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Do macroprudential policy instruments reduce the procyclical impact of capital ratio on bank lending? Cross-country evidence

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ABSTRACT

In this paper, we ask about the capacity of macroprudential policies to reduce the procyclical impact of capital ratio on bank lending. We focus on aggregated macroprudential policy measures and on individual instruments and test whether their effect on the association between lending and capital depends on bank size. Applying the GMM 2-step Blundell and Bond approach to a sample covering over 60 countries, we find that macroprudential policy instruments reduce the procyclical impact of capital on bank lending during both crisis and non-crisis times. This result is stronger in large banks than in other banks. Of individual macroprudential instruments, only borrower-targeted LTV caps and DTI ratio weaken the association between lending and capital and thus act countecyclically. Generally, with our study we are able to support the view that macroprudential policy has the potential to curb the procyclical impact of bank capital on lending and therefore, the introduction of more restrictive international capital standards included in Basel III and of macroprudential policies are fully justified.

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1. Introduction

The Global Financial Crisis (GFC) has highlighted the need to go beyond a purely micro-prudential approach to regulation and supervision of the banking sector. There is a growing consensus among financial practitioners (BCBS, 2011, CGFS, 2012; ESRB, 2014) and researchers (Lim et al., 2011; Claessens, Ghosh, & Mihet, 2014; Cerutti, Claessens, & Laeven, 2015) that a set of macroprudential policy standards should be adopted. Such standards should increase the resilience of the banking sector to systemic risk and help curb the credit cycle (CGFS, 2012), thereby decreasing excessive procyclicality (BIS-IMF-FSB, 2011; Borio & Zhu, 2012, p. 246). The empirical literature supports the view that macroprudential policies are able to decrease the vulnerability of the banking sector (see Claessens, 2014 for a review, and Cerutti et al., 2015). The increased resilience of

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the banking sector means that banks are able to absorb losses of greater magnitude – due to higher capital buffers (or provisions) or better access to funding sources, thus reducing the likelihood of a costly disruption to the supply of credit (CGFS, 2012), in particular during crises or recessionary periods. Considering this, macroprudential policies are expected to reduce the procyclical impact of capital ratio on loan supply.

It is a well-known tenet in the banking literature that capital adequacy rules have an impact on the behaviour of banks (Borio & Zhu, 2012). Previous literature stresses the importance of capital ratios for lending behaviour, during both good economic conditions and in crisis or recessionary periods, in particular in banks with insufficiently high capital ratios (see Beatty & Liao, 2011; Carlson, Shan, & Warusawitharana, 2013) or in large banks (Beatty & Liao, 2011). The problem of the effect of capital ratio on bank lending has been studied extensively since the 1990s, when the first Basel Accord was introduced as an international capital standard. Early studies of the association show that bank capital may exert some impact on lending, but this effect is relatively weak (see Jackson et al., 1999). In the wake of the recent GFC, the topic has attracted renewed attention as concerns have arisen that large losses at banks would hinder their capital adequacy and restrain their lending. Capital is found to affect lending behaviour in large publicly-traded banks by Beatty and Liao (2011) and in US commercial banks by Carlson et al. (2013). Additionally, in a cross-country study, Gambacorta and Marqués-Ibáñez (2011) show that publicly traded banks tend to restrict their lending more during recessions or crisis periods due to insufficient capital ratios. Such an effect is referred to as a procyclical capital ratio on bank lending (Beatty & Liao, 2011; Peek & Rosengren, 1995a).

While policy standards setters argue that the new macroprudential approach to regulation and supervision should reduce procyclicality in banking, and in particular by increasing banks' resilience it should diminish the effect of capital ratio on loan supply, the empirical evidence on this subject is not available. We employ a cross-country data-set to examine whether the application of macroprudential policies affects the link between loan supply and capital ratio, before and during the crisis period in a sample of over 4500 banks from 67 countries. The main purpose of the paper is to examine whether macroprudential policy instruments, which were in use before the GFC, had a significantly negative impact on the positive association between lending and capital ratio, during the crisis and in the non-crisis period. If we identify such a negative effect, we will be able to empirically test the view that macroprudential policy is effective in increasing the resilience of banks and thus affects procyclicality of bank capital regulation.

Based on the previous evidence, we first hypothesize that the link between lending and capital is positive, and is reduced in countries which applied macroprudential policies in the pre-crisis period. Following the capital crunch theory (see Peek & Rosengren, 1995b; and Beatty & Liao, 2011), we expect that the link between lending and capital is strengthened in the crisis period, and is reduced in countries in which the use of macroprudential instruments was more extensive in the pre-crisis period and continued to be used during the crisis. As the association between loans growth and capital ratio, in particular during crisis periods was found to be stronger in large banks (see Beatty & Liao, 2011), we also examine whether macroprudential policy effects on the association differ between large and other banks (i.e. medium and small).

We use the Bankscope database and data-set on macroprudential policies available in Cerutti et al. (2015) to test our hypotheses. We analyse the effects of macroprudential policies on the association between lending and capital ratio using individual commercial bank data from 65 countries over the period of 2000–2011. We control for endogeneity in our data-set applying the two-step GMM Blundell and Bond (1998) robust estimator with finite sample Windmeijer's (2005) correction. We find a consistent and strong effect of macroprudential policies on the association between loans growth and capital ratio. We also find evidence in favour of the expectation that bank size matters for the impact of macroprudential policies for the link between lending and capital. Analysis of the role of individual macroprudential policy instruments shows that only two borrower-based instruments, i.e. *LTV-caps* and *DTI* ratios weaken the positive effect of capital ratio on lending.

This paper extends the existing research by including the macroprudential policy indices that may affect the amount of capital private banks maintain and capital buffers of banks, and thus the resilience of banks, and in effect the procyclicality of bank lending due to capital constraints. Previous studies on the link between lending and capital have been limited to individual countries (United States by Beatty & Liao, 2011 and Carlson et al., 2013; France by Labonne & Lame, 2014; United Kingdom by Mora and Logan, 2012), so that all banks were equally affected by the country's regulations and supervisory policy towards banks. Those studies, which focused on the link between lending and capital across countries, have not accounted for macroprudential policy and its instruments (Gambacorta & Marqués-Ibáñez, 2011). In other words, this paper explores the countercyclical effects of macroprudential policy factors on the association between loan growth and capital ratio during both good times and during the GFC. Unlike previous studies on the link between bank vulnerability and macroprudential policy, we differentiate between large, medium and small banks, because previous evidence shows that capital ratios affect bank lending with a different magnitude, depending on the bank size (see Beatty & Liao, 2011).[1] With this study, we also show that the range of application of macroprudential instruments does matter for procyclical impact of capital ratio on lending. We also identify which instruments are better at curbing procyclicality of capital standards. In particular, we ask whether borrower targeted macroprudential instruments (such as loan-to-value caps) or restrictions on balance sheets of financial institutions (such as dynamic provisions or leverage ratios), are more effective in reducing the procyclicality of capital standards.

The rest of the paper is organized as follows. Section 2 puts our study in the context of research on the role of bank capital for loan supply and the impact of macroprudential policies on bank resilience and thus develops our hypotheses. We describe our sample and research design in Section 3. We discuss results in Section 4. Section 5 concludes our work.

2. Related literature and hypotheses

Our study is related to two broad streams in the literature. The first one consists of studies focusing on the link between lending and capital ratios in the banking industry. The other stream covers the growing literature on the links between macroprudential policy instruments and financial stability.

The empirical literature on the role of bank capital on loan supply[2] can be divided into two basic streams. The first focuses on the impact of the Basel I Accord, which was implemented around the world in the beginning of 1990s. This research aimed at answering the question whether the newly introduced uniform capital ratios had an effect on bank behaviour (for a review see Chiuri, Ferri, & Majnoni, 2002, p. 884) and on the macro-economy. Most of those studies were analysed by Jackson et al. (1999), thus for brevity, we skip detailed insights into this literature and proceed to the second stream. This stream started flourishing in the first half of the 2000s and can be roughly divided into two areas: the first concentrating on the role of bank capital in bank lending under different monetary policy stances (see Kishan & Opiela, 2000, p. 2006; Nier & Zicchino, 2008) and the second investigating more generally the size of the effect of bank capital on loan supply (see e.g. Berrospide & Edge, 2010; Beatty & Liao, 2011; Gambacorta and Mistrulli, 2004; Carlson et al., 2013; Bridges et al., 2014 and Labonne & Lame, 2014). Kishan and Opiela (2000) provide evidence of a credit channel and a bank lending channel of monetary policy in the United States from 1980 to 1995. Kishan and Opiela (2006) investigate the effects of expansionary and contractionary policy separately on the loan behaviour of low-capital and high-capital banks, and between pre-Basel/FDICIA and post-Basel/FDICIA periods. Their results show that low-capital banks are adversely affected by contractionary policy. Expansionary policy, however, is not effective in stimulating the loan growth of low-capital banks. These results are consistent with lending channel predictions, but only hold in the post-Basel/FDICIA period when the capital constraint is stringent, relative to the pre-Basel/FDICIA period. These asymmetric policy results have implications for the interaction of monetary and capital regulatory policies.

The empirical evidence on the effectiveness of macroprudential policies in managing the resilience of the banking (and financial) sector and the credit cycle, and thus financial stability, is still preliminary. The literature presenting this evidence falls into two groups, of which the first includes cross-country studies and the other covers micro-level evidence mostly based on the use of one,[3] or a few, macroprudential policy instruments. One of the first cross-country studies was a paper by Lim et al. (2011). They document evidence suggesting that the presence of policies such as LTV and DTI limits, ceilings on credit growth, reserve requirements and dynamic provisioning rules can mitigate the procyclicality of credit and leverage (i.e. they reduce the positive sensitivity of credit and leverage to the business cycle, proxied by real GDP growth). Their study also shows that reserve requirements and dynamic provisions are effective in reducing credit growth during booms.

Crowe, Deniz, Dell'Ariccia, and Rabanal (2011) find that LTV caps have the best chance to curb a real estate boom. Similarly, but in a different sample, Vandenbussche, Vogel, and Detragiache (2012) find that capital ratio requirements and non-standard liquidity measures (such as marginal reserve requirements on foreign funding or linked to credit growth) helped slow down house-price inflation in Central, Eastern and Southeastern Europe. Seemingly, Dell' Ariccia et al. (2012) find that macroprudential instruments can reduce the incidence of general credit booms and decrease the probability that booms end badly. Claessens, Ghosh, and Mihet (2013, p. 2014) investigate how changes in balance sheets – i.e. in leverage, assets and non-core liabilities growth, of some 2800 banks in 48 countries over 2000–2010 respond to specific macroprudential policy instruments. They find that borrower-targeted instruments – LTV and DTI caps, and CG and FC limits – are effective in reducing the growth in bank's leverage, asset and non-core liabilities. Countercyclical instruments (such as RR and DP) also help mitigate increases in bank leverage, but they are of little effect thorough the cycle.

Kuttner and Shim (2013) using data from 57 countries find that housing credit growth is significantly affected by changes in the maximum debt-service-to-income (DSTI) ratio, the maximum loan-to-value ratio, limits on exposure to the housing sector and housing-related taxes. Zhang and Zoli (2016) review the use of key macroprudential instruments and capital flow measures in 13 Asian economies and 33 economies in other regions since 2000 and find that Asian economies appear to have made greater use of macroprudential tools, especially housing-related measures, than their counterparts in other regions. Cerutti et al. (2015) show that usage of macroprudential policies is generally associated with lower growth in aggregated credit, notably in household credit. However, these effects are less evident in financially more developed and open economies, in which the usage of macroprudential policies comes with greater cross-border borrowing, suggesting that these countries face issues of avoidance.

Olszak, Kowalska, and Roszkowska (2018) test whether sensitivity of loan-loss provisions (i.e. net loan-loss allowance charged to bank income statement) to business-cycle in individual commercial banks may be affected by the macroprudential policy instruments. Applying both consolidated and unconsolidated financial data of banks operating in 76 countries this paper shows that borrower restrictions (such as loan-to-value ratios – LTV, and debt-to-income ratios – DTI) are definitely more effective in reducing the procyclicality of loan-loss provisions than other macroprudential policy instruments. Moreover, considering the fact that large banks exhibit grater procyclicality of loan-loss provisions to business-cycle (see Olszak, Pipień, Roszkowska, & Kowalska, 2017), this study identifies that the effect of LTV and DTI is stronger in the case of large banks.

2.1. Hypotheses

To sum up, the analysis of the literature conducted thus far shows that the association between lending and capital ratio may be positive, and this positive association is strengthened during recessionary periods, thus implying procyclicality of capital standards. However, this relationship is diversified across countries. Previous research also shows that many countries have applied macroprudential policies, which may potentially influence the resilience of banks and curb the credit cycle. However, no previous study has focused on the role of macroprudential policies in the link between lending and capital ratio. Therefore, it seems reasonable to ask how the use of macroprudential policies impacts the link between loans growth and capital ratio. In particular, capital-based and provisioning instruments (like leverage ratio or dynamic provisioning) create additional buffers and thus make banks' immune to losses of a greater magnitude before their solvency is endangered, thus diminishing the likelihood of a costly disruption to the supply of credit. Such a disruption has been identified in publicly-traded banks in the U.S. (Beatty & Liao, 2011), in a cross-country sample of banks (Gambacorta & Marqués-Ibáñez, 2011), in the EU (Olszak et al., 2015) as well as in U.S. Commercial banks (Carlson et al., 2013). Borrower-targeted macroprudential policy instruments decrease the PD and LGD of an average bank borrower and enhance the overall quality of bank credit portfolio, and thus decrease the likelihood that banks (and their solvency) will suffer from loan losses during bust periods. Liquidity-based instruments make banks resilient to disruptions to liquidity in financial markets (in particular in the wholesale market, e.g. interbank market), thereby decreasing the impact of losses related to such disruptions on capital adequacy of banks. Considering the fact that macroprudential policy should increase the resilience of individual banks and of the banking sector to disruptions in financial markets (and thus to crisis periods) we expect that this will affect negatively the positive association between lending and capital ratios, and therefore the procyclical impact of capital ratio on lending. Thus we put forward following primary hypothesis:

H1: In countries in which more macroprudential policy instruments are applied, the procyclical impact of capital ratio on lending is weakened, during both non-crisis periods and during the recent crisis period.

The empirical evidence on the role of bank size for procyclicality suggests that large banks lending is more affected by capital ratio (Beatty & Liao, 2011) and that large banks exhibit greater sensitivity of loan-loss provisions to business cycle (Olszak et al., 2017). Large banks, on average, create more individual and systemic risk than smaller banks, especially when they have insufficient capital or unstable funding – both common features of large banks (Laeven, Ratnovski, & Tong, 2014). The currently implemented macroprudential policies, in particular, the capital surcharges on systemically important banks included in Basel III, are designed to increase the resilience of large banks. However, no such specific instruments had been applied in the pre-crisis period. Thus the resilience of large banks could only had been increased due to the application of other macroprudential policies, such as borrower based (LTV or DTI) or financial-institutions targeted policies (e.g. dynamic provisions or credit growth limits). These policies have been applied by micro-prudential supervision, which in the supervisory review and evaluation process focuses on large banks. Following these inferences we hypothesize that:

H2: The impact of macroprudential policy instruments on the procyclicality of capital ratio is strongest in the sample of large banks.

The association between lending and capital ratio has been shown to be positive (Beatty & Liao, 2011; Carlson et al., 2013; Gambacorta & Marqués-Ibáñez, 2011), implying that bank loan supply is constrained by capital ratio. Generally, the lower the capital ratio of a bank, the higher is its effect on loans growth (Carlson et al., 2013), consistent with the view that banks with lower capital ratio are less resilient. However, macroprudential policies applied in many countries before the recent crisis could have increased the resilience of large banks in particular. Thus the reduction of effect of capital ratio on bank lending could be the most significant in the case of these banks. Therefore we hypothesize that:

H3: Macroprudential policy instruments reduce the procyclical impact of capital ratio on lending in large banks during both non-crisis and crisis period.

3. The model specification and data description

3.1. The model specification

The most problematic issue in the measurement of the impact of bank capital on loan extension is the identification of supply and demand factors, which affect lending activity, both during favourable and unfavourable economic conditions. In particular, during recessionary periods, not only loan supply (due to bank capital and liquidity problems) may decrease, but also loan demand of households and firms may decline. This makes difficult any identification of bank capital effects on lending in recessionary or crisis periods. Several approaches have been used in the literature to take account of both supply side and demand side determinants of bank lending. The empirical models that addressed the question of whether a bank-capital induced credit crunch was hindering the recovery were developed in the early- and mid-1990s in the US (see, e.g. Bernanke & Lown, 1991; Hancock & Wilcox, 1994a, 1994b; 1997; 1998; Peek & Rosengren, 1995a). In our study, we apply contemporary adoptions of those models available in several studies (Beatty & Liao, 2011; Carlson et al., 2013). We apply a reduced form model (equation (1)), including both supply and demand side of the lending market and macroprudential policies (See Table A1 in Annex with description of variables used in the study):

The model reads as:

$$\begin{aligned}\Delta Loan_{i,t} = f(&CAP_{i,t-1}; Crisis; Crisis * CAP_{\ i,t-1}; Macroprud_j; Macroprud_j * Crisis;\\ &Macroprud_j * CAP_{i,t-1}; Macroprud_j * CAP_{i,t-1} * Crisis; OBSV_{i,t;t-1}; BC_{j,t-1};\\ &Country_j; T_t) + \vartheta_{i,t} + \varepsilon_t\end{aligned} \tag{1}$$

where i – the number of the bank; j – the number of country; t – the number of observation for the i-th bank; j – the number of country;

- $\Delta Loan$ – real annual loans growth rate, measured as ($Loan_{i,t}$-$Loan_{i,t-1}$)/$Loan_{i,t-1}$, deflated with CPI (i.e. consumer price index);
- *CAP* – the lagged capital ratio, i.e. equity capital divided by total assets lagged by one year (as in Beatty & Liao, 2011; and Carlson et al., 2013);
- *Crisis* – dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise. We predict a negative coefficient on Crisis if loan supply declines during crisis for reasons other than capital and liquidity constraints (as do Beatty & Liao, 2011, p. 7);
- *Macroprud* – macroprudential policies variable, which covers aggregated indices of macroprudential policy (denoted in the next sections as *Macropr index*) and individual macroprudential policy instruments (denoted in the next sections as *Macropr instr*) – computed for each country separately using data from the period of 2000–2011 available in Cerutti et al. (2015);
- OBSV denotes other bank-specific variables, and includes: ΔCAP – annual change in capital ratio; *Dep* – one year lagged deposits from non-financial customers divided by total assets; *Depbank* – one year lagged deposits from banks divided by total assets; *QLP* – is quality of lending portfolio (lagged by one year), it equals loan loss provisions divided by average loans; *size* – logarithm of assets;
- BC denotes business cycle, as a proxy for demand side of the bank lending market, and includes: *GDPG per capita* – real GDP per capita growth. A positive coefficient suggests procyclicality of bank lending; as well as $\Delta Unempl$ – annual change in unemployment rate (see, e.g. Bikker & Metzemakers, 2005);
- elements Country relate to a set of country dummy variables and T_t to a set of time dummies.; $\vartheta_{i,t}$ are unobservable bank-specific effects that are not constant over time but vary across banks; ε_t is a white-noise error term.

In our equation, we also include a couple of interaction terms, i.e.: Crisis * CAP, *Macropr index*CAP*; *M. index*Crisis*CAP*. *Crisis*CAP* denotes interaction between Crisis and capital ratio (CAP) and was added to the model in order to investigate the effect of CAP depending on the crisis (the presence or not of the period of crisis).

*Macropr index*CAP* is the interaction term between CAP and macroprudential policy variable and informs about the impact of macroprudential policies on the association between loans growth and capital ratio both in the good times; A negative (positive) regression coefficient on double interaction of *M. index*CAP* implies that in countries with a larger set of macroprudential instruments bank lending is relatively less (more) affected by capital ratio in non-crisis period in comparison to countries in which macroprudential polices were applied less intensively. Thus, such a negative association implies that macroprudential policy instruments did stimulate bank resilience, because they created additional buffers which insulate banks' lending from sensitivity to capital ratio.

*Macropr index*Crisis*CAP* denotes the interaction term between CAP and macroprudential policy variable during the last financial crisis and informs us about the impact of capital ratio on lending during crisis periods. A positive coefficient on *M. index*Crisis*CAP* implies that banks' lending is constrained by capital ratio during the crisis period in countries with more intense macroprudential policies (i.e. with more macroprudential instruments applied). In economic terms, such an effect would imply that macroprudential policies were ineffective in enhancing the resilience of individual banks. In contrast, a negative coefficient on this interaction term implies that in countries in which macroprudential policies are used extensively, the effect of capital ratio on lending during crisis is weakened.

In this model, we also include one lag of dependent variable (as Beatty & Liao, 2011; Gambacorta & Marqués-Ibáñez, 2011). The econometric model we use in our study is the system of generalized method of moments (GMM) developed by Blundell and Bond (1998), with robust standard errors and Windmejer's correction.[4] This model is advantageous because it corrects for biases introduced by endogeneity problems. We control for the potential endogeneity in the two-step system GMM estimation procedure, by the inclusion of up to four lags of explanatory bank-specific variables (*CAP, ΔCAP, Dep, Depbanks, QLP*) as instruments. The GDPG per capita and ΔUNEMPL as well as the country and the time dummy variables are the only variables considered exogenous. In all regressions we also include one lag of dependent variable to allow for natural convergence (as in Claessens et al., 2013, p. 2014). The GMM estimator is efficient and consistent if the models are not subject to serial correlation of order two and the instruments are not proliferated. Therefore we apply the test verifying the hypothesis of absence of second-order serial correlation in the first difference residuals (m2). The second test which we apply is Hansen's J statistic for over-identifying restrictions, which tests the overall validity of the instruments sets. When interpreting the *p*-values of Hansen's J statistics we follow Roodman's warning (2009) that the Hansen test should not be relied upon too faithfully, as it is prone to weaknesses, the most serious of which is instrument proliferation. A high *p*-value of the Hansen test is usually the basis of researchers' arguments for the validity of GMM results. Unfortunately, the proliferation of instruments validates the test (see Roodman, 2009, p. 141).

Additionally, as a robustness check, we decline the number of lags of explanatory endogenous variables to one. In the robustness section, we test the sensitivity of our results to change in estimation methods, applying one-step Arellano and Bond (1991) approach. The address the problem of endogeneity, our basic regression (given by equation 1) is also estimated applying ordinary least squares (OLS) and fixed effects (FE) models.

3.2. Data description

We use pooled cross-section and time series data of individual banks' balance sheet items and profit and loss accounts from 65 countries and country-specific macroeconomic indicators for these countries, over a period from 2000 to 2011. The balance sheet and profit and loss account data are taken from the Bankscope database, whereas the macroeconomic data were accessed from the World Bank and the IMF web pages. All data included are annual and in US dollars. We apply several filters to remove potential data errors and outliers. We exclude from our sample outlier banks by eliminating the extreme bank-specific observations when a given variable adopts extreme values (e.g. negative capital ratios or negative deposits to total assets which may be the result of misreporting or other data problems). Additionally, in order to conduct the analysis, we apply only the data for which there were a minimum of 5 successive values of dependent variable from the period 2000–2011. Our final sample consists of 89051 observations and some 8872 banks (for the loans growth variable) (see Table A1 in the appendix). We decided to exclude the period after 2011 because since 2012 onwards, many countries have started implementation of macroprudential policy instruments, as a response to international standard setters recommendations (e.g. Basel Committee rules, Committee on Global Financial System, IMF, etc.). In the period under analysis, we cover countries which differ significantly in the use of macroprudential policy instruments. Some of them applied almost all of them in the whole period, whereas other used them to a very small extent or did not apply them at all. Our sample covers sample covers 31 advanced economies, 31 emerging economies, 3 Low-income developing economies (classification by the IMF, also included in Cerutti et al., 2015). Such structure of data covers diversity of loans growth and capital ratios across countries.

As we are interested in the impact of macroprudential policy on procyclical impact of capital ratio on lending, we include indices designed by the IMF and presented in Claessens et al. (2014). In particular, we apply aggregated indices of macroprudential policy i.e.: *MPI aggregated* (which is an average value of macroprudential index available in Cerutti et al., 2015, computed for the period of 2000–2010), *BORROWER* (which is an average value of macroprudential index which covers instruments targeted on taming the risk-taking by borrowers), and *FINANCIAL* (an average value of macroprudential index which covers instruments targeted on taming the risk-taking by financial institutions, in particular by banks). As can be seen from Table A3 in the appendix, our sample covers countries applying a huge range of macroprudential instruments (e.g. Argentina, Canada, Colombia, Ecuador, Pakistan, Peru, Ukraine), as well as countries not using them in this period (e.g. Estonia, Finland, Ireland, Kenya, Lithuania, Malta, Netherlands, New Zealand, Slovenia, South Africa, Tunisia). We also test the impact of individual macroprudential policy instruments included in the data-set collected by Cerutti et al. (2015). These instruments include: loan-to-value cap ratio (*LTV_CAP)*, debt-to-income ratio (DTI), dynamic loan-loss provisioning (*DP*), leverage ratio (LEV), limits on interbank exposures (*INTER*), limits on foreign currency loans (*FC*), reserve requirements ratios (RR), limits on domestic currency growth (*CG*), levy/tax on financial institutions (TAX), *FX* limits and/or countercyclical reserve requirements (RR_REV). To test our hypotheses, for each country we construct a dummy variable which takes the value of 1 if the instrument was applied at least since 2004, and 0 otherwise. Such an approach is necessary to differentiate between countries in which banks had the necessary time in the pre-crisis period to build capital buffers, which are important in increasing financial stability and thus the resilience of banks in the crisis period. In fact, as for our sample, most countries which applied individual macroprudential instruments did so for almost the whole period of analysis. However, there is a huge diversity of application of individual macroprudential policy instruments across countries. As is shown in Table A3 in the appendix *LTV_CAP* was applied in 13 countries, *DTI* in 6 countries, *DP* in 2 countries, *LEV* in 6 countries, *INTER* in 16 countries, *CONC* in 35 countries, *FC* in 7 countries, *RR* in 13 countries, *RR_REV* in 5 countries, *CG* in 5 countries and *TAX* in 8 countries.

In order to show empirically how loan growth of banks of different size is affected by capital ratios, we divide our sample of banks into three subsamples: large, medium and small. Large banks are 30% of banks with the largest assets within a given country. Small banks are the 30% of banks with the smallest assets. Medium banks comprise 40% of other banks.

In Table 1 we present descriptive statistics of the variables and degree of correlation amongst dependent and independent variables. Looking at median values of bank-specific variables included in Table 1 we can find that large banks loans growth is the highest but these banks operate at lowest values of capital ratios (thus their capital adequacy is the worst). These banks are more reliant on less stable interbank market funding (the median *Depbanks* is 5.29) in comparison to medium or small banks. *Dep* is the lowest in large banks, which suggests that they must use unstable funding in loans extension, which potentially makes them more prone to liquidity funding risk. What's more the median and average quality of loan portfolio is the worst in large banks compared to medium and small banks, as exhibited by the highest mean and median *QLP*. Overall, our descriptive statistics for large bank seem to confirm the view (Laeven et al., 2014) that large banks are riskier. Therefore it is possible, that bank lending is more affected by capital ratio in those banks, and in countries applying macroprudential policies because these banks that may potentially benefit from increased resilience. Consequently, the impact of capital ratio on loans growth may be considerably reduced in countries which apply macroprudential policy instruments more extensively.

The correlation between loans growth and lagged capital ratio (*CAP*) is positive, which suggests that bank lending may be constrained by the capital ratio (as was found e.g. by Beatty & Liao, 2011; and Carlson et al., 2013). The correlation between size and loans growth is negative, suggesting that large banks extend less loans. The positive correlation coefficient between loans growth and *GDPG per capita* and negative correlation between loans growth and change in unemployment rate imply potential procyclicality of bank lending.

4. Research results

Table 2 reports the base results. While the full sample consists of some 8000 banks in 65countries (see Table 1), because some of bank variables are not always available and since we drop outliers, and use lags of dependent variables and up to four lags of

Table 1. Descriptive statistics and correlations of the main regression variables.

	ΔLoan (in %)	CAP (in %)	ΔCAP (in %)	Dep (in %)	Depbanks (in %)	QLP (in %)	size	GDPper capita (in %)	ΔUnempl
Panel A: Descriptive statistics									
Full sample									
mean	3.35	11.12	−0.16	75.18	12.92	0.79	12.26	1.54	0.23
median	1.23	9.75	0.01	82.71	4.42	0.36	11.91	1.68	0.00
sd	13.23	5.68	2.82	20.71	19.04	1.64	1.87	2.82	1.15
min	−49.86	0.00	−41.66	0.00	0.00	−19.90	3.74	−17.95	−5.40
max	199.47	50.00	41.97	99.83	97.00	19.99	21.85	30.34	9.70
Large									
mean	3.79	9.90	−0.08	72.15	13.00	0.86	13.76	1.63	0.22
median	1.65	9.08	0.03	79.67	5.29	0.39	13.14	1.68	0.00
sd	13.50	4.57	2.46	21.03	17.88	1.64	1.82	2.92	1.15
min	−49.85	0.01	−35.82	0.00	0.00	−17.56	7.10	−17.95	−5.40
max	199.47	50.00	37.36	99.83	97.00	19.89	21.85	30.34	9.70
Medium									
mean	3.50	11.03	−0.22	75.70	13.28	0.77	12.12	1.55	0.23
median	1.31	9.74	0.00	83.17	4.22	0.36	11.77	1.68	0.00
sd	13.01	5.54	2.99	20.56	19.97	1.57	1.32	2.84	1.16
min	−49.86	0.07	−41.66	0.00	0.00	−19.90	4.19	−17.95	−5.40
max	198.42	49.95	41.97	98.96	96.55	19.63	18.29	30.34	9.70
Small									
mean	2.61	12.74	−0.17	78.09	11.87	0.73	10.69	1.43	0.26
median	0.62	10.86	−0.01	85.10	2.77	0.31	10.62	1.68	0.00
sd	13.20	6.66	2.97	20.07	19.29	1.76	1.09	2.66	1.14
min	−49.85	0.00	−41.42	0.00	0.00	−17.17	3.74	−17.95	−5.40
max	198.43	50.00	38.46	98.73	96.69	19.99	16.38	30.34	9.70
Panel B: Correlations									
Full sample									
ΔLoan	1								
CAP	0.0215***	1							
ΔCAP	−0.238***	0.151***	1						
Dep	−0.056***	−0.340***	−0.009**	1					
Depbanks	0.062***	−0.037***	−0.033***	−0.494***	1				
QLP	−0.022***	0.063***	−0.091***	−0.128***	−0.023***	1			
size	0.073***	−0.305***	0.029***	−0.203***	0.129***	0.077***	1		
GDPG per capita	0.056***	0.076***	−0.039***	−0.185***	−0.011*	−0.054***	0.047***	1	
ΔUnempl	−0.018***	−0.051***	0.002	0.145***	−0.100***	0.109***	−0.053***	−0.689***	1

(*Continued*)

Table 1. Continued.

	ΔLoan (in %)	CAP (in %)	ΔCAP (in %)	Dep (in %)	Depbanks (in %)	QLP (in %)	size	GDPGper capita (in %)	ΔUnempl
Large									
ΔLoan	1								
CAP	−0.005	1							
ΔCAP	−0.159***	0.184***	1						
Dep	−0.046***	−0.170***	−0.002	1					
Depbanks	0.088***	−0.102***	−0.047***	−0.563***	1				
QLP	−0.041***	0.106***	−0.075***	−0.125***	−0.068***	1			
size	0.061***	−0.294***	0.046***	−0.314***	0.155***	0.073***	1		
GDPG per capita	0.089***	0.056***	−0.029***	−0.153***	0.015	−0.082***	0.047***	1	
ΔUnempl	−0.050***	−0.027***	−0.004	0.141***	−0.130***	0.164***	−0.062***	−0.675***	1
Medium									
ΔLoan	1								
CAP	0.024***	1							
ΔCAP	−0.314***	0.150***	1						
Dep	−0.037***	−0.390***	−0.014***	1					
Depbanks	0.053***	−0.015	−0.024**	−0.504***	1				
QLP	−0.013**	0.055***	−0.084***	−0.124***	−0.016	1			
size	0.063***	−0.271***	0.041***	−0.128***	0.127***	0.086***	1		
GDPG per capita	0.061***	0.075***	−0.059***	−0.180***	−0.033***	−0.044***	0.048***	1	
ΔUnempl	−0.028***	−0.053***	0.015***	0.139***	−0.074***	0.093***	−0.068***	−0.682***	1
Small									
ΔLoan	1								
CAP	0.067***	1							
ΔCAP	−0.219***	0.146***	1						
Dep	−0.084***	−0.583***	0.001	1					
Depbanks	0.037**	0.011	−0.034**	−0.362***	1				
QLP	−0.012*	0.058***	−0.127***	−0.126***	0.043**	1			
size	0.094***	−0.192***	−0.035***	0.033***	0.181***	0.053***	1		
GDPG per capita	−0.002	0.133***	−0.021***	−0.226***	−0.013	−0.035***	−0.027***	1	
ΔUnempl	0.038***	−0.092***	−0.011*	0.154***	−0.101***	0.062***	−0.007	−0.717***	1

Note: *Δloan*- real loans growth; *CAP* – equity capital divided by total assets; *ΔCAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; *QLP* – loan loss provisions divided by average loans; *size* – logarithm of total assets; *GDPG per capita* – real GDP per capita growth; *ΔUnempl* – is change in annual unemployment rate.

Table 2. Baseline results without macroprudential policies.

	GLS – full sample 1	Fe – full sample 2	GMM two step – full sample 3	GMM two step – full sample 4	GMM two step – large 5	GMM two step – medium 6	GMM two step – small 7
Δloan(−1)	0.079***	−0.095***	0.297***	0.038*	0.032	0.027	0.000
	(11.71)	(−10.57)	(9.83)	(1.93)	(1.07)	(0.76)	(0.01)
CAP	0.143***	0.418***	0.161***	0.200***	0.072	0.227***	0.236***
	(6.50)	(9.46)	(3.32)	(3.61)	(0.86)	(3.74)	(2.85)
ΔCAP	−0.097***	−0.247***	−0.013	−0.153***	−0.049	−0.203***	−0.161*
	(−3.09)	(−6.18)	(−0.35)	(−3.57)	(−0.76)	(−3.31)	(−1.92)
Dep	0.014**	0.019	−0.009	−0.002	0.019*	0.006	−0.023
	(2.41)	(1.05)	(−1.31)	(−0.30)	(1.65)	(0.52)	(−1.32)
Depbanks	0.033***	−0.018	0.030**	0.051***	0.095***	0.018	−0.048
	(4.26)	(−0.89)	(2.47)	(3.44)	(3.85)	(0.93)	(−1.63)
QLP	−0.072	0.102	−0.180***	−0.096	0.136	−0.227*	−0.126
	(−1.49)	(1.53)	(−2.58)	(−1.05)	(0.81)	(−1.74)	(−0.79)
size	0.698***	4.034***	0.780***	1.303***	1.057***	1.173***	1.690***
	(11.59)	(13.70)	(8.51)	(11.26)	(6.79)	(7.48)	(5.42)
GDPG per capita	0.175***	−0.109**	0.093***	0.170***	0.311***	0.071	−0.030
	(5.87)	(−2.43)	(2.82)	(3.79)	(4.17)	(1.03)	(−0.37)
ΔUnempl	−0.371***	−0.614***	0.325*	−0.403***	−0.481***	−0.335**	−0.530
	(−3.37)	(−4.89)	(1.71)	(−3.77)	(−2.84)	(−2.30)	(−1.35)
Crisis	−1.575***	−4.304***	−1.907***	−1.055	−0.709	−1.308	−1.521
	(−3.53)	(−7.61)	(−3.34)	(−1.41)	(−0.56)	(−1.29)	(−0.94)
*Crisis*CAP*	−0.082**	0.008	−0.122***	−0.091*	−0.139	−0.106	0.008
	(−2.48)	(0.20)	(−2.81)	(−1.68)	(−1.40)	(−1.45)	(0.08)
Intercept	−8.067***	−55.3***	−9.134***	−16.5***	−15.0***	−13.8***	−17.3***
	(−7.43)	(−12.37)	(−5.17)	(−7.46)	(−4.76)	(−5.17)	(−3.94)
R-sq within	0.002	0.0374					
R-sq between	0.2153	0.0354					
R-sq overall	0.0391	0.0123					
F stat.		F(11, 11996) 42.35					
F test that all u_i = 1		F(4544, 11996) 0.8					
m2			1.62	−1.91*	−2.46**	0.19	−1.32
Hansen test			0.00	0.00	0.996	0.159	1.00

(*Continued*)

Table 2. Continued.

	GLS – full sample 1	Fe – full sample 2	GMM two step – full sample 3	GMM two step – full sample 4	GMM two step – large 5	GMM two step – medium 6	GMM two step – small 7
#instruments			927	927	887	899	704
#observations	16552	16552	12440	12440	6903	7260	2389
#banks	4545	4545	2041	2041	1992	1808	745
year dummies/ country dummies/ interacted country and year dummies	yes / yes /no	yes / yes / no	yes / yes /no	no / no / yes	no / no / yes	no / no / yes	no / no / yes

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. The bank-specific determinants include *CAP* – equity capital divided by total assets; ΔCAP – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; *QLP* – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include *GDPG per capita* – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with OLS, FE and the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

endogenous explanatory variables, the sample reduces to some 2041 (4545) banks in case of two-step GMM estimator (GLS and FE estimator). Specifications 1–4 present the results of regressing the loans growth on only its own lag and bank-specific and macroeconomic variables in the full sample, using four different estimation techniques, i.e. GLS, FE and two-step system GMM without interacted country and year dummies and two-step system GMM with interacted country and year dummies. In columns 5, 6 and 7 we show results obtained with two-step system GMM for large, medium and small banks, respectively. The coefficients on bank-specific variables are largely as expected when significant. Specifically, in all specifications the coefficient on capital ratio is positive, and with exception of large banks subsample, statistically significant. This supports the view that access to external finance is not frictionless and banks are concerned that they may violate regulatory capital requirements. Thus our results are consistent with the empirical findings of other studies (e.g. Beatty & Liao, 2011; Bridges et al., 2014; Carlson et al., 2013). The fact that large banks do not respond to changes in capital ratio in a statistically significant way is also consistent with previous evidence that in boom periods large banks' lending is not constrained with capital ratio (Beatty & Liao, 2011). The negative and statistically significant coefficient of the previous year's annual change in capital ratio (*ΔCAP*) implies that banks which had to increase capital ratio tended to reduce their lending in the subsequent period. The sign for the degree to which bank relies on deposit funding (*Dep*) is, as expected, largely positive when significant, implying that better access to stable funding results in higher loans growth. The same can be inferred for the impact of interbank deposits (*Depbanks*), particularly in large banks. Interestingly, small banks relying on interbank funding tend to reduce loans growth as the use of interbank deposits is more intense. When the quality of lending portfolio (*QLP*) worsens, banks are reluctant to increase their loans growth. This effect is particularly strong only in medium banks. The significant and in all specification statistically significant impact of size on loans growth is consistent with the view that when bank assets are larger, the bank has a greater capacity to increase lending and take on more credit risk. Banks' lending is procyclical because in almost all specifications in Table 3 the coefficient on *G. per capita* is positive and on *ΔUnempl* is negative (and statistically significant). The negative coefficient on *Crisis* implies that loan supply during crisis declines for reasons other than capital and liquidity constraints (Beatty & Liao, 2011). The negative coefficient on interaction between *Crisis* and *CAP*, which measures the association between loans' growth and capital ratio during crisis period, indicates that the impact of capital ratio on lending during crisis periods is not as expected positive, implying potential insignificance of capital for lending. Such a result may, however, be indicative of huge diversity of association between loans growth and double interaction of capital ratio and *Crisis* dummy. This diversity may be a result of differences in the use of macroprudential policies which can stimulate bank resilience to crisis periods. Therefore we proceed by estimating regressions covering not only bank-specific and macroeconomic determinants of loans growth, but also macroprudential policies.

4.1. Impact of macroprudential policies on association between lending and capital, and bank size

In Table 3, we first investigate the question of whether macroprudential policies reduce the impact of capital ratio on loans growth, and then we test how the effects of

Table 3. Effects of average macroprudential policy index (MPI_AGGREGATED), macroprudential policy instruments targeted at borrowers (BORROWER) and macroprudential policy instruments targeted at financial institutions (FINANCIAL).

	Full sample			large			medium			small		
Type of macroprudential policy index	MPI aggregated 1	BORROWER 2	FINANCIAL 3	MPI aggregated 4	BORROWER 5	FINANCIAL 6	MPI aggregated 7	BORROWER 8	FINANCIAL 9	MPI aggregated 10	BORROWER 11	FINANCIAL 12
CAP	0.275***	0.168**	0.201**	0.163	0.013	0.168	0.199**	0.132*	0.167*	0.327***	0.316***	0.326***
	(3.11)	(2.40)	(2.54)	(1.30)	(0.12)	(1.30)	(2.15)	(1.72)	(1.81)	(2.83)	(3.68)	(2.81)
Crisis	−10.87***	−4.901***	−5.115**	−9.187***	−4.878***	−3.919	−6.47***	−3.512***	−2.903	1.344	−0.446	3.308
	(−4.90)	(−5.53)	(−2.57)	(−3.16)	(−3.79)	(−1.35)	(−2.86)	(−3.75)	(−1.31)	(0.40)	(−0.21)	(0.88)
*Crisis*CAP*	0.751***	0.212***	0.269	0.632**	0.126	0.123	0.349*	0.099	0.066	−0.125	−0.048	−0.236
	(4.12)	(3.08)	(1.64)	(2.33)	(1.27)	(0.46)	(1.91)	(1.38)	(0.38)	(−0.69)	(−0.43)	(−1.21)
Macropr index	0.485	4.858***	0.253	0.900	3.918*	0.844	0.186	2.623*	0.043	0.195	0.243	0.537
	(1.18)	(3.18)	(0.41)	(1.24)	(1.83)	(0.91)	(0.40)	(1.69)	(0.08)	(0.34)	(0.16)	(0.64)
*Macropr index * Crisis*	8.173***	41.328***	4.313**	6.401***	32.501***	2.990	4.709***	31.607***	2.425	−1.428	−1.052	−3.304
	(4.75)	(5.70)	(2.54)	(3.06)	(5.17)	(1.29)	(2.59)	(3.84)	(1.37)	(−0.88)	(−0.18)	(−1.49)
*Macropr index * CAP*	−0.075**	−0.446***	−0.069	−0.104	−0.398*	−0.113	−0.060	−0.239*	−0.064	−0.043	−0.119	−0.066
	(−2.19)	(−3.41)	(−1.37)	(−1.51)	(−1.91)	(−1.31)	(−1.54)	(−1.66)	(−1.32)	(−1.10)	(−1.18)	(−1.11)
*Macropr index *Crisis*CAP*	−0.684***	−3.545***	−0.355**	−0.591***	−2.781***	−0.261	−0.362**	−2.739***	−0.182	0.066	0.145	0.188
	(−4.77)	(−4.79)	(−2.53)	(−3.06)	(−4.24)	(−1.24)	(−2.51)	(−3.67)	(−1.30)	(0.65)	(0.41)	(1.20)
m2	−1.76*	−1.19	−2.04**	−2.36**	−1.79*	−2.62**	−0.04	0.23	−0.15	−1.15	−1.13	−1.16
Hansen test	0.00	0.00	0.00	1.00	0.998	1.00	0.68	0.60	0.62	1.00	1.00	1.00
#instruments	825	825	825	785	785	785	687	687	687	632	632	632
# observations	12440	12440	12440	5056	5056	5056	5654	5654	5654	1730	1730	1730
# banks	2041	2041	2041	742	742	742	913	913	913	386	386	386

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. For brevity, we present reduced results for interactions of macroprudential policy instruments and capital ratios. The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; QLP – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include GDPG per capita – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. *Macropr index* covers one of three types of macroprudential policy indices: *MPI aggregated, BORROWER* and *FINANCIAL*. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

macroprudential policies on the association between lending and capital ratio differ between large versus medium and small banks. Consistent with prior studies of the association between loans growth and capital ratio, *CAP* is positively associated with Δ*loans* (Beatty & Liao, 2011; Carlson et al., 2013; Gambacorta & Marqués-Ibáñez, 2011), both during non-crisis periods and during the recent crisis period. The results for the full-sample (see specifications 1, 2 and 3) confirm the view that during the crisis periods the association between loans growth and capital ratio is strengthened relative to non-crisis period. The negative and almost always statistically significant coefficient on *M. index * CAP*, indicates that macroprudential policies reduce the impact of capital ratio on lending in non-crisis periods. The effect of macroprudential policies on the association between lending and capital ratio is strengthened during the recent crisis, because the coefficient on the triple interaction of *M. index*Crisis*CAP* is negative and stronger than the respective coefficient on double interaction (without crisis dummy). To start, in the full sample estimation of loans growth analysing the impact of macroprudential indices on the association between lending and capital ratio in two regressions (1 and 2), the interaction of *M. index* and capital ratio obtains negative coefficients of −0.075 and −0.446 that are statistically significant, indicating that the impact of capital ratio on loans growth is relatively low in countries applying macroprudential policies during non-crisis periods. This effect is also negative for financial institution targeted instruments, but not statistically significant (see column 3 in Table 3). Furthermore, the triple interactions obtain negative coefficients with the significance of at least 5% in all regressions in columns (1), (2) and (3), indicating that the association between lending and capital ratio during the recent crisis is weakened in countries in which more macroprudential policy instruments are applied. Generally, the full sample results give empirical support to hypothesis H1, that in countries in which more macroprudential policy instruments are applied, the procyclical impact of capital ratio on lending is weakened, during both non-crisis periods and during the recent crisis period.

In the next set of regressions in Table 3, we present effects of interactions between macroprudential policy indices (*M. index*) and capital ratio in banks which differ in size, i.e. in large banks (specifications 4, 5 and 6), medium banks (specifications 7, 8 and 9) and small banks (specifications 10, 11 and 12). Estimated negative coefficients of double interactions, significant in case of borrower-targeted macroprudential policies (see regressions 5 and 8) and stronger in the subsample of large banks (coefficient on *Borrower*CAP* is −0.398), relative to medium (coefficient on *Borrower * CAP* equals −0.239) and small banks, suggest that large banks benefit the most from increased resilience linked to macroprudential approach. From regression 5 (large banks), for instance, we infer that the impact of capital ratio on loans growth during non-crisis periods in countries applying more borrower targeted instruments is −0.385 (−0.395 + 0.013). In the medium banks' regression, the overall effect of capital ratio on loans growth in countries applying macroprudential instruments reducing borrower risk is −0.132 (−0236 + 0.132). Thus sensitivity of lending to capital ratio is more weakened in the sample of large banks, which is consistent with hypothesis H2. Furthermore, the significantly negative coefficients for triple interactions (i.e. *Macropr index*Crisis*CAP*) obtained for large banks (regression 4 and 5) support hypothesis H3, predicting that macroprudential policy instruments reduce the procyclical impact of capital ratio on lending in large banks during both non-crisis and crisis periods. Some of results in Table 3 should be interpreted with caution, as the m2 test is not always rejected and the Hansen J test for over-identifying restrictions is not always rejected, suggesting problems with instruments. To resolve this problem we will run additional regressions with a reduced number of instruments (see Roodman, 2009) in the robustness checks section.

4.2. Impact of individual macroprudential policy instruments

Regression results in Table 4 consider individual macroprudential policy instruments one-by-one. We find that of borrower based instruments, only *LTV-caps* and *DTI* ratios weaken the effect of capital ratio on lending. More importantly, after controlling for the bank-specific and macroeconomic factors, the coefficient on double interaction term of *Macropr instr * CAP* is negative as well as being negative on triple interaction term of *Macropr instr*CAP*Crisis* and significant at 1%, indicating that macroprudential instruments (*LTV cap* and *DTI*) weaken the positive association between loans growth and capital ratio. This weakening effect is stronger during the crisis. Generally, we find the results for borrower-targeted instruments to be consistent with the aggregated macroprudential index (see Table 3). Of the two borrower-based measures, coefficient on *LTV cap*CAP* is strongly significant and negative, with an effect of −0.538 in non-crisis periods and −4.119 during the recent crisis. As for the *DTI* ratio, we find the effect to be stronger, as the coefficient on double interaction is −0.666 and on triple integration is −5.137. Thus our results for borrower based instruments are consistent with the view that macroprudential policy instruments increase the resilience of banks and with our prediction that macroprudential policies weaken the procyclical impact of capital ratio on lending, during both non-crisis and crisis-period, as expressed in hypothesis H1.

Of measures aimed at addressing bank risk (or on balance-sheets of financial institutions, covered in the FINANCIAL index), only the buffer-oriented dynamic provisions seem to reduce the effect of capital ratio on lending during non-crisis period, with the significant coefficient on double interaction of *DP*CAP* of −1.058. Interestingly, however, their impact on association between loans growth and capital ratio during the recent crisis is positive, implying that DP's use increases the importance of capital ratio for lending in crisis period. Such a result may be indicative of increased risk-taking by banks (and thereby weakened resilience) in countries where dynamic provisions are in use, as evidenced by Illueca, Norden, and Udell (2015) or of relative incapability of dynamic provisions to increase the resilience of the banking sector to negative shocks to capital which were experienced by many banks during and just after the recent crisis. Overall, when statistically significant, the results seem to support our prediction that in countries in which macroprudential policy instruments are applied, the positive association between lending and capital ratio is weakened, implying reduced procyclicality of capital ratio (consistent with hypotheses H1).

Differentiating banks by size, in Table 5, and for brevity showing only those estimations in which the weakening impact of individual macroprudential instruments is statistically significant during non-crisis and/or crisis period, we find again that borrower-targeted instruments weaken the association between lending and capital ratio. This effect is, moreover, stronger in large banks relative to medium banks, which confirms our prediction expressed in H2, that macroprudential policy instruments impact on the link between lending and capital is strongest in the sample of large banks.

Table 4. Impact of individual macroprudential policy indices – full sample results.

Type of macropr instr	LTV CAP 1	DTI 2	DP 3	LEV 4	INTER 5	CONC 6	FC 7	RR 8	RR REV 12	CG 9	TAX 10
CAP	0.156**	0.451***	0.409***	0.394***	0.436***	0.520***	0.427***	0.440***	0.156**	0.425***	0.125**
	(2.26)	(7.03)	(6.62)	(6.31)	(6.57)	(4.58)	(7.29)	(7.15)	(2.35)	(7.26)	(2.01)
Crisis	−4.634***	−4.594***	−2.881***	−1.191	−0.377	−2.451	−1.020	−0.901	−0.905	−0.934	−0.139
	(−5.22)	(−5.66)	(−3.88)	(−1.54)	(−0.39)	(−1.13)	(−1.19)	(−1.01)	(−0.98)	(−1.13)	(−0.12)
*Crisis*CAP*	0.196***	0.164**	0.042	−0.050	−0.064	0.049	−0.043	−0.050	−0.065	−0.067	−0.128
	(2.89)	(2.49)	(0.71)	(−0.88)	(−0.95)	(0.26)	(−0.70)	(−0.78)	(−0.97)	(−1.12)	(−1.61)
Macropr instr	6.039***	8.268***	9.732**	−2.596	0.006	0.446	−2.987	−5.281***	−3.766	−6.711***	1.404
	(3.22)	(3.59)	(2.14)	(−0.80)	(0.00)	(0.30)	(−1.53)	(−3.24)	(−1.20)	(−2.79)	(0.47)
*Macropr instr * Crisis*	47.477***	62.294***	−10.490	13.617	−2.042	1.863	0.538	−3.410	2.658	−6.037	−13.758**
	(5.38)	(4.68)	(−0.38)	(0.83)	(−0.82)	(0.71)	(0.10)	(−0.92)	(0.56)	(−0.75)	(−2.56)
*Macropr instr * CAP*	−0.538***	−0.666***	−1.058*	0.064	0.019	−0.174	0.123	0.231*	0.162	0.333*	−0.331
	(−3.36)	(−3.86)	(−1.66)	(0.24)	(0.18)	(−1.46)	(0.76)	(1.89)	(0.73)	(1.85)	(−1.29)
*Macropr instr *Crisis*CAP*	−4.119***	−5.137***	4.982	−0.966	−0.090	−0.146	−0.238	0.128	−0.276	0.557	1.137**
	(−4.54)	(−3.69)	(1.05)	(−0.79)	(−0.43)	(−0.67)	(−0.53)	(0.44)	(−0.79)	(0.75)	(2.25)
m2	−1.21	−1.33	−1.86*	−2.04**	−2.02**	−2.02**	−2.01**	−2.05**	−2.10**	−2.07**	−2.19**
Hansen test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
#instruments	825	825	825	825	825	825	825	825	825	825	825
# observations	12440	12440	12440	12440	12440	12440	12440	12440	12440	12440	12440
# banks	2041	2041	2041	2041	2041	2041	2041	2041	2041	2041	2041

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. For brevity, we present reduced results for interactions of macroprudential policy instruments and capital ratios. The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; Depbanks – interbank deposits divided by total assets; *QLP* – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include GDPG per capita – real GDP growth per capita; ΔUnempl – annual change in unemployment rate. *Macropr instr* covers individual macroprudential policy instruments, i.e.: loan-to-value ratio (*LTV*), loan-to-value ratio caps (*LTV_CAP*) debt-to-income ratio (*DTI*), dynamic loan-loss provisioning (*DP*), leverage ratio (*LEV*), limits on interbank exposures (*INTER*), limits on foreign currency loans (*FC*), reserve requirements ratios (*RR*), limits on domestic currency growth (*CG*), levy/tax on financial institutions (*TAX*), and *FX* and/or countercyclical reserve requirements (*RR_REV*). To test our hypotheses, for each country we construct a dummy variable which takes the value of 1 if the instrument was applied at least since 2005, and 0 otherwise. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

Table 5. Macroprudential policy instruments and the link between lending and capital ratio – the role of bank size.

Type of macropr instr	LTV CAP	DTI large	DP	LTV CAP	DTI medium	DP	LTV CAP	DTI small	DP
	1	2	3	4	5	6	7	8	9
CAP	0.016	0.174*	0.174*	0.121	0.463***	0.455***	0.310***	0.201	0.256***
	(0.16)	(1.84)	(1.80)	(1.49)	(5.58)	(5.35)	(3.56)	(0.00)	(3.43)
Crisis	−4.409***	−5.468***	−3.358**	−3.151***	−3.745***	−2.835***	−0.699	−3.081	−1.939
	(−3.41)	(−4.17)	(−2.13)	(−3.31)	(−3.90)	(−3.11)	(−0.32)	(−0.00)	(−0.94)
*Crisis*CAP*	0.088	0.189*	−0.006	0.076	0.093	0.022	−0.043	0.069	0.042
	(0.90)	(1.71)	(−0.05)	(1.06)	(1.16)	(0.29)	(−0.36)	(0.00)	(0.36)
Macropr instr	4.349*	11.763***	7.515	3.565*	8.463***	15.068***	0.722	−7.247	−10.548
	(1.84)	(3.39)	(1.16)	(1.67)	(3.66)	(3.07)	(0.26)	(−0.00)	(−1.05)
*Macropr instr * Crisis*	34.91***	56.814***	−168.12**	36.622***	66.97***	−3.644	0.027	24.868	42.196**
	(4.74)	(5.53)	(−2.02)	(3.79)	(4.26)	(−0.16)	(0.00)	(0.00)	(2.08)
*Macropr instr * CAP*	−0.475**	−0.992***	−0.586	−0.293	−0.709***	−1.698**	−0.142	0.382	0.492
	(−2.09)	(−3.35)	(−0.41)	(−1.46)	(−4.32)	(−2.56)	(−0.98)	(0.00)	(0.96)
*Macropr instr *Crisis*CAP*	−3.059***	−5.069***	34.641**	−3.259***	−5.246***	3.906	0.197	−0.162	−1.074
	(−3.94)	(−4.17)	(2.27)	(−3.62)	(−3.54)	(1.14)	(0.35)	(−0.00)	(−0.87)
m2	−1.94 *	−1.66*	−2.24**	0.14	0.45	−0.02	−1.11	−0.00	−0.88
Hansen test	0.998	0.99	0.997	0.54	0.53	0.47	1.00	0.00	1.00
#instruments	785	785	785	807	807	807	632	632	632
# observations	5056	5056	5056	5654	5654	5654	1730	1730	1730
#banks	742	742	742	913	913	913	386	386	386

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. For brevity, we present reduced results for interactions of macroprudential policy instruments and capital ratios. The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; Depbanks – interbank deposits divided by total assets; *QLP* – loan loss provisions divided by average loans; *size* – logarithm of total assets. Macroeconomic variables include *GDPG per capita* – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. Macropr Instr covers individual macroprudential policy instruments, i.e.: loan-to-value ratio (*LTV*), loan-to-value ratio caps (*LTV_CAP*) debt-to-income ratio (*DTI*) and dynamic loan-loss provisioning (*DP*). To test our hypotheses, for each country we construct a dummy variable which takes the value of 1 if the instrument was applied at least since 2005, and 0 otherwise. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

4.3. Robustness checks

To build more confidence into our main findings, we employ several robustness checks. Firstly, we estimate our baseline model with significantly reduced numbers of lags of bank-specific variables (*CAP, ΔCAP, Dep, Depbanks, QLP, Size*), to check the sensitivity of our estimation to the number of GMM-style instruments and to the change in estimation method. The results for the effect of a reduced number of instruments are presented in Table 6 in PANEL A, B and C, whereas the alternative estimation technique is presented in PANEL D. To test the sensitivity of results to the change in the number of instruments, we use three methods: GMM 2 step with one lag of bank-specific variables (PANEL A), GMM 2 step with collapsed instruments option in STATA software (PANEL B), GMM 2 step with 2–3 lags of bank-specific variables (PANEL C). In PANEL D we apply the GMM 1 step (Arellano & Bond, 1991).

As can be inferred from Table 6, the number of instruments slightly improves the Hansen OIR test *p*-values in large and medium banks (but not in the full sample). However, this change in estimation approach does not seem to matter for the conclusions presented in Section 4.1. The same can be stated for the application of GMM 1 step estimator. Therefore, we infer that predictions given in the main hypothesis H1, that in countries in which more macroprudential policy instruments are applied, the link between lending and capital ratio is weakened, during both non-crisis periods and during the recent crisis period (thus the procyclical effect of capital ratio on lending is reduced). In particular, of macroprudential policies, those targeted to contain borrower risk seem to be more important in alleviating the effect of capital ratio on lending in non-crisis periods, are supported. Furthermore, macroprudential policies seem effective in reducing the role of the capital ratio during the last financial crisis and its direct aftermath period, because in our robustness regressions, the triple interactions between *Macroprudential index, CAP* and *Crisis* obtain negative statistically significant coefficients in the full sample (see columns 1–3 in Table 6), in the large banks (see columns 4–6 in Table 6) and in the medium banks sample (see columns 7–9 in Table 6). The results presented in Table 6 enable us to further support hypothesis 2 and 2a, because the effect of macroprudential policies is stronger (i.e. negative and statistically significant) in the sample of large banks in comparison to the medium-sized banks.

Secondly, we test the sensitivity of our results to change in the number of large and medium banks, by reducing the number of large and medium banks to make it comparable with the number of small banks. To make the presentation of results more readable, we include this table in the appendix (Table A4). In this test, we assume that large banks are those with 15% of highest assets in particular countries. The group of banks with medium assets are those with assets between 4th and 6th deciles. Specifications in Table A4 show that the implications presented in Table 3 in columns 4–6 (large banks) and 7–9 (medium banks) still hold. The Hansen OIR test *p*-value and m2 test are still correct in such subsamples. More importantly, the economic significance of macroprudential policy instruments for large banks is still supported. Estimated negative coefficients of double interactions, significant in case of borrower-targeted macroprudential policies (see regressions 5 and 8) and stronger in the subsample of large banks (coefficient on *Borrower*CAP* is −0.547), relative to medium (coefficient on *Borrower * CAP* equals −0.197) and small banks, suggest that large banks benefit the most from increased resilience

Table 6. Sensitivity of results to adjusted number of instruments or change in estimation method – full sample estimations of aggregated macroprudential policy indices.

Estimation technique description	Type of macroprudential policy index	Full sample			Large			medium			small		
		MPI aggregated	BORROWER	FINANCIAL	MPI aggregated	BORROWER	FINANCIAL	MPI aggregated	BORROWER	FINANCIAL	MPI aggregated	BORROWER	FINANCIAL
PANEL A: One lag of bank-specific variables included; Estimated with 2-step robust GMM		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	CAP	0.275***	0.196***	0.171**	0.118	−0.053	0.094	0.178**	0.143*	0.140	0.258**	0.276***	0.216*
		(2.98)	(2.68)	(2.14)	(0.71)	(−0.48)	(0.59)	(1.97)	(1.68)	(1.47)	(2.13)	(2.89)	(1.89)
	*Crisis*CAP*	0.797***	0.220***	0.289*	0.649**	0.169	0.170	0.468***	0.107	0.188	−0.025	−0.004	−0.141
		(4.16)	(3.08)	(1.74)	(2.12)	(1.54)	(0.54)	(2.58)	(1.33)	(1.03)	(−0.16)	(−0.03)	(−0.72)
	*Macropr index * CAP*	−0.078**	−0.492***	−0.057	−0.091	−0.326	−0.092	−0.042	−0.219	−0.036	−0.016	−0.091	−0.010
		(−2.29)	(−3.77)	(−1.19)	(−1.14)	(−1.59)	(−0.93)	(−1.08)	(−1.63)	(−1.13)	(−0.43)	(−0.74)	(−0.17)
	*Macropr index *Crisis*CAP*	−0.713***	−3.173***	−0.367**	−0.593***	−2.691***	−0.280	−0.436***	−2.802***	−0.282**	0.026	0.117	0.147
		(−4.72)	(−5.28)	(−2.54)	(−2.81)	(−3.65)	(−1.19)	(−3.05)	(−3.64)	(−2.06)	(0.28)	(0.36)	(0.96)
	m2	−1.49	−1.18	−1.78*	−2.40**	−1.83*	−2.59**	0.40	0.72	0.38	−0.92	−0.92	−0.93
	Hansen test *p*-value	0.00	0.00	0.00	0.98	0.93	0.97	0.25	0.08	0.16	1.00	1.00	1.00
	#instruments	705	705	705	665	665	665	687	687	687	518	518	518
	#observations	12440	12440	12440	5056	5056	5056	5654	5654	5654	1730	1730	1730
	#banks	2041	2041	2041	742	742	742	913	913	913	386	386	386
PANEL B: Collapsed instruments option employed; Estimated with 2-step robust GMM		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	CAP	0.308***	0.198**	0.168**	0.211	0.059	0.149	0.200**	0.165*	0.159	0.268*	0.286***	0.272**
		(3.11)	(2.55)	(2.02)	(0.96)	(0.60)	(0.86)	(1.97)	(1.77)	(1.39)	(1.87)	(2.98)	(2.12)
	*Crisis*CAP*	0.832***	0.239***	0.289	0.572*	0.212	0.113	0.466**	0.118	0.165	−0.022	−0.004	−0.114
		(3.94)	(3.13)	(1.64)	(1.83)	(1.63)	(0.33)	(2.34)	(1.25)	(0.78)	(−0.12)	(−0.03)	(−0.57)
	*Macropr index * CAP*	−0.094**	−0.516***	−0.051	−0.092	−0.347*	−0.052	−0.038	−0.192	−0.018	−0.026	−0.135	−0.038
		(−2.42)	(−3.90)	(−1.05)	(−0.92)	(−1.71)	(−0.47)	(−0.81)	(−1.39)	(−0.35)	(−0.53)	(−1.01)	(−0.68)
	*Macropr index *Crisis*CAP*	−0.749***	−3.378***	−0.385***	−0.585***	−2.564***	−0.273	−0.460***	−3.040***	−0.287*	0.031	0.327	0.145
		(−4.59)	(−4.60)	(−2.62)	(−2.69)	(−3.49)	(−1.10)	(−2.82)	(−3.80)	(−1.76)	(0.31)	(0.69)	(0.94)
	m2	−1.516	−1.183	−1.840*	−2.359**	−1.913*	−2.505**	0.298	0.606	0.269	−0.899	−0.891	−0.837
	Hansen test *p*-value	0.00	0.00	0.00	0.95	0.86	0.936	0.06	0.03	0.04	1.00	1.00	1.00
	#instruments	626	626	626	586	586	586	608	608	608	439	439	439
	#observations	12440	12440	12440	5056	5056	5056	5654	5654	5654	1730	1730	1730
	#banks	2041	2041	2041	742	742	742	913	913	913	386	386	386
PANEL C: Between 2 and 3 lags of endogenous variables included; Estimated with 2-step robust GMM		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	CAP	0.217**	0.157**	0.134	0.166	−0.041	0.074	0.203**	0.136	0.151	0.251**	0.268***	0.226**
		(2.35)	(2.09)	(1.51)	(1.10)	(−0.35)	(0.50)	(2.31)	(1.61)	(1.63)	(2.09)	(3.00)	(2.13)
	*Crisis*CAP*	0.729***	0.187***	0.329**	0.427	0.173	0.155	0.404**	0.077	0.148	−0.266*	−0.215*	−0.362*
		(3.81)	(2.59)	(2.02)	(1.59)	(1.45)	(0.67)	(2.23)	(1.06)	(0.85)	(−1.71)	(−1.86)	(−1.93)
	*Macropr index * CAP*	−0.065	−0.490***	−0.061	−0.107	−0.392**	−0.063	−0.060	−0.304***	−0.061	−0.004	−0.079	−0.004
		(−1.61)	(−3.68)	(−0.82)	(−1.44)	(−2.04)	(−0.67)	(−1.59)	(−2.79)	(−1.27)	(−0.11)	(−0.67)	(−0.07)
	*Macropr index *Crisis*CAP*	−0.711***	−3.280***	−0.455***	−0.437**	−2.734***	−0.268	−0.423***	−2.828***	−0.276*	0.078	0.359	0.217
		(−4.70)	(−4.75)	(−3.18)	(−2.22)	(−3.92)	(−1.39)	(−2.83)	(−3.76)	(−1.88)	(0.94)	(0.81)	(1.52)
	m2	−1.25	−0.83	−1.57	−2.39**	−1.66*	−2.56**	0.35	0.63	0.27	−1.00	−1.02	−1.01
	Hansen test *p*-value	0.00	0.00	0.00	0.99	0.99	1.00	0.62	0.54	0.52	1.00	1.00	1.00

	#instruments	740	740	740	700	700	700	722	722	722	553	553	553
	#observations	12440	12440	12440	5056	5056	5056	5654	5654	5654	1730	1730	1730
	#banks	2041	2041	2041	742	742	742	913	913	913	386	386	386
PANEL D: Estimated with		1	2	3	4	5	6	7	8	9	10	11	12
1-step system robust	*CAP*	0.617***	0.519***	0.481***	0.320***	0.158**	0.276***	0.534***	0.480***	0.470***	0.331***	0.314***	0.333***
GMM		(10.19)	(12.21)	(8.36)	(3.04)	(2.23)	(2.77)	(7.54)	(9.09)	(6.90)	(3.95)	(4.76)	(4.04)
	*Crisis*CAP*	0.785***	0.218***	0.408***	0.620***	0.183*	0.197	0.400***	0.121*	0.196*	−0.054	−0.014	−0.201
		(8.20)	(4.41)	(4.06)	(3.49)	(1.96)	(1.08)	(3.51)	(1.86)	(1.67)	(−0.42)	(−0.16)	(−1.49)
	*Macropr index * CAP*	−0.100***	−0.612***	−0.038	−0.101**	−0.461***	−0.081	−0.062*	−0.372***	−0.040	−0.037	−0.095	−0.065
		(−3.39)	(−6.41)	(−1.05)	(−1.97)	(−2.83)	(−1.36)	(−1.86)	(−2.64)	(−1.07)	(−1.00)	(−0.83)	(−1.29)
	*Macropr index *Crisis*CAP*	−0.708***	−3.234***	−0.471***	−0.536***	−2.774***	−0.270**	−0.384***	−2.681***	−0.265***	0.046	0.166	0.209*
		(−10.41)	(−13.94)	(−5.48)	(−4.89)	(−7.88)	(−2.02)	(−5.10)	(−8.41)	(−2.88)	(0.58)	(0.62)	(1.93)
	m2	−2.48**	−1.96*	−2.83***	−3.46***	−2.78*	−3.73***	0.12	0.48	−0.01	−1.92*	−1.88*	−1.94*
	Sargan test *p*-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	#instruments	823	823	823	782	782	782	805	805	805	630	630	630
	#observations	12440	12440	12440	5056	5056	5056	5654	5654	5654	1730	1730	1730
	#banks	2041	2041	2041	742	742	742	913	913	913	386	386	386

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. For brevity, we present reduced results for interactions of macroprudential policy instruments and capital ratios. The bank-specific determinants include*: CAP* – equity capital divided by total assets; *M. index* covers one of three types of macroprudential policy indices: *MPI aggregated, BORROWER* and *FINANCIAL*. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 20% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

linked to macroprudential approach. This gives further support to hypothesis H2, that sensitivity of lending to capital ratio is more weakened in the sample of large banks. Furthermore, the negative coefficients for triple interactions (i.e. *Macropr index*Crisis*CAP*) obtained for large banks (regression 4, 5 and 6) support hypothesis H3, predicting that macroprudential policy instruments reduce the procyclical impact of capital ratio on loans growth in crisis period. This effect is again stronger and statistically significant in the sample of large banks, than in the case of medium and small banks.

Thirdly, we divide our research period into two subsample periods: before crisis (i.e. up to 2006), during and after the crisis (since 2007 onwards). We also show full sample results for the whole period. All regressions are run without the crisis dummy, because its role for the link between capital ratio and loans growth is accounted for in the sub-periods. We conduct these estimations applying not only 2-step system GMM but also with Random Effects method. We do this because we expect that in the full sample the OIR Hansen test will not be satisfactory (as it is in Table 3). The results obtained in such subsamples are shown in Table A5 in the appendix, and further support the results presented in Table 3 for the whole sample (see columns 1, 2 and 3 in Table 3). In particular, we still find that capital ratio constraints loans growth before the crisis (up to 2006) and during and after the crisis (since 2007 onwards) because the link between CAP and ΔLoan is positive and statistically significant. Moreover, countries in which macroprudential policy instruments were applied to a greater extent, exhibited weakened association between lending and capital ratio. Looking at the results in columns 1–6 in PANEL A, we find that the link between capital ratio and loans growth is weakened before the crisis (up to 2006) and during and after the crisis (since 2007 onwards). However, the relative importance of capital ratio for loans growth is definitely reduced during and after the crisis in those countries which applied macroprudential policy instruments to a greater extent before the crisis (i.e. at least since 2004). With such results, we find robust support for the view expressed in hypothesis H1, that in countries in which more macroprudential policy instruments are applied, the procyclical impact of capital ratio on lending is weakened, during both non-crisis periods and during the recent crisis period. The discussed effects hold also in the RE estimations in PANEL B.

Looking at the coefficients presented for the whole period in columns 7–9 in Table A5 in the appendix we find evidence in line with previous research (e.g. Lim et al., 2011, Claessens et al., 2014; Cerutti et al., 2015), that macroprudential policy instruments reduce average loans growth, because the link between *M. index* and *ΔLoan* is negative and statistically significant. Additionally, in the whole period they tend to increase the role of capital ratio for lending, consistent with the preventive effect of macroprudential policy.

And finally, we investigate the robustness of our results by employing two different measures for the business cycle, i.e. we use real GDP growth rate and in separate models Distance to Frontier (from the World Bank database) instead of real GDP growth per capita. Specifications in Table A6 in the appendix show that the implications presented in previous subsections remain unchanged. In particular, we find that on average bank lending is procyclical, because the link between loans growth and previous period business cycle measure is positive in the full sample. This effect is particularly strong in regressions applying Distance to frontier (DTF growth) business cycle measure, where the coefficient on DTF positive of 0.286 and significant at 1% (see column 5 in Table A6). What's more, the procyclicality of lending is stronger in the sample of large banks, in both real GDP growth rate and DTP rate, consistent with the notion that large banks' lending is the most procyclical. Turning our attention to the effects of macroprudential policy on the link between loans growth and capital ratio in both non-crisis (see double interaction terms on *M. index*CAP*) and in crisis period (see triple interaction terms on *M. index*CAP*crisis*) we find robust support for the predictions expressed in hypotheses H2 and H3.

5. Conclusions

In this paper, we ask whether the procyclical impact of capital ratio on lending is reduced due to macroprudential policy instruments. We examine this effect in banks differing in size (large, medium and small) and taking into account several macroprudential policy measures (i.e. aggregated macroprudential policy index, borrower-risk-targeted index and financial-institutions oriented index) as well as individual macroprudential policy instruments (such as e.g. *LTV caps*, *DTI* ratios and dynamic provisions). Our sample includes banks from 65 countries and spans the year of 2000–2011 (including pre-crisis periods and the recent crisis and its direct aftermath period).

We find a consistent and strong effect of macroprudential policies on the association between loans growth and capital ratio. The full sample results give empirical support to the prediction that in countries in which more macroprudential policy instruments are applied, the procyclical link between capital ratio and lending is weakened, during both non-crisis periods and during the recent crisis period. We also find evidence in favour of the expectation that bank size matters for the impact of macroprudential policies for the procyclicality of capital ratio. In particular, the sensitivity of lending to capital ratio is more markedly weakened in the sample of large banks, during both non-crisis and in the recent crisis period. Analysis of the role of individual macroprudential policy instruments shows that only two borrower-based instruments, i.e. *LTV-caps* and *DTI* ratios weaken the positive effect of capital ratio on lending.

Our finding that macroprudential policies are able to alleviate the impact of capital ratio on lending, in particular during the crisis, may have certain implications for policymakers in the area of implementation of commonly recognized standards targeted at the reduction of borrower risk-taking. Our results suggest that more frequent use of these instruments may create additional buffers in large banks and in emerging and closed-capital-account economies, thus making large banks' lending and lending of banks in emerging markets and closed economies less affected by capital ratios in during crisis periods. Therefore, in the current work aimed at creating macroprudential regulations, more attention should be focused on instruments which have the potential to reduce borrower risk.

Notes

1. For more general inferences on the role of bank size for systemic risk, refer to Laeven et al. (2014).
2. For the general discussion on the role of bank capital, see Dewatripont and Tirole (1994), Berger, Herring, and Szegö (1995), Freixas and Rochet (1997) and Borio and Zhu (2012).
3. For a review of these individual country studies, refer to Cerutti et al. (2015)
4. Several other papers have used dynamic GMM models to test the determinants of lending (Barajas, Chami, & Cosimano, 2005; Gambacorta and Marqués-Ibáñez, 2011) and of loans or asset growth in a macroprudential policy context (Claessens et al., 2013, p. 2014; Cerutti et al., 2015).

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Appendix

Table A1. Description of data applied in the study.

Variable name	Variable description and definition	Expected effect on dependent variable
ΔLoan	real annual loans growth rate, measured as $(Loan_{i,t}\text{-}Loan_{i,t-1})/Loan_{i,t-1}$, deflated with CPI (i.e. consumer price index)	Not applicable. This is dependent variable
CAP	the lagged capital ratio, i.e. equity capital divided by total assets lagged by one year	+
Crisis	dummy variable equal to one in 2008, 2009, 2010 and 0 otherwise. We predict a negative coefficient on Crisis if loan supply declines during crisis for reasons other than capital and liquidity constraints	+/−
*Crisis * CAP*	interaction between Crisis and capital ratio (CAP) was added to the model in order to investigate the effect of CAP depending on the crisis (the presence or not of the period of crisis)	+/−
Macroprud	macroprudential policies variable, which covers aggregated indices of macroprudential policy (denoted in the next sections as *M. index*) and individual macroprudential policy instruments (denoted in the next sections as *Macropr instr*) – computed for each country separately using data from the period of 2000–2011 available in Cerutti et al. (2015)	−
CAP Macroprud*	interaction term between CAP and macroprudential policy variable which informs about the impact of macroprudential policies on the association between loans growth and capital ratio both in the good times; A negative (positive) regression coefficient on double interaction of *Macroprud * CAP* implies that in countries with a larger set of macroprudential instruments bank lending is relatively less (more) affected by capital ratio in non-crisis period in comparison to countries in which macroprudential polices were applied less intensively. Thus, such a negative association implies that macroprudential policy instruments did stimulate bank resilience, because they created additional buffers which insulate banks' lending from sensitivity to capital ratio;	+/−
*Macroprud *Crisis*CAP*	interaction term between CAP and macroprudential policy variable during the last financial crisis. The interaction term between *Macroprud *Crisis*CAP* informs us about the impact of capital ratio on lending during crisis periods. A positive coefficient on *Macroprud *Crisis*CAP* implies that banks' lending is constrained by capital ratio during the crisis period in countries with more intense macroprudential policies (i.e. with more macroprudential instruments applied). In economic terms such an effect would imply that macroprudential policies were ineffective in enhancing the resilience of individual banks. In contrast, a negative coefficient on this interaction term implies that in countries in which macroprudential policies are used extensively, the effect of capital ratio on lending during crisis is weakened	+/−
ΔCAP	annual change in capital ratio	−
Dep	One year lagged deposits from non-financial customers divided by total assets. It proxies for bank reliance on stable retail funding.	+
Depbank	One year lagged deposits from banks divided by total assets; It proxies bank reliance on wholesale funding.	+/−
QLP	Is quality of lending portfolio (lagged by one year), it equals loan loss provisions divided by average loans	−
size	Logarithm of assets. It is a proxy for bank size and thus the range of bank activities	+/−
BC	denotes business cycle, as a proxy for demand side of the bank lending market, and includes: *GDPG per capita* – real GDP per capita growth rate and *ΔUnempl* – annual change in unemployment rate	
G. per capita	real GDP per capita growth rate	+
ΔUnempl		−

Notes: +denotes positive link between loans growth and the explanatory variable; − denotes negative link between loans growth and the explanatory variable; +/− denotes the direction of link which is ambiguous, i.e. the one that could be either positive or negative.

Table A2. Sample medians by country and country classification.

	Country	Δloan	CAP	ΔCAP	Dep	Depbanks	QLP	size	GDPG per capita	ΔUnempl	# observations (Loans growth)	# banks (loans growth)
1	Argentina	0.77	12.22	−0.03	40.82	2.18	1.73	12.50	7.03	−0.60	479	56
2	Australia	4.43	6.20	−0.03	52.00	2.83	0.20	16.11	1.73	−0.40	192	21
3	Austria	2.00	8.77	−0.02	51.96	18.19	0.57	13.04	1.51	−0.05	510	57
4	Belgium	1.91	5.37	0.02	56.17	24.50	0.13	14.56	1.22	−0.10	230	25
5	Brazil	2.61	14.66	−0.38	30.08	5.41	2.22	13.56	2.34	−0.60	730	82
6	Bulgaria	3.43	11.53	−0.31	64.95	9.00	0.82	12.55	6.50	−1.25	175	19
7	Canada	3.80	11.41	0.26	71.33	18.36	0.21	13.16	1.66	−0.30	106	11
8	Chile	2.66	10.01	−0.15	61.99	1.88	0.85	14.37	3.28	−0.35	162	21
9	China	6.42	5.11	−0.10	78.26	4.50	0.80	15.62	9.21	−0.10	430	54
10	Colombia	1.02	11.37	0.00	68.27	8.33	1.99	14.46	2.61	−0.20	173	17
11	Croatia	4.41	12.57	−0.44	68.64	2.94	0.84	12.45	4.10	−0.65	274	29
12	Cyprus	4.47	7.24	−0.22	81.40	1.99	1.07	13.07	1.63	−0.05	53	7
13	Czech Republic	8.46	7.59	0.09	72.50	7.21	0.34	14.67	3.54	−0.50	140	15
14	Ecuador	1.50	9.99	−0.09	78.04	3.67	1.27	11.65	2.05	−0.05	254	27
15	El Salvador	0.95	10.90	0.40	67.53	.	1.60	12.89	1.62	−0.20	99	10
16	Estonia	4.66	10.45	−0.08	54.63	11.19	0.42	12.75	7.64	−0.70	55	6
17	Finland	5.94	5.43	−0.19	40.00	11.11	0.02	16.56	2.39	−0.40	50	5
18	France	2.59	6.77	−0.01	51.85	18.35	0.40	14.15	1.34	−0.10	979	102
19	Germany	2.25	7.11	0.00	56.58	22.63	0.57	13.57	1.38	−0.25	1086	114
20	Ghana	1.04	10.95	−0.39	70.59	9.75	3.20	11.93	3.04	−0.10	139	16
21	Hong Kong	1.48	10.50	0.00	75.00	3.36	0.75	15.87	4.82	−0.80	231	27
22	Hungary	1.36	10.01	0.14	33.25	44.07	1.07	13.14	4.02	0.15	100	11
23	Iceland	−0.92	5.80	0.10	22.71	8.96	0.75	15.43	1.91	0.20	5	1
24	India	2.55	5.77	0.05	80.95	2.79	0.94	15.54	6.23	−0.10	606	54
25	Indonesia	1.64	10.67	0.13	76.92	2.24	0.72	13.59	3.77	−0.35	382	41
26	Ireland	3.07	4.71	−0.24	38.46	31.58	0.18	16.71	2.53	0.25	87	10
27	Israel	1.45	6.12	0.11	85.00	1.91	0.70	16.34	2.83	−0.45	92	9
28	Italy	4.97	8.18	−0.17	48.14	8.71	0.56	14.77	0.69	−0.35	725	80
29	Jamaica	0.11	11.81	0.35	65.30	2.56	0.57	13.36	0.45	−0.25	56	6
30	Japan	7.88	4.79	0.04	90.91	0.61	0.44	16.86	1.38	−0.10	1281	120
31	Jordan	1.42	10.26	0.57	75.65	10.91	0.78	15.83	3.21	−0.10	22	2
32	Kazakhstan	2.31	13.63	−0.99	59.43	10.04	1.48	12.45	8.79	−0.50	82	9
33	Kenya	0.65	14.47	−0.06	76.49	3.29	1.29	11.58	1.68	0.00	251	28
34	Latvia	5.09	9.17	−0.43	71.96	10.14	0.56	12.81	8.09	−0.75	195	20
35	Lithuania	6.45	9.05	−0.46	61.86	20.80	0.76	13.54	8.07	−0.70	93	10
36	Malaysia	2.54	8.76	0.10	66.23	12.61	0.65	15.61	3.53	−0.05	247	24
37	Malta	3.14	7.64	0.53	85.36	3.39	0.13	14.31	1.95	−0.20	28	3
38	Mexico	0.53	11.58	−0.38	52.45	9.81	1.65	13.46	1.82	0.10	160	22

39	Morocco	4.59	8.06	−0.25	77.42	5.71	0.88	15.42	3.62	−0.25	71	7
40	Netherlands	4.32	8.24	0.04	67.27	13.58	0.07	14.81	1.35	0.00	144	19
41	New Zealand	2.43	4.91	0.01	61.76	2.75	0.12	15.91	1.86	−0.15	79	8
42	Norway	3.56	6.63	−0.35	52.51	10.92	0.16	14.77	1.22	0.15	90	11
43	Pakistan	0.67	7.91	0.13	74.13	9.70	1.06	14.22	1.59	−0.10	176	18
44	Peru	3.04	10.08	0.10	63.83	14.00	1.57	13.79	4.55	−0.10	105	11
45	Philippines	0.97	12.04	−0.52	74.07	0.29	1.34	14.08	2.63	−0.15	213	23
46	Poland	4.20	10.03	−0.21	53.53	25.77	0.68	13.81	3.72	−0.15	283	34
47	Portugal	4.71	6.75	0.01	36.00	31.01	0.73	15.04	0.90	0.65	122	15
48	Romania	1.19	13.18	−0.69	56.12	17.66	1.32	12.82	6.44	0.10	170	19
49	Russian Federation	1.12	15.41	−0.57	17.01	1.36	0.64	11.11	6.22	−0.75	3466	557
50	Singapore	1.98	11.84	0.05	62.61	12.14	0.14	15.14	4.83	−0.15	87	9
51	Slovakia	2.82	8.49	0.05	70.97	10.12	0.87	13.82	5.01	−0.80	81	9
52	Slovenia	2.23	8.65	−0.26	59.68	17.68	1.05	14.46	3.42	−0.10	109	12
53	South Africa	1.96	8.36	−0.04	73.78	6.27	0.88	12.44	2.00	−0.05	146	14
54	South Korea	2.39	5.40	0.22	61.90	0.21	0.93	16.99	4.13	−0.10	155	15
55	Spain	4.20	6.27	−0.10	56.72	21.70	0.52	14.81	1.37	−0.15	314	37
56	Sri Lanka	0.35	7.40	−0.12	74.03	2.38	0.96	13.42	5.06	−0.65	123	12
57	Sweden	6.63	10.64	−0.16	77.11	1.52	0.13	13.48	2.21	0.15	145	16
58	Switzerland	5.45	11.51	0.07	54.17	5.61	0.17	12.65	1.44	−0.05	1093	115
59	Thailand	2.37	8.96	0.07	74.45	4.09	0.94	15.66	3.98	−0.15	178	18
60	Tunisia	1.49	8.86	−0.28	71.43	4.87	1.39	14.15	3.28	−0.20	145	15
61	Turkey	0.17	11.99	0.50	64.64	5.03	2.13	15.10	4.93	0.10	63	8
62	Uganda	1.91	14.70	0.17	70.62	2.98	1.09	11.40	3.17	0.00	111	11
63	Ukraine	2.69	12.03	−0.83	58.16	18.05	1.99	12.67	6.61	−0.45	224	25
64	United Kingdom	2.91	8.88	−0.10	48.17	20.61	0.34	14.40	1.95	−0.05	928	101
65	United States	1.07	9.78	0.03	84.57	2.00	0.32	11.64	1.27	0.10	69271	6562
	Total										89051	8872

Note: This table provides a description of the sample. It includes sample medians of 2000–2011 and the number of banks and observations for the dependent variable. The classification of countries is taken from Cerutti et al. (2015); Δ*Loans* – real loans growth; *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; QLP – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include *GDPG per capita* – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. n.a. denotes countries not covered in the classification; *denotes full number of observations or banks; **denotes the number of observations and banks for countries with classification (i.e. we exclude these observations and banks with n.a. classification status).

Table A3. Values of macroprudential policy indices and macroprudential instruments use in 2000–2011.

	Type of macroprudential index			Type of macroprudential policy instrument										
Country	MPI aggregated	borrower	financial	LTV_CAP	DTI	DP	LEV	Inter	CONC	FC	RR	RR_REV	CG	TAX
Argentina	4.6	0.0	4.6	0	0	0	0	1	1	1	1	1	1	0
Australia	1.0	0.0	1.0	0	0	0	0	1	0	0	0	0	0	0
Austria	0.1	0.0	0.1	0	0	0	0	0	0	0	0	0	0	0
Belgium	2.0	0.0	2.0	0	0	0	0	0	1	0	0	0	0	1
Brazil	2.0	0.0	2.0	0	0	0	0	0	1	0	1	1	0	0
Bulgaria	2.6	0.5	2.2	0	0	0	0	0	1	0	0	0	0	0
Canada	3.5	0.5	3.0	0	0	0	1	1	1	0	0	0	0	0
Chile	6.0	2.0	4.0	1	1	0	1	1	1	0	0	0	0	1
China	3.3	1.3	2.0	1	1	1	0	0	1	0	0	0	0	0
Colombia	6.4	2.0	4.4	1	1	0	0	1	1	1	1	0	0	1
Croatia	1.1	0.0	1.1	0	0	0	0	1	0	0	0	0	0	0
Cyprus	0.7	0.7	0.0	1	0	0	0	0	0	0	0	0	0	0
Czech Republic	1.0	0.0	1.0	0	0	0	0	0	1	0	0	0	0	0
Ecuador	4.6	0.8	3.8	0	1	0	1	0	1	0	0	0	1	1
El Salvador	1.0	0.0	1.0	0	0	0	0	0	1	0	1	0	0	0
Estonia	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Finland	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
France	2.0	0.0	2.0	0	0	0	0	1	1	0	0	0	0	0
Germany	0.2	0.0	0.2	0	0	0	0	0	0	0	0	0	0	0
Ghana	2.6	0.0	2.6	0	0	0	0	0	1	0	0	0	1	1
Hong Kong	3.0	2.0	1.0	1	1	0	0	0	1	0	0	0	0	0
Hungary	0.3	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0
Iceland	1.9	0.0	1.9	0	0	0	0	0	1	1	0	0	0	0
India	1.4	0.0	1.4	0	0	0	0	0	1	0	0	0	0	0
Indonesia	0.5	0.0	0.5	0	0	0	0	0	0	0	0	0	0	0
Ireland	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Israel	1.1	0.1	1.0	0	0	0	0	0	1	0	0	0	0	0
Italy	2.0	0.0	2.0	0	0	0	0	1	1	0	0	0	0	0
Jamaica	1.5	0.0	1.5	0	0	0	1	0	0	0	0	0	0	1
Japan	1.0	0.0	1.0	0	0	0	0	0	1	0	0	0	0	0
Jordan	2.6	0.0	2.6	0	0	0	1	0	1	1	0	0	0	0
Kazakhstan	1.0	0.0	1.0	0	0	0	0	0	0	0	1	1	0	0
Kenya	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Latvia	0.4	0.4	0.0	0	0	0	0	0	0	0	0	0	0	0
Lithuania	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Malaysia	2.0	1.0	1.0	1	0	0	0	0	0	0	0	0	1	0
Malta	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0

Mexico	1.8	0.0	1.8	0	0	0	0	1	1	0	0	0	0	0
Morocco	3.0	0.0	3.0	0	0	0	0	1	1	1	0	0	0	0
Netherlands	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
New Zealand	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Norway	1.2	0.2	1.0	0	0	0	0	0	1	0	0	0	0	0
Pakistan	5.9	1.5	4.4	1	0	0	0	1	1	1	1	0	0	1
Peru	3.3	0.0	3.3	0	0	0	0	1	1	0	1	1	0	0
Philippines	1.8	0.0	1.8	0	0	0	0	0	1	0	1	0	0	1
Poland	1.1	0.1	1.0	0	0	0	0	0	1	0	0	0	0	0
Portugal	0.2	0.0	0.2	0	0	0	0	0	0	0	0	0	0	0
Romania	2.7	1.0	1.7	1	1	0	0	1	1	0	1	0	0	0
Russian Federation	1.0	0.0	1.0	0	0	0	0	0	1	0	0	0	0	0
Singapore	1.8	1.0	0.8	1	0	0	0	0	1	0	1	0	0	0
Slovakia	1.0	1.0	0.0	1	0	0	0	0	0	0	0	0	0	0
Slovenia	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
South Africa	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
South Korea	1.7	1.4	0.4	1	0	0	0	0	0	0	0	0	0	0
Spain	3.0	1.0	2.0	1	0	1	0	0	1	0	0	0	0	0
Sri Lanka	1.0	0.0	1.0	0	0	0	0	0	1	0	1	0	0	0
Sweden	0.1	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0
Switzerland	1.0	0.0	1.0	0	0	0	0	0	0	0	0	0	0	0
Thailand	0.7	0.7	0.0	1	0	0	0	0	0	0	0	0	0	0
Tunisia	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
Turkey	1.6	0.4	1.3	0	0	0	0	0	1	0	0	0	0	0
Uganda	0.7	0.0	0.7	0	0	0	0	1	0	0	0	0	0	0
Ukraine	3.6	0.0	3.6	0	0	0	0	1	1	1	1	1	0	0
United Kingdom	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0
United States	2.9	0.0	2.9	0	0	0	1	1	1	0	1	0	0	0

Note: This table includes values of macroprudential policy indices and of individual macroprudential policy instruments per country. Macroprudential policy index covers one of three types of macroprudential policy indices: MPI aggregated, *BORROWER* and *FINANCIAL*. Individual macroprudential policy instruments include: loan-to-value ratio (*LTV*), loan-to-value ratio caps (*LTV_CAP*) debt-to-income ratio (*DTI*), dynamic loan-loss provisioning (*DP*), leverage ratio (*LEV*), limits on interbank exposures (*INTER*), limits on foreign currency loans (*FC*), reserve requirements ratios (*RR*), limits on domestic currency growth (*CG*), levy/tax on financial institutions (*TAX*), and *FX* and/or countercyclical reserve requirements (*RR_REV*). To test our hypotheses, for each country we construct a dummy variable which takes the value of 1 if the instrument was applied at least since 2005, and 0 otherwise.

Table A4. Sensitivity of results to change in the number of large and medium banks.

	Full sample			large			medium			small		
Type of macroprudential policy index	MPI aggregated 1	BORROWER 2	FINANCIAL 3	MPI aggregated 4	BORROWER 5	FINANCIAL 6	MPI aggregated 7	BORROWER 8	FINANCIAL 9	MPI aggregated 10	BORROWER 11	FINANCIAL 12
CAP	0.275***	0.168**	0.201**	0.461***	0.354***	0.339**	0.396**	0.237**	0.291**	0.327***	0.316***	0.326***
	(3.11)	(2.40)	(2.54)	(−3.03)	(−2.89)	(−2.25)	(−2.43)	(−2.27)	(−2.14)	(2.83)	(3.68)	(2.81)
Crisis	−10.87***	−4.901***	−5.115**	−10.042***	−7.707***	−7.561***	−2.246	−1.804	−0.45	1.344	−0.446	3.308
	(−4.90)	(−5.53)	(−2.57)	(−4.22)	(−6.61)	(−3.85)	(−0.70)	(−1.23)	(−0.14)	(0.40)	(−0.21)	(0.88)
Crisis*CAP	0.751***	0.212***	0.269	0.599**	0.334***	0.383*	−0.011	−0.032	−0.145	−0.125	−0.048	−0.236
	(4.12)	(3.08)	(1.64)	(−2.32)	(−2.81)	(−1.78)	(−0.05)	(−0.30)	(−0.60)	(−0.69)	(−0.43)	(−1.21)
Macropr index	0.485	4.858***	0.253	1.026	5.036**	0.005	1.022	3.566	0.223	0.195	0.243	0.537
	(1.18)	(3.18)	(0.41)	(−1.46)	(−2.05)	(−0.01)	(−1.40)	(−1.47)	(−0.33)	(0.34)	(0.16)	(0.64)
Macropr index * Crisis	8.173***	41.328***	4.313**	5.087**	29.803***	3.673*	1.567	18.973**	0.502	−1.428	−1.052	−3.304
	(4.75)	(5.70)	(2.54)	(−2.46)	(−3.96)	(−1.89)	(−0.75)	(−2.16)	(−0.23)	(−0.88)	(−0.18)	(−1.49)
Macropr index * CAP	−0.075**	−0.446***	−0.069	−0.120*	−0.547**	−0.029	−0.086	−0.197	−0.046	−0.043	−0.119	−0.066
	(−2.19)	(−3.41)	(−1.37)	(−1.74)	(−2.37)	(−0.39)	(−1.49)	(−0.95)	(−0.89)	(−1.10)	(−1.18)	(−1.11)
Macropr index *Crisis*CAP	−0.684***	−3.545***	−0.355**	−0.451**	−2.397***	−0.328*	−0.1	−1.564**	(−0.031)	0.066	0.145	0.188
	(−4.77)	(−4.79)	(−2.53)	(−2.25)	(−3.23)	(−1.69)	(−0.66)	(−2.46)	(−0.19)	(0.65)	(0.41)	(1.20)
m2	−1.76*	−1.19	−2.04**	−1.299	−0.654	−1.493	−0.355	−0.178	−0.486	−1.15	−1.13	−1.16
Hansen test *p*-value	0.00	0.00	0.00	1.00	0.998	1.00	0.68	0.60	0.62	1.00	1.00	1.00
#instruments	825	825	825	732	732	732	662	662	662	632	632	632
# observations	12440	12440	12440	2938	2938	2938	2311	2311	2311	1730	1730	1730
# banks	2041	2041	2041	424	424	424	392	392	392	386	386	386

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices. For brevity, we present reduced results for interactions of macroprudential policy instruments and capital ratios. The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; QLP – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include GDPG per capita – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. *Macropr index* covers one of three types of macroprudential policy indices: *MPI aggregated, BORROWER* and *FINANCIAL*. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

Table A5. The role of macroprudential policies before and after the crisis.

	Before the crisis (up to 2006)			During and after the crisis (2007 onwards)			Whole period		
	MPI aggregated 1	BORROWER 2	FINANCIAL 3	MPI aggregated 4	BORROWER 5	FINANCIAL 6	MPI aggregated 7	BORROWER 8	FINANCIAL 9
PANEL A: 2 – step GMM									
Δloan(−1)	0.154***	0.137***	0.180***	−0.148***	−0.184***	−0.128***	0.011	−0.015	0.016
	(5.85)	(4.92)	(6.71)	(−5.80)	(−5.85)	(−5.03)	(0.51)	(−0.62)	(0.75)
CAP	**0.198****	**0.122**	**0.101**	**0.796*****	**0.260****	**0.510*****	**1.955*****	**11.668*****	**1.101***
	(2.07)	(1.29)	(1.14)	(4.80)	(2.28)	(3.14)	(4.29)	(5.90)	(1.82)
Macropr index	0.522	4.466***	0.202	5.578***	28.106***	3.108**	−0.190***	−0.966***	−0.131***
	(1.18)	(3.45)	(0.38)	(4.57)	(4.75)	(2.50)	(−5.28)	(−6.03)	(−2.63)
Macropr index * CAP	**−0.074****	**−0.387*****	**−0.069**	**−0.499*****	**−2.388*****	**−0.324*****	**0.409*****	**0.277*****	**0.257*****
	(−1.99)	(−3.45)	(−1.48)	(−4.85)	(−4.15)	(−3.38)	(5.24)	(4.01)	(2.80)
ΔCAP	0.003	−0.052	−0.276	−0.204***	−0.209***	−0.179**	−0.129***	−0.167***	−0.112***
	(0.03)	(−0.79)	(−1.39)	(−2.94)	(−3.60)	(−2.51)	(−2.87)	(−3.56)	(−2.66)
Dep	0.005	0.010	−0.028	0.017	0.012	0.009	0.020**	0.031***	0.018**
	(0.25)	(0.51)	(−1.15)	(0.89)	(0.77)	(0.55)	(2.22)	(3.16)	(2.09)
Depbanks	0.051*	0.075***	0.011	0.042	0.029	0.006	0.077***	0.093***	0.062***
	(1.95)	(3.19)	(0.35)	(1.44)	(0.94)	(0.21)	(4.74)	(5.85)	(3.76)
QLP	−0.021	−0.060	−0.062	0.154	0.090	0.175	0.081	−0.010	0.097
	(−0.13)	(−0.43)	(−0.27)	(1.00)	(0.61)	(1.12)	(0.74)	(−0.10)	(0.98)
size	0.649***	0.621**	0.545**	1.643***	1.114***	1.721***	1.238***	1.072***	1.179***
	(2.59)	(2.47)	(2.00)	(4.89)	(3.22)	(5.06)	(5.82)	(5.48)	(6.09)
GDPG per capita	0.033	0.034	0.010	0.217**	0.036	0.282***	0.131**	0.085	0.158**
	(0.53)	(0.60)	(0.18)	(2.25)	(0.38)	(2.99)	(2.20)	(1.49)	(2.39)
ΔUnempl	−0.834***	−0.636***	−0.869***	−0.834***	−1.030***	−0.766***	−0.773***	−0.730***	−0.774***
	(−5.05)	(−5.29)	(−4.70)	(−6.89)	(−8.69)	(−6.36)	(−6.85)	(−6.51)	(−6.78)
Intercept	−7.74	−7.73	−2.588	−29.68***	−15.82***	−26.38***	−19.86***	−16.85***	−16.77***
	(−1.51)	(−1.46)	(−0.45)	(−5.14)	(−2.66)	(−4.22)	(−5.50)	(−5.05)	(−4.87)
Hansen test *p*-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
m2	−0.72	−0.94	−0.28	−0.33	−0.41	−0.22	−2.21**	−2.62***	−2.16**
#instruments	454	454	454	370	370	370	823	823	823
#observations	6245	6245	6245	6195	6195	6195	12440	12440	12440
# banks	1460	1460	1460	1828	1828	1828	2041	2041	2041
PANEL B: Random Effects estimation									
Δloan(−1)	0.121***	0.119***	0.120***	0.018	0.008	0.020	0.074***	0.070***	0.074***
	(10.49)	(10.29)	(10.46)	(1.32)	(0.59)	(1.48)	(8.33)	(7.93)	(8.37)

(*Continued*)

Table A5. Continued.

	Before the crisis (up to 2006)			During and after the crisis (2007 onwards)			Whole period		
	MPI aggregated 1	BORROWER 2	FINANCIAL 3	MPI aggregated 4	BORROWER 5	FINANCIAL 6	MPI aggregated 7	BORROWER 8	FINANCIAL 9
CAP	**0.205*****	**0.168*****	**0.190*****	**0.128*****	**0.061***	**0.038**	**0.417****	**4.767*****	**0.024**
	(5.20)	(5.20)	(5.05)	(2.86)	(1.81)	(0.85)	(2.20)	(7.59)	(0.10)
Macropr index	0.174	2.716***	0.077	0.928***	8.932***	−0.210	−0.050***	−0.306***	−0.035**
	(0.76)	(3.65)	(0.27)	(2.81)	(7.95)	(−0.52)	(−3.54)	(−6.01)	(−2.05)
Macropr index * CAP	**−0.050*****	**−0.239*****	**−0.061*****	**−0.073*****	**−0.485*****	**0.005**	**0.162*****	**0.123*****	**0.129*****
	(−2.98)	(−4.09)	(−3.06)	(−2.87)	(−5.00)	(0.16)	(5.56)	(5.33)	(4.55)
ΔCAP	−0.073	−0.087*	−0.075	−0.054	−0.070	−0.053	−0.070**	−0.083**	−0.071**
	(−1.50)	(−1.77)	(−1.52)	(−1.07)	(−1.40)	(−1.05)	(−1.99)	(−2.36)	(−2.00)
Dep	0.011	0.015	0.006	0.033***	0.019**	0.033***	0.031***	0.026***	0.029***
	(0.91)	(1.24)	(0.51)	(3.36)	(1.97)	(3.42)	(4.54)	(3.82)	(4.19)
Depbanks	0.020	0.026*	0.014	0.050***	0.044***	0.048***	0.044***	0.043***	0.041***
	(1.48)	(1.93)	(1.04)	(3.70)	(3.22)	(3.54)	(5.00)	(4.84)	(4.56)
QLP	−0.023	−0.041	−0.009	−0.007	−0.051	−0.003	−0.002	−0.023	0.008
	(−0.31)	(−0.55)	(−0.12)	(−0.09)	(−0.59)	(−0.03)	(−0.03)	(−0.41)	(0.14)
size	0.493***	0.449***	0.479***	0.575***	0.459***	0.602***	0.566***	0.498***	0.573***
	(4.43)	(4.02)	(4.31)	(5.11)	(4.11)	(5.35)	(7.34)	(6.47)	(7.44)
GDPG per capita	−0.002	0.000	−0.008	0.158***	0.058	0.179***	0.080**	0.036	0.088**
	(−0.03)	(0.00)	(−0.12)	(3.00)	(1.09)	(3.42)	(2.02)	(0.90)	(2.25)
ΔUnempl	−0.836***	−0.713***	−0.900***	−0.681***	−0.829***	−0.661***	−0.730***	−0.725***	−0.756***
	(−4.66)	(−4.02)	(−4.97)	(−4.06)	(−4.94)	(−3.94)	(−6.06)	(−6.06)	(−6.24)
Intercept	−4.731**	−4.602**	−3.895*	−7.903***	−4.756***	−7.038***	−7.457***	−6.113***	−6.841***
	(−2.20)	(−2.14)	(−1.80)	(−4.30)	(−2.59)	(−3.83)	(−5.64)	(−4.62)	(−5.18)
#observations	6245	6245	6245	6195	6195	6195	12440	12440	12440
# banks	1460	1460	1460	1828	1828	1828	2041	2041	2041

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices obtained in subperiods: before crisis, after the crisis, and for the whole period. The estimators applied in the table are GMM 2-step robust (PANEL A) and Random Effects estimator (PANEL B). The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; QLP – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include GDPG per capita – real GDP growth per capita; Δ*Unempl* – annual change in unemployment rate. *Macropr index* covers one of three types of macroprudential policy indices: *MPI aggregated, BORROWER* and *FINANCIAL*. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.

Table A6. Sensitivity of results to change in the business cycle measure – the effects of MAPI – aggregated.

	2-step GMM; GDP growth rate included				2-step GMM; Distance to Frontier included			
	full 1	large 2	medium 3	small 4	full 5	large 6	medium 7	Small 8
Δloan(−1)	0.003	0.007	−0.010	−0.026	0.006	0.015	−0.013	−0.028
	(0.11)	(0.22)	(−0.25)	(−0.90)	(0.27)	(0.45)	(−0.35)	(−0.96)
CAP	**0.275*** **	**0.203***	**0.210** **	**0.330*** **	**0.273*** **	**0.254** **	**0.203** **	**0.326*** **
	(2.97)	(1.66)	(2.19)	(2.83)	(3.08)	(2.08)	(2.14)	(2.95)
ΔCAP	−0.118**	−0.029	−0.158**	−0.145*	−0.119***	−0.030	−0.144**	−0.144*
	(−2.39)	(−0.45)	(−2.39)	(−1.70)	(−2.59)	(−0.45)	(−2.23)	(−1.72)
Dep	0.009	0.025*	0.022	−0.033	0.020	0.046***	0.034**	−0.029
	(0.76)	(1.71)	(1.41)	(−1.29)	(1.58)	(2.86)	(2.10)	(−0.96)
Depbanks	0.060***	0.141***	0.008	−0.085***	0.065***	0.144***	0.028	−0.080***
	(3.10)	(5.78)	(0.35)	(−2.95)	(3.66)	(5.53)	(1.26)	(−2.69)
QLP	0.125	0.282	−0.003	0.114	0.179	0.342*	0.037	0.116
	(0.99)	(1.44)	(−0.02)	(0.62)	(1.52)	(1.73)	(0.25)	(0.62)
size	1.236***	0.987***	0.775***	2.359***	1.309***	1.050***	0.888***	2.388***
	(5.86)	(4.00)	(2.95)	(4.62)	(6.24)	(4.15)	(3.44)	(4.95)
GDP growth rate	**0.026**	**0.221** **	**−0.106**	**−0.024**				
	(0.41)	(2.08)	(−0.98)	(−0.22)				
DTF growth					**0.286*** **	**0.511*** **	**0.206***	**0.125**
					(3.32)	(3.74)	(1.77)	(0.48)
ΔUnempl	−0.650***	−0.680***	−0.654***	−0.421	−0.657***	−0.788***	−0.583***	−0.379
	(−5.18)	(−3.47)	(−4.03)	(−0.92)	(−5.17)	(−3.87)	(−3.38)	(−0.91)
Crisis	−11.133***	−9.180***	−6.698***	1.312	−11.473***	−10.898***	−6.911***	1.286
	(−4.87)	(−3.17)	(−3.01)	(0.38)	(−4.84)	(−3.58)	(−2.77)	(0.37)
Crisis*CAP	**0.774*** **	**0.634** **	**0.363** **	**−0.122**	**0.771*** **	**0.694** **	**0.368***	**−0.131**
	(4.03)	(2.34)	(2.00)	(−0.68)	(3.96)	(2.41)	(1.89)	(−0.70)
Macropr index	0.540	1.027	0.312	0.240	0.492	1.266*	0.110	0.173
	(1.22)	(1.39)	(0.67)	(0.42)	(1.14)	(1.73)	(0.27)	(0.33)
Macropr index * Crisis	8.318***	6.439***	4.762***	−1.489	8.330***	6.953***	4.840***	−1.595
	(4.63)	(3.07)	(2.60)	(−0.91)	(4.54)	(3.20)	(2.61)	(−0.91)
Macropr index * CAP	−0.080**	−0.122*	−0.069*	−0.044	−0.073**	−0.140**	−0.053	−0.042
	(−2.16)	(−1.76)	(−1.76)	(−1.13)	(−2.03)	(−2.07)	(−1.59)	(−1.09)
Macropr index *Crisis*CAP	**−0.696*** **	**−0.596*** **	**−0.366** **	**0.069**	**−0.699*** **	**−0.628*** **	**−0.375** **	**0.074**
	(−4.58)	(−3.09)	(−2.52)	(0.70)	(−4.54)	(−3.08)	(−2.56)	(0.69)
Intercept	−16.15***	−15.56***	−7.71*	−25.08***	−18.18***	−17.86***	−10.65***	−25.81***
	(−4.27)	(−3.36)	(−1.86)	(−3.90)	(−4.91)	(−3.73)	(−2.63)	(−4.18)

(*Continued*)

Table A6. Continued.

	2-step GMM; GDP growth rate included				2-step GMM; Distance to Frontier included			
	full	large	medium	small	full	large	medium	Small
	1	2	3	4	5	6	7	8
m2	−1.67*	−2.33**	0.03	−1.15	−1.51	−2.12**	−0.03	−1.15
Hansen test	0.00	1.00	0.59	1.00	0.00	0.98	0.50	1.00
#instruments	818	777	800	626	793	752	782	621
#observations	12416	5046	5644	1726	12342	5000	5621	1721
#banks	2039	742	911	386	2026	736	905	385

Note: This table presents the coefficient estimates of loans growth on bank-specific determinants, macroeconomic variables and macroprudential indices obtained in regressions with changed business cycle measure (i.e. real GDP growth rate and Distance to Frontier are included instead of real GDP per capita growth rate). The bank-specific determinants include *CAP* – equity capital divided by total assets; Δ*CAP* – annual change in capital ratio; *Dep* – nonfinancial borrowers deposits divided by total assets; *Depbanks* – interbank deposits divided by total assets; QLP – loan loss provisions divided by average loans; size – logarithm of total assets. Macroeconomic variables include Δ*Unempl* – annual change in unemployment rate. *Macropr index* covers one of three types of macroprudential policy indices: *MPI aggregated, BORROWER* and *FINANCIAL*. Bank size is captured by total average assets in the whole research period: large is a dummy variable equal to 1 if a bank belongs to the 30% corresponding to the largest banks; medium is a dummy variable equal to 1 if a bank belongs to the next 40% of banks; small is a dummy variable equal to 1 if a bank belongs to the last 30% of banks with the smallest assets. Reported regressions are estimated with the dynamic two-step system-GMM estimator as proposed by Blundell and Bond (1998) with Windmeijer's (2005) finite-sample correction for the period of 2000–2011 for panel data with lagged dependent variable. All regressions include interactions between country and year dummies. T-statistics are given in parentheses. ***, ** or * next to coefficients indicate that coefficients are significantly different from zero at the 1%, 5%, or 10% levels, respectively. # – denotes the number of.