

The macroprudential policy framework in Colombia

Hernando Vargas, Pamela Cardozo and Andrés Murcia¹

Abstract

Macroprudential policy in Colombia is described along with a discussion of the main challenges faced by the authorities in implementing it and a review of episodes in which macroprudential measures were taken. An overview and some estimates of their effectiveness in preventing the buildup of imbalances, increasing buffers and cushioning downswings are presented.

Keywords: macroprudential policy, financial stability, financial regulation, financial safety net, central banking, Colombia

JEL classification: E51, E58, F32, F38, G18, G28

¹ Technical Deputy Governor, Vice-President of Monetary Affairs and International Investments, and Advisor at Banco de la República, respectively. The opinions contained herein are the sole responsibility of the authors and do not necessarily reflect those of Banco de la República or its Board of Directors. All errors and omissions remain the authors' own. The authors are grateful to Yanneth R Betancourt, Esteban Gómez and the staff of the Financial Stability Department at Banco de la República for useful comments and contributions.

1. Introduction

Macroprudential policy in Colombia has been implemented on an occasional basis in a context of decentralised financial regulation. Financial stability has been successfully preserved after a crisis at the end of the twentieth century. This note describes the Colombian macroprudential policy framework, reviewing the various episodes in which macroprudential measures were implemented and discussing the main challenges faced by the authorities. In addition, an overview and some estimates of the effectiveness of macroprudential policies in preventing the buildup of imbalances, increasing buffers and cushioning downswings in Colombia are presented.

2. The macroprudential policy framework

a. Institutional setting

There is no explicit macroprudential policy framework in Colombia. Financial regulation, supervision and resolution were assigned by law to different state institutions decades ago. The bulk of financial regulation is directly in the hands of the Ministry of Finance (MoF), including capital requirements for financial institutions, the definition of operations that different financial intermediaries are allowed to conduct, and controls on portfolio and foreign direct investment. Financial intermediaries' liquidity and market risk regulations are within the purview of the Financial Superintendency, which is part of the executive branch of government. Foreign exchange regulations, controls on foreign indebtedness and reserve requirements are set by the Banco de la República (Bank of the Republic), an independent Central Bank. Congress has established limits on loan-to-value (LTV) and debt service-to-income (DSI) ratios for mortgage credit.

The Financial Superintendency is in charge of the supervision of all intermediaries, with the exception of non-financial cooperatives. Resolution is a responsibility of the Financial Superintendency and the Deposit Guarantee Fund (DGF). The former determines whether an intermediary is to be liquidated, merged or subject to administration. The latter performs the liquidation process. The central bank acts as lender of last resort to credit establishments deemed to be solvent by the Financial Superintendency.

There are two mechanisms for policy coordination between the different financial authorities. One is provided by the presence of the Finance Minister on the Board of Directors of the central bank which allows for a degree of coordination between monetary policy and overall economic policy. Another is ensured by the presence of the Finance Minister, the Governor of the central bank and the Financial Superintendent on the Board of Directors of the DGF.

In the late 1990s, this setting went through a difficult test, as the country underwent a financial crisis concentrated in the cooperative, mortgage and publicly-owned bank sectors. In this case, the pre-emptive functioning of the framework performed poorly. Inadequate capital and liquidity regulations of key intermediaries, as well as insufficient supervision of others, left the system vulnerable to the cycle of large inflows and outflows of capital that the country experienced throughout the decade. As a result, a surge of credit with low underwriting standards increased the

indebtedness of households and produced a real estate bubble. At the same time, firms incurred currency mismatches, partly because of the implicit guarantee provided by the existing exchange rate target zone regime. Government indebtedness grew throughout the decade and exhibited a currency mismatch as well. When capital flowed out of the country by the end of the decade, these fragilities led to a financial crisis and the deepest recession of the Colombian economy since the beginning of the twentieth century.

By contrast, the resolution of the crisis was conducted adequately along orthodox lines. The central bank only intervened as lender of last resort. The government absorbed the losses on its balance sheet and funded them with public debt. The liquidation process was performed efficiently.

As a result of this experience, Congress established a Coordinating Committee for the Monitoring of the Financial System (CCMFS) in 2003. This Committee has to meet at least quarterly and is chaired by the Finance Minister. It includes the Governor of the Central Bank, the Financial Superintendent and the Director of the DGF. The main purpose of the committee is to share information and analysis pertaining to the financial system. It does not make any policy decision, as legally each institution retains its original functions. Recently, the Committee established its own internal regulations. The main one states that every semester its members must present, from their own perspective, their risk analysis of the financial system. This provides a setting for the discussion of macroprudential measures.

In addition, as a consequence of the crisis, the central bank created its own Financial Stability Department with the purpose of enhancing its monitoring of systemic and macroeconomic risks. The Department publishes two Financial Stability Reports per year, prepares the central bank's input for the CCMFS discussions and offers risk analysis to the Board regarding specific issues that may influence policy (eg quantification of currency mismatches in the real sector and their effect on the financial system, exposure of the financial system to the oil industry etc). It has also been in charge of calibrating changes in reserve requirements when such tools have been used.

b. Some Interesting Episodes

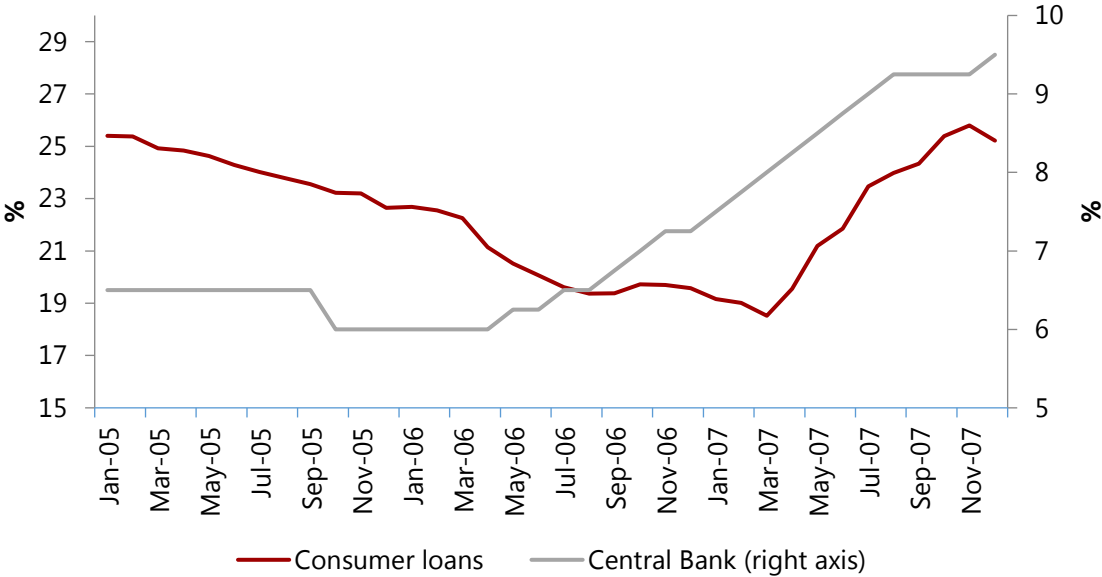
After the financial crisis of the end of the 20th century, there have been two episodes in which macroprudential challenges have emerged and macroprudential policy actions have been taken. The **first one** occurred between 2006 and the first half of 2008, during which strong credit growth followed a sharp recomposition of commercial bank assets. After the financial crisis of 1998–2000, the financial and real sectors were in a process of deleveraging and balance sheet clean-up. Consequently, credit growth was weak and banks invested heavily in local currency, fixed-rate government bonds, whose supply was abundant as the government was reducing its currency mismatch.

By 2005, banks had made a profit from such investments as sovereign risk premia declined in the wake of a structural adjustment of public finances and improved security conditions. Simultaneously, inflation came down steadily, leading to a substantial appreciation of the value of bond holdings. Moreover, firm and household balance sheets had been repaired by then. In 2006 there was no clear perspective of further appreciation of the value of public bond holdings, as the economy was heating up and policy rates increased (and were expected to rise further). At the same

time, sovereign risk premia continued on a declining trend, so that the incentives to invest abroad were subdued. Therefore, depositors kept their savings in local banks, while the latter shifted their portfolios away from government bonds and into loans. In particular, the supply of consumer loans grew very fast (close to 45% in real terms in the second half of 2006). This effect was so strong, that the pass-through of policy rate hikes to consumer loan rates was reversed (Graph 1).

This situation was a cause for concern for policymakers. For one, the transmission of monetary policy was being partially hindered. Aggregate expenditure growth was turning excessive, the current account deficit was widening fast and the quality of new loans was decreasing, according to the vintage analysis performed at the time. The memories of the credit excesses of the 1990s and their painful consequences prompted the authorities to search for new tools to contain expenditure and credit growth. Monetary policy was implemented based on a fully-fledged inflation targeting (IT) regime, so “old-fashioned” tools such as reserve requirements were no longer being used.

Policy and consumer loan nominal interest rates Graph 1



Source: Financial Superintendency, Banco de la República.

However, in view of the risk build-up, a consensus grew among policymakers at the Central Bank and the Government on the need to contain it. Hence, reserve requirements were recast as a tool to moderate credit growth rather than as monetary control instrument (as in the past). In fact, in an IT regime, changes in reserve requirements would amount to shifts to short-term money demand that would be smoothed by an interest rate-stabilising policy. Nevertheless, as long as central bank funding is an imperfect substitute for other sources of financing for banks, credit supply would be negatively affected by an increase in reserve requirements.

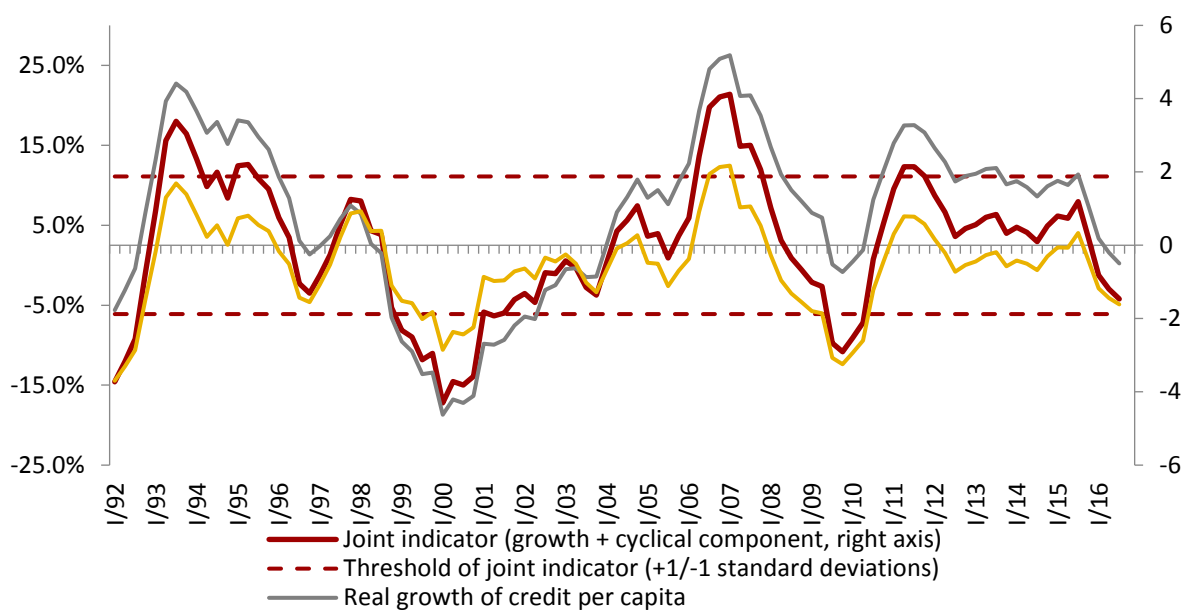
With this idea in mind, in May 2007 the central bank established marginal reserve requirements on domestic bank deposits. Aware of the substitution of local for external credit that this might induce, it imposed an unremunerated reserve

requirement on all foreign indebtedness. Besides containing leverage, this measure was also aimed at avoiding potential currency mismatches. Shortly after the central bank took these actions, the MoF imposed an unremunerated reserve requirement on foreign portfolio investment inflows as a way of complementing central bank policies. These policy responses strengthened an ongoing hiking cycle of policy rates. Later on, the Financial Superintendency brought earlier the operation of new permanent provisioning requirements for commercial and consumer loans. The timing of this measure helped moderate credit and expenditure growth.

By the second semester of 2008, credit growth had been reduced and the economy was cooling. Although part of this phenomenon was due to the effects of the Global Financial Crisis (GFC), several studies have documented the contribution made by the macroprudential policy response. Vargas et al (2010) find positive long-term effects of reserve requirements on commercial, prime and treasury lending rates, as well as on average term deposit rates (and on term deposits rates longer than one year). Using data from 2003 to 2011, Tovar et al (2012) report that reserve requirements in Latin America (Colombia included) had some transitory effects on credit growth and played a complementary role to monetary policy. Based on Colombian microlevel loan data, Gómez et al (2017) estimate a significantly negative effect of a variable summarising macroprudential policies on commercial loan growth in this episode, controlling for shifts in monetary policy, macroeconomic conditions, bank characteristics and risk indicators at the bank and firm level. Finally, using a general equilibrium model with heterogeneous agents and risk-averse financial intermediaries calibrated to Colombian data, Bustamante (2011) concludes that reserve requirements reinforce the effects of the policy rate and that this complementary effect is most important when commercial bank risk aversion is high. The results also show that when both instruments are used jointly, business cycles are dampened. Moreover, an increase in reserve requirements diminishes consumption (*ceteris paribus*).

After the Lehman Brothers crisis, macroeconomic and financial conditions changed dramatically. There was, in particular, concern about liquidity in the domestic financial system, as risk aversion skyrocketed worldwide. In response, in December 2008 the central bank reduced reserve requirements and began a rapid cycle of interest rate cuts (it was the first central bank to do so among the largest Latin American economies). Simultaneously, unremunerated reserve requirements on foreign indebtedness and portfolio investment were set to zero. This was the first time Colombian monetary authority had undertaken a timely accommodative countercyclical reaction.

A **second noteworthy episode** occurred during 2011. Then, consumer credit accelerated from an already high level (Graph 2). Although this time around policy rate hikes were transmitted to consumer credit rates, authorities were concerned by the rise in household leverage. Several macroprudential measures were discussed, among them reserve requirement increases. However, since reserve requirements have a broad impact on total credit, a more focused tool was ultimately used. The Financial Superintendency decided to increase consumer loan provisions within an arrangement that imposed higher requirements on banks that exhibited historically larger rises in non-performing loans. This provisioning mechanism is still in place.



Source: Financial Superintendency, Banco de la República's calculations.

c. Features of the macroprudential policy framework in Colombia

As it transpires from the above description of the institutional setting and the main events since 2000, there is no formal macroprudential policy framework in Colombia, in the same way as Inflation Targeting or the Fiscal Rule may be for monetary and fiscal policy. There is neither a clear objective variable to target nor a set of pre-defined tools that could be adjusted to reach financial stability. The responsibility and the potential tools to ensure financial stability are disseminated across different authorities.

Therefore, macroprudential policy tools have not been used systematically but rather occasionally in response to episodes of excessive build-up of systemic risk. In addition, macroprudential policies have drawbacks that make the authorities reluctant to use them more widely or frequently. A significant drawback is uncertainty about their effects on the economy, which makes it difficult to calibrate them. Their use may lead to unintended consequences. Macroprudential policies may also create incentives to circumvent them (when narrowly applied), which may obscure the information required to monitor risks adequately.

Aside from microprudential regulations with a macroprudential scope (LCR, limits on currency mismatches etc), the measures that could be called macroprudential – and are permanently in place in Colombia – include limits on LTV and DSI ratios for mortgage credit established by Congress in 1999 as well as the countercyclical component of the provisioning regime.

The Financial Superintendency established countercyclical provisions for commercial and consumer credit in 2007 and 2008, respectively. Under such schemes, banks increase or decrease provisions depending on whether they are in a “good” or a “bad” phase. Individual bank indicators, such as credit growth and loan portfolio deterioration, determine the bad phase. This allows an institution facing difficulties,

even under a generally favorable economic scenario, to diminish its provisioning expenses. So far, some banks have met the requirements for being in a bad phase but have decided not to reduce their provisions. Looking at the impact of this macroprudential tool, López et al (2014) find a negative relationship between the amplitude of credit cycles and the provisioning scheme, while Gómez et al (2017) report that countercyclical provisions had a negative effect on credit growth.

d. Challenges ahead

The use of macroprudential measures has been successful in Colombia hitherto. Episodes of excessive systemic risk build-up have been timely identified and dealt with, despite the prevailing decentralised institutional setting. However, this success cannot be taken for granted in the future and the country faces challenges in this respect.

To begin, the structure of the economy has implied the absence of conflicts between the policy actions aimed at containing risks on inflation, spending pressures, and excessive credit creation and loan misallocation. Increases in inflation above target have coincided with high growth of credit and aggregate expenditure. Inflation has been driven more by demand pressures than by the appreciation of the currency in episodes of large capital inflows or high terms of trade. This is in part explained by the fact that the economy is still relatively closed and non-tradable sectors are important in the determination of inflation and output² According to Garcia et al (2014), despite the initial opening efforts of the 1990s, Colombia's foreign trade regime has remained strongly restrictive (with high tariff and non-tariff barriers).

In addition, capital mobility in Colombia is high but there are still frictions and a home bias that partially separate internal and external financial conditions. This means that improvements in the latter do not simultaneously produce a substantial risk to financial stability and a fall in inflation (due to currency appreciation).

Nevertheless, these conditions are changing and may further do so in the future. For example, since 2014 foreign participation in the local bond market has risen to 24% in 2016 (from 7% in 2013). This was due to the reduction of the withholding tax on portfolio investment returns and the increase of Colombia's weight in JPMorgan's emerging market bond indices. In addition, the central bank further liberalised the capital account by changing its foreign exchange regulations (and will probably continue to do so). For instance, in 2014 the central bank allowed banks to issue external bonds denominated in Colombian pesos. It also permitted banks to obtain funding in foreign currency to conduct peso lending, as long as the foreign exchange rate risk was hedged with a derivative contract. In 2016, regulations relating to foreigners' peso deposits in domestic banks became less restrictive. Regarding the current account, the government has continued to enhance its opening, by signing free trade agreements, for example.

In recent years, external events had a stronger influence on local financial conditions. In 2014, the increased participation of foreigners in the domestic public bond market not only reduced the yields on these bonds, but also affected lending

² In 2015, total trade represented 39% of GDP in Colombia, compared with 73% in Mexico, 45% in Peru and 60% in Chile. Brazil is less open than Colombia at 27%.

and deposit rates, as banks sold their bond holdings, raised credit supply and reduced their demand for deposits. This coincided with a hiking cycle of policy interest rates and partially hindered its transmission.

Hence, in the future a “divine coincidence” of favourable responses to different risks in the economy may not occur and difficult trade-offs may arise.³ The effects of policy actions aimed at controlling some risks may exacerbate other risks and complicate the overall policy response. For example, large capital inflows may loosen financial conditions, while appreciating the currency and reducing inflation. A monetary policy response targeting inflation may exacerbate risks to financial stability. In this context, a more active use of macroprudential measures may be necessary, but the wider openness of the capital account may hamper the effectiveness of some macroprudential measures used in the past. Thus, a deeper understanding of the working of these policies and a better coordination between institutions may be required. This is an important challenge for Colombian financial and monetary authorities.

More specifically, Colombia’s decentralised institutional setting has worked well so far in the presence of risks requiring coinciding responses. However, frictions and difficulties in coordination may appear when conflicting policy effects and trade-offs emerge.

Other challenges regarding the institutional setting result from the legal separation of functions and the transformation of financial intermediation. The legal allocation of responsibilities among authorities was set decades ago, based on the structure of financial intermediation prevailing at the time. In particular, intermediation was concentrated in credit establishments. This means that central bank lender of last resort facilities and lending support from the DGF are only allowed for this type of institutions. In time, however, there has been significant growth of non-credit financial intermediaries, like broker-dealers, pension funds and investment funds. Consequently, the central bank has given them access to other liquidity facilities but they still lack the possibility of having support from the DGF.

Another dimension of the challenges implied by the legal separation of functions between financial authorities is the resolution of possible conflicts or redundancy of regulation issued by different authorities. For example, many years ago the central bank, acting as regulator to the foreign exchange market, established a limit on the net foreign exposure of financial intermediaries. This means that foreign assets are roughly matched by foreign liabilities and that, therefore, the solvency ratio is negatively impacted by a depreciation of the local currency. This became evident with the sharp depreciation of the COP between mid-2014 and 2015 which constituted a source of concern for Colombian conglomerates with large investments in Central and South America. There is a discussion on whether currency risk is adequately captured by the market risk component of the solvency ratio or whether protection of net worth in the face of strong currency movements is required separately. Such a discussion needs coordination because market risk regulation is under the responsibility of Financial Superintendency and the overall solvency ratio regulation is set by the MoF.

³ The Appendix shows examples of a small open economy with a credit channel of monetary policy in which trade and capital account opening may generate or deepen financial stability/price stability trade-offs in the face of temporary shifts in external financial conditions.

An example of redundancy is provided by liquidity regulations. In 2009, the Financial Superintendency issued such regulations along the lines of the LCR comprised in the Basel III framework. Recently, the central bank, acting as regulator to the foreign exchange market, established stronger liquidity requirements aimed at minimising the foreign currency liquidity risk of financial intermediaries. Revision of this redundancy is made difficult by the existence of different authorities dealing with similar risks.

Financial innovation (eg fintech, the emergence and expansion of new financial products etc.) constitutes another challenge facing financial authorities. The law establishes precisely the activities that supervised financial intermediaries are allowed to conduct, subjecting financial innovation to an examination and approval process. A possible outcome of this framework is that part of the innovation could take place outside the perimeter of traditional financial regulation and supervision. In particular, unlike deposit-taking, lending activities are not restricted to conventional financial institutions. Consequently, non-financial entities may develop non-deposit based financial intermediation without proper control and regulation. A timely assessment of these new risks would require better coordination among financial authorities and would require additional resources.

A recent example in this regard is the wave of failures of payroll loans that had been made by non-financial cooperatives and then sold on to non-financial firms for final distribution to the public. High yields were offered to investors but ultimately could not be delivered, as borrowers defaulted. The non-financial intermediaries then resorted to illegal practices to keep themselves afloat. Eventually many went broke and the whole scheme fell apart. This situation did not have any systemic impact since financial institutions were not exposed to those firms and their own payroll loans were made with adequate standards. A law is being discussed to restrict the sale of payroll loans to entities monitored by the Financial Superintendency. This episode illustrates the risks and challenges that may arise in the future, as financial innovation proceeds outside the current regulatory and supervisory perimeter.

3. Effectiveness and interactions of macroprudential policies in Colombia

The ultimate objective of macroprudential policy is to reduce systemic risk. Along that line, the evaluation of their effectiveness should consider its impact on: i) credit dynamics, since it should help reduce the amplitude of credit cycles; and ii) the resilience of the financial sector, since its instruments should help avoid scenarios of banking distress. In other words, macroprudential policy should help authorities to deal with two dimensions of systemic risk: i) the time dimension, namely, the buildup of systemic risk during credit booms and asset prices bubbles, and related ex-post negative externalities from the financial to the real sector during busts; and ii) the cross-sectional dimension, namely, the contribution to systemic risk of negative externalities associated with spillover and contagion effects (Freixas et al (2015)).

The results of a joint research project coordinated by the Bank for International Settlements (BIS)⁴ suggest that macroprudential policies in the Americas region have been effective in stabilising credit growth. In addition, researchers found evidence that policies affecting prudential buffers (provisions and capital requirements) were particularly effective in limiting risks to the banking sector. That project used credit registry data (information at loan level) to evaluate different policies for eight countries.

The Banco de la República participated in this cooperative project. Using information for the first episode mentioned above (2006-09), Gomez et al (2017) found that dynamic provisions and marginal reserve requirements had a negative effect on loan growth. Additionally, they found that an increase in an aggregate measure of the macroprudential policy stance (MPP index) was related to a reduction in credit growth, suggesting that a tightening of the macroprudential policy stance helped dampen credit cycles. They also hinted at differential effects of macroprudential policies (which depended on bank and debtor characteristics). Specifically, firms and banks with a higher risk profile were associated with weaker loan growth when macroprudential policies were in place. In other words, access to credit by riskier debtors was reduced when macroprudential policies were tightened (risk-taking channel). In the same line, credit supply from less stable financial institutions was more severely affected when macroprudential tools were implemented (lending channel).

A relevant question on the effectiveness of macroprudential tools has to do with the interaction of these instruments with monetary policy. In this regard, Gomez et al (2017) found that restrictive monetary and macroprudential policies both have negative effects on credit growth. They also report weaker evidence suggesting that both policies reinforce each other.

To complement these results, it is important to examine the effects of macroprudential policies on the resilience of the banking sector. In this note, microlevel bank data were used to evaluate whether these policies affected two relevant dimensions of banking resilience: i) the solvency; and ii) liquidity of banking institutions. In addition, some estimations using credit registry data are reported to evaluate the effects of macroprudential tools on an ex post bank risk indicator.

To evaluate the effects of different macroprudential policies on banking resilience, an equation for solvency and another one for liquidity of banking institutions were estimated using quarterly data over the period 2005–09. The explanatory variables included a proxy for two macroprudential tools and some controls for bank characteristics and macroeconomic variables. The following specification was used:

$$\begin{aligned} \Delta Bank\ indicator_{bt} &= \delta_b + \sum_{j=1}^3 a_j Macrotool_{1,b,t-j} + \sum_{j=1}^3 \beta_j Macrotool_{2,b,t-j} + \gamma BC_{bt} + \theta MC_t \\ &+ \varepsilon_{bt} \end{aligned}$$

where $\Delta Bank\ indicator_{bt}$ is the change in the measure of liquidity or solvency of bank b at time t , and δ_b are bank fixed effects. The liquidity measure is calculated per bank

⁴ Working group of the BIS CCA Consultative Group of Directors of Financial Stability on the impact of macroprudential policies using credit registry data. The main findings of this network are summarised in Gambacorta and Murcia (2017).

as the ratio of liquid assets (cash reserves and bond holdings) to total assets in each quarter. The solvency measure is the capital adequacy ratio per bank.

The evaluated macroprudential tool variables $Macrotool_{i,b,t-j}$ correspond to two instruments employed in 2007 in response to the exuberance described previously: the new provisioning regime and the marginal reserve requirements. These variables are defined as: i) the ratio of dynamic provisions to commercial loans (*DP*); and ii) the ratio of effective marginal reserve requirements to total liabilities (*MRR*). The individual macroprudential policies are calculated for each bank from quarter $t-3$ to quarter $t-1$, thus accounting for their differential impact given the balance sheet structure of each institution. Importantly, unlike other studies, this work uses a policy variable that accounts for the intensity of each policy tool and not a simply a dichotomous variable reflecting the existence or absence of the tool. The reported coefficient in Table 1 for each policy variable corresponds to the sum of the coefficients for the respective lags. This specification is particularly convenient, since the effects of macroprudential policy on different bank dimensions may take some time.

The vector *BC* comprises a set of bank-specific characteristics as control variables, including the log of total assets (*Assets*) and a measure of profitability (*ROA*).

The model controls for changes in reserves that are related to shifts in the structure of deposits and the remuneration of reserve requirements during the sample period. The control variable (*ORR*) is defined as the ratio of ordinary reserve requirements (excluding the remuneration by the central bank) to deposits. Another control is a dummy variable that takes a value of 1 when the unremunerated external reserve requirement was in use (*DURR*). As mentioned, this policy was implemented in tandem with the marginal reserve requirement on domestic deposits to reduce the possibilities of substitution of internal liabilities for external loans.

The vector *MC* includes a set of macroeconomic variables to control for changes in the economy that might impact the banks. In particular, this vector includes a measure for the monetary policy stance denoted by *MP* (annual change of interbank rate), a measure of the output gap (calculated using a Hodrick-Prescott filter) as a proxy of the business cycle (*Outputgap*), the change in the VIX index of US stock market volatility as an indicator of international risk aversion in global financial markets (*VIX*) and the annual percentage variation of the exchange rate (*ER*).

The results are presented in Table 1. Each column represents one of the banking resilience attributes evaluated (solvency and liquidity). In general, macroprudential tools introduced during a period of financial exuberance had a significant impact on the resilience of Colombian banking institutions through higher levels of bank solvency and liquidity. In particular, the introduction of the new provisioning framework had a positive and significant effect on the solvency ratio of banking institutions. As expected, an increase in the level of provisions tends to reduce the level of risk-weighted assets, thus increasing bank solvency. There is no evidence of a significant effect of marginal reserve requirements on that attribute, even though Gómez et al (2017) found a negative impact on loan growth.

The impact of macroprudential policies on different bank dimensions¹

Dep variable: First difference in solvency ratio (column I) and liquidity (II),

Table 1

	I (SOLV)	II (LIQ)
$\sum_{i=1}^3 \text{Prov}_{b,t-i}$	0.5998** (0.2931)	1.007* (0.5671)
$\sum_{i=1}^3 \text{MRR}_{b,t-i}$	0.5625 (0.9573)	3.6908** (1.9012)
DURR _{b,t-1}	0.00425 (0.0131)	0.0073 (0.02244)
ORR _{b,t-1}	0.27664 (0.2699)	0.2555* (0.1122)
MP _t	0.3756 (0.5200)	-0.7238 (0.89663)
EXR _t	-0.03743 (0.0669)	-0.00763 (0.11443)
VIX _t	0.00046 (0.00027)	-0.00102* (0.00049)
Outputgap _t	0.093 (0.3820)	1.3252* (0.7810)
Assets _{b,t}	0.0151* (0.00676)	0.03999* (0.02252)
ROA _{b,t}	2.6520*** (0.3023)	2.3358*** (0.5143)
Bank effects	Yes	Yes
Number of banks	15	15
Number of obs.	86	86
R-squared (percent)	62.88	41.9
F test (overall sign.)	10.3***	3.54***

¹ System estimation using fixed effects panel estimation. Standard errors are reported in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

The evaluation above can be complemented using loan-level information to estimate the effect of macroprudential policy on ex post credit risk indicators based on non-performing loan data. Following some proposals of the BIS network,

estimates of the probability of a loan becoming non-performing using granular information was produced. A modification of the equation proposed is presented here. In particular, the estimated loan-level equation using the same period of reference and quarterly information is the following:⁵

$$\begin{aligned} \text{Prob}(NPL_{bft} = 1) & \\ &= \delta_{bf} + \alpha \Delta \text{Macro tool}_{1,t-j} + \beta \Delta \text{Macro tool}_{2,t-j} + \gamma BC_{bt-1} + \theta MC_{t-1} \\ &+ \mu \text{Collateral}_{bft} + \varepsilon_{bft} \end{aligned}$$

NPL_{bft} is a dummy variable that takes the value of 1 if the firm f is in default on a specific loan. Macro tool_{t-j} corresponds to the macroprudential policy variables used in the previously presented estimated model. To account for the time these measures may take to influence credit risk, four lags are used. The variable δ_{bf} corresponds to fixed effects at the banking relationship level. There are also some controls at the bank and macro levels.

In particular, the macroeconomic controls include the change in the policy rate (MP) and the exchange rate (ER), defined as before. A dummy variable to control for the international financial crisis is also included ($Globalcrisis$). The bank-specific controls include a proxy for the profitability (ROA), the log of total assets ($Assets$) and the ratio of liabilities different from deposits as a proportion of total liabilities, as a measure of funding taken into account non-core liabilities ($Noncoreliab$). A dummy variable that identifies loans with eligible collateral is also included ($Collateral$).

The results are presented in Table 2. They suggest that both macroprudential policies considered did have a significant effect in reducing future default probability. Higher levels of provisions and marginal reserve requirements helped reduce the future level of ex post loan-level bank risk.

The controls included also shed some light on the determinants of bank risk. In particular, differences among bank-specific characteristics appear as relevant determinants of ex post credit risk. Loans granted by larger banks tend to exhibit lower default probabilities. By contrast, banks that are more profitable tend to present higher levels of risk realisation. Additionally, the ex post probability of default tends to be lower for collateralised loans.

It is also found that increases in short-term interest rates and ordinary reserve requirements are associated with higher ex post default probabilities. A tightening of credit conditions tends to affect negatively the financial capability of riskier borrowers, increasing the realisation of credit risk.

The results presented here are in line with Altunbas et al (2017) who evaluate the effects of macroprudential tools on bank risk indicators for a large set of countries. They found evidence suggesting that macroprudential tools have a significant impact on bank risk, especially those that are specifically designed to enhance banks' resilience.

⁵ The information is sourced from the Financial Superintendency and includes 1.9 million of exclusively commercial bank-firm relationships.

The impact of macroprudential policies on bank risk¹

Dep variable: dummy variable that takes the value of 1 if the loan is in default and 0 otherwise

Table 2

Prov _{b,t-4}	-1.2499*** (0.02779)
MRR _{b,t-4}	-0.6084*** (0.05025)
ORR _{b,t-1}	0.2657*** (0.01909)
DURR _{b,t-1}	0.0053 (0.0065)
ΔMP _{t-1}	0.01204*** (0.03875)
ΔExchrate _{t-1}	0.0021 (0.0025)
Globalcrisis _t	0.01623*** (0.001633)
VIX _t	0.0011 (0.00356)
OutputGap _{t-1}	-0.8423*** (0.0265)
Assets _{b,t-1}	0.1311*** (0.0016)
ROA _{b,t-1}	0.6626*** (0.05438)
Collateral _{bf,t}	-0.01491*** (0.00071)
Noncoreliab _{b,t-1}	0.0508*** (0.00629)
Debtor effects	Yes
Number of banks	23
Number of obs (million)	1.95
Number of debtors	268700
R-squared (percent)	55

¹ System estimation using fixed effects panel estimation. Standard errors are reported in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

4. Conclusions

Macroprudential policy tools have been used occasionally in Colombia to deal with systemic risk in a context of decentralised financial regulation. This institutional feature has not prevented the adoption of successful policy responses to episodes of excessive build-up of systemic risk since the beginning of the 2000s. These episodes have been timely identified and dealt with. In particular, the experience of 2006–08, when a credit boom emerged, represented a big test for the Colombian macroprudential framework.

There is evidence that macroprudential policies have been effective in preventing the build-up of financial risks. They seem to soften credit cycles by reducing credit growth in boom periods. In addition, they have added to the resilience of banks through increases in solvency and liquidity buffers. Moreover, there is some evidence that those policies helped decrease ex post bank credit risk. They may have also helped cushion the financial downswing in the aftermath of the global financial crisis. Despite a marked deceleration, a credit crunch did not occur and economic growth remained in positive territory.

However, future success cannot be taken for granted and the country could face challenges in this respect. The exposure of the domestic financial system to international factors has increased and risks are continuously changing. The presence of foreign agents in local markets has significantly increased, Colombian banks have expanded abroad, and variants of financial intermediation have emerged, posing challenges to the various authorities entrusted with financial stability objectives. Also, a more open economy increases the probability of policy trade-offs and may reduce the effectiveness of some macroprudential policy tools used successfully in the past. In this context, better knowledge on the effects of macroprudential policies and enhanced coordination among financial authorities may be necessary.

Appendix

This appendix provides an example of the inflation/financial stability policy trade-offs that may arise in the face of changing financial external conditions, particularly when trade and capital account openness deepens in a small economy characterised by some degree of nominal price rigidity and a credit channel of monetary policy. The short-term equilibrium of this economy is described by the following equations:

Equilibrium in the goods market (IS):

$$y = A(i, i_l, y) + nx(q, y)$$

Balance of Payments (BP):

$$nx(q, y) = -F(i, i^* + e^e - e) q$$

Equilibrium in the credit market (CM):

$$\begin{aligned} P_s &= \lambda(i, i_l) D(i, i^* + e^e - e, y) && \text{(Loan supply)} \\ P_d &= P_d(i_l, y) && \text{(Loan demand)} \end{aligned}$$

$$P_s = P_d$$

Phillips curve (PC):

$$\pi = \pi^e + \beta (y - y^n) + \gamma (e - e_{-1})$$

Aggregate demand (IS) is made up of domestic absorption and net exports. Domestic absorption depends not only on the policy rate, i , but also on the loan rate, i_l , reflecting the existence of a credit channel of monetary policy. Net exports depend on the real exchange rate, q , and GDP, y . The real exchange rate is defined as $q \equiv E/P$, where E is the nominal exchange rate (local currency per unit of foreign currency) and P is the domestic price level (the foreign price level is normalised to 1).

The balance of payments (BoP) equates net exports, nx , to the real value of net capital outflows $-F q$. The latter are determined by the local policy rate and the foreign interest rate adjusted for expectations of nominal depreciation of the domestic currency.⁶ It is assumed that foreign and local financial assets are imperfect substitutes, so that UIP does not hold, but net capital outflows are affected by the interest rate differential. For simplicity, the BoP abstracts from transfers and factor income flows.

Since the loan rate affects domestic absorption, equilibrium in the lending market is modelled explicitly (CM). Following a variant of Bernanke and Blinder (1988), loan supply is a fraction of total deposits that depends on policy and loan rates. Deposits are demand-driven and, therefore, a function of local and foreign interest rates, and GDP. As a reflection of imperfect capital mobility, the response of deposits to shifts in local or foreign interest rates is potentially different. Loan demand is

⁶ The variable e is defined as the natural logarithm of the nominal exchange rate E . Likewise, e^e corresponds to the natural logarithm of the expected exchange rate.

standard and determined by output as a scale variable and the loan rate. Note that loan demand is not affected by foreign interest rates. Thus, capital mobility is assumed to take place through movements in bonds and bank deposits.

Price formation is summarised by an open-economy Phillips curve, in which inflation depends on inflation expectations, the output gap and nominal depreciation. For simplicity, it is assumed that expectations of inflation and the exchange rate are static and pre-determined.

The idea of the exercise is to examine the response of the endogenous macroeconomic variables (y , i_l , P , e and π) to a temporary shift in the external interest rate, i^* , under different degrees of capital and trade openness. This is done to explore the resulting changes in the monetary/financial stability trade-offs confronting policymakers. To do so, a comparative statics exercise is undertaken on the basis of the system of equations (IS), (BP), (CM) and (PC). Differentiating these equations with respect to i^* , the following system of simultaneous equations is obtained:

$$dy/di^* (1 - nx_y - A_y) - di_l/di^* A_{il} - de/di^* nx_q q + d\pi/di^* (nx_q q/(1+\pi)) = 0 \quad (\text{A.1})$$

$$dy/di^* (Pd_y - \lambda D_y) + di_l/di^* (Pd_{il} - \lambda_{il} D) + de/di^* \lambda D_{i^*} = \lambda D_{i^*} \quad (\text{A.2})$$

$$dy/di^* nx_y/q + de/di^* (nx_q + F - F_{i^*}) - d\pi/di^* ((nx_q + F)/(1+\pi)) = -F_{i^*} \quad (\text{A.3})$$

$$dy/di^* \beta + de/di^* Y - d\pi/di^* = 0 \quad (\text{A.4})$$

To build the examples, values for dy/di^* , di_l/di^* , de/di^* and $d\pi/di^*$ are calculated assuming linear functions for A , nx , F , D , λ and Pd , the following initial values: $q = 1$, $F = 0$, $\pi = 0$, $D = 0.3$, and $\lambda = 0.7$ and a set of parameter values.⁷

As trade openness increases, the importance of foreign goods and inputs in local consumption and production must increase. Hence, the pass-through parameter in the Phillips curve, Y , should be higher. Likewise, as capital account openness rises, capital flows become more responsive to risk premia and interest rate differentials (higher F_{i^*}). Consequently, the above derivatives are calculated for different values of the pass-through parameter, Y , and the sensitivity of net capital inflows to the foreign interest rate, F_{i^*} .⁸

Note that the system of equations (A.1)–(A.4) assumes a constant policy rate, i . Therefore, the derivatives must be understood as the expected movements of the endogenous variables after a temporary shift in the foreign interest rate without a response of the monetary authority.

As a reference, Graphs A.1 to A.6 show the derivatives calculated without a credit channel of monetary policy ($A_{il} = 0$). The responses of the exchange rate, output and inflation to an increase in the foreign interest rate are all positive, in accordance with the predictions of a simple, small open economy Mundell-Fleming model. As the pass-through coefficient, Y , rises, so do the positive effects on the exchange rate and inflation (Graphs A.1 and A.3). By contrast, the positive impact on output decreases

⁷ $A_{il} = -0.05$, $A_y = 0.7$, $nx_q = 0.01$, $nx_y = -0.15$, $\lambda_{il} = 0.01$, $D_{i^*} = -0.01$, $D_y = 1$, $Pd_{il} = -0.01$, $Pd_y = 1$, $\beta = 4$.

⁸ To compute the derivatives for different values of parameter Y , F_{i^*} is set to -0.01 . To compute the derivatives for different values of F_{i^*} , Y is set to 0.1 and D_{i^*} is set equal to F_{i^*} .

due to the lower real depreciation of the currency implied by a higher pass-through coefficient (Graph A.2). Increased capital account openness enhances the positive effects of higher foreign interest rates on the exchange rate, inflation and output (Graphs A.4 to A.6).

The introduction of a credit channel of monetary policy significantly changes the above results (Graphs A.7 to A.14). Although the currency depreciates in the face of an increase in the foreign interest rate and capital outflows (Graph A.7), local deposits are reduced in the process and loan supply is restrained. As a result, lending rates rise (Graph A.8), driving output down (Graph A.9). Thus, there are conflicting effects on inflation. On the one hand, the depreciation of the currency pushes it up. On the other, the contraction of output exerts a downward pressure on it. The net impact depends on the size of the pass-through coefficient, Y , among other things. Graph A.10 shows that for low values of Y , inflation falls with the increase in the foreign interest rate, since the impact of output contraction prevails. In this case, there is no policy dilemma. Monetary policy should be unambiguously relaxed to deal with both too low inflation and subdued credit supply and economic activity.

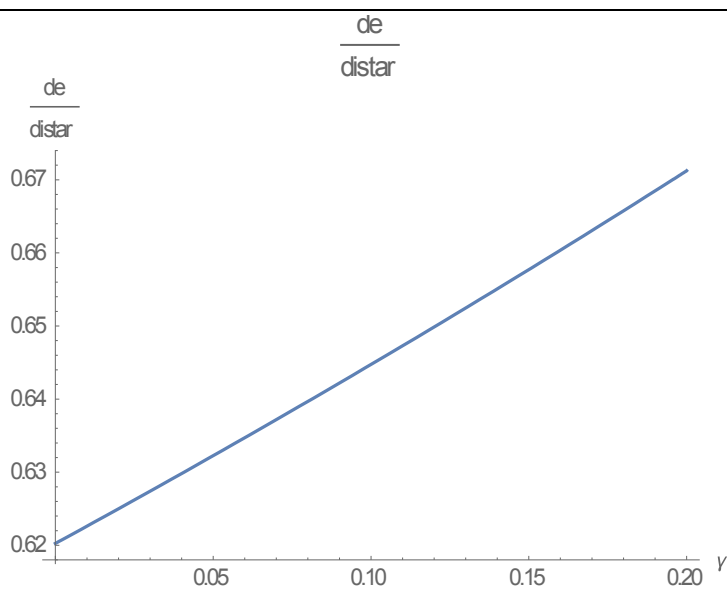
As Y increases, however, the sign of the derivative shifts due to the relatively greater effect of the depreciation on local prices. At this point, a dilemma arises for the monetary policymaker. The increase in the foreign interest rate depresses credit and output but increases inflation. The appropriate monetary policy response is not apparent.

Something similar happens when capital inflows become more responsive to the foreign interest rate. As the parameter F_i^* increases, a hike in the foreign interest rate produces a larger depreciation of the currency and a greater jump in inflation. However, the reduction in deposits, loan supply and output is also larger. Hence the policy dilemma is heightened under greater capital account openness (Graphs A.11 to A.14).

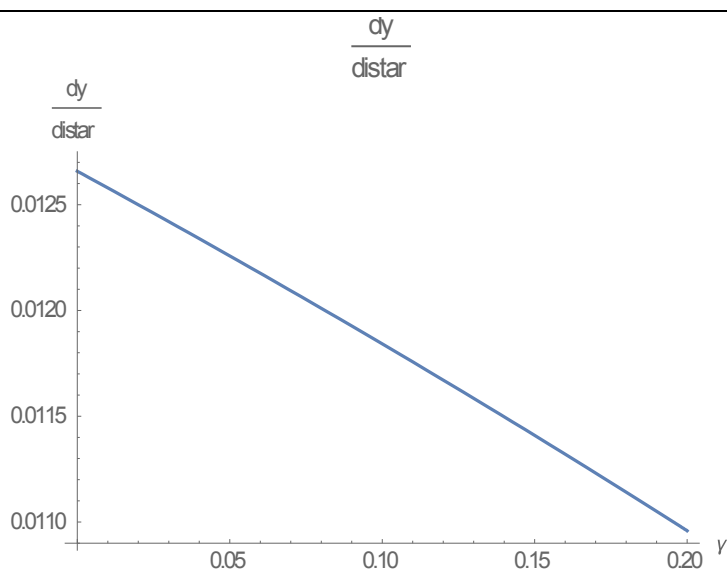
On the basis of the above results, it is possible to appreciate the effects of an increased opening of the economy on the policy trade-offs when external financial conditions improve. In a relatively closed economy (low pass-through and low sensitivity of capital flows to the foreign interest rate), decreasing costs of external funds lead to fast credit growth and higher output and inflation. No policy dilemma arises, since tightening monetary policy simultaneously moderates both financial and price stability risks.

By contrast, in a more open economy a decrease in the costs of foreign borrowing produces a spike in credit supply and aggregate demand while inflation falls with the appreciation of the currency. In this case, a trade-off between price and financial stability risks emerges.

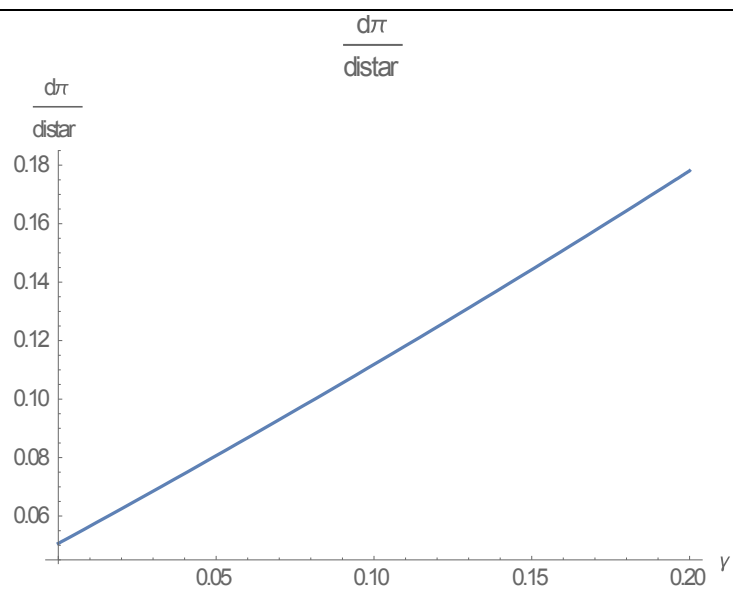
Graph A.1



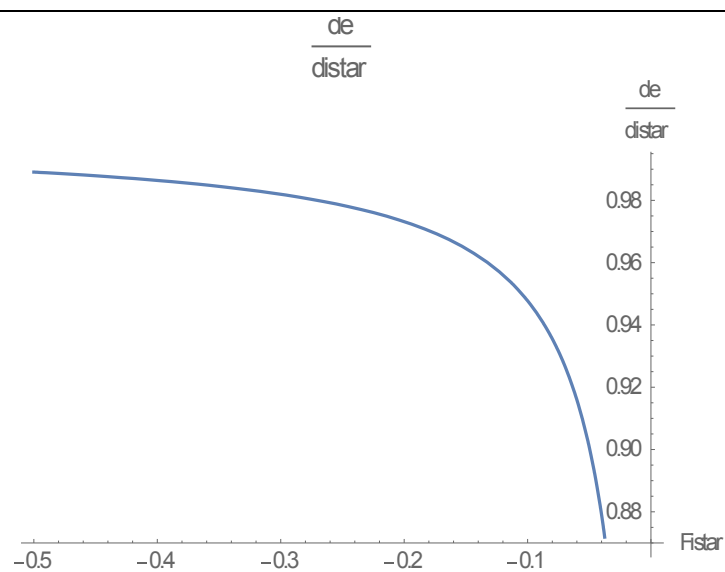
Graph A.2



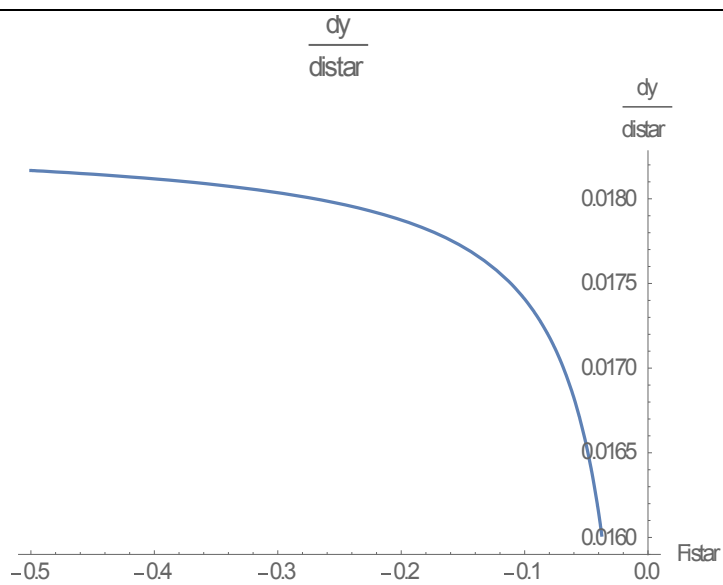
Graph A.3



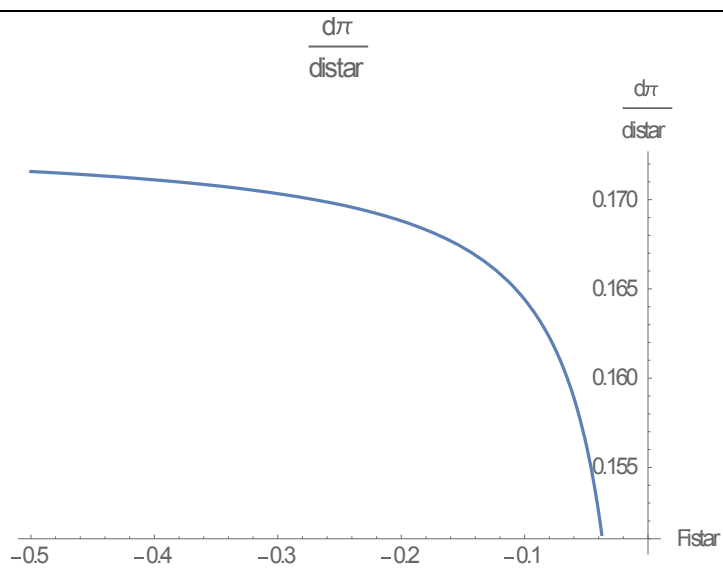
Graph A.4



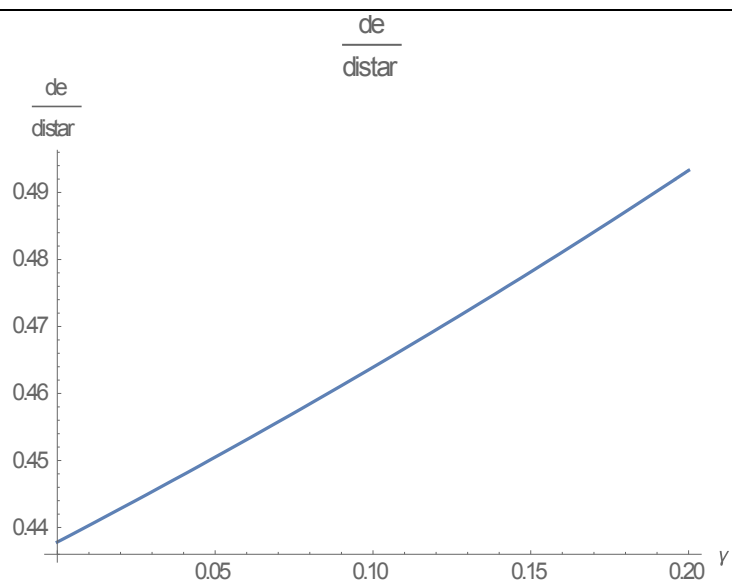
Graph A.5



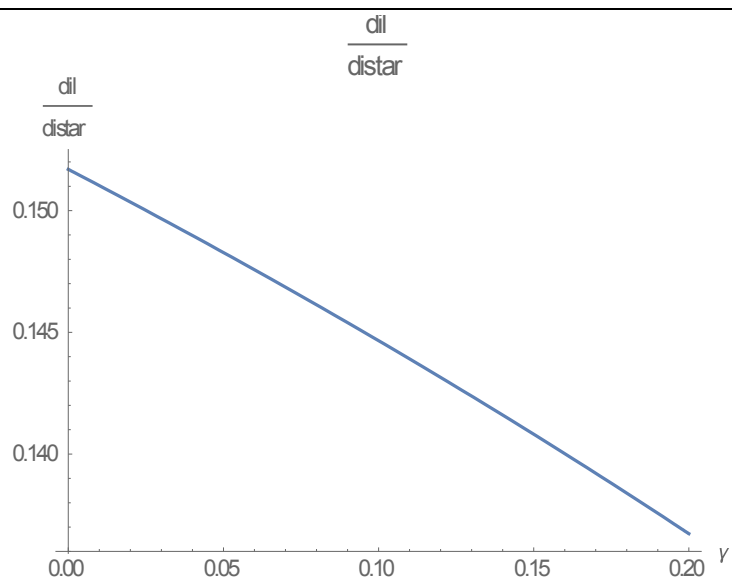
Graph A.6



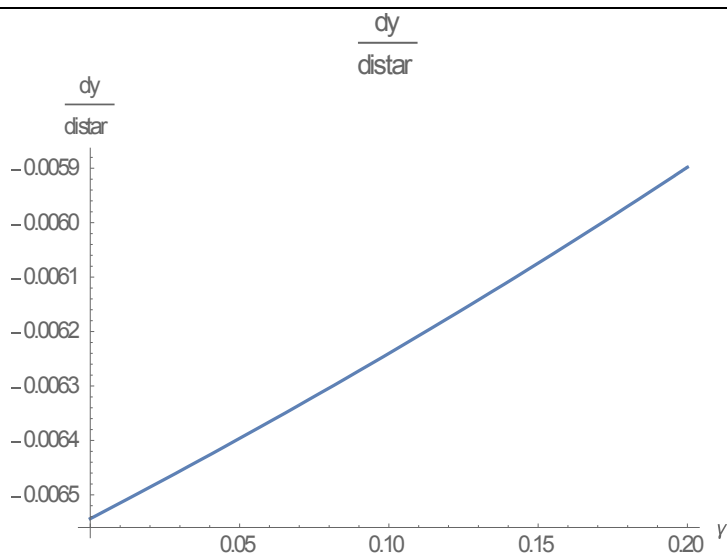
Graph A.7



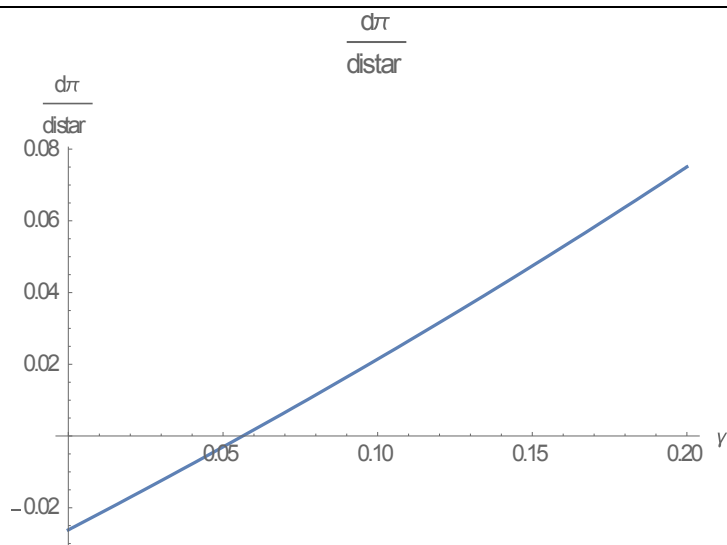
Graph A.8



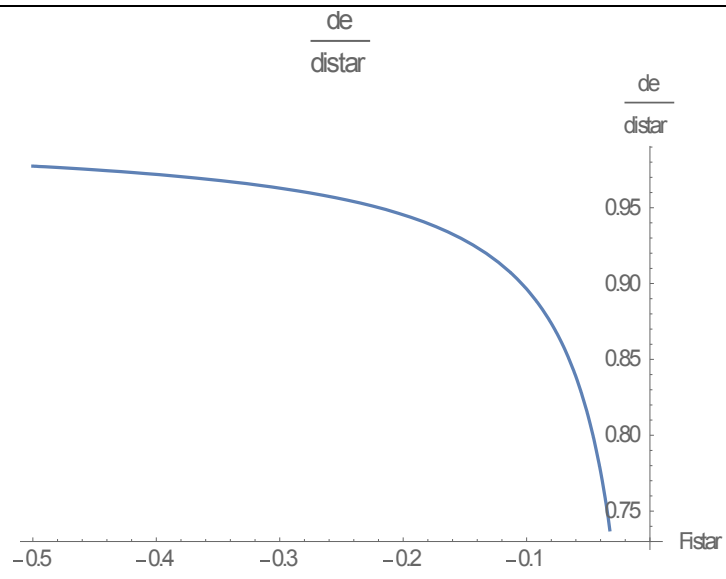
Graph A.9



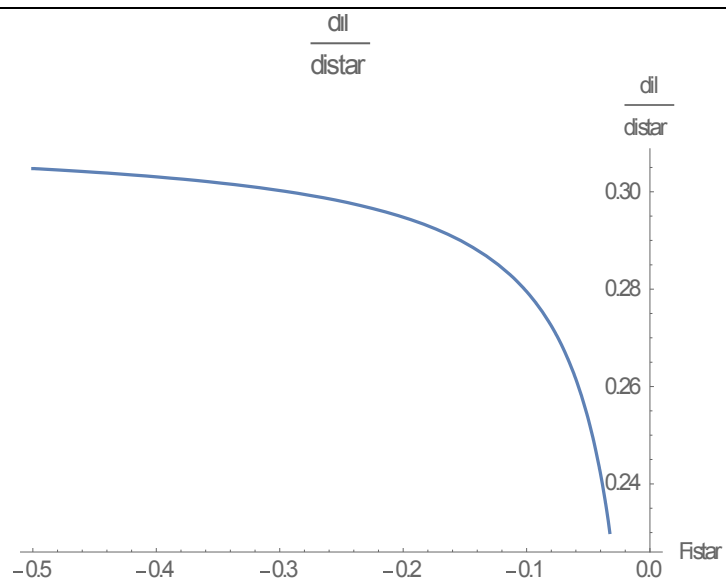
Graph A.10



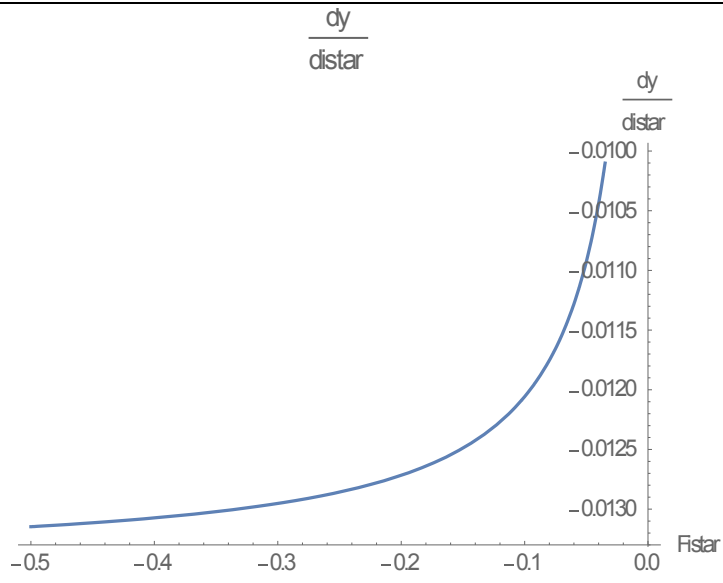
Graph A.11



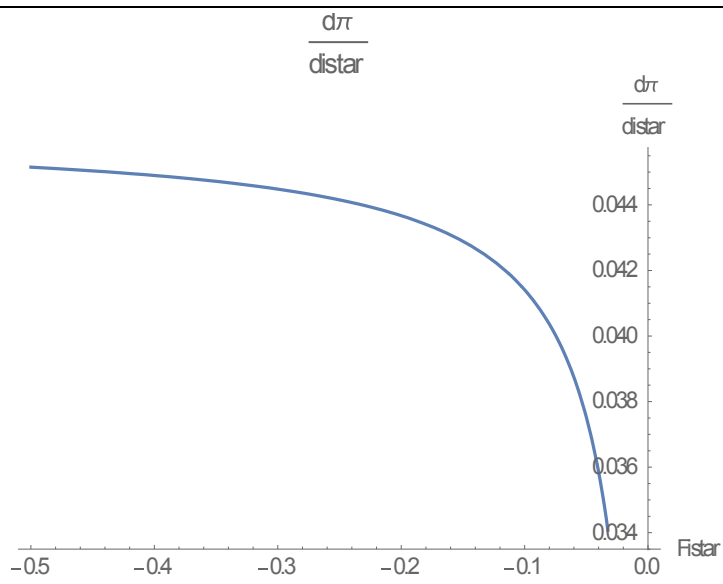
Graph A.12



Graph A.13



Graph A.14



References

Altunbas, Y, M Binici, and L Gambacorta (2017): "Macroprudential policies and bank risk", *BIS Working Papers*, no 646.

Bernanke, B and A Blinder (1988): "Credit, money, and aggregate demand". *American Economic Review*, vol 78, no 2, pp 435–39.

Bustamante, C (2011): "Política monetaria contracíclica y encaje bancario", *Banco de la República Working Paper Series*, no 646.

Freixas, X, L Laeven and J-L Peydró (2015): *Systemic risk, crises and macroprudential regulation*, MIT Press.

Gambacorta, L. & Murcia, A (2017): "The impact of macroprudential policies and their interaction with monetary policy: an empirical analysis using credit registry data", *BIS Working Papers*, no 636.

García, J, D López, E Montes and P Esguerra (2014): "Una visión general de la política de comercial colombiana entre 1950 y 2012", *Banco de la República Working Paper Series*, no 817.

Gómez, E, A Lizarazo, J Mendoza and A Murcia (2017): "Evaluating the impact of macroprudential policies on credit growth in Colombia", *BIS Working Papers*, no 634.

López, M, F Tenjo and H Zárate (2014): "Credit cycles, credit risk and countercyclical loan provisions", *Ensayos sobre Política Económica*, vol 32, no 74, pp 9–17.

Tovar, C, M García-Escribano and V Marti (2012): "Credit growth and the effectiveness of reserve requirements and other macroprudential instruments in Latin America", *IMF Working Papers*, no 12/142.

Vargas, H, C Varela, Y Betancourt and N Rodríguez (2010): "Effects of reserve requirements in an inflation targeting regime: the case of Colombia", *Banco de la República Working Paper Series*, no 587.