΔMaP_res $_{t}$ x DEP $_{t-1}$				-1.681	***	0.432
Macroeconomic controls	yes			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	750			750		
Overall R-Squared	0.972			0.975		
Within R-Squared	0.915			0.924		
Between R-Squared	0.997			0.997		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively (2) For the interaction terms between MaP and bank characteristics, only statistically significant coefficients are reported

Table B10. Effects of MaP policies on non-performing loans (Tightening and loosening episodes)

	Dependent variable: Non performing loan ratio (NPL)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
NPL $_{t-1}$	0.912	***	0.037	0.905	***	0.038
NPL $_{t-2}$	0.066		0.047	0.099	*	0.049
NPL $_{t-3}$	-0.060		0.041	-0.075		0.044
NPL $_{t-4}$	0.005		0.030	0.001		0.032
SIZE $_{t-1}$	0.013		0.025	0.002		0.025
LIQ $_{t-1}$	0.189		0.223	0.306		0.277
CAP $_{t-1}$	-0.143		0.262	-0.349		0.297
DEP $_{t-1}$	0.044		0.066	-0.000		0.079
ΔMaP_loose $_{t}$	-0.016		0.050	-1.078	**	0.352
ΔMaP_loose $_{t-1}$	0.056		0.043	0.011		0.359
ΔMaP_loose $_{t-2}$	-0.016		0.043	-0.290		0.347
ΔMaP_loose $_{t-3}$	-0.028		0.043	-0.935	**	0.346
ΔMaP_loose $_{t-4}$	-0.024		0.045	-0.302		0.343
ΔMaP_tight $_{t}$	-0.052	*	0.022	-0.637	**	0.204
ΔMaP_tight $_{t-1}$	0.034		0.023	-0.085		0.194
ΔMaP_tight $_{t-2}$	-0.030		0.023	-0.153		0.192
ΔMaP_tight $_{t-3}$	0.023		0.022	0.130		0.188
ΔMaP_tight $_{t-4}$	0.018		0.022	0.109		0.185
ΔMaP_loose $_{t}$ x CAP $_{t-1}$				1.699	*	0.812
ΔMaP_loose $_{t-3}$ x CAP $_{t-1}$				2.473	**	0.785
ΔMaP_loose $_{t}$ x DEP $_{t-1}$				0.777	*	0.349
ΔMaP_tight $_{t}$ x SIZE $_{t-1}$				0.067	***	0.016
ΔMaP_tight $_{t-1}$ x CAP $_{t-1}$				1.111	*	0.535
ΔMaP_loose $_{t}$ x CAP $_{t-1}$				1.699	*	0.812
Macroeconomic controls	yes			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	750			750		
Overall R-Squared	0.973			0.975		
Within R-Squared	0.915			0.923		
Between R-Squared	0.997			0.997		

Notes: (1) The symbols *, **, and *** represent significance levels of 10%, 5% and 1%, respectively
(2) For the interaction terms between MaP and bank characteristics, only statistically significant coefficients are reported

Table B11. Effects of MaP policies on non-performing loans (MaP and monetary policy conditions)

	Dependent variable: Non performing loan ratio (NPL)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
NPL_{t-1}	0.902	***	0.036	0.908	***	0.037
NPL_{t-2}	0.073		0.046	0.072		0.047
NPL_{t-3}	-0.056		0.041	-0.060		0.041
NPL_{t-4}	0.003		0.029	0.004		0.030
$SIZE_{t-1}$	0.022		0.017	0.015		0.026
LIQ_{t-1}	0.166		0.212	0.149		0.224
CAP_{t-1}	-0.125		0.223	-0.104		0.270
DEP_{t-1}	0.044		0.062	0.039		0.068
ΔMaP_{t}	-0.051		0.029	-0.044		0.030
ΔMaP_{t-1}	0.012		0.029	0.040		0.032
ΔMaP_{t-2}	-0.031		0.029	-0.011		0.030
ΔMaP_{t-3}	0.004		0.028	0.010		0.029
ΔMaP_{t-4}	0.008		0.027	0.009		0.028
$realrate_{t}$	-0.020		0.017	-0.018		0.021
$realrate_{t-1}$	-0.005		0.018	-0.026		0.021
$realrate_{t-2}$	0.031		0.018	0.053	*	0.022
$realrate_{t-3}$	0.005		0.021	0.002		0.022
$realrate_{t-4}$	-0.006		0.018	-0.022		0.023
ΔMaP_{t} x $realrate_{t}$	-0.005		0.039	-0.017		0.042
ΔMaP_{t-1} x $realrate_{t-1}$	-0.005		0.039	0.023		0.043
ΔMaP_{t-2} x $realrate_{t-2}$	-0.022		0.035	0.020		0.040
ΔMaP_{t-3} x $realrate_{t-3}$	-0.032		0.031	-0.011		0.033
ΔMaP_{t-4} x $realrate_{t-4}$	-0.035		0.030	-0.031		0.033
Macroeconomic controls	no			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	780			750		
Overall R-Squared	0.973			0.973		
Within R-Squared	0.916			0.916		
Between R-Squared	0.997			0.997		

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

Table B12. Effects of MaP policies on non-performing loans (MaP and the business cycle)

	Dependent variable: Non performing loan ratio (NPL)			
	(1)		(2)	
	coeff	Std err	coeff	Std err
NPL_{t-1}	0.909 ***	0.037	0.908 ***	0.037
NPL_{t-2}	0.068	0.047	0.071	0.047
NPL_{t-3}	-0.060	0.041	-0.062	0.041
NPL_{t-4}	0.005	0.029	0.006	0.030
$SIZE_{t-1}$	0.022	0.017	0.011	0.025
LIQ_{t-1}	0.215	0.216	0.201	0.225
CAP_{t-1}	-0.117	0.228	-0.120	0.267
DEP_{t-1}	0.049	0.066	0.039	0.070
ΔMaP_{t}	-0.037	0.039	-0.022	0.043
ΔMaP_{t-1}	0.015	0.034	0.026	0.037
ΔMaP_{t-2}	-0.008	0.035	0.025	0.043
ΔMaP_{t-3}	0.001	0.030	0.033	0.033
ΔMaP_{t-4}	0.020	0.025	0.031	0.026
$\Delta rgdp_{t}$	-0.417	0.356	-0.124	0.379
$\Delta rgdp_{t-1}$	-0.313	0.359	0.184	0.486
$\Delta rgdp_{t-2}$	-0.173	0.299	-0.053	0.340
$\Delta rgdp_{t-3}$	-0.180	0.316	-0.032	0.344
$\Delta rgdp_{t-4}$	0.011	0.333	0.125	0.352
$\Delta MaP_{t} \times \Delta rgdp_{t}$	-0.110	0.945	-0.331	1.021
$\Delta MaP_{t-1} \times \Delta rgdp_{t-1}$	-0.478	0.891	-0.480	0.974
$\Delta MaP_{t-2} \times \Delta rgdp_{t-2}$	-0.634	0.964	-0.921	1.061
$\Delta MaP_{t-3} \times \Delta rgdp_{t-3}$	0.364	0.859	-0.885	1.138
$\Delta MaP_{t-4} \times \Delta rgdp_{t-4}$	0.274	0.861	-0.674	1.000
Macroeconomic controls	no		yes	
Policy controls	no		no	
Fixed effect	yes		yes	
Sample Period	2004:q1 - 2018:q1		2004:q1 - 2018:q1	
Banks	17 (domestic)		17 (domestic)	
Observations	765		750	
Overall R-Squared	0.972		0.973	
Within R-Squared	0.914		0.915	
Between R-Squared	0.996		0.997	

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

Table B13. Effects of MaP policies on non-performing loans (MaP and the financial cycle)

	Dependent variable: Non performing loan ratio (NPL)					
	(1)			(2)		
	coeff		Std err	coeff		Std err
NPL_{t-1}	0.913	***	0.037	0.912	***	0.037
NPL_{t-2}	0.064		0.047	0.070		0.047
NPL_{t-3}	-0.062		0.041	-0.066		0.041
NPL_{t-4}	0.008		0.030	0.007		0.030
$SIZE_{t-1}$	0.014		0.026	0.013		0.026
LIQ_{t-1}	0.228		0.222	0.201		0.224
CAP_{t-1}	-0.115		0.278	-0.104		0.280
DEP_{t-1}	0.041		0.067	0.039		0.070
ΔMaP_{t}	-0.068	***	0.020	-0.059	**	0.022
ΔMaP_{t-1}	0.022		0.021	0.026		0.022
ΔMaP_{t-2}	-0.031		0.021	-0.029		0.022
ΔMaP_{t-3}	0.039		0.022	0.030		0.024
ΔMaP_{t-4}	0.022		0.020	0.015		0.021
$creditgap_{t}$	-0.002		0.006	-0.001		0.007
$creditgap_{t-1}$	0.003		0.011	-0.001		0.012
$creditgap_{t-2}$	-0.004		0.009	-0.001		0.011
$creditgap_{t-3}$	0.008		0.009	0.006		0.009
$creditgap_{t-4}$	-0.005		0.005	-0.004		0.006
ΔMaP_{t} x $creditgap_{t}$	-0.001		0.001	-0.001		0.002
ΔMaP_{t-1} x $creditgap_{t-1}$	0.005	***	0.001	0.005	**	0.001
ΔMaP_{t-2} x $creditgap_{t-2}$	0.000		0.001	-0.000		0.001
ΔMaP_{t-3} x $creditgap_{t-3}$	0.000		0.001	-0.000		0.001
ΔMaP_{t-3} x $creditgap_{t-4}$	-0.001		0.001	-0.001		0.001
Macroeconomic controls	no			yes		
Policy controls	no			no		
Fixed effect	yes			yes		
Sample Period	2004:q1 - 2018:q1			2004:q1 - 2018:q1		
Banks	17 (domestic)			17 (domestic)		
Observations	750			750		
Overall R-Squared	0.973			0.973		
Within R-Squared	0.916			0.917		
Between R-Squared	0.997			0.997		

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