

# The Cyclical Behavior of Bank Capital Buffers in an Emerging Economy: Size Does Matter<sup>12</sup>

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## **Abstract**

Using a panel of Colombian banks and quarterly data between 1996:1 and 2010:3, we study the relationship between short-run adjustments in bank capital buffers and the business cycle. We follow a partial adjustment framework and control for several variables that have been identified as important determinants of bank capital buffers in previous studies, and find that bank capital buffers vary over the business cycle. We are able to identify a negative co-movement of capital buffers and the business cycle. However, we also find that capital buffers of small and large banks behave asymmetrically during the business cycle. While the former appear to be constant over time, once the appropriate set of control variables is used, the latter present a countercyclical behavior. Our results suggest the possible need of the implementation of regulatory policy measures in developing countries.

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**Keywords:** *Bank capital buffers; Credit risk; Regulation; Colombia*

# 1 Introduction

Studying the time-series behavior of banks' capital buffers is important for at least two fundamental reasons. First, capital requirements have become one of the main instruments of today's banking regulation. Following the Basel accord, financial institutions' supervisors around the world follow closely the capital ratio of the institutions they regulate and impose minimum requirements. Arguably the main objective of Basel II is to create a closer liaison between banks' risk taking and individual capital requirements. In order to promote a sound asset and liability management, the current regulatory framework pretends to stimulate banks to hold an adequate level of capital which corresponds to their risk-taking decisions. Clearly, appropriate capital levels vary during the business cycle. There is ample evidence showing that the probabilities of observing counterparty credit rating downgrades and defaults is quite different during economic expansions and during cyclical downturns (see, for instance, Kavvathas (2000), and Gómez-González and Hinojosa (2010)). During an economic upturn firms and households perform well and are less prone to committing default on their debt obligations than during an economic downturn. Thus, the amount of bank capital required to cover against unexpected losses depends on the state of the business cycle. Given that capital is costly, it will not be optimal for banks to hold a constant level of capital across time, and thus observed capital buffers should fluctuate during the business cycle. Second, the literature on capital crunch shows that under capital regulations the capitalization ratio is important for financial institutions when they are taking decisions on portfolio composition (see Peek and Rosengren (1995), and Estrella et al (2000)). Particularly interesting, as shown by Van den Heuvel (2009), bank capital regulations might have an effect on bank lending and on the response of lending to monetary policy actions in a dynamic setting. If the market for bank equity is imperfect, banks cannot readily issue new equity at all moments in time<sup>1</sup>. Therefore, in the presence of minimum capital requirements, banks forgo profitable lending opportunities to reduce the probability of falling below the regulatory minimum levels in the future in case credit risk materializes. There are

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<sup>1</sup>There is ample theoretical (see, for instance, Myers and Majluf (1984), and Stein (1998)) and empirical support (Cornett and Tehranian, and Calomiris and Hubbard (1995)) for the assumption that issuing new equity can be costly, and that the cost might depend on banks' individual characteristics.

explicit as well as implicit costs for falling below the minimum capital requirement. Explicit costs depend on the particular regulatory design of the country in which the bank operates and relate to penalties and restrictions imposed by the supervisor. Implicit costs deal with the effect of the penalization of a bank on its depositors' behavior.

Bank capital buffers are defined as the excess capital maintained by financial institutions at a given point in time. If capital markets were perfect, the optimal capital buffer will be set to zero for all banks, because it would be inefficient to maintain idle capital which is more costly to hold than insured deposits. However, in the presence of imperfect equity markets, capital can not be raised without cost. Therefore, it might be optimal for financial institutions to hold positive capital buffers.

Banks will hold different levels of capital depending on their individual characteristics, such as their access to equity markets, the levels of risk they assume, and their size, and also on the stage of the business cycle. The decisions they take on the amount of capital they withhold affect lending, and thus the transmission of monetary policy to the economy.

The dependence of capital buffers on the business cycle may have a negative impact on macroeconomic stability. Empirical studies have shown that banks' capital buffers of Western European banks fluctuate countercyclically over the business cycle (Ayuso et al. (2004), Lindquist (2004), Jopikii and Milne (2008), and Stolz and Wedow (2011)). Banks undertake a riskier behavior during times of economic expansion, expanding their loan portfolio without building up their capital buffers accordingly. In a bust, when banks observe the materialization of credit risk, those poorly capitalized will face the possibility of falling below the minimum required levels. Therefore, they will have to either issue new equity or increase their capital buffers reducing lending. Given that raising capital is specially hard during economic downturns when capital is scarce and costly, many banks have to cut lending in a considerable proportion. The resulting reduction in loanable funds experienced by firms and households amplifies the magnitude of the economic recession.

In this paper we study the behavior of Colombian banks' capital buffers during the business cycle. Our objective is to test whether capital buffers behave countercyclically, and whether individual characteristics of the banks influence their time-series behavior. We call the attention that the business cycle may affect

banks' capital buffers both due to supply-side effects and through demand-side effects. In order to overcome this spicification issue, we follow Stolz and Wedow (2011) and test for asymmetries with respect to the capitalization of banks. Thus, we specify a partial adjustment model in which capital buffers this period depend on last period capital buffers, on the business cycle, and on other variables controlling for heterogeneity in the risk-behavior of banks.

Using quarterly balance sheet information on the universe of Colombian banks for the period 1996:1 - 2010:3, we show that capital buffers vary over the business cycle. However, the behavior of capital buffers across banks is heterogeneous: big banks' buffers are more responsive to the business cycle. In particular, we find that while large banks' capital buffers behave countercyclically, there is no statistical evidence that smaller banks' capital buffers change over time. We also find that increases in the ratio of total loans over assets has an asymmetric effect on capital buffers depending on banks' size. While the effect of an increase in lending as a proportion of total assets is positive on the capital buffers of large banks, the effect is negative on small banks' capital buffers. This interesting result may be evidence of the short-sightedness of small banks who do not increase their safety margins when they are assuming higher risks while expanding credit. On the contrary, large banks appear to increase their capital buffers to hedge against possible negative shocks that can lead to credit risk materialization when loans are growing fast. Similarly, we find that while increases in the real growth rate of loans has a negative impact on capital buffers for small banks, it has a positive - though not statistically significant - effect on large banks' buffers. Finally, we find that a prudential regulation introduced in 2007 by the Colombian financial system supervisor, that consisted in establishing a new system for managing credit risk in Colombian financial institutions (SARC), has had no significant effect in the time-series behavior of banks' capital buffers, although it might have had an effect in the level of buffers of small banks.

This study contributes to the literature on the behavior of capital buffers in several ways. First, up to our knowledge this is the first paper on the topic that provides evidence for banks of an emerging economy. The existing literature has focused on the behavior of banks' buffers in Western European economies. Therefore, our study allows the comparison of results for an emerging economy with those of developed European economies. Second, Colombia is a bank-based economy. More than 60% of non-financial firms' external funds are provided by banks.

In that sense, the behavior of bank lending influences importantly firms' performance and investment behavior. Our results can be compared to those of Stolz and Wedow (2011), who study the case of banks in Germany, a developed bank-based economy. Third, we have a rich data set comprised of quarterly balance sheet information for over 15 years of all commercial banks in Colombia. Other related studies use yearly data, shorter time-periods, or only a sample of the existing banks. In that sense, our study has informational advantages over previous studies. Credit cycles in Colombia have been very pronounced. During the years 1998 - 2000 Colombia experienced a major banking crisis which led to changes in the concentration of the banking industry and to structural changes in the behavior of banks toward risk. Therefore, with our data set we are able to test for the effects of the banking crisis on banks' selection of capital buffers. In contrast, during 2004 - 2008 Colombia's banking system experimented an extraordinary period of credit expansion. For instance, in the years 2006 and 2007 the annual real growth rate of loans exceeded 30%. Credit expansion was so rapid and pronounced that the financial system's authorities had to impose regulatory measures such as marginal reserve requirements.

Finally, our results suggest that capital buffers of banks with better access to equity markets tend to vary more over the business cycle. Specifically, security buffers of large banks with privileged access to capital markets behave counter-cyclically, and this may have negative impacts on macroeconomic stability. An interesting implication of this finding is that if capital markets develop in such a way that smaller banks gain more access to them, it will be possible to expect that capital buffers of these banks will react more vigorously to the stage of the business cycle. From a macro-prudential policy perspective, this would suggest that regulation measures should be undertaken to incentive banks to behave in a less procyclical way. For instance, regulatory capital measures that take into account this aspect could be implemented, particularly in emerging economies in which capital markets are developing at a rapid pace.

The structure of this paper is as follows: Section 2 presents the empirical model, Section 3 analyzes the data, Section 4 presents the results and robustness checks, and Section 5 concludes.

## 2 The empirical model

Our objective is to test whether bank capital buffers change over the business cycle or not. In order to do so, we follow the methodology proposed by Ayuso et al. (2004) and Estrella (2004), who study the cyclical behavior of capital buffers of banks in Spain and the United States. We use a partial adjustment framework in which bank  $i$  seeks to attain its optimal capital buffer,  $BUF_{i,t}^*$ , given its observed capital buffer at time  $t - 1$  is  $BUF_{i,t-1}$ :

$$\Delta BUF_{i,t} = \lambda (BUF_{i,t}^* - BUF_{i,t-1}) + \varepsilon_{i,t} \quad i = 1, \dots, N ; t = 1, \dots, T \quad (1)$$

where  $\lambda$  represents the speed of adjustment of the observed capital buffer towards its optimum level,  $\Delta BUF_{i,t} = BUF_{i,t} - BUF_{i,t-1}$ , and  $\varepsilon_{i,t}$  is the error term.

Even though the optimal capital buffer of bank  $i$  is unobservable, following Jopikii and Milne (2008) and Stolz and Wedow (2011) it is sensible to assume it depends on the stage of the business cycle due to its effect on credit risk and bank-specific variables. Adding  $BUF_{i,t-1}$  to both sides of equation (1), we obtain the following expression:

$$\begin{aligned} \Delta BUF_{i,t} + BUF_{i,t-1} &= \lambda (BUF_{i,t}^* - BUF_{i,t-1}) + BUF_{i,t-1} + \varepsilon_{i,t} \\ BUF_{i,t} &= \lambda BUF_{i,t}^* + (1 - \lambda) BUF_{i,t-1} + \varepsilon_{i,t} \\ BUF_{i,t} &= \lambda BUF_{i,t}^* + \gamma BUF_{i,t-1} + \varepsilon_{i,t} \quad i = 1, \dots, N ; t = 1, \dots, T \end{aligned} \quad (2)$$

where  $\gamma = (1 - \lambda)$ . Following the argument above, we instrument the target capital buffer in terms of observables such as the business cycle, credit risk variables, and bank-specific variables. Our empirical specification is given by equation (3) :

$$BUF_{i,t} = \beta_0 + (1 - \lambda) BUF_{i,t-1} + X'_{i,t} \theta + \varepsilon_{i,t} \quad (3)$$

where  $X_{i,t}$  is a vector of control variables that includes the annual GDP growth rate ( $GDP$ ), profitability of equity ( $ROE$ ), the ratio of non-performing loans to total loans ( $RISK$ ), the real growth rate of loans ( $DLOAN$ ), and the loan to asset ratio ( $LOANS$ ). Additionally we included two dummy variables; one controls

for bank size (*DUMMYSIZE*), separating large banks from small banks<sup>2</sup>, and the other one control for the inclusion of SARC in 2007 (*DUMMYSARC*). We define  $\varepsilon_{i,t} = \alpha_i + u_{it}$ , where  $\alpha_i$  is an idiosyncratic component which we assume uncorrelated with the regressors contained in vector  $X_{i,t}$ , and  $u_{it}$  is a white-noise disturbance term.

All of the variables in equation (3) are defined in levels. Following conventional wisdom in panel data analysis, we proceed to transform equation (3) into first differences in order to obtain unbiased estimates.

Our main interest relies in the sign of the parameter associated with the variable *GDP*. The existing empirical literature suggests this sign is negative, indicating that capital buffers behave countercyclically (see, for instance, Stolz and Wedow (2011)). A negative impact of the business cycle variable on the change in capital buffers will indicate that during expansions, when banks are expanding credit, capital buffers fall; while during economic contractions capital buffers increase. This behavior has been called in the literature "banks short-sightedness" (Borio et al. (2001)). We test for this hypothesis for the whole universe of banks, and we test the same hypothesis separating banks according to their size characteristics. Particularly, we run separate regressions for small banks and for large banks. The intuition behind performing separate estimations according to bank size is that large institutions are less exposed to risk because they can diversify their assets more, because they can achieve economies of scale, or because they likely have been in business longer (Gómez-González and Kiefer, 2009). Thus, we expect a stronger effect of the business cycle variable on capital buffers for large banks than for small institutions.

Note that equation (3) specifies a dynamical structure in a panel data context. For that reason, we employ the dynamic panel data GMM estimator proposed by Blundell and Bond (1998). This estimation method generalized the method proposed by Arellano and Bond (1991), avoiding the weak instruments problem<sup>3</sup>, and controlling for specific components in the error term.

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<sup>2</sup>Takes on the value 1 if the bank is large and the value 0 if the bank is small.

<sup>3</sup>The weak instruments problem appears in models with endogenous regressors in which using too many instruments may result in biased estimates of the parameters of interest.

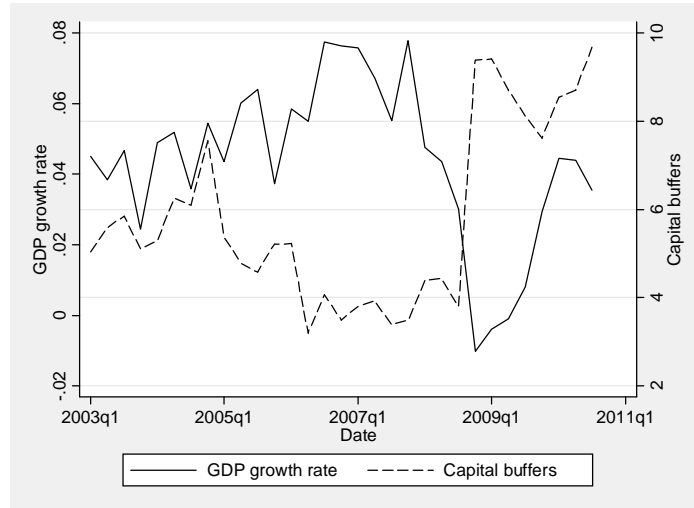


### 3 Data description

We count with a rich data set, provided by the Superintendencia Financiera de Colombia<sup>4</sup>, which contains quarterly data with balance sheet information on the whole universe of Colombian banks for the period 1996:1 - 2010:3. Using this information we construct the financial variables mentioned above. The growth rate of GDP was obtained from the Central Bank of Colombia.

It is important to mention that we define  $BUF_{i,t}$  as the difference between the observed capital ratio of bank  $i$  in period  $t$  and 9%, which is the regulatory level of minimum capital in Colombia<sup>5</sup>. Figure 1 shows the time-series behavior of bank capital buffers and GDP. It can be seen that apparently capital buffers behave countercyclically. In fact, the Spearman correlation coefficient between capital buffers and GDP is of -0.61. Figure 2 shows the behavior of capital buffers over time, discriminating by bank size. It is noticeable that after the banking crisis of the late 1990s small banks increased their capital buffers significantly more than large banks<sup>6</sup>. This can be explained by differences in risk aversion of banks of different sizes and characteristics.

Figure 1: Capital buffers and GDP

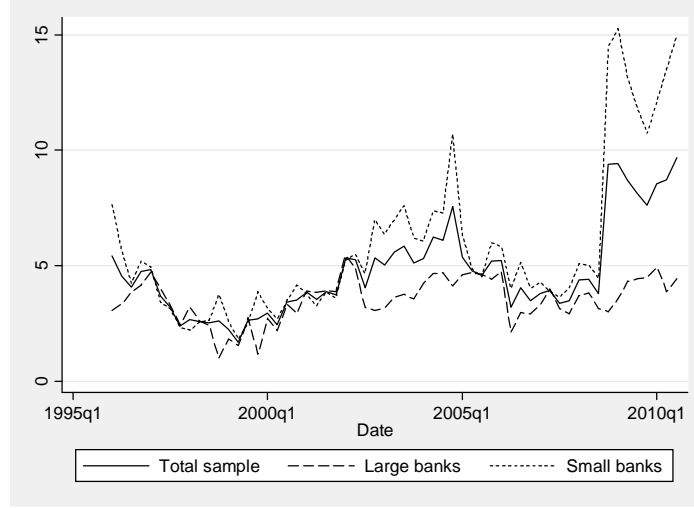


<sup>4</sup>The Superintendencia Financiera de Colombia is Colombia's financial system unique supervisor. Regulation of the financial system is in charge of the Ministry of Finance.

<sup>5</sup>If a bank falls below that capital level it is directly intervened by the Superintendencia Financiera de Colombia.

<sup>6</sup>In this study we consider large banks as those whose assets are above the median. Small banks are defined as the complement of large banks. For robustness of the empirical results we tried several different definitions of small and large banks. However, qualitative results were identical under all these definitions.

Figure 2: Capital buffers and bank size



The control variables also vary significantly over the business cycle. In particular, the average *ROE* for the whole sample of banks exhibits negative levels during the period of economic downturn and positive levels during the period of economic expansion, as expected. However, its behavior is heterogeneous depending on bank size. For large banks, the average *ROE* is always positive, although it presents quite different levels during moments of expansion and moments of contraction. It is also important to note that the growth rate of loans of large banks during periods of economic upturn (21.9%) is much higher than that of small banks (12.7%). With respect to *RISK*, both small and large banks register a higher indicator during bad times than during good times, as expected, although both types of banks do not appear to show very different behaviors. Finally, the share of loans out of total assets remains relatively constant during the sample period for both types of banks (see Tables (1a), (1b), and (1c)).

Note there is a change in the level of buffers in 2008, especially noticeable for small banks. This change responds to the implementation of SARC and, particularly, to a decision taken by Colombia's financial system supervisor of suggesting a higher level of capitalization to a group of banks at the end of 2008. This change in the level of buffers generates a possible unit-root problem in the series of capital buffers. That is one of the reasons that led us to model the first difference of the series instead of its level. Below we show that the estimation results for the whole sample period do not change significantly when data from 2008:4 on is not considered for the regressions. We also show that the introduction of SARC

led to a change in the level of small banks' capital buffers, but did not change the time-series behavior of their first differences.

Table 1a: Average value of regressors by sub-period. Whole sample

<b>Period</b>	<b>ROE</b>	<b>RISK</b>	<b>DLOAN</b>	<b>LOANS</b>
<b>1996-1999</b>	-0.011	0.067	0.188	0.663
<b>2000-2003</b>	-0.056	0.076	0.001	0.611
<b>2004-2008</b>	0.193	0.045	0.169	0.610
<b>2009-2010</b>	0.127	0.047	0.067	0.629

Table 1b: Average value of regressors by sub-period. Large banks

<b>Period</b>	<b>ROE</b>	<b>RISK</b>	<b>DLOAN</b>	<b>LOANS</b>
<b>1996-1999</b>	0.106	0.068	0.128	0.653
<b>2000-2003</b>	0.023	0.089	-0.027	0.568
<b>2004-2008</b>	0.251	0.043	0.219	0.576
<b>2009-2010</b>	0.228	0.043	0.068	0.602

Table 1c: Average value of regressors by sub-period. Small banks

<b>Period</b>	<b>ROE</b>	<b>RISK</b>	<b>DLOAN</b>	<b>LOANS</b>
<b>1996-1999</b>	-0.107	0.067	0.237	0.670
<b>2000-2003</b>	-0.119	0.066	0.024	0.646
<b>2004-2008</b>	0.145	0.047	0.127	0.639
<b>2009-2010</b>	0.026	0.051	0.066	0.656

## 4 Estimation results

In this section we present the results of estimating equation (3), and we account for the asymmetric behavior of capital buffers of small and large banks over the business cycle. We perform estimations using both quarterly data and annual data for a time span of fifteen years. Results obtained with annual data are directly comparable to those of previous studies for developed countries, such as Ayuso et al. (2004), Jopikii and Milne (2008), and Solz and Wedow (2011). Results using quarterly data are presented both as a robustness check and for the sake of making maximal use of the available data set.

The partial adjustment model presented above suggests a dynamical structure for bank capital buffers in which today's buffer adjusts to the buffer observed in the previous period. Thus, we included the first lag of the capital buffer as an explanatory variable in the empirical model. Given our particular interest on the effect of size in the behavior of bank capital buffers over the business cycle, an interaction variable was constructed using *DUMMYSIZE* and *GDP*. This variable is labeled *INTERACT1* in the results' tables and accounts for the heterogeneous behavior of capital buffers for small and large banks over time. We constructed two additional interaction variables, labeled *INTERACT2* and *INTERACT3*. The former results from the interaction between *DUMMYSIZE* and *DLOANS*, while the latter corresponds to the interaction between *DUMMYSIZE* and *LOANS*.

Table 2 shows estimation results following the Blundell Bond (1998) two-step system GMM method for the capital buffers of Colombian banks for the whole sample period (1996 - 2010) using annual data.

Table 2: Blundell-Bond two-step system GMM estimates  
Dependent variable is capital buffers, 1996 - 2010

Variable	Coefficient	Standard Error
$BUF(t - 1)$	-0.0785***	0.0181
$ROE$	0.0657	0.0901
$RISK$	1.012	1.091
$DLOAN$	-0.012**	0.006
$LOANS$	-0.005**	0.003
$GDP$	-0.132***	0.030
$DUMMYSARC$	0.523	0.498
$DUMMYSIZE$	-1.051**	0.489
$INTERACT1$	1.121***	0.211
$INTERACT2$	0.035***	0.004
$INTERACT3$	0.029***	0.005
$CONSTANT$	0.854	0.795
$SARGANTEST$ ( $p - value$ )	0.79	
$m1$ ( $p - value$ )	0.00	
$m2$ ( $p - value$ )	0.86	

Note: m1 and m2 stand for first and second order residual autocorrelation tests.

\*p<0.10, \*\*p<0.05, \*\*\*p<0.01

Note first, from Table 2, that  $DUMMYSIZE$  is negative and statistically significant at the 5% level, indicating that average capital buffers are lower for large banks. The sign of  $GDP$  is negative and highly significant, as expected, indicating that capital buffers behave countercyclically. In other words, economic expansions induce the reduction in bank capital buffers. However, estimation results show that differences in bank size account importantly for differences in the cyclical behavior of bank capital buffers. The coefficient of  $INTERACT1$  is negative and statistically significant at the 1% level, indicating that capital buffers of large banks respond more intensively to changes in the business cycle than those of small banks. While a one percentage point increase in the annual growth rate of GDP leads to an average reduction of 0.132 percentage points of the capital buffers for small banks, it leads to a reduction of  $-0.132 - 1.121 = -1.253$  percentage points of the capital buffers for large banks. Symmetrically, the response of

capital buffers to a reduction in GDP's growth rate is much more pronounced for large banks than for small banks. This quite interesting result is similar to the one obtained by Jopikki and Milne (2008)<sup>7</sup>, who find that capital buffers behave countercyclically for large banks in countries of the EU15. However, while they find that capital buffers of small banks behave procyclically, we do not find such behavior for Colombian small banks.

If both types of banks have the same access to equity markets, and these markets do not work efficiently, this heterogeneous behavior of capital buffers will suggest that large banks are more prone to exacerbate business cycle fluctuations in Colombia than smaller banks. If obtaining capital is equally hard for small and large banks, those banks that lower more their capital buffers during periods of economic expansion are assuming higher risks and will be more likely to fall below the level of regulatory capital during economic downturns when credit risk materializes, having to cut lending in order to avoid regulatory penalties. However, if small and large banks have differential access to equity markets (see for instance Holmström and Tirole (1997)), the reason for observing a heterogeneous behavior of capital buffers over the business cycle might be a different one. If large banks have better access to equity markets than small banks, as it is the case in Colombia<sup>8</sup>, the former can lower their capital buffers during economic expansions without incurring in major risks, while the latter do not have that possibility. Smaller banks find it more costly to re-build their capital stocks, and thus their optimal capital buffer is less responsive to short-run variations of economic conditions.

The fact that large banks' capital buffers present such a strong negative co-movement with the business cycle may have an interesting implication for the transmission of monetary policy. If during busts the materialization of credit risk leads to a reduction of these banks' capital buffers to an extent in which they approach the minimum regulatory level, these banks will have to either raise additional capital or cut lending. Reducing lending leads to an increase in the capital ratio through the immediate reduction in risk-weighted assets. Equity capital is relatively costly

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<sup>7</sup>Stolz and Wedow (2011), and other studies, have also found evidence of a countercyclical behavior of bank capital buffers for Western European economies. Unfortunately, those papers have not tested for a heterogeneous behavior of capital buffers over the business cycle depending on bank size.

<sup>8</sup>Private capital markets in Colombia are highly underdeveloped, as it is the case in most emerging economies. Only a few number of firms issue equity regularly, due to the difficulties of finding demand for equity at a reasonable price. These firms (financial and non-financial) are large, traditional Colombian firms.

in relation to debt because the payments on debt-interest receive tax deductions and because equity carries the most risk since it has no claim to the company's assets. Therefore, banks tend to cut lending under this situation, amplifying the business cycle. The transmission of monetary policy is therefore potentially asymmetric depending on the behavior of banks' capital buffers over the business cycle. The signs of the coefficients related to *DLOANS* and *LOANS*, and the corresponding interaction variables *INTERACT2* and *INTERACT3* provide additional support to our story. The signs of both *DLOANS* and *LOANS* are negative and statistically significant, showing that capital buffers reduce when banks increase lending. However, the signs of the coefficients of both interaction variables are positive and statistically significant. An interesting implication derives from this result. On average, increases in lending tend to reduce bank capital buffers. However, when heterogeneity with respect to size is taken into account the story changes. Large banks' capital buffers reduce less than those of small banks, or even remain unmodified when lending increases. This result is obtained after controlling for variables related to risk-taking decisions (*RISK*). Therefore, our findings suggest that small banks encounter difficulties when trying to increase their capital buffers due to limited access to equity markets<sup>9</sup>.

The variable *DUMMYSARC* is statistically equal to zero in all three specifications. Therefore, apparently the introduction of SARC in 2007 did not influence the behavior of the change in banks' capital buffers in Colombia. As shown in figures 1 and 2, the introduction of SARC, and more specifically the decision taken by Colombia's financial system supervisor of suggesting a higher level of capitalization to a group of banks at the end of 2008, had a one-time (level) impact on small banks' capital ratios. However, this regulation did not seem to change the behavior of capital buffers over time.

Important to note, we cannot reject the null hypothesis that overidentifying restrictions are valid (Sargan test). We reject the null hypothesis of no first-order serial autocorrelations in the residuals, compatible with the fact that the dynamic model has the first lag of the endogenous variable as a regressor, while we can-

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<sup>9</sup>In a first instance, the fact that both *DLOANS* and *LOANS* exert a negative influence over *BUF* while the interaction variables exert a positive influence over them could indicate either a riskier behavior of small banks or a lower access of these banks to capital markets, relative to the access of large banks. However, after controlling for covariates proxying for risk-taking behavior, the fact that both signs are negative can be interpreted as evidence of a limited access to capital markets by small banks in Colombia.

not reject the null hypothesis of no second-order serial autocorrelation. Thus, there is evidence that valid instruments are being used and that the dynamic model is well specified.

As mentioned above, there was a change in the level of small banks' capital ratios at the end of 2008. As a robustness check of our results, we performed the same estimations but we reduced our sample period, eliminating all observations after 2008. Table 3 presents the results of performing Blundell Bond (1998) two-step system GMM estimations of the behavior of capital buffers for the constrained sample period. Notice that the results are qualitatively identical to those reported in Table 2 and interpreted above. The magnitudes of the estimated coefficients are also very similar, and again we cannot reject the null hypothesis that over-identifying restrictions are valid (Sargan test). We also find that there is no evidence of second-order serial autocorrelation in the residuals.

Table 3: Blundell-Bond two-step system GMM estimates  
Dependent variable is capital buffers, 1996 - 2008

Variable	Coefficient	Standard Error
$BUF(t - 1)$	-0.0740***	0.0183
$ROE$	0.0732	0.0922
$RISK$	1.321	1.112
$DLOAN$	-0.015***	0.006
$LOANS$	-0.007***	0.003
$GDP$	-0.131***	0.032
$DUMMYSIZE$	-1.065**	0.500
$INTERACT1$	1.128***	0.219
$INTERACT2$	0.037***	0.004
$INTERACT3$	0.031***	0.006
$CONSTANT$	0.724	0.784
$SARGANTEST$ ( $p - value$ )	0.92	
$m1$ ( $p - value$ )	0.00	
$m2$ ( $p - value$ )	0.65	

Note: m1 and m2 stand for first and second order residual autocorrelation tests.

\*p<0.10, \*\*p<0.05, \*\*\*p<0.01

As a final robustness check of our main results, and in order to make a maximal



use of the data we count with, we performed quarterly regressions of our empirical model. Results, shown in Table 4, are qualitatively identical to those discussed above. Results in Table 4 are not directly comparable, though, to those of related research, because in all previous studies only annual estimations have been reported.

Table 4: Blundell-Bond two-step system GMM estimates  
Dependent variable is capital buffers

Variable	1996:3 - 2010:3		1993:3-2008:4	
	Coefficient	Standard Error	Coefficient	Standard Error
$BUF(t-1)$	-0.0855***	0.0261	-0.0855***	0.0244
$ROE$	0.0799	0.0907	0.0740	0.0858
$RISK$	1.712	1.090	1.717*	0.676
$DLOAN$	-0.113**	0.049	-0.106**	0.045
$LOANS$	-1.640	1.402	-1.269	1.193
$GDP$	-1.210**	0.601	-1.231**	0.0601
$DUMMYSIZE$	-1.054**	0.495	-1.002	0.396
$INTERACT1$	1.151***	0.213	1.025	0.310
$INTERACT2$	0.047***	0.008	0.051	0.008
$INTERACT3$	0.051***	0.009	0.079	0.012
$CONSTANT$	0.964	0.886	0.682	0.756
$SARGANTEST$ ( $p-value$ )	0.91		0.88	
$m1$ ( $p-value$ )	0.00		0.00	
$m2$ ( $p-value$ )	0.89		0.94	

Note: m1 and m2 stand for first and second order residual autocorrelation tests.

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

## 5 Concluding remarks

Using a panel of Colombian banks and annual and quarterly data between 1996 and 2010, we study the relationship between short-run adjustments in bank capital buffers and the business cycle. We follow a partial adjustment framework and control for several variables that have been identified as important determinants of bank capital buffers in previous studies, and find that bank capital buffers vary

over the business cycle. We are able to identify a negative co-movement of capital buffers and the business cycle. However, we also find that capital buffers of small and large banks behave asymmetrically during the business cycle. While the former appear to vary slightly over time, once the appropriate set of control variables is used, the latter present a strong countercyclical behavior.

We also find that while when small banks increase lending their capital buffers reduce. Meanwhile, increases in lending do not appear to affect large banks' capital buffers. Given we are controlling for banks' risk-taking decisions, we interpret our results as showing that optimally small and large banks behave differently due to the differential access they have to equity markets. Large banks, with better access to capital markets, lower their capital buffers during economic expansions without incurring in major risks while seeking to take advantage of profitable lending opportunities. Small banks find it more costly to re-build their capital stocks due to limited access to equity markets, and thus their optimal capital buffer is less responsive to short-run variations on economic conditions. Our findings suggest that a change in prudential regulation implemented by Colombia's financial system supervisor in 2007 has had no impact on the behavior of banks' capital buffers over time. The decision taken by the supervisor of suggesting a higher level of capitalization to a group of banks at the end of 2008 had a one-time (level) impact on small banks' capital ratios but did not seem to change the dynamic behavior of capital buffers.

Finally, our results suggest that capital buffers of banks with better access to equity markets tend to vary more over the business cycle. Specifically, security buffers of large banks with privileged access to capital markets behave countercyclically, and this may have negative impacts on macroeconomic stability. An interesting implication of this finding is that if capital markets develop in such a way that smaller banks gain more access to them, it will be possible to expect that capital buffers of these banks will react more vigorously to the stage of the business cycle. From a macro-prudential policy perspective, this would suggest that regulation measures should be undertaken to incentive banks to behave in a less procyclical way. For instance, regulatory capital measures that take into account this aspect could be implemented, particularly in emerging economies in which capital markets are developing at a rapid pace.

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