Evaluating the Impact of Macroprudential Policies in Colombia*

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Abstract

Macroprudential tools have been used around the world as a mechanism to control potential risks and imbalances in the financial sector. Colombia is a good example of a country that has employed different regulatory measures to manage systemic risks in the economy. The purpose of this paper is to evaluate the effectiveness of three policies employed in said country to increase the resilience of the system and to moderate exuberance in credit supply. The first two measures, namely the countercyclical reserve and external borrowing requirements, were implemented in 2007 to control excessive credit growth and reduce currency mismatches generated by foreign borrowing, respectively. The third tool corresponds to the dynamic provisioning scheme for commercial loans, whose objective was to consolidate a countercyclical buffer through loan loss provision requirements. To perform this analysis a rich data set based on loan-by-loan information for Colombian banks during the period between 2006 and 2009 is used. A fixed effects panel model is estimated using debtors', banks' and macroeconomic characteristics as control variables. Findings suggest that dynamic provisions and the countercyclical reserve requirement had a negative effect on credit growth, while the effect of the three tools on both the cost of credit and the riskiness of banks differs between policies. Results also suggest that the aggregate macroprudential policy stance in Colombia has worked as an effective stabilizer of credit cycles and bank risk-taking. Moreover, evidence is found that macroprudential policies have worked as a complement of monetary policy, accompanying the stabilizing effects of changes in interest rates on credit growth.

JEL classification: *E58, G28, C23*
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1 Introduction

In the late nineties, Colombia experienced one of its severest financial crises in recent history. During the beginning of this decade, the country underwent a period of structural reforms characterized by a "laissez faire" approach which promoted economic openness and financial liberalization. These factors facilitated an enormous flow of capital into the economy, which in Colombia are highly (and positively) correlated with credit (Carrasquilla et al. (2000), Tenjo & López (2002) and Villar et al. (2005)). During these years there was also an enormous growth in the financial intermediation industry, which saw a sharp increase in the number of institutions and less restrictions on financial operations and interest rates. Additionally, total expenditure (public and private) grew at high rates, and deficits in both private and public balances were signals of an overheated economy. These elements were the main contributors to the credit boom that Colombia experienced during the first half of the nineties[1].

Throughout this period, a substantial share of households in Colombia took out mortgage loans, pushed by the favorable conditions in credit markets, causing housing prices to increase at a very high rate and augmenting households' leverage and financial burden. This peak in housing prices was, however, followed by a sudden and sharp decrease in this variable and an increment in interest rates, as a consequence of the sudden stop in capital inflows, leading to a credit crunch in the Colombian economy, which resulted in the 1998-99 crisis (Tenjo & López (2002)). This episode was a painful reminder that, like other countries in the region, being a commodity exporting, small, open and banking-oriented economy with low levels of domestic saving rates country, makes one especially vulnerable to unexpected swings in the availability of external financing (Uribe (2012)).

Nevertheless, the financial crisis of the late nineties also left many important lessons for monetary and banking authorities. One of such lessons is that episodes of excessive credit growth, which simultaneously fuel increases in asset prices, are particularly dangerous for macroeconomic sustainability. In addition to that, external imbalances and currency mismatches can be particularly costly, since they tend to generate a misallocation of resources, leading to asset and credit bubbles. Furthermore, the need for proper and timely coordination between the agencies in charge of macroeconomic and financial stability was shown to be essential. Moreover, a flexible exchange rate regime, the search for a sustainable fiscal policy and a continuous improvement of financial regulation and supervision were also underpinned as key features to decrease the potential impact and likelihood of future episodes of financial distress. Last but not least, that financial stability is a necessary condition for macroeconomic stability, and the achievement of the former is not guaranteed through the use of microprudential instruments, rather these have to be complemented with macroprudential tools.

Indeed, after the crisis of the nineties, many prudential measures were implemented and/or modified in Colombia. Some examples are: i) introduction of caps on loan-to-value (LTV) and changes on debt-to-income (DTI) ratios for mortgage loans; ii) the Central Bank altered limits on net total FX positions; and iii) the creation of the Financial System Surveillance Committee as a mechanism of coordination among the financial authorities that make up the system's safety net[2].

Following the implementation of said measures, the first test that financial stability authorities had to face took place during the period 2006-2009. During these years, the Colombian economy went through a

[1] Commercial loans grew at a real rate of 102.7% between December 1990 and December 1995. Mortgage loans grew 101.9% during the same period.

[2] Created in 2003, the Committee is comprised of the Minister of Finance, the Governor of the Central Bank, the Director of the deposit insurance corporation and the Financial Superintendent.

similar situation to that observed at the middle of the nineties (i.e. excessive capital inflows, abnormally high credit growth and robust dynamics of housing prices). On one hand, the real annual growth rate of the loan portfolio (including leasing operations) of the financial system rose from 11.8% in December 2005 to 27.3% twelve months later, with a real GDP growth of 6.7% at the end of 2006. The increase in aggregate demand was initially driven by an acceleration in investment and subsequently by private consumption, generating some inflationary pressures, threatening the fulfillment of inflationary targets (Cardozo (2012)). The increase in capital flows caused the current account deficit to rise from 1.8% of GDP in the second half of 2006 to 3.6% of GDP by the first half of 2007, suggesting the presence of external imbalances.

In response to the expansionary scenario, the Central Bank increased its intervention rate gradually: monetary interest rates were increased 400 bps between April 2006 and July 2008. With this policy, the Central Bank tried to moderate the inflationary pressures generated by the strong growth of aggregate demand and credit (Vargas (2011)). However, the loan portfolio of financial institutions continued to grow at historically high rates, particularly in the commercial and consumer portfolios. The transmission of monetary policy was sluggish and the limited reaction of credit dynamics suggested the convenience of taking complementary measures (Uribe (2012)).

In this context, the Central Bank decided to establish a marginal reserve requirement in order to attenuate both the high growth of the loan portfolio and the leverage of the private sector. Moreover, in order to prevent possible arbitrages and to limit a potential substitution from local funding to external borrowing, the Central Bank reactivated a reserve requirement for short-term external borrowing and a limit on exchange rate derivatives exposure. The objective of these measures was, not only limiting the currency mismatches of banks, but also reducing gross currency positions, thus limiting counter-party risks. Simultaneously, the Ministry of Finance established a deposit for foreign portfolio investment and, a year later, a minimum permanence period for foreign direct investment. The result was a set of macroprudential policies that helped mitigate inflationary pressures whilst dealing with latent financial risks (Cardozo (2012)). In addition to those measures, the Financial Superintendence of Colombia (SFC) designed a new system of countercyclical provisions, in the spirit of the Spanish system (Saurina (2009)), which modified the provision requirements on commercial and consumer loans.

The conjunction of these policies seems to have caused credit growth to decelerate since the end of 2007. Thus, when the external shock arrived in 2008, the Central Bank had enough space for acting in a countercyclical way; reducing its policy rate rapidly and aggressively (from 10% in December 2008 to 3% in May 2010) with the purpose of attenuating the impact of the foreign shock on the domestic economy while maintaining inflation under control. In contrast to the experience of many other emerging economies, during this period Colombia's GDP did not register a negative growth rate in annual terms (Cardozo (2012)).

Though this would seem to point to the effectiveness of the macroprudential tools set in place at the time, it is still difficult to ascertain the individual impact of each tool, as well as to isolate the idyisincratic effects from those caused by the global financial crisis. Indeed, even the potential effect on the credit cycle of these instruments at the theoretical level has been a subject of debate. For instance, as pointed out by Betancourt & Vargas (2009), the effectiveness of reserve requirements in an inflation targeting regime depends on the degree of substitution between bank deposits and Central Bank loans and the degree of uncertainty regarding the future policy rate. In any case, the authors conclude that the impact on the price and volume of credit is lower than under a monetary aggregates regime. Nevertheless, others argue

that reserve and liquidity requirements can play an important role for affecting credit supply, especially under scenarios of asymmetric information (Almeida et al. (2004) and Acharya et al. (2007)). Liquid deposits can also play as a buffer against noisy signals (Calomiris & Kahn (1991)), and these buffers could reduce dependence on the lender of last resort by having banks self-insure against liquidity risk.

Whether one believes that the use of this set of macroprudential policies during that period actually helped towards a smooth adjustment of the Colombian economy during 2008-2009, the truth of the matter is that little is known about the real impact of these tools on the supply of credit and/or banks' risk-taking. For the most part, impact evaluation of these measures employ aggregate data, in which it is not possible to distinguish between supply and demand effects. A careful review of the literature for Colombia reveals that there is only one document that evaluates the impact of a specific measure (i.e. countercyclical provisions) on credit cycles using credit registry data (López et al. (2014)).

The experience of Colombia in the 2006-2009 period is thus especially rich and unexplored. During this time, financial authorities simultaneously employed different measures to deal with the build-up of systemic vulnerabilities and increase the resilience of the financial system. In particular, it is interesting to analyze the potential effect of these measures on credit growth and banks' risk indicators. Therefore, in this paper, the impact of three macroprudential policies is evaluated: i) the marginal (i.e. countercyclical) reserve requirement on deposits; ii) the external borrowing requirement; and iii) the new dynamic provisioning system.

In evaluating said policies, a micro dataset containing information on over 1.6 million bank-debtor relationship observations for the period comprised between 2006Q1-2009Q4 is utilized. The information, provided by the SFC, is a sample from the commercial loans' portfolio comprised of credit operations in which the debtor is a legal entity (i.e. a firm), thus excluding individuals. The use of loan-by-loan information is particularly valuable in that it allows disentangling different effects and effectively estimating the impact of the aforementioned macroprudential policies on credit growth and banks' risk profile. Through a series of estimations, using a fixed effects panel data methodology, one finds that dynamic provisions and the countercyclical reserve requirement had a negative effect on credit growth, while the effect of the three tools on both the cost of credit and the riskiness of banks' loan portfolio differs between policies. Findings also suggest that the aggregate macroprudential policy stance in Colombia has worked as an effective stabilizer of credit cycles and bank risk-taking. Moreover, evidence is found that macroprudential policies have worked as a complement of monetary policy, thereby accompanying the stabilizing effects of changes in interest rates on credit growth.

The remainder of this paper is organized as follows: Section 2 provides a selective review of the related literature. Section 3 describes the data and empirical approach used, whilst Section 4 discusses the main results. Some concluding remarks follow.

2 Related literature

The proper implementation of a new macroprudential framework requires the evaluation of the potential impact of different policies on some variables of interest. Nevertheless, little is known about the effectiveness of these kind of policies and their interaction with monetary policy. One possible explanation of this fact is that, unlike monetary policy, the macroprudential policy toolkit is comprised of a variety of tools and targets various objectives, which are in fact difficult to disentangle in practice: some macroprudential policies seek to increase the resilience of the financial sector while others may attempt to dampen credit

cycles. In other words, and using the terminology initially introduced by Borio & Crockett (2000), the evaluation of the impact of macroprudential tools should take in consideration, simultaneously, the time and cross-sectional dimensions of systemic risk.

In addition to that, cumulative experience and the information required for performing proper evaluations of the effectiveness of macroprudential tools is not particularly rich or available around the globe. On one hand, many macroprudential tools in developed countries have been introduced only in response to the recent crisis, which makes it difficult to empirically assess their effectiveness and transmission channels, and thus provide a guide in the design of said tools going forward (Galati & Moessner (2014) and Turner (2010)). On the other hand, in developing countries, even if the experience with the use of macroprudential policies is richer, the existence of restrictions in terms of data availability and capability for processing this information have limited the possibility of evaluating the effects of different policies.

Given the importance of this subject, some specialized international groups have devoted significant efforts to its analysis. A prime example is the influential report prepared by the CGFS (Committee on the Global Financial System (2012)), which offers a conceptual discussion of the transmission mechanism of a range of instruments, aiming to provide guidance on how the effectiveness of the latter could be judged in practice. One key conclusion is that the effects of capital, liquidity and asset-side tools on different variables of interest tend to be mixed. On one hand, there is consensus in the sense that all of these tools could provide buffers that contribute to the resilience of the financial sector[3], however, there are differing views on the effects on credit cycles: while some evidence indicates that capital-based macroprudential policies affect the price and quantity of credit (though the precise magnitude is uncertain)[4], liquidity-based tools seem to have only transitory effects[5], while the effect of asset-side tools is less well documented, as relatively few countries have utilized LTV and debt to income (DTI) restrictions with countercyclical purposes[6].

Notwithstanding the aforementioned data limitations, the recent interest in macroprudential policies has spawned a host of literature on the evaluation of their impact on a wide array of economic variables of interest. The state-of-the-art in such assessments can be schematically differentiated depending on the information used. In particular, it is possible to find documents that employ aggregate information at the country level, while others use bank level data and, finally, there are those that estimate the impact of macroprudential policies using information at the bank-debtor relationship level or credit registry data. In the theoretical field there are also some works that evaluate the impact of macroprudential policies on different dimensions using Dynamic Stochastic General Equilibrium Models (DSGE) finding that these policies have a potential role dealing with credit cycles and that they are more effective if used as a complement to monetary policies (Angelini et al. (2011), Agénor et al. (2012) and Brunnermeier & Sannikov (2014), among others).

Starting with the first group, it is noteworthy that most of the papers in the literature have used aggregate macro data to evaluate the impact of different policies on some variable of interest (e.g. credit growth or

[3]For instance, asset-side tools (such as caps on loan to value - LTV) can play an important role in increasing the resilience of the banking system by decreasing both the probability of default and the loss given default of loans (Committee on the Global Financial System (2012)).

[4]The Macroeconomic Assessment Group (Macroeconomic Assessment Group (2010)) estimates that the median impact of increasing capital ratios by 1 percentage point (pp) is a reduction in lending by 1 to 2 pp.

[5]Evidence for Latin America suggests that increased reserve requirements have a negative impact on the provision of credit. Nevertheless, effects seem to last mostly two and at best 10 months, suggesting that such tools would need to be continuously recalibrated (Committee on the Global Financial System (2012)).

[6]Tightening LTV or DTI ratios tends to reduce real credit growth by 1 to 2 pp and real house price appreciation between 2 to 5 pp. However, the latter effect on prices is not as evident in other studies (Committee on the Global Financial System (2012)).

housing prices). These papers commonly perform event studies or panel data regressions at the country level. The overall findings of this literature can be summarized as follows: (i) macroprudential policies can reduce the impact of a bust, diminishing the impact on the real economy (Bakker et al. (2012)); (ii) their tightening is associated with lower bank credit growth and house price inflation (Bruno et al. (2015), Cerutti et al. (2015) and Akinci & Olmstead-Rumsey (2015)); (iii) the effects appear to be smaller in more financially developed and open economies (Cerutti et al. (2015)) and; iv) macroprudential policies are more successful when they complement monetary policy by reinforcing monetary tightening, than when they act in opposite directions (Bruno et al. (2015)).

The use of aggregate data has been used, in particular, to examine the use of reserve requirements, as these have been used by several countries in Latin America, including Colombia. The evidence suggests that these requirements had some transitory effects on credit growth and played a complementary role to monetary policy (Tovar et al. (2012) Agénor & da Silva (2016)). In the region, changes in reserve requirements were occasionally quite large, so the impact could have been significant (Montoro & Moreno (2011)). In the same direction, Federico et al. (2014) finds that exogenous changes in this tool in Argentina, Brazil, Colombia and Uruguay had a significant effect on output. The use of aggregate information in Colombia also suggest that reserve requirements are important long-run determinants of business loan interest rates and have been effective in strengthening the pass-through from policy to deposit and lending interest rates (Vargas et al. (2010)).

Regarding the second group, some papers have used information at the bank level to evaluate the impact of various macroprudential policies on individual banking indicators. This strand of the literature has mainly found that DTI ratios and LTV ratios seem to be comparatively more effective than capital requirements as tools for containing credit growth (Claessens et al. (2013) and Lim et al. (2011)). In addition, maximum LTV and DTI ratios and limits on credit growth and foreign currency lending are effective in reducing bank leverage during booms; the authors also find that few policies help to stop declines in bank leverage and assets during downturns (Claessens et al. (2013)). Studying the case of China, Wang & Sun (2013) find that reserve requirements and housing related policies can be useful to reduce procyclicality, but are not enough to reduce systemic risks, suggesting that better targeted policies could have greater potential to contain macro financial vulnerabilities.

Other papers, also using information at the bank level, find that the implementation of macroprudential policies can generate spill-over effects that are commonly ignored. For instance, Aiyar et al. (2014) study the effects of bank capital regulation in the UK (time-varying and bank-specific capital requirements), and find that banks tend to reduce lending when capital ratios increase, but that non-UK regulated banks (resident foreign branches) increased lending in response to tighter capital requirements on regulated banks.

More recently, efforts have been aimed towards evaluating macroprudential policy tools using credit registry data, which allows quantifying the effects of different tools in a more precise way, since the level of granularity allows disentangling supply and demand effects. Nevertheless, there are still relatively few papers in the literature that have used this information to evaluate certain policies. One remarkable exception is the work done by Jiménez et al. (2012), in which the authors examine the effect of countercyclical provisions on credit growth in Spain and the associated real effects. The authors find that these provisions were successful in reducing the effects of a credit crunch (due to build-up of capital buffers) but they were not as successful in curbing the pre-crisis credit boom. In the same line, López et al. (2014) find that countercyclical provisions in Colombia effectively helped reduce the amplitude of credit cycles.

In Brazil, using credit registry data, Martins & Schechtman (2013) find that increases in risk weights on highly leveraged automobile loans significantly reduced such financing. For the case of Uruguay, Dassatti & Peydró (2014) show that reserve requirements for short-term foreign deposits reduced credit supply. The authors also find that more affected banks increased their exposure to riskier firms and that larger banks were less affected by this regulation.

In summary, even if the literature on the effectiveness of macroprudential policies is still in an early stage, there is an increasing interest to evaluate the impact of different instruments. At this point, the experience of countries that have employed macroprudential policies in the past is of particular relevance. The findings in the literature suggest that the use of these tools can have significant effects on different variables of interest, such as credit growth and measures of bank performance. There is also evidence that the implementation of these policies is accompanied by some effects outside the banking sector. However, many of these papers employ aggregate or bank level information for their analysis, which is not devoid of identification problems that could affect the validity of the results. Colombia represents an interesting experiment, since it is a country that has employed different macroprudential policies, mainly to dampen credit cycles and reduce systemic risk. Therefore, in what follows an evaluation of different macroprudential policies using a rich data set for commercial loans controlling by some characteristics of debtors and lenders is performed.

3 Data and Methodology

3.1 Experience with macroprudential policies in Colombia: 2006-2009

During the second half of 2006 and through the first semester of 2007, the Colombian financial system experienced a period of rapid credit growth, partially countervailing the Central Bank's monetary policy tightening aimed at curbing excessive expenditure growth and inflation. Specifically, total loans expanded at an average annual real rate of 25.6% during the period, with consumer loans reaching 41.0% and commercial loans registering a rate of 21.7%. In an attempt to reinforce the sluggish transmission of policy rates and limit credit growth, marginal reserve requirements were introduced in May 2007. In particular, a requirement of 27% was initially placed on current accounts, 12.5% for savings accounts and of 5% for term deposits with a maturity lower than 18 months, though by July the requirement for current and savings accounts was unified at 27%; over this period, policy rates rose from 8.25% to 9.25%. By the third quarter of 2008, the economy started to show signs of a slowdown and, given the uncertainty around the possible effects of what turned out to be the global financial crisis, certain local lending interest rates rose in the last quarter of 2008 as liquidity risk premia increased. The Central Bank reacted by reducing the effective reserve requirement[7], thus expanding liquidity in the market (Montoro & Moreno (2011) and Vargas et al. (2010)). Policy rates followed and began progressively decreasing in December 2008, from a high of 10% (set in July 2008) to 4.5% only six months later.

Moreover, complementary macroprudential measures were also undertaken during this period. In an attempt to contain a potential substitution from local funding to external borrowing, in May 2007 the Central Bank reactivated a reserve requirement for short-term external borrowing, with the hope of reducing currency mismatches[8]. In tandem, the Ministry of Finance established a deposit of 40% on

[7] Marginal reserve requirements were set at a level of zero in September 2008.
[8] External loans were required a deposit (i.e. reserve) of 40% with a holding period of 6 months.

portfolio investment[9] and, one year later, required foreign direct investment to have a minimum permanence of two years, thus discouraging speculative flows. The response of financial authorities to reduce the extent of liquidity and foreign currency mismatches by introducing these limits seems coherent with the lessons derived from the financial crisis of the late 90's, as it became apparent that capital flows are largely intermediated (directly and indirectly) through the domestic banking system, hence inducing important liquidity and foreign currency risks that may materialize if there is a sudden stop in capital flows (Reinhart & Kaminsky (1999), Villar et al. (2005) and Uribe (2011)). These controls on foreign flows were terminated in October 2008.

The dynamics of the commercial loan portfolio, the policy rate and the macroprudential tools put in place between 2007-2008 can be seen in Figure 1. In addition to the countercyclical reserve and external borrowing requirements mentioned above, the effects of the new provisioning scheme for deposit-taking institutions supervised by the SFC can also be observed. Though the dynamic provisioning model had been announced in previous years (specifically, July 2005), the new regime for commercial loans came in effect in July 2007, where an evident increase in specific provisions can be witnessed[10]. Therefore, even though the provisioning scheme was not conceived as a tool to dampen credit growth, its possible effect on the credit cycle cannot be brushed aside, as some evidence seems to confirm their effect on the latter in Colombia (López et al. (2014)). The credit cycle of the commercial portfolio can also be evidenced in Figure 1: between June 2006 and May 2007, commercial loans grew at an average real annual rate of 21.6%; once the macroprudential tools were activated and for the following two years growth rates decelerated, averaging 14.2%. By the final half of 2009 the cycle was evidently in the downturn, and commercial loans grew at an average rate of 1.6% between July and December, with a low of -3.1% in November.

3.2 Data

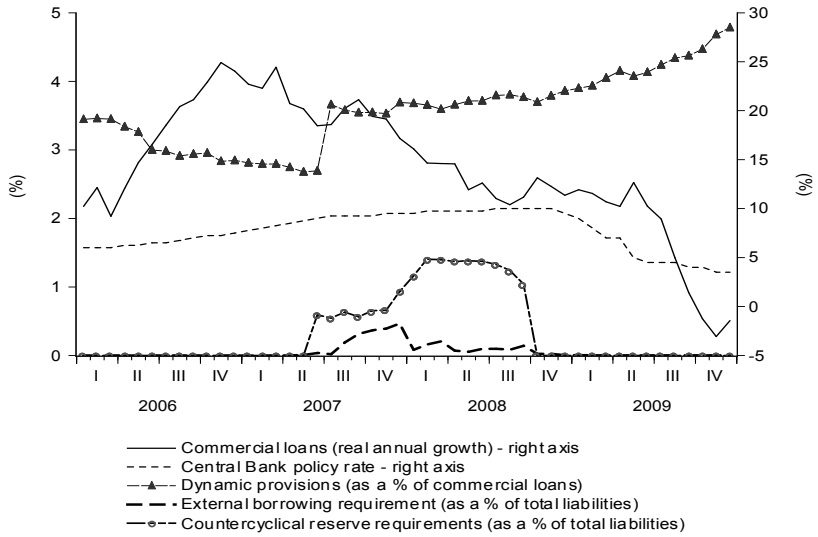
To evaluate the effectiveness of the aforementioned macroprudential policies on credit growth and banks' riskiness, a quarterly dataset containing microdata on the loan-by-loan operations of firms in the commercial portfolio of banking institutions between 2006Q1 and 2009Q4 is utilized[11]. The period for the analysis considers information of the year prior to the adoption of the macroprudential policies to be evaluated as well as the year following their elimination (countercyclical reserve and external borrow-

[9] The deposit on portfolio flows was increased to 50% in May 2008, before being eliminated in October of the same year.

[10] With the new model, individual (i.e. specific) provisions can be calculated with an internal model or with a benchmark model proposed by the Financial Superintendence of Colombia (SFC). When institutions use the latter model, all inputs in the calculation of the Expected Loss are supplied by the supervisor (i.e. Probability of Default and Loss Given Default). In a nutshell, the methodology for calculating the individual provision consists of estimating two components, an individual procyclical component and an individual countercyclical component. Depending on whether the institution is in a "good phase" or in a "bad" one (to trigger from one to the other, 4 individual indicators on the general financial health of the institution must be above a specified threshold for a period of at least three consecutive months), the formulas to calculate the provisioning level differ; in a "good phase" the accumulation methodology is used, whilst during a "bad phase" the reduction methodology is used. The regulation of the provisioning scheme allows an individual institution facing difficulties, even under a general favorable economic scenario, to compensate part of its provisioning expense, for a particular category, with the use of the countercyclical components obtained from the individual provisions of that loan category.

[11] The information is from the SFC. Variables included in the dataset contain: Outstanding value of loan (in local and foreign currency), interest rate, maturity, credit rating, payment delays (in days), collateral information, provisions, Probability of Default and Loss Given Default, among others.

FIGURE 1: Credit Dynamics, Macroprudential Policies and Central Bank Policy Rate



Source: Superintendencia Financiera de Colombia and Banco de la República; authors' calculations.

ing requirements) or last modification (dynamic provisions)[12]. The resulting sample consists of over 1.9 million observations and 272,306 unique bank-debtor relationships[13](Table 1).

TABLE 1: General characteristics of the firms-only sample

Total Observations	1,953,520
Banks	22
Debtors	152,862
Bank-debtor relations	272,306

Source: Superintendencia Financiera de Colombia; authors' calculations.

In addition, attention is centered on firms' commercial loans for two main reasons. On the one hand, they represented the bulk of credit of Colombian banks, thus embodying the most important debtor of the financial system. As can be seen in Figure 2, commercial loans averaged 61.3% of total loans in the financial system in the period under study, with an average outstanding value of USD 37.7 billion[14]. Of this total, firm's commercial loans with banks represented roughly 72%, implying a concentration of 44% of total loans on this kind of debtors.

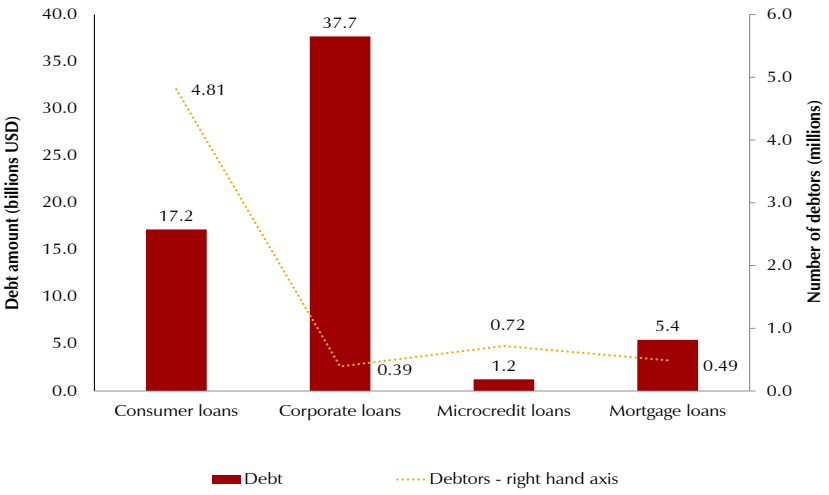
On the other hand, since one of the variables of interest is loan growth at the bank-client level, one can only incorporate in the sample those debtors that have loans in at least two consecutive quarters. Therefore, the dataset does not consider the value of a new loan on the quarter on which it is granted, unless it is the result of an existing bank-client relationship. A loan for a new bank-debtor relationship would be considered after two consecutive quarters. Therefore, working with a sample of only firms, which

[12]The dynamic provisioning scheme was tightened on June of 2008.

[13]The complete commercial loans sample (after dropping null observations) includes 6,581,117 observations, of which 4,627,597 are individuals and the remaining 1,953,520 are firms. In terms of bank-debtor relationships, the complete sample is comprised of 888,860 unique relationships, with individuals accounting for 616,554 of these.

[14]Average of the outstanding loan amounts at the end of each year in the period 2006-2009 converted to dollars using the end-of December exchange rate between the COP and the USD of each year.

FIGURE 2: Financial system's debtors and debt amounts
(average 2006Q1-2009Q4)



Source: Superintendencia Financiera de Colombia; authors' calculations.

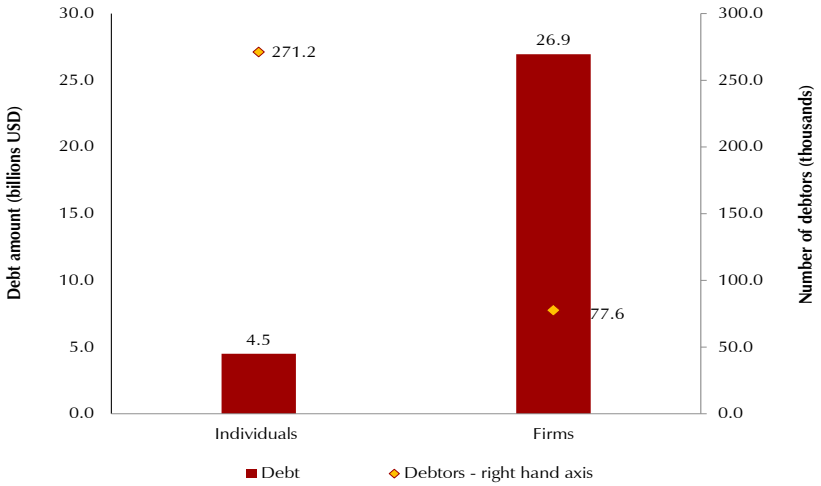
intuitively have more stable and long-lasting banking relationships than individuals, should reduce a potential data bias (see Appendix A). In this context, stability is associated with both a higher likelihood of observing new loan operations on existing relations, thus allowing one to observe positive changes through time in loan growth at the bank-debtor level, and a lower number of new (hence dropped) relationships[15]. Figure 3 allows one to gauge the potential benefits from using the sub-sample of firms, as individuals (which should account for a large number of new banking relationships) are large in number but represent only a fraction of total commercial banking loans (around 14.3%).

The sub-sample of firms has some interesting characteristics itself. For instance, as evidenced in Figure 4, there is an evident concentration in the borrowers of the commercial loan portfolio of the sub-sample of firms. Indeed, the cumulative distribution of the number of debtors reaches values over 90% much faster than that of the debt amount (Panel A). In particular, while close to 96% of the total number of borrowers in a given year have loans of up to USD 1 million, their debt roughly accounts for 16% of total outstanding commercial loans to firms. On the flip side, around 4% of the number of debtors hold close to 84% of the outstanding debt.

Moreover, the analysis of the average number of banking relationships of borrowers (Panel B) suggests that firms that hold large amounts of debt tend to have a high number of banking connections. Specifically, 3.4% of total debtors, which account for 54.1% of the outstanding debt, have five or more banking relationships; indeed, less than 7% of total debtors have 4 or more banking connections, but concentrate over 67.6% of total debt. Most debtors (66.9%) only have one banking relationship in the period of analysis, and represent 10.9% of total debt. Lastly, one can notice that the percentage of debtors gradually

[15]Initially, a sample of commercial loans which included both individuals and firms was employed and indeed, the distribution of the credit growth variable presented positive skewness. This was the result of a high number of new banking relationships (observations that are dropped from the sample) and the negative changes in loan value that characterize the amortization process (see Appendix A). Specifically, the average percentage of existing bank-debtor relationships in the sample that reported an increase in their outstanding loan amount each quarter reached 33.6% for firms, against a mere 8.5% for individuals.

FIGURE 3: Banks' corporate loan portfolio: debtors and debt amount
(average 2006Q1-2009Q4)

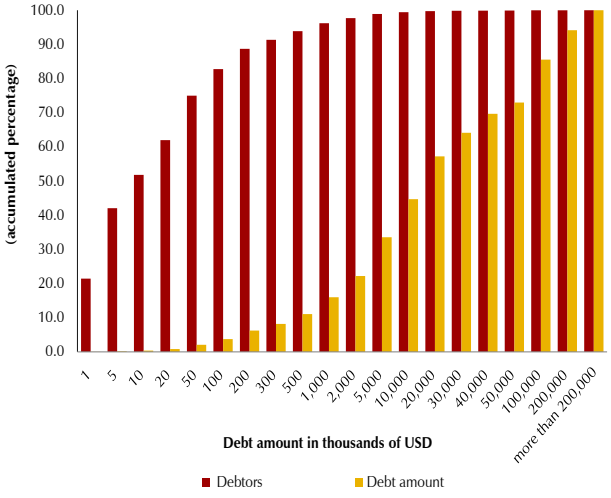


Source: Superintendencia Financiera de Colombia and Banco de la República; authors' calculations.

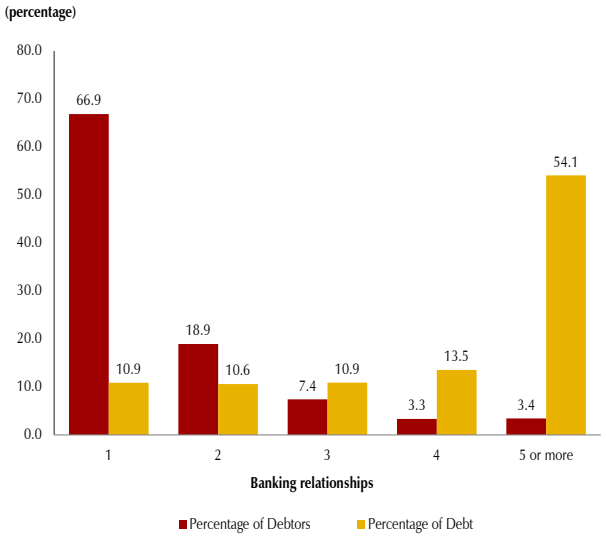
decreases as the number of banking relationships is incremented, but the percentage of debt actually tends to increase as one goes from three to five or more banking relationships.

FIGURE 4: Debtors and debt amount
(average 2006Q1-2009Q4)

A. Cumulative distribution



B. By number of banking relationships



Source: Superintendencia Financiera de Colombia and Banco de la República; authors' calculations.

Intuitively, the aforesaid concentration corresponds to large firms, given their enhanced access to formal credit, both in terms of a larger number of counterparts and higher credit lines. Table 2 corroborates said

intuition. As can be seen, large firms account for close to 72% of total debt in the sample under analysis despite the fact that they represent just 10.2% of the total number of bank-debtor relations. Moreover, when attention is focused only on debtors with 4 or more banking relationships, the representativeness of large firms rises to 85% and 27.1% of outstanding debt and number of relationships, respectively. In addition, the concentration of the commercial loan portfolio sample under study is also observed at the sector level. As can be seen in Table 3, two sectors of economic activity concentrate more than 50% of both the total outstanding debt amount and the number of bank-debtor connections (Manufacturing and Wholesale and Retail); these sectors represented 14% and 12% of GDP, respectively, on average between 2006 and 2009.

TABLE 2: Debt amount and bank-debtor relationships, by firm size
(2006Q1-2009Q4)

	All observations		**Debtors with # relationships $\geq$ 4**	
Size	**Debt amount**	**# relationships**	**Debt amount**	**# relationships**
Micro	0.03%	0.45%	0.01%	0.09%
Small	4.86%	38.28%	1.25%	25.23%
Medium	9.96%	15.75%	6.56%	33.28%
Large	72.01%	10.16%	85.04%	27.08%
Others*	13.14%	35.36%	7.13%	14.32%

*Others corresponds to firms for which it was not possible to determine firm size. It is likely these are small and micro-enterprises.

Source: Superintendencia Financiera de Colombia and Superintendencia de Sociedades; authors' calculations.

TABLE 3: Debt amount and bank-debtor relationships, by sector of economic activity
(2006Q1-2009Q4)

Sector of Economic Activity	**Debt amount**	**# relationships**
Agriculture and Fishing	3.4%	4.1%
Mining	2.4%	0.7%
Manufacturing	29.6%	19.8%
Electricity, gas and water suppliers	6.4%	0.4%
Construction	8.5%	6.5%
Wholesale and retail	23.8%	33.8%
Accommodation and Food Services	0.6%	1.6%
Transportation and Storage	8.2%	6.7%
Real State Activities	5.2%	15.0%
Others*	11.6%	10.8%
Without classification	0.1%	0.5%

*Others include firms that belong to the following sectors: public administration and defense, education and community, social and health services, among others.

Source: Superintendencia Financiera de Colombia and Superintendencia de Sociedades; authors' calculations.

Table 4 presents some interesting characteristics of the data as well. In particular, one can see that, on average, close to 44% of the outstanding debt amount corresponded to loans with a time-to-maturity of less than one year, whilst in terms of the number of bank-debtor relationships this share was 33.7%. This result indicates that there are loans of significant amount which were granted with a term of less than a year. The opposite occurs with both non-performing loans and the share of collateralized loans. In these cases, the share of debt represented by loans with more than 30-days overdue and those with eligible collateral is lower than the share of bank-debtor observations which meet the same criteria. The latter

implies that loans of a larger amount have lower levels of risk materialization and of collateralization. It may be argued that this is associated with the fact that such loans are extended to client-firms, which given their risk profile, are not required to pledge collateral.

TABLE 4: Debt amount and bank-debtor relationships, by certain loan characteristics
(2006Q1-2009Q4)

	Debt amount	**# relationships**
Maturity $<$ 1 year	44.3%	33.67%
Non-Performing loans	2.11%	10.73%
Collateralized loans	27.17%	28.35%

Source: Superintendencia Financiera de Colombia; authors' calculations.

Lastly, the mean amount of loans granted in the sample reached USD197,463, with a median time-to-maturity of 1.42 years and an annual interest rate of 21% (Table 5). The measures of variability of these variables are indicative of the significant dispersion in this portfolio generated by the heterogeneity of the debtors in the sample (e.g. the median outstanding debt amount is a mere USD10,170).

TABLE 5: Descriptive statistics
(2006Q1-2009Q4)

Measure	**Debt amount (USD)**	**Loan rate (%)**	**Maturity (years)**
Central tendency	197,463.25	20.95	1.42
Dispersion	1,648,786	5.56	1.04

The measure of central tendency corresponds to the mean in the case of the debt amount, while the median is used for the interest rate and maturity of the loan. Consistent with this, the measure of dispersion is the standard deviation, in the case of the first variable, and the median absolute deviation otherwise. The usage of the median and median absolute deviation for the loan rate and maturity is a consequence of outliers in the data. These are the result of errors in the information reported by the institutions.

Source: Superintendencia Financiera de Colombia; authors' calculations.

3.3 Estimating the Effects of Macroprudential Policies

In order to evaluate the effects on lending and bank riskiness of the macroprudential tools that are being analyzed, a loan-by-loan database is employed. As there are many factors that may influence lending dynamics and bank riskiness, different types of control variables are used to obtain a more precise measure of the macroprudential tools' impact on the variables of interest. In particular, these controls include a set of macroeconomic variables, as well as bank, bank-debtor relationship and debtor characteristics. A set of dummy variables is also included to take into account potential seasonal effects.

Additionally, different equations are estimated to check whether the macroprudential tools' effect on lending varies depending on different conditions, such as the business or financial cycle, the monetary policy stance, and banks' and firms' riskiness. In performing all these estimations, a panel methodology using fixed effects is employed[16].

[16]The Hausman test was performed for all equations and statistical evidence to use the fixed effects approach was found.

3.3.1 Variables' Description[17]

In practical terms, the dependent variables that are considered to evaluate the effect of the macroprudential tools on lending are: i) the quarterly growth of the actual value of loans ($\Delta Log\ Credit_{br,t}$); ii) the quarterly change in the loans' interest rate ($\Delta Interest\ rate_{br,t}$)[18]; and iii) the quarterly growth of the value of non-performing loans ($\Delta Log\ NPL_{br,t}$).

For the purpose of this paper, which is to evaluate the effect of the macroprudential tools on the aforementioned variables, the specification used for the three macroprudential policies mentioned is: i) the ratio between the total amount of dynamic provisions and total commercial loans ($DP_{br,t}$); ii) the amount of the external borrowing requirement to total liabilities ratio ($EBR_{br,t}$)[19]; and iii) the amount of the countercyclical reserve requirement to total liabilities ratio ($CRR_{br,t}$). Importantly, all the individual macroprudential policies included in this paper are calculated for each bank in quarter t, thus accounting for the differential impact of the former given the balance-sheet structure of each institution.

Additionally, as some of the macroprudential tools were active at the same time, an aggregate variable is used to estimate the joint effect of the tools ($MPP\ index_t$). This index captures the aggregate macroprudential policy stance of the country, and is defined as the sum of the three individual policies' dummy variables (dummies that take the value of 1 if the policy is in place and 0 otherwise). Figure 5 presents the aggregate index along with real annual growth in commercial credit and in commercial non-performing loans. As can be seen, macroprudential policy was implemented in a countercylical fashion, with most policies being activated by mid-2007; a period of rapid credit growth. Following the activation of these policies a deceleration in loan growth is readily observable, with the effect on non-performing loans' growth ensuing a few quarters later. Though it is important to keep in mind that other factor where at work during the dynamics in credit markets here presented, particularly the collapse of Lehman bothers in 2008, the observed relationship between these variables points towards a linkage that should, at the very least, be better understood.

Control variables are divided in four groups: macroeconomic, bank-specific, bank-debtor relationship and debtor-specific controls. The first group includes the following variables in annual (Δ^A) and quarterly (Δ^Q) changes: real GDP growth ($\Delta Log\ GDP_t$), the change in the interbank rate as a proxy of the monetary policy stance ($\Delta MP\ rate_t$), the real growth in the exchange rate ($\Delta Log\ EX\ rate_t$)[20] and the real growth in the current account deficit ($\Delta Log\ CA\ deficit_t$). Moreover, the following variables are included in levels: a dummy variable to control for the global financial crisis ($Dummy\ Crisis_t$) and the credit to GDP gap ($CGDP\ gap_t$) to control for the stance of the financial cycle.

In terms of bank controls several financial ratios are used, such as the liquidity ratio ($Bank\ Liquidity_{br,t}$), return on assets ($Bank\ ROA_{br,t}$), bank size ($Bank\ Size_{br,t}$), and the deposits to total liabilities ratio ($Bank\ Fund\ Composition_{br,t}$). Additionally, given that specific effects on credit could originate from regulation, an indicator signalling whether a bank is close to the regulatory minimum capital ratio is included ($Bank\ Signalling_{br,t}$)[21]. This control variable is also useful to evaluate if changes in macropru-

[17] The precise definition of the variables employed in the regressions is found in Appendix B.

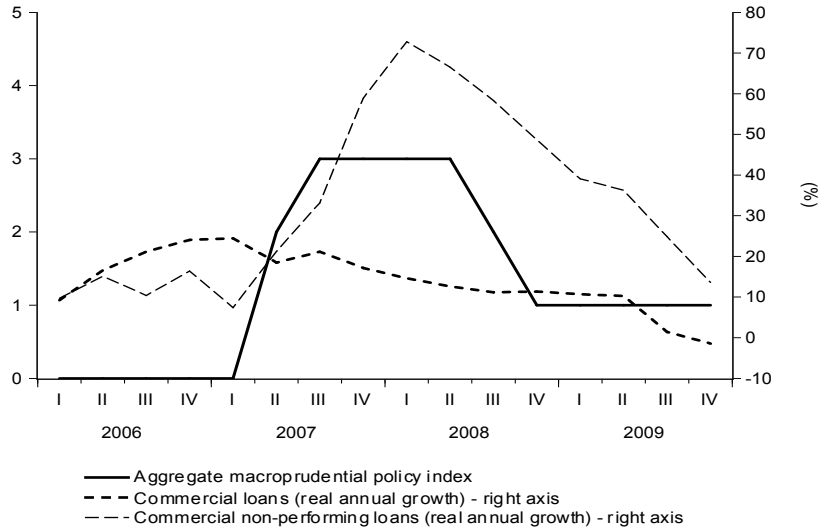
[18] The interest rate estimated is the weighted average by credit amount of all loans' interest rates for each bank-debtor relationship.

[19] The requirement on external borrowing includes only those deposits done by the commercial bank directly as a result of its indebtedness decisions, and excludes those of clients who intermediate their external borrowing with said institutions.

[20] The exchange rate considered is that of the COP to USD. The level of the exchange rate is expressed relative to the CPI.

[21] Specifically, the indicator takes a value of 1 if the bank's capital ratio is below the regulatory minimum of 9% plus 200 basis points.

FIGURE 5: Aggregate Macroprudential Policy Index, Commercial Loans and NPL Growth (2006Q1-2009Q4)



Source: Superintendencia Financiera de Colombia and Banco de la República; authors' calculations.

dential policies could have a differential impact on those banks which are more capital-constrained. For bank riskiness, a dummy variable that takes the value of 1 if the bank's Z-score indicator[22] is below the quarterly average of the banking system is used ($Zscore_{br,t}$).

The bank-debtor relationship controls are related to the loans' collateral and the debtor's riskiness. In particular, a dummy variable is defined to distinguish if the loans have an acceptable collateral ($Collateralized\ Loans_{br,t}$) and, as a proxy for debtor riskiness, a dummy variable based on the number of days a loan has been past due is used. Specifically, this variable takes the value of one when any of the loans of a specific debtor has been past due for more than 30 days in quarter t or at least one of the previous three quarters ($Firm\ Risk_t$). Additionally, for a sub-sample of firms[23], a set of variables to take into account the specific characteristics of each debtor is employed. These variables include the return on assets ratio ($Firm\ ROA_{br,t}$), the current assets to current liabilities ratio ($Firm\ Liquidity_{br,t}$), the leverage ratio ($Firm\ Leverage_{br,t}$) and the size of the firm ($Firm\ Size_{br,t}$).

3.3.2 Estimating the Effects on Different Dimensions of Credit

Effects on Credit Growth

As stated above, to estimate the different equations, a fixed effects panel methodology is implemented, where the two dimensions of the panel are time (t) and the bank-debtor relationship (br)[24]. Equation (1)

[22] The Z-score variable is defined as the ratio between the sum of the capital ratio and the mean of the ROA and the standard deviation of the ROA. This measure is negatively related with a bank's probability of default.

[23] This sub-sample consists of firms for which there is available balance sheet information. This corresponds to the universe of firms supervised by the Superintendencia de Sociedades (a superintendence for corporates), which for the period 2006-2009 accounted to roughly 23.000 firms per year. In turn, these firms represented close to 58% of banks' commercial loans granted to firms during the same period.

[24] Originally, the panel database has three dimensions: time (t), bank (b) and debtor (d). In order to simplify the calculations and reduce the database to two dimensions, the bank and debtor dimension are considered jointly in one; the bank-debtor relationship (br).

is estimated to assess the effect of the macroprudential tools on lending dynamics. It can be expressed as:

$$\Delta Log\ Credit_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \quad (1)$$

where δ_{br} are the bank-debtor relationship fixed effects, $quarter_t$ contains the set of dummy variables to consider seasonal effects, $Macro\ Controls_{t-i}$ are the macroeconomic variables aforementioned, $Bank\ Controls_{br,t}$ contains the five financial indicators described above, and $Firm\ Controls_{br,t-i}$ includes the variables related to the firms' or loans' characteristics[25]. The indicator j is a counter for the variables employed in each category, while subscript i denotes the lag. To evaluate the effect of the macroprudential tools on the dependent variable, one is interested in the statistical significance of each of the parameters that multiply these variables ($\beta_j \ \ \forall j = 1, 2, 3.$). As one of the main objectives of these tools is to reduce excessive credit growth, the expected signs for these parameters is negative.

Likewise, to confirm whether the effect of the business cycle over credit growth is altered by the stance of the macroprudential policies, in equation (2) an interaction term between $\Delta Log\ GDP_{t-i}$ and $\Delta MPP\ index_t$ is included. In this case, as the macroprudential tools that are evaluated tend to increase the costs of new disbursements, the effect of GDP growth on loan dynamics should be lower when the stance of the macroprudential policy is tightened. Therefore, γ is expected to be statistically negative.

$$\Delta Log\ Credit_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} + Firm\ Controls_{br,t-i} + \gamma \Delta MPP\ index_t * \Delta Log\ GDP_{t-i} + quarter_t + \varepsilon_{br,t} \quad (2)$$

Another analysis is performed using equation (3), where the intention is to test if a strong stance of the macroprudential policies reinforces the negative impact that increases in the monetary policy rate should have on lending dynamics (credit channel). Then, if this is the case, θ should be statistically lower than zero. The estimated equation can be written as:

$$\Delta Log\ Credit_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} + Firm\ Controls_{br,t-i} + \theta \Delta MPP\ index_t * \Delta MP\ rate_{t-i} + quarter_t + \varepsilon_{br,t} \quad (3)$$

Additionally, on one hand we are interested in evaluating if macroprudential policies affects risk-taking decisions of financial institutions. In equation (4), ρ evaluates if these policies affect the selection of debtors depending on their risk profile (i.e. risk-taking channel). On the other hand, it is interesting to evaluate whether macroprudential policies have different effects depending on the financial health of banking institutions. A significant coefficient of α suggests that the effect of these tools lending is

[25] In the case where the entire database is used, *Firm Controls* include $Collateralized\ Loans_{br,t}$ for all equations and in addition, $Firm\ Risk_{br,t}$ for equation (4). When the estimations are performed using the sub-sample of firms from Superintendencia de Sociedades, *Firm Controls* also include the firm's financial ratios mentioned in the previous section.

conditioned to the financial situation of lenders (lending channel)[26]. In order for the effect on risk-taking to be significant, both ρ and α should be statistically lower than zero. The model can be expressed as:

$$\begin{aligned}\Delta Log\ Credit_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} \\ + Firm\ Controls_{br,t-i} + \alpha \Delta MPP\ index_t * Bank\ Risk_{br,t} \\ + \rho \Delta MPP\ index_t * Firm\ Risk_{br,t} + quarter_t + \varepsilon_{br,t} \end{aligned} \tag{4}$$

In order to complement the previous analysis, equation (1) is re-estimated using the aggregate macroprudential index ($MPP\ index_t$) instead of the individual $Macro\ Tool$ variables. In this case β represents the marginal effects on credit growth of the macroprudential policy stance, and is expected to have a negative sign. Equation (5) is expressed as:

$$\begin{aligned}\Delta Log\ Credit_{br,t} = \delta_{br} + \beta \Delta MPP\ index_t + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} \\ + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \end{aligned} \tag{5}$$

Effects on Loans' Interest Rates

Moreover, another interesting analysis is to quantify the potential effect of the macroprudential tools on the cost of lending. Ergo, in equation (6) the change in the loans' interest rate is the dependent variable, and the estimated model can be represented as:

$$\begin{aligned}\Delta Interest\ rate_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} \\ + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \end{aligned} \tag{6}$$

As the macroprudential tools that are evaluated may have different effects on banks' lending behavior, the expected signs of the β_j are non-trivial. While some of the policies may create incentives to reduce exposure to riskier clients (e.g. provisions), others may lead to higher credit costs associated with a decline in available loanable funds (e.g. reserve requirements). Similarly, the previous equation is also estimated using the aggregate index that represents the macroprudential policy stance:

$$\begin{aligned}\Delta Interest\ rate_{br,t} = \delta_{br} + \alpha \Delta MPP\ index_t + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} \\ + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \end{aligned} \tag{7}$$

Given the expected differential effect between the individual policies, the sign of the α coefficient in equation (7) is ambiguous.

Effects on Non-Performing Loans

[26] As the bank's riskiness measure depends on the Z-score, that is a function of the bank's ROA and capital ratio, the latter are removed from the $Bank\ Controls_{br,t}$ and replaced by the bank riskiness measure. Moreover, for this equation, $Firm\ Controls$ also include the $Firm\ Risk_{br,t}$ indicator.

Equation (8) is estimated in order to quantify the effect of each macroprudential tool on the riskiness of the banks' loan portfolio. The dependent variable is the quarterly change of non-performing loans, and the model specification is the same as the one used in equation (1). Specifically, one is interested in assessing if each of the β_j is statistically significant, though the sign is again expected to vary between policies and be directly related to the impact of these tools on the loans' interest rates. The model is given by:

$$\Delta Log\ NPL_{br,t} = \delta_{br} + \sum_{j=1}^{3} \beta_j Macro\ Tool^j_{br,t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \quad (8)$$

Additionally, equation (9) evaluates the effect of the aggregate stance of macroprudential policy on the behavior of non-performing loans. In this case, the first two lags of the $MPP\ index_t$ are included in the estimations to take into account that the effects on credit risk materialization may take several months. In this specification, $\sum_{j=0}^{2} \beta_j$ represents the aggregate marginal effect on non-performing loans' growth of the stance of macroprudential policy.

$$\Delta Log\ NPL_{br,t} = \delta_{br} + \sum_{i=0}^{2} \beta_j \Delta MPP\ index_{t-i} + \sum_{j=1}^{5} Macro\ Controls^j_{t-i} + \sum_{j=1}^{5} Bank\ Controls^j_{br,t-i} + Firm\ Controls_{br,t-i} + quarter_t + \varepsilon_{br,t} \quad (9)$$

On a final note, it is worth mentioning that in the estimation process of all the equations both null observations and outliers were removed. In particular, for each dependent variable, values below its 1^{st} percentile and over its 99^{th} percentile were dropped. Moreover, for all the equations, based on the statistical significance of the parameters, the value of $i = 0, 1$ or 2 is selected for the control variables as well as the macroprudential tools.

4 Results

4.1 Estimation Results Using the Full Sample of Firms

The main results from the econometric models explained above can be found in the Tables below. In particular, Table 6 depicts the estimated coefficients for the first five equations described in Section 3.3.2. As can be seen, macroprudential policies associated with higher provisioning and reserve requirements effectively have a negative effect on loan growth (equations (1) - (4)). These results are as expected, as both policies imply an increase in the cost of intermediation; in the first case associated with higher provisioning expenses, and in the other with a reduction in the amount of available funds to lend. On the other hand, note that the requirement on external borrowing does not have a statistically significant effect on credit growth. This last result is consistent with the findings reported by Ostry et al. (2010), who survey a number of papers on the role of the 2007-2008 capital controls in Colombia and find that they had no effect on reducing the volume of net foreign flows[27]. Moreover, the change in the *MPP index*,

[27] The papers surveyed in Ostry et al. (2010) for the case of Colombia are Concha & Galindo (2008), Cárdenas (2007) and Clements & Kamil (2009).

which captures the aggregate stance of macroprudential policy, also has a negative and significant effect on credit growth.

The impacts of the relevant macroeconomic controls used in the distinct specifications show consistency in their effect on loan dynamics. On one hand, higher economic growth leads to an increase in lending, consistent with the procyclicality exhibited in credit markets: a growing economy requires financing for investment projects and higher consumption of goods, while at the same time improves the balance-sheet of the private sector, increasing bank's willingness to lend (Kiss et al. (2006)). On the other, the policy rate has a negative and consistently significant effect on credit growth, highlighting the countercyclical nature of monetary policy and the effectiveness of its tool. In addition, this last result conveys an important implication, namely, it confirms the complementarity between macroprudential and monetary policy, as they both have a moderating effect on loan growth when tightened (as was the case in the 2007-2008 period).

Pertaining to the effect of the interaction between the *MPP index* and real GDP growth (equation (2)), results show that this is also consistent with the notion that macroprudential policy serves as a stabilizing tool in the economy. In particular, when the macroprudential policy stance is tightened, the expansionary effects of economic growth on credit are reduced, thus dampening the prociclicality of loan growth. The interaction with the policy rate (equation (3)) has the expected sign, with macroprudential policy reinforcing the effect of monetary policy. However, the coefficient is not statistically significant.

In addition, equation (4) provides an interesting insight as to the role of macroprudential policy in altering banks' risk-taking behavior. As can be seen, firms and banks with a higher risk profile are associated with lower loan growth. Moreover, results show that when macroprudential policies are in place, the access to credit of riskier debtors is further reduced and that the credit supply of less stable financial institutions is more severely affected. Thus, a tightening of the aggregate macroprudential policy stance adversely affects the selection of debtors depending on their risk profile (i.e. risk taking channel), while at the same time suggesting that the effect on credit is conditioned to the lenders' financial situation (i.e. lending channel).

The effects of the individual macroprudential policies, as well as the change in the *MPP index*, on loans' interest rates can be found on Table 7. In this case, all the individual policies have a statistically significant effect, though this impact differs between policies; dynamic provisions effectively reduce loan's interest rate while the marginal reserve and external debt requirements exert a positive effect. These results seem to be in line with the particular objectives sought after with each policy. Provisions, which are targeted at increasing provisioning expenses, specifically those of riskier loans (which have higher expected losses), could create incentives for banks to cherry-pick their clients, thus allowing for lower interest rates. On the flip side, the use of requirements which reduce the amount of (stable) loanable funds, ultimately leads to a higher cost of credit[28]. The lack of statistical significance in the coefficient for the aggregate index seems to be driven by the opposing effects of the distinct policies.

With respect to the macroeconomic controls, it is found that higher GDP growth and higher policy rates both have a positive effect on loan interest rates. The former could be associated with the fact that economic growth is related to higher credit demand factors, so that an expansion in the loan portfolio eventually implies originating to riskier debtors. The latter simply corroborates the existence of a bank-lending channel in the Colombian economy.

[28] Even in the case in which a bank decides to maintain loan growth through an increased use of open market operations with the Central Bank, these would be done at a higher cost.

TABLE 6: Estimation Results on Credit Growth

Relevant Exogenous variables	Equations (1)	(2)	(3)	(4)	(5)
$DP_{br,t}$	-0.511***	-0.577***	-0.512***	-0.298***	
$EBR_{br,t}$	0.220	0.063	0.187	0.085	
$CRR_{br,t}$	-0.665**	-0.856***	-0.720***	-0.709***	
$\Delta MPP\ index_t$					-0.012***
$\Delta MPP\ index_t * \Delta^A GDP_{t-1}$		-0.188***			
$\Delta MPP\ index_t * \Delta^A MP\ rate_t$			-0.163		
$\Delta MPP\ index_t * Firm\ Risk_t$				-0.005**	
$Firm\ Risk_t$				-0.065***	
$\Delta MPP\ index_t * Zscore_t$				-0.004**	
$Zscore_t$				-0.005***	
$\Delta^A Log\ GDP_{t-1}$	0.235**	0.422***	0.295**	0.267***	0.654***
$\Delta^A MP\ rate_t$	-0.648***	-0.383***	-0.583***	-0.273**	-0.364***
Observations	1,635,741	1,635,741	1,635,741	1,412,071	1,635,741
Hausman Test p-value	0.000	0.000	0.000	0.0000	0.000
F Test p-value	0.000	0.000	0.000	0.0000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

Concerning the determinants of non-performing loans, it is found that, amongst the individual macroprudential policies, only dynamic provisions have a statistically significant effect. Results for this tool are consistent with what was found on equations (6) and (7), and confirm the intimate link between debtors' riskiness and the price associated with their loans; i.e. the implementation of provisions seems to have induced reduced risk-taking from banks, thus resulting in both lower interest rates and non-performing loans. On the other hand, both the marginal reserve and external borrowing requirements, which led to a higher cost of credit, do not seem to have had a significant effect on the quality of banks' loan portfolios. Also note that, as mentioned in Section 3.3.2, these are the only specifications in which the individual macroprudential policies are lagged (2 quarters)[29]. The rationale for this follows from the fact that as soon as the policies are in place, the changes induced in banks' incentives should be immediately reflected in their new loan origination and interest rate setting. Moreover, increments in market rates associated with the imposition of reserves/deposits will lead to an increase in the cost of loans whose interest payments are indexed to said rates. This is not the case with non-performing loans, as the effects on this variable are, by definition, only materialized when debtors' financial capacity is impaired in such a way that they are unable to meet their credit obligations for a period of more than 30 days.

[29]The choice of the order of the lag follows from Figure 5, which confirms the lagged response on non-performing loan dynamics following the implementation of macroprudential policies.

TABLE 7: Estimation Results on Loans' Interest Rate

Relevant Exogenous variables	**Equations (6)**	**(7)**
$DP_{br,t}$	-37.920***	
$EBR_{br,t}$	29.036***	
$CRR_{br,t}$	73.854***	
$\Delta MPP\ index_t$		0.003
$\Delta^Q Log\ GDP_t$	61.575***	80.234***
$\Delta^Q MP\ rate_t$	28.549***	21.956***
Observations	1,459,331	1,459,331
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

In this order of ideas, the specification which includes the change in the *MPP index* is evaluated with the contemporaneous and first two lags[30], and validates the aforementioned intuition, as only the second lag proves to be statistically significant[31].

Relating to the macroeconomic controls used in these specifications, it is interesting that the policy rate has no statistically significant effect on non-performing loans. The latter could be related to the particular period under analysis (2006-2009) in which monetary and macroprudential policies where used countercyclically during a period of high economic growth, thereby having a moderate impact on debtors' repayment capacity. Conversely, the credit-to-GDP gap (which is used in place of GDP to account specifically for the stance of the financial cycle)[32], shows a positive and significant relationship with non-performing loans, confirming the strong link found in the literature between periods of high credit growth and posterior scenarios of financial instability (Kaminsky & Reinhart (1999), Allen & Gale (2000) and Borio & Lowe (2002, 2004), among others).

Lastly, the robustness in the estimated coefficients, which yield similar results under the different specifications considered, is a strong indication of the validity of the findings in this paper.

[30] A regression including the contemporaneous individual policies along with their lags is not statistically possible, given the high persistence in these series. The same does not hold for the *MPP index*.

[31] An alternate model in which the first lags of the individual macroprudential policies are used as the explanatory variables results in the coefficients pertaining to dynamic provisions and marginal reserves being statistically significant; the former negative and the latter positive. This seems consistent with the non-significance of the coefficient associated with the change in the first lag of the *MPP index*, which could be reflecting the opposing effect between policies.

[32] A model with the usual macroeconomic controls was also estimated. The coefficient on GDP was found to be negative and statistically significant.

TABLE 8: Estimation Results on Non-Performing Loans' Growth

Relevant Exogenous variables	Equations (8)	(9)
$DP_{br,t-2}$	-0.682***	
$EBR_{br,t-2}$	-0.054	
$CRR_{br,t-2}$	0.452	
$\Delta MPP\ index_t$		-0.010
$\Delta MPP\ index_{t-1}$		0.009
$\Delta MPP\ index_{t-2}$		-0.008**
$CGDP\ gap_{t-1}$	1.585***	1.696***
$\Delta^Q MP\ rate_{t-1}$	0.218	-0.379
Observations	123,331	123,331
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

4.2 Estimation Results Using a Sub-Sample of Firms

All the equations are also estimated using a sub-sample of firms for which balance-sheet information is readily available; these are firms under the surveillance of the Superintendencia de Sociedades (SS - Colombia's corporate sector supervisor)[33]. These estimations are done with the double intention of checking the robustness of the previous results as well as to be able to include certain financial characteristics of the firms as control variables in the estimations; these are related to size, profitability, liquidity and leverage[34]. Results for credit growth and loan interest rates are fairly similar to those obtained using the complete sample, while the relationship of non-performing loans with the macroprudential tools is not statistically significant for this group of firms.

Results for the effect on credit growth can be found on Table 9. As can be seen, only the imposition of the dynamic provisioning scheme had a significant negative impact on credit growth for these firms, with both the external borrowing and marginal reserve requirements having no statistically significant effect. The *MPP index* seems to reflect the effect of countercyclical provisions, also having a negative impact on credit growth. Most of the other relevant coefficients have the expected sign, with GDP growth

[33]The Superintendencia de Sociedades (SS) supervises corporations that have total assets that exceed 30.000 monthly minimum legal wages (Article 2.2.2.1.1.1 of Decree 1074 of 2015). According to Law 590 of 2000 (known as the SME Law), a medium enterprise in Colombia is one with a total asset value between 5.001 and 15.000 monthly minimum legal wages. The SS can also supervise other firms based on several criteria (e.g. enterprises which have financial expenditures that exceed 50% of their net operational income, irrespective of their asset size), but in essence most corporations under its scope are indeed large.

[34]Specifically, the variables included are: a categorical variable based on the amount of assets that distinguishes between Micro, Small, Medium and Large firms (size); Return on Assets (profitability); current assets as a share of current liabilities (liquidity); and the ratio of total liabilities to total assets (leverage).

increasing loan dynamics and the policy rate playing its stabilizing role, though being significant only on equation (1). The interaction between real GDP growth and the *MPP index* is also in line with those found for the entire sample, with a tighter aggregate macroprudential policy stance diluting the effect of economic growth on loan dynamics. Moreover, under these specifications, the interaction between monetary and macroprudential policy yields a negative and significant relationship. Thus, results for this sample confirm the stabilizing role of macroprudential policies, which dampen the procyclicality of credit by reducing the effect of the business cycle on the loan portfolio and through a reinforcement of monetary policy. Results on the effect of macroprudential tools on banks' risk-taking do not hold in this sample.

When the effect of the idiosyncratic balance-sheet indicators on loan growth are tested, only the size of the firm seems to be a significant determinant; a higher level of assets is positively related to loan growth.

TABLE 9: Estimation Results on Credit Growth Using the SS Sample

Relevant	**Equations**				
Exogenous variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$DP_{br,t}$	-0.523***	-0.589***	-0.534***	-0.515***	
$EBR_{br,t}$	0.031	-0.092	-0.089	0.076	
$CRR_{br,t}$	-0.112	-0.296	-0.472	-0.084	
$\Delta MPP\ index_t$					-0.015***
$\Delta MPP\ index_t * \Delta^A Log\ GDP_{t-1}$		-0.228***			
$\Delta MPP\ index_t * \Delta^A MP\ rate_t$			-1.185**		
$\Delta MPP\ index_t * Firm\ Risk_t$				-0.003	
$Firm\ Risk_t$				-0.045***	
$\Delta MPP\ index_t * Zscore_t$				0.001	
$Zscore_t$				-0.002	
$\Delta^A Log\ GDP_{t-1}$	0.322*	0.557***	0.759***	0.442**	0.697***
$\Delta^A MP\ rate_t$	-0.503*	-0.179	-0.030	-0.427	-0.156
$Firm\ Size_{br,t}$	0.054***	0.054***	0.054***	0.047***	0.053***
$Firm\ ROA_{br,t}$	0.000	0.000	0.000	0.000	0.000
$Firm\ Liquidity_{br,t}$	-0.000	-0.000	-0.000	-0.000	-0.000
$Firm\ Leverage_{br,t}$	0.000	0.000	0.000	0.000	0.000
Observations	500,255	500,255	500,255	482,250	500,255
Hausman Test p-value	0.000	0.000	0.000	0.0000	0.000
F Test p-value	0.000	0.000	0.000	0.0000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 10: Estimation Results on Loans' Interest Rate Using the SS Sample

Relevant Exogenous variables	Equations (6)	(7)
$DP_{br,t}$	-36.098***	
$EBR_{br,t}$	10.387***	
$CRR_{br,t}$	71.492***	
$\Delta MPP\ index_t$		-0.096***
$\Delta^Q Log\ GDP_t$	61.693***	75.434***
$\Delta^Q MP\ rate_t$	9.023***	10.701***
$Firm\ Size_{br,t}$	-0.020	0.024
$Firm\ ROA_{br,t}$	0.000	0.000
$Firm\ Liquidity_{br,t}$	0.000	0.000
$Firm\ Leverage_{br,t}$	0.000	0.001
Observations	449,111	449,111
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

The effects on interest rates yield basically the same results as those found in the entire sample, confirming the robustness of the results; dynamic provisions have a negative effect on loan rates, while reserve and external borrowing requirements increase the cost of credit. The macroeconomic controls also have the expected signs, with both higher growth and policy rates leading to an increase in the price of loans. An interesting difference with the results for the entire sample, is the statistical significance of the macroprudential policy index under equation (7). In this case, a tighter macroprudential policy stance leads to lower interest rates, possibly as a result of banks' incentives to reduce risk-taking by seeking debtors with a lower risk profile. No idiosyncratic characteristics of the firms provide a significant effect on interest rates.

Lastly, the effects on non-performing loans of the macroprudential tools under study proves to be particularly interesting, as no significant effect of any individual tool (or the aggregate index) is found (Table 11). Thus, as macroprudential policies reduce the availability of funds (or in the case of provisions the marginal cost of each unit lent), they have a negative effect on loan growth across the board and affect the cost of credit; however, for the largest firms in the sample, this does not affect their repayment capacity. Indeed, under this specification, only the stance of the financial cycle seems to be a determinant of the observed materialization of credit risk on banks' loan portfolios.

The (non-existent) impact of macroprudential tools on certain relevant dimensions, such as non-performing loans or the risk-taking channel, along with the statistical non-significance of variables such as the policy

TABLE 11: Estimation Results on Non-Performing Loans' Growth Using the SS Sample

Relevant Exogenous variables	**Equations (8)**	**(9)**
$DP_{br,t-2}$	0.797	
$EBR_{br,t-2}$	-1.080	
$CRR_{br,t-2}$	0.401	
$\Delta MPP\ index_t$		-0.002
$\Delta MPP\ index_{t-1}$		0.005
$\Delta MPP\ index_{t-2}$		-0.022
$CGDP\ gap_{t-1}$	3.105**	3.004*
$\Delta^Q MP\ rate_{t-1}$	-0.608	-0.686
$Firm\ Size_{br,t}$	-0.038	-0.036
$Firm\ ROA_{br,t}$	0.001	0.001
$Firm\ Liquidity_{br,t}$	-0.001	-0.001
$Firm\ Leverage_{br,t}$	-0.001	-0.002
Observations	11,072	11,072
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

rate and the firm controls used, may be associated with the particular sample under study. Specifically, the firms that are under supervision of the SS are companies that have been chosen for said purpose, implying a bias towards relatively large firms in the economy. In other words, this is not a random sample from the corporate sector. Thus, while having distinct features among them, these firms tend to be large, better-behaved firms than those of the complete sample, therefore constituting high quality debtors of the financial system[35].

5 Concluding remarks

Following the Global Financial Crisis of 2007-2008, considerable interest has been centered on the relevance and virtues of macroprudential policies, as a complement to microprudential and monetary policy. In a nutshell, the objective of macroprudential tools has been the mitigation of systemic vulnerabilities; by limiting the build-up of risk (time series dimension of systemic risk) and increasing the resilience of the financial system (cross-sectional dimension). In this way, these tools foster and help maintain financial stability. Nevertheless, despite the recent renaissance of these policies, particularly in developed

[35] For the period under study, the average ratio of commercial non-performing loans to total loans was 1.7% for the entire sample, while for those firms under corporate supervision was 1.3%.

economies, developing countries have actually been very active in the use of these tools. In this respect, analyzing the experience of said economies with the use of macroprudential policies can shed some light on the potential effectiveness of these tools in, for instance, curbing credit growth.

In this order of ideas, this paper uses a micro dataset containing information of over 1.9 million observations, for the period comprised between 2006Q1-2009Q4. The use of loan-by-loan information is particularly valuable in that it allows disentangling different effects and effectively estimating the impact of three distinct macroprudential policies on credit growth and banks' risk profile. Using a fixed effects panel data method, one finds that dynamic provisions and the countercyclical reserve requirement have a negative effect on loan growth, while the effect of the three tools on both the cost of credit and the riskiness of banks' loan portfolio differs between policies. In particular, the introduction of new rules in provisioning seems to be negatively related to bank risk-taking (i.e. lower interest rates and consequently lower non-performing loans' growth). In contrast, there is no statistical evidence that the imposition of marginal reserves or the external borrowing requirements exhibited a significant impact on non-performing loans, though they do have an effect on borrowing costs. The fact that the requirement on external borrowing does not yield a significant effect on loan growth could be related to the fact that it was employed in conjunction with other policies that were more specifically directed towards said purpose.

The effects on credit growth of the dynamic provisioning scheme hold when a sub-sample of firms with available balance-sheet information is used in the estimations, as do the effects of the individual policies on the interest rate. The latter provides a valuable contrast test on the full sample results.

Additionally, findings presented in this paper also support the notion that macroprudential policies have been historically used as a complement of monetary policy, thus increasing the stabilizing effects of changes in interest rates on credit cycles. In other words, said policies have been used in a countercyclical way with respect to business cycles, thereby helping to reduce the procyclicality of credit. Another key finding is that macroprudential policies are effective in influencing the risk-taking behavior of banks. In particular, a tightening of the aggregate macroprudential policy stance is shown to reduce credit access to riskier debtors, and to have a stronger adverse effect on the credit supply of less stable financial institutions. Furthermore, a tighter policy stance is also found to have a negative effect on the dynamics of non-performing loans; this result seems to be driven by the incentives generated in the dynamic provisioning scheme.

Results presented in this paper are particularly relevant for policy makers as they highlight an important fact; macroprudential policies seem to be an effective tool to dampen credit cycles, thus allowing to reduce systemic vulnerabilities and the build-up of risks. They also seem to be complementary to monetary policy, thereby strengthening the transmission of the policy stance to market rates. Nevertheless, findings in this paper also seem to confirm the broad spectrum of macroprudential policy tools, which can target resilience and risk accumulation through various channels and intermediate objectives. They also suggest that the effects of said policies are not homogeneous between economic agents, having impacts on banks and debtors that depend on their financial health and credit quality, respectively. Thus, the choice of the tool is non-trivial, and should consider the idiosyncratic effects of each as well as the particular objectives sought so as to utilize the most effective and efficient policy at hand.

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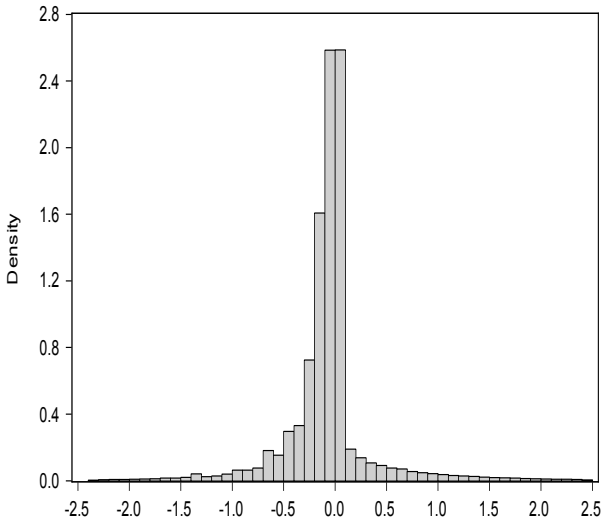
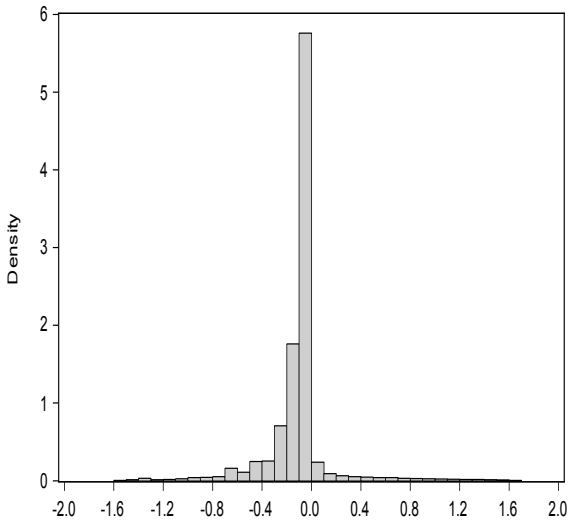
Appendix A Endogenous Variables' Histograms

FIGURE 6: Credit growth, by sample
anchor = -1.6, step = 0.1
(2006Q1-2009Q4)

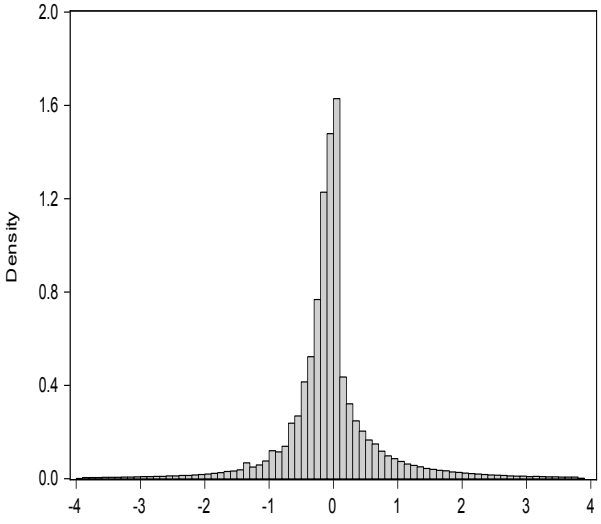
A. Complete sample (individuals and firms)



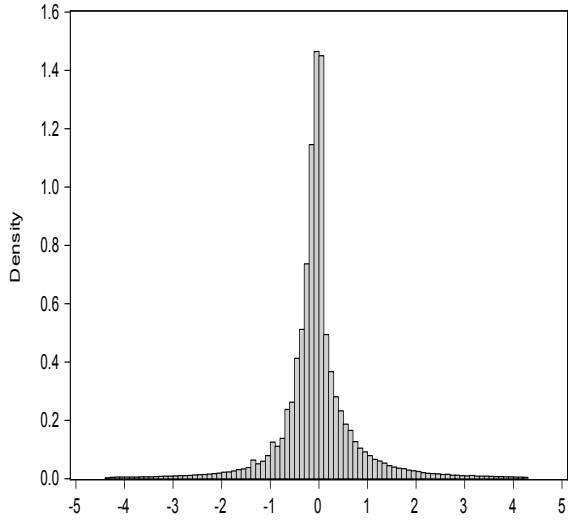
B. Individuals



C. Firms



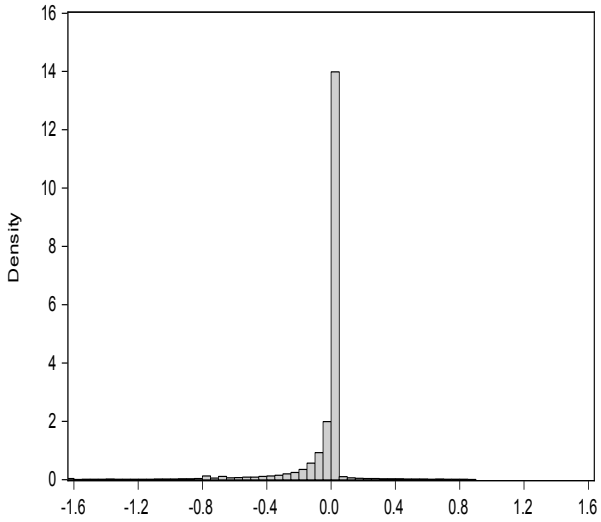
D. Firms supervised by Superintendencia de Sociedades



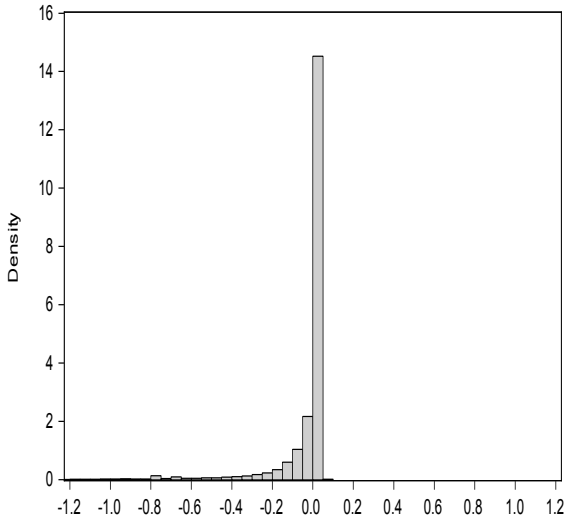
Source: Financial Superintendence; authors' calculations

FIGURE 7: Non-performing loans, by sample
anchor = -1.25, step = 0.05
(2006Q1-2009Q4)

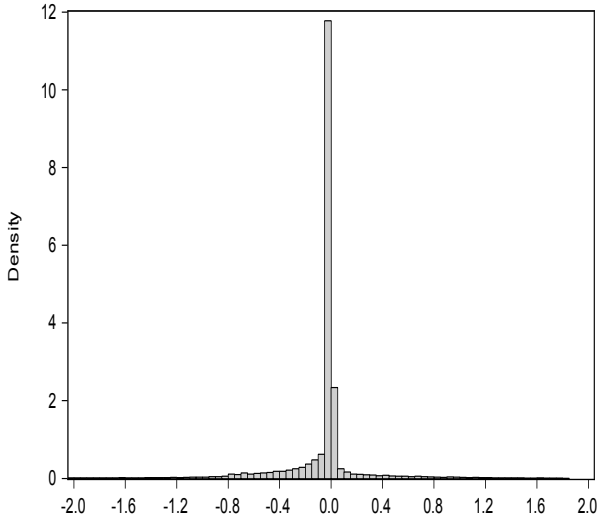
A. Complete sample (individuals and firms)



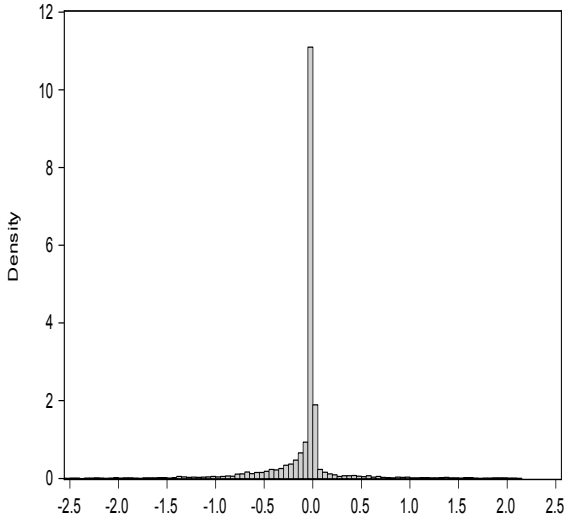
B. Individuals



C. Firms



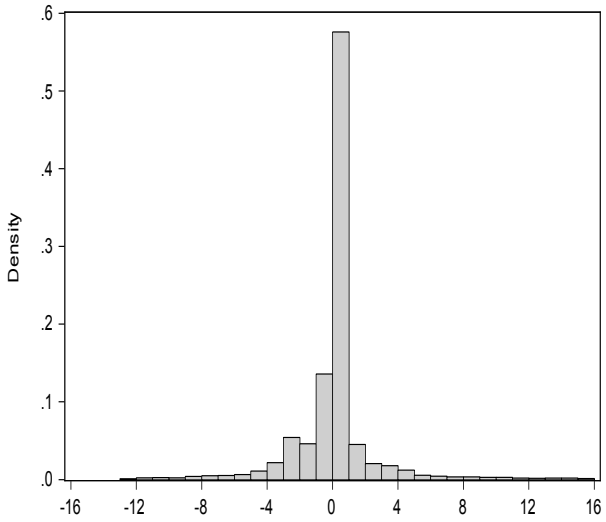
D. Firms supervised by Superintendencia de Sociedades



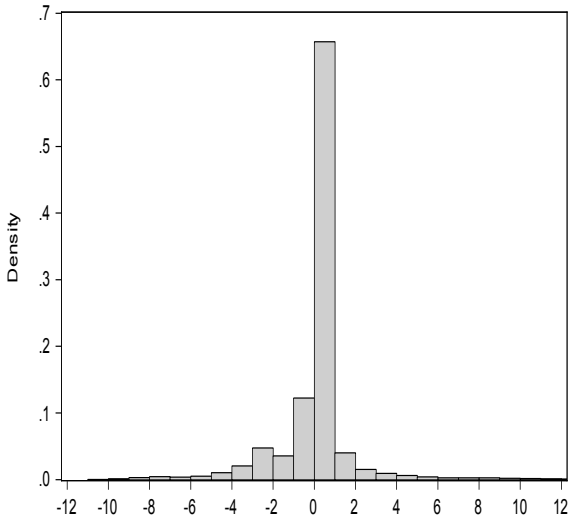
Source: Financial Superintendence; authors' calculations

FIGURE 8: Change in the loans' interest rate, by sample
anchor = -11, step = 1
(2006Q1-2009Q4)

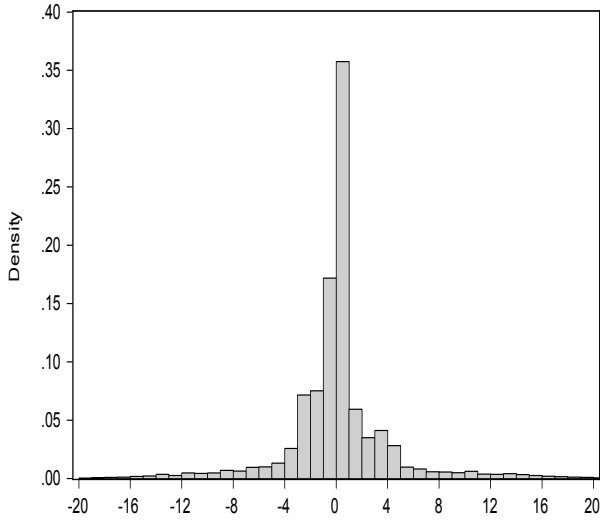
A. Complete sample (individuals and firms)



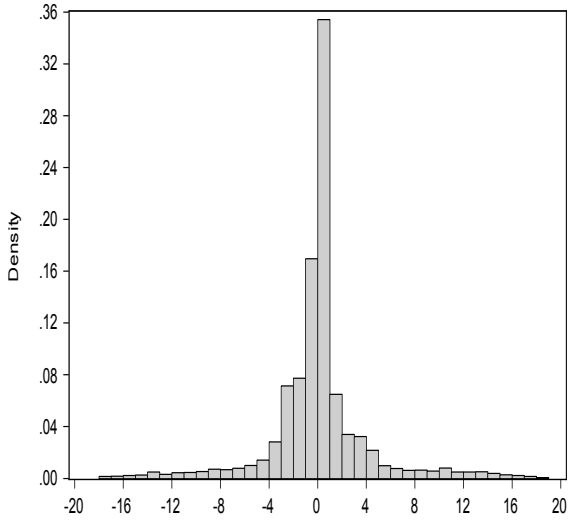
B. Individuals



C. Firms



D. Firms supervised by Superintendencia de Sociedades



Source: Financial Superintendence; authors' calculations

Appendix B Variables

TABLE 12: Variables Description

Type of Variable	Variable	Description
Dependent Variables	$\Delta Log\ Credit$	Quarterly growth of the actual value of loans for each bank-debtor relationship.
	$\Delta Interest\ Rate$	Quarterly change in the loans' interest rate (weighted average by credit amount of all loans' interest rates for each bank-debtor relationship).
	$\Delta Log\ NPL$	Quarterly growth of the value of non-performing loans for each bank-debtor relationship.
Macroprudential Policies Variables	DP	Dynamic provisions to commercial loans ratio for each bank.
	EBR	External borrowing requirement to total liabilities ratio for each bank.
	CRR	Countercyclical reserve requirement to total liabilities ratio for each bank.
	$\Delta MPP\ index$	Quarterly change in the Macroprudential Policy Index. The index captures the aggregate macroprudential policy stance of the country, and is defined as the sum of the three individual policies' dummy variables (dummies that take the value of 1 if the policy is in place and 0 otherwise).
Macroeconomic Controls	$\Delta^A Log\ GDP$	Annual real GDP growth (constant prices of 2012).
	$\Delta^Q Log\ GDP$	Quarterly real GDP growth (constant prices of 2012).
	$\Delta^A MP\ rate$	Annual real change in the interbank rate as a proxy of the monetary policy stance.
	$\Delta^Q MP\ rate$	Quarterly real change in the interbank rate as a proxy of the monetary policy stance.
	$\Delta^A Log\ CA\ deficit$	Real annual growth in the current account deficit (constant prices of 2012).
	$\Delta^Q Log\ CA\ deficit$	Real quarterly growth in the current account deficit (constant prices of 2012).
	$\Delta^A Log\ EX\ rate$	Real annual growth in the exchange rate (constant prices of 2012).
	$\Delta^Q Log\ EX\ rate$	Real annual growth in the exchange rate (constant prices of 2012).
	$Credit\ GDP\ gap$	Difference between the credit-to-GDP ratio and its trend (one sided HP filter methodology).
	$Dummy\ Crisis$	Dummy equal to 1 in quarters between 2008Q3-2009Q4.
Bank characteristics	$Bank\ Liquidity$	Ratio between the sum of cash and short term investments and total assets.
	$Bank\ Fund\ Composition$	Deposits to total liabilities ratio.
	$Bank\ ROA$	Ratio between bank annualized EBIT and total assets annual average.
	$Bank\ Signalling$	Dummy that takes the value of 1 if bank TIER2 is below 11% and 0 otherwise.
	$Bank\ Size$	Natural logarithm of total assets.
	$Zscore$	Dummy that takes the value of 1 if bank Zscore (ratio between the sum of the capital ratio and the mean of ROA and the standard deviation of ROA) is below the quarterly average of the bank system, 0 otherwise.
Firm characteristics	$Collateralized\ Loans$	Dummy that takes the value of 1 if the largest amount of credit for each bank-debtor relationship has an acceptable collateral, 0 otherwise.
	$Firm\ Risk$	Dummy that takes the value of 1 if in quarter t firm f had non-performing loans outstanding in t or in one of the previous 3 quarters (even with another bank).
	$Firm\ Size$	Categorical variable according to the value of assets (for micro firms 1, small firms 2, medium firms 3 and big firms 4).
	$Firm\ ROA$	EBIT to total assets ratio.
	$Firm\ Liquidity$	Current assets to current liabilities ratio.
	$Firm\ Leverage$	Total liabilities to total assets ratio.

Appendix C Estimation Results - Full sample and sub-sample of firms from the Superintendencia de Sociedades

TABLE 13: Estimation Results on Credit Growth

	Equations				
Exogenous variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$DP_{br,t}$	-0.511***	-0.577***	-0.512***	-0.298***	
$EBR_{br,t}$	0.220	0.063	0.187	0.085	
$CRR_{br,t}$	-0.665**	-0.856***	-0.720***	-0.709***	
$\Delta MPP\ index_t$					-0.012***
$\Delta MPP\ index_t * \Delta^A GDP_{t-1}$		-0.188***			
$\Delta MPP\ index_t * \Delta^A MP\ rate_t$			-0.163		
$\Delta MPP\ index_t * Firm\ Risk_t$				-0.005**	
$Firm\ Risk_t$				-0.065***	
$\Delta MPP\ index_t * Zscore_t$				-0.004**	
$Zscore_t$				-0.005***	
$\Delta^A Log\ GDP_{t-1}$	0.235**	0.422***	0.295**	0.267***	0.654***
$\Delta^A MP\ rate_t$	-0.648***	-0.383***	-0.583***	-0.273**	-0.364***
$\Delta^A Log\ CA\ deficit_{t-1}$	-0.015***	-0.008**	-0.016***	-0.013***	-0.010***
$\Delta^A Log\ EX\ rate_{t-1}$	-0.064***	-0.075***	-0.073***	-0.054***	-0.038***
$Dummy\ Crisis_t$	-0.056***	-0.048***	-0.052***	-0.044***	-0.047***
$Bank\ Liquidity_{br,t-1}$	0.171***	0.162***	0.171***	0.162***	0.196***
$Bank\ Fund\ Composition_{br,t-1}$	-0.052**	-0.014	-0.052**	-0.025	-0.026
$Bank\ ROA_{br,t-1}$	-0.348*	-0.875***	-0.357*		-0.507***
$Bank\ Signalling_{br,t-1}$	-0.008***	-0.010***	-0.008***		-0.009***
$Bank\ Size_{br,t-1}$	-0.161***	-0.152***	-0.162***	-0.132***	-0.161***
$Collateralized\ Loans_{br,t}$	0.069***	0.069***	0.069***	0.067***	0.069***
Observations	1,635,741	1,635,741	1,635,741	1,412,071	1,635,741
Hausman Test p-value	0.000	0.000	0.000	0.0000	0.000
F Test p-value	0.000	0.000	0.000	0.0000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 14: Estimation Results on Loans' Interest Rate

	Equations	
Exogenous variables	**(6)**	**(7)**
$DP_{br,t}$	-37.920***	
$EBR_{br,t}$	29.036***	
$CRR_{br,t}$	73.854***	
$\Delta MPP\ index_t$		0.003
$\Delta^Q Log\ GDP_t$	61.575***	80.234***
$\Delta^Q MP\ rate_t$	28.549***	21.956***
$\Delta^Q Log\ CA\ deficit_t$	1.123***	0.371***
$\Delta^Q Log\ EX\ rate_t$	1.295***	2.679***
$Dummy\ Crisis_t$	-0.468***	-1.449***
$Bank\ Liquidity_{br,t-1}$	-1.302***	-4.511***
$Bank\ Fund\ Composition_{br,t-1}$	1.171***	1.017***
$Bank\ ROA_{br,t-1}$	-70.396***	-62.514***
$Bank\ Signalling_{br,t-1}$	-0.110***	0.051***
$Bank\ Size_{br,t-1}$	1.015***	1.878***
$Collateralized\ Loans_{br,t}$	-0.667***	-0.637***
Observations	1,459,331	1,459,331
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 15: Estimation Results on Non-Performing Loans' Growth

Exogenous variables	Equations (8)	(9)
$DP_{br,t-2}$	-0.682***	
$EBR_{br,t-2}$	-0.054	
$CRR_{br,t-2}$	0.452	
$\Delta MPP\ index_t$		-0.010
$\Delta MPP\ index_{t-1}$		0.009
$\Delta MPP\ index_{t-2}$		-0.008**
$CGDP\ gap_{t-1}$	1.585***	1.696***
$\Delta^Q MP\ rate_{t-1}$	0.218	-0.379
$\Delta^Q Log\ CA\ deficit_{t-1}$	-0.041***	-0.004
$\Delta^Q Log\ EX\ rate_{t-1}$	0.019	0.006
$Dummy\ Crisis_t$	-0.000	-0.016
$Bank\ Liquidity_{br,t-1}$	0.320***	0.310***
$Bank\ Fund\ Composition_{br,t-1}$	0.149***	0.149***
$Bank\ ROA_{br,t-1}$	0.706*	1.091**
$Bank\ Signalling_{br,t-1}$	-0.004	-0.004
$Bank\ Size_{br,t-1}$	0.025	0.049**
$Collateralized\ Loans_{br,t}$	0.127***	0.129***
Observations	123,331	123,331
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 16: Estimation Results on Credit Growth Using the SS Sample

	Equations				
Exogenous variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$DP_{br,t}$	-0.523***	-0.589***	-0.534***	-0.515***	
$EBR_{br,t}$	0.031	-0.092	-0.089	0.076	
$CRR_{br,t}$	-0.112	-0.296	-0.472	-0.084	
$\Delta MPP\ index_t$					-0.015***
$\Delta MPP\ index_t * \Delta^A Log\ GDP_{t-1}$		-0.228***			
$\Delta MPP\ index_t * \Delta^A MP\ rate_t$			-1.185**		
$\Delta MPP\ index_t * Firm\ Risk_t$				-0.003	
$Firm\ Risk_t$				-0.045***	
$\Delta MPP\ index_t * Zscore_t$				0.001	
$Zscore_t$				-0.002	
$\Delta^A Log\ GDP_{t-1}$	0.322*	0.557***	0.759***	0.442**	0.697***
$\Delta^A MP\ rate_t$	-0.503*	-0.179	-0.030	-0.427	-0.156
$\Delta^A Log\ CA\ deficit_{t-1}$	-0.006	0.001	-0.015**	-0.009	-0.000
$\Delta^A Log\ EX\ rate_{t-1}$	-0.055***	-0.066***	-0.117***	-0.057***	-0.042***
$Dummy\ Crisis_t$	-0.035***	-0.025**	-0.004	-0.029***	-0.029***
$Bank\ Liquidity_{br,t-1}$	0.181***	0.169***	0.186***	0.172***	0.185***
$Bank\ Fund\ Composition_{br,t-1}$	-0.043	0.004	-0.038	-0.048	-0.004
$Bank\ ROA_{br,t-1}$	-0.054	-0.603	-0.106		-0.332
$Bank\ Signalling_{br,t-1}$	0.002	-0.000	0.002		0.001
$Bank\ Size_{br,t-1}$	-0.149***	-0.138***	-0.155***	-0.143***	-0.143***
$Collateralized\ Loans_{br,t}$	0.070***	0.070***	0.070***	0.067***	0.069***
$Firm\ Size_{br,t}$	0.054***	0.054***	0.054***	0.047***	0.053***
$Firm\ ROA_{br,t}$	0.000	0.000	0.000	0.000	0.000
$Firm\ Liquidity_{br,t}$	-0.000	-0.000	-0.000	-0.000	-0.000
$Firm\ Leverage_{br,t}$	0.000	0.000	0.000	0.000	0.000
Observations	500,255	500,255	500,255	482,250	500,255
Hausman Test p-value	0.000	0.000	0.000	0.0000	0.000
F Test p-value	0.000	0.000	0.000	0.0000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 17: Estimation Results on Loans' Interest Rate Using the SS Sample

Exogenous variables	Equations (6)	(7)
$DP_{br,t}$	-36.098***	
$EBR_{br,t}$	10.387***	
$CRR_{br,t}$	71.492***	
$\Delta MPP\ index_t$		-0.096***
$\Delta^Q Log\ GDP_t$	61.693***	75.434***
$\Delta^Q MP\ rate_t$	9.023***	10.701***
$\Delta^Q Log\ CA\ deficit_t$	1.157***	0.573***
$\Delta^Q Log\ EX\ rate_t$	1.160***	2.152***
$Dummy\ Crisis_t$	-0.148***	-1.160***
$Bank\ Liquidity_{br,t-1}$	-1.214***	-4.344***
$Bank\ Fund\ Composition_{br,t-1}$	1.063***	1.130***
$Bank\ ROA_{br,t-1}$	-63.184***	-56.042***
$Bank\ Signalling_{br,t-1}$	-0.282***	-0.159***
$Bank\ Size_{br,t-1}$	0.227***	1.249***
$Collateralized\ Loans_{br,t}$	-0.613***	-0.601***
$Firm\ Size_{br,t}$	-0.020	0.024
$Firm\ ROA_{br,t}$	0.000	0.000
$Firm\ Liquidity_{br,t}$	0.000	0.000
$Firm\ Leverage_{br,t}$	0.000	0.001
Observations	449,111	449,111
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.

TABLE 18: Estimation Results on Non-Performing Loans' Growth Using the SS Sample

	Equations	
Exogenous variables	**(8)**	**(9)**
$DP_{br,t-2}$	0.797	
$EBR_{br,t-2}$	-1.080	
$CRR_{br,t-2}$	0.401	
$\Delta MPP\ index_t$		-0.002
$\Delta MPP\ index_{t-1}$		0.005
$\Delta MPP\ index_{t-2}$		-0.022
$CGDP\ gap_{t-1}$	3.105**	3.004*
$\Delta^Q MP\ rate_{t-1}$	-0.608	-0.686
$\Delta^Q Log\ CA\ deficit_{t-1}$	-0.052	-0.044
$\Delta^Q Log\ EX\ rate_{t-1}$	0.039	0.015
$Dummy\ Crisis_t$	-0.008	-0.029
$Bank\ Liquidity_{t-1}$	0.213	0.189
$Bank\ Fund\ Composition_{t-1}$	-0.076	-0.087
$Bank\ ROA_{t-1}$	2.565*	3.521**
$Bank\ Signalling_{t-1}$	-0.014	-0.013
$Bank\ Size_{t-1}$	0.086	0.115
$Collateralized\ Loans_{br,t}$	0.050**	0.052**
$Firm\ Size_{br,t}$	-0.038	-0.036
$Firm\ ROA_{br,t}$	0.001	0.001
$Firm\ Liquidity_{br,t}$	-0.001	-0.001
$Firm\ Leverage_{br,t}$	-0.001	-0.002
Observations	11,072	11,072
Hausman Test p-value	0.000	0.000
F Test p-value	0.000	0.000

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Source: authors' calculations.