Bank capital buffers around the world: Cyclical patterns and the effect of market power

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Abstract

We examine the effect of competition and business cycles on bank capital buffers around the world. We use a dataset of 3,461 banks from 25 developed and 54 developing countries over the 2001-2013 period. Banks tend on average to exhibit pro-cyclical behavior. But capital buffers seem to be more pro-cyclical in developing countries. Our results show that more competition leads to higher buffers in developed countries but to lower buffers in developing ones. This evidence suggests that the "competition-stability" thesis adheres in developed economies, whereas "competition-fragility" makes more sense in developing countries. This asymmetric result may have important policy implications, particularly with regard to new, globally-negotiated capital adequacy standards.

Keywords: Bank capital buffers; Business cycle; Regulation; Market power.

1. Introduction

The term 'capital buffers' refers to any of a bank's capital holdings that are in excess of the regulatory minimum. In this study, we measure capital buffers by finding the difference between observed regulatory capital-to-asset ratios and minimum regulatory ratios[1]. Positive capital buffers are persistent both across countries and over time, and they well exceed regulatory capital standards (Barth *et al.,* 2006). According to the initial buffer calculations we use in this paper, average capital buffers are 9.20% for developed economies and 11.22% for developing economies (Table 1)[2]. This is notable as, according to corporate finance theory, issuing equity is costly, in part due to information asymmetries and agency problems faced by firms (Myers, 1984; Jensen and Meckling, 1976). As long as the costs of obtaining capital remain sufficiently high with respect to the cost of deposits, we would expect leverage to increase consistently with regulation. However, banks on the whole maintain substantial regulatory capital buffer holdings.

There are bank- and country-level factors that come to bear on a bank's decision to have capital buffers. Some examples of bank-level variables include the bank's business model, its relative size, and its profitability and risk levels. Country-level factors, meanwhile, include systemic levels of funding liquidity, banking regulations, the degree of competition within the banking industry, and the economy-wide business cycle. In this paper we control for these bank- and country-level variables when analyzing capital buffer determinants, and focus our analysis on the role played by market power and the business cycle.

Market power may affect buffers through multiple channels. Large banks with market power may become more risk-averse when they see their charter value threatened by competition. Rates charged by banks with market power can cause adverse selection effects across borrowers, increasing risk and prompting banks to increase buffers. Credit rationing by large banks can determine risk levels in their pool of borrowers, implying different buffer profiles. Given this theoretical line of reasoning, we are interested in further exploring the role of market competition in stimulating buffer creation. There are documented global differences (across regions and income groups) in levels of financial development and bank competition (Čihák *et al*., 2012); an interesting but rarely touched-upon question concerns the extent to which regional differences in competition translate to differential patterns in capital buffers (after taking into account country-level heterogeneity in the business cycle).

The business cycle may also affect buffers. When banks fail to accumulate capital buffers during economic booms, they can find themselves with insufficient levels of capital during economic downturns, meaning the cost of raising equity capital may force them to deleverage assets in order to meet regulatory minimum capital requirements (Repullo and Suarez, 2013; Borio and Zhu, 2012)[3].

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[1] See Table B, Appendix B for a detailed description of variables and sources.

[2] We also separate the also into four groups: OECD non-emerging, OHI (other high income, non-OECD), emerging, and other developing, following the classification in Claessens and Van Horen, 2015. Initial regression results indicate that the variables have a similar effect on the OECD (non-emerging) and OHI (non-OECD) groups, and the emerging and developing groups. "OECD" only includes the core OECD countries and "OHI" includes all countries classified as high-income by the World Bank in 2000 that do not are not OECD members.

[3] We refer to pro-cyclical behavior, throughout the paper, as behavior that tends to reinforce the current cyclical phase. We refer to pro-cyclical co-movement or fluctuations as the correlation of a particular variable with the cycle. Thus, a negative (positive) coefficient of the

Before addressing these questions, though, it may make sense to sketch the recent history of macro-prudential regulation. After the date for implementation of the Second Accord was agreed by 2008, numerous countries were expected to gradually adapt Basel II. But the eruption of the global financial crisis postponed the adoption of the Second Accord in most of the world. Basel III calls for an overhaul of macro-prudential regulation, particularly for issues related to financial pro-cyclicality. Because of both the timing of the implementation and drastic regulatory changes after the crisis, the current state of banking regulation in developing markets can be characterized as non-convergent – countries have not fully implemented either Basel II or Basel III. Non-convergent regulation is thus another possible source of country-level heterogeneity.

To prevent the destabilizing cyclical impacts of capital buffer fluctuations, Basel III requires banks to increase capital buffers during economic booms, through a "mandatory capital conservation buffer" of 2.5%, as well as a "discretionary counter-cyclical buffer" of up to 2.5% more in times of credit booms. This counter-cyclical capital buffer tool is a central element of Basel III. However, since these proposals were calibrated mostly against BIS membership information, crucial questions remain unanswered: Are buffers pro-cyclical globally? What is the role of bank competition in explaining buffers? How do these factors interact across regions?

Figure 1 shows average capital buffers in both developed and developing countries from 2001 to 2013. It also shows average real GDP growth rates for the two groups. During the period of economic expansion prior to the global financial crisis, average capital buffers in both regions seem to have followed the same pro-cyclical patterns. Capital buffers depleted progressively as the global economy expanded. However, after the crisis erupted, the buffer levels in the two regions started to diverge. In developed economies, the recovery was accompanied by increasing buffer levels, first because of rapid de-leveraging, and later because of increased regulatory pressure. Developing economies had a different experience. The post-crisis era was not accompanied by strong buffer accumulation. With economic deceleration beginning in 2010, these countries have seen both a rather rapid depletion of bank buffers and an increase in leverage. It seems that buffers became more counter-cyclical after the crisis, but the implications of this shift are various. Given the divergent experiences of developed and developing nations, future regulatory policy approaches in both regions should be closely informed by the existence of differences between countries and cyclical patterns, as well as the evolution of leverage and competition levels. Other factors to take into account include idiosyncratic characteristics specific to different banking systems.

<Insert here Figure 1>

At present there does not exist a wide literature on the cyclical patterns of buffers and effects of competition on a global scale. It is true that the heterogeneity of financial systems across the world has been well documented.

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business cycle in the buffer regressions is an indicator of the counter-cyclical (pro-cyclical) fluctuation of the capital buffer over the business cycle. This implies pro-cyclical (counter-cyclical) behavior.

Significant differences persist in levels of financial development, and bank competition in particular, across regions and income groups (Čihák *at al*., 2012). In light of this heterogeneity, and the potential channels through which competition can affect bank capital decisions, a worthwhile research question might be asked regarding the extent to which these regional differences in competition translate into differential patterns in capital buffers. Country and regional evidence is mixed. In this paper, we use Boone indicators of market competition, searching for data on the effect of banking competition on buffer formation. We employ, for our baseline specifications, a database containing 10,632 bank-year observations from 54 developing and 25 developed countries during the period 2001 to 2013. Prompted by previous literature, we also explore regional differences in the cyclical patterns of buffers, taking into account both developed and developing economies.

The empirical evidence presented in this paper is used to systematically explore the marginal effect of market power and the business cycle on buffer levels. Although we find that, taking the world as a whole, the average bank exhibits pro-cyclical behavior, implying that implementation of Basel III's counter-cyclical buffer tools has been extensive and effective, we also find cross-national differences connected to each country's respective levels of development and of bank competition.

This paper contributes to the existing literature by examining an expanded range of banks and countries, including multiple dimensions, and incorporating various methodological improvements and robustness checks. There are, to the best of our knowledge, only two other previous studies that examine the determinants of global capital buffers: Fonseca and Gonzalez (2010) and Chen *et al.* (2014). Our empirical exercise is close in nature to that of Fonseca and Gonzalez (2010), as we include both bank- and country-level determinants in our analysis. In particular, our results indicate that competitive conditions in the banking system may play an acutely important role in the determination of capital buffer levels. This effect differs, however, for developed and developing economies.

The paper is ordered as follows. In Section 2, we present a review of the related literature with regard to both theory and evidence. In Section 3, we present the econometric approach used across the empirical work in the field. The data and empirical results are presented in Section 4, after which we conclude with some policy-related comments.

2. *Related Literature and Empirical Evidence*

A plethora of recent articles scrutinize the cyclical behavior, at both a national and a regional level, of bank capital buffers. However, the evidence in these studies is inconclusive as to whether buffers are pro-cyclical for either segments of the banking sector or the sector as a whole. For advanced economies, some studies find general evidence of pro-cyclical behavior (Ayuso *et al.*, 2004; Lindquist, 2004; Stolz and Wedow, 2011; Bikker and Metzemakers, 2004; Jokipii and Milne, 2008; Shim, 2012; and Chen *et al*, 2014). Ayuso *et al.* (2004) find a significant, negative relationship between the business cycle and capital buffers for Spanish commercial and savings banks, after controlling for other bank-level buffer determinants such as size, risk profile and cost of capital. Similarly, Lindquist (2004) finds a negative relationship with the cycle for Norwegian commercial and

savings banks. This paper also detects a strong competition effect: the elasticity of a bank's buffer capital with respect to an increase in competitors' buffers is equal to one; higher competition is thus found to incentivize an increase in buffers. Stolz and Wedow (2011) examine German commercial and saving banks in the period 1993-2003, also finding a negative correlation between buffers and the economic cycle. In addition, they observe that savings banks correlate more strongly with the cycle. Bikker and Metzemakers (2004) use a large worldwide dataset to search for global patterns in bank capital behavior. They find a significant, negative correlation between capital ratios and the cycle, but these effects are small in magnitude.

Cyclical patterns are far from homogenous, however, even within advanced economies. Jokipii and Milne (2008) find evidence of pro-cyclical capital buffer behavior for commercial and savings banks and large banks in Europe. The capital buffers of cooperative and smaller banks are found to change in line with the cycle. They also find evidence of counter-cyclical behavior for banks located in recently admitted countries to the EU. In Australia, Vu and Turnell (2015) find evidence of pro-cyclical behavior for large banks, but counter-cyclical behavior for smaller banks. Turning to emerging markets, Carvallo *et al*. (2015) examine the determinants of capital buffer levels for the banking sectors in 13 Latin American and Caribbean countries from 2001 to 2012. They find a negative relationship between capital buffers and GDP growth for Argentina, Colombia, Ecuador, Peru and Uruguay, while buffers in Bolivia, Brazil, the Dominican Republic, Mexico, Panama and Venezuela are found to behave pro-cyclically. For Colombia, Garcia-Suaza *et al*. (2012) find a negative correlation between buffers and the economic cycle, with a stronger correlation for large banks. Tabak *et al.* (2011) also find a significant, negative relationship between the business cycle and capital buffers. Domestic private banks in Brazil are found to behave in a more pro-cyclical manner than their foreign and state-owned peers. Indian commercial banks, foreign ones in particular, are also found to behave pro-cyclically (Mahakud and Dash, 2013). Similarly, while Kontbay-Busun and Kasman (2015) find that in general Turkish banks behave counter-cyclically, Gursoy and Atici (2012) observe that commercial banks included in the Turkish deposit insurance fund scheme (Savings Deposit and Insurance Fund) behave counter-cyclically, whereas those not included behave pro-cyclically. In China, a recent study by Huang and Xiong (2015) shows that bank capital buffers have a counter-cyclical relationship with business cycle fluctuations. Zheng, Xu and Liang (2012) also find that the speed with which Chinese banks adjust to the target buffer level depends on the size of their capital buffers; banks with smaller buffers adjust more quickly.

Among more comprehensive, cross-national studies, Saadaoui (2014) analyzes the relationship between capital buffers, the business cycle, and the default risk of 740 commercial banks in 50 emerging countries in the period 1997 to 2008. Bank capital buffers and loan default risk are found to be negatively correlated with the business cycle, supporting the implementation of counter-cyclical buffers in these countries. Yet, notably, higher market power is found to be a critical mediating factor, as it attenuates this pro-cyclical behavior. Thus, for emerging economies, higher market power – as measured by bank Lerner indexes – is found to reduce the pro-cyclical behavior of banks. Returning to the only two papers that examine the global determinants of bank capital buffers for both advanced and developing regions: Fonseca and Gonzalez (2010) look at global determinants of capital

buffers for a sample of 1,337 banks from 70 countries, in the period 1995 to 2002. Their model uses a partial adjustment framework and pays special attention to the effect of market power and the role of regulation and institutional frameworks. With respect to bank-specific variables, the study includes factors such as the cost of funds, profitability and size. Buffers are not found to be systematically related to the business cycle, but they are found to be positively related to market power and the cost of deposits. However, these effects are sensitive to variations in regulation between countries, especially accounting disclosure rules and the stringency of regulations on the scope of banking activities. We find the paper's use of country-level controls and bank-specific factors to be critically important, as it illustrates differentiated patterns in the levels of capital buffer holdings across and within developed and developing countries. One failing of the paper derives from the weak robustness of the results[4]. More recently, Chen *et al.* (2014) examine the relations between total capital and common equity buffers with the business cycle, using a sample of banks from 171 countries, in the period 1995 to 2009. They conclude that capital buffers are pro-cyclical at a global scale, regardless of organizational type or size. Their results also suggest that banks manipulate Tier 2 capital in order to signal stronger capital adequacy ratios. This seems to suggest that the stringency of accounting disclosure regulations may play an important role. Contrary to the two previous studies, however, only bank-specific variables are included in the regression analysis, which raises the question of how to compare banking ratios from unequal competitive and regulatory landscapes. The present study is in line with Fonseca and Gonzales (2010) and Saadaoui (2014), as it incorporates both bank and country variables, while trying to improve on some of the underlying technical issues, as explained in more detail below.

The relationship between competition and bank risk attitudes demands complex and multifaceted analysis (Allen and Gale, 2004). The relationship between competition and financial stability is likewise a controversial question, and one which remains unresolved despite a large body of work having been produced on the issue. According to the so-called "competition-fragility" view, competition increases risk-taking, undermining the "charter value" of banks; it would follow that banks with market power have less incentive to engage in risky activities (Keeley, 1990). Another version of this view states that larger banks diversify better and are more efficient due to economies of scale that allow them to spread out their operations geographically (Boyd and Prescott, 1986; Méon and Weill, 2005). This lack of consensus has manifested itself in recent contributions to the literature. The "charter value hypothesis" has also been rationalized as large banks enjoy increased profit buffers (Allen and Gale, 2004; Matutes and Vives, 2000; Cordella and Yeyati, 2003). Larger banks engaging in "credit rationing" enhance soundness as they pick fewer but higher quality investments (Boot and Thakor, 2000).

Under the "competition-stability" view, the "too big to fail" doctrine posits that implicit public guarantees led to increased risk-taking by the largest banks (Mishkin, 1999). Boyd and De Nicoló (2005) argue that rates

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[4] This may reflect econometrics issues. First, the Arellano and Bond (1991) GMM difference estimator is used. Estimation by alternative techniques, such as the Arellano and Bover (1995) GMM two step estimator, could yield different results. Secondly, standard errors are not corrected for finite sample bias, which undermines significance results (Windmeijer, 2005). All these improvements have proved useful in more recent work. Finally, the global studies reviewed include a size variable related to the global market and not to the national jurisdiction, which would have seemed more appropriate.

charged by banks with market power induce increased risk-taking by entrepreneurs. Increased scope and scale economies can be counterbalanced by increased managerial inefficiency ("X-inefficiency") due to increased complexity (Beck *et al.,* 2006). While some empirical work supports the "competition-fragility" view (Beck *et al.*, 2006), other studies provide evidence supporting a "competition-stability" hypothesis (De Nicoló *et al.*, 2004; Schaeck *et al.*, 2006; Uhde and Heimeshoff, 2009).

This debate bears on the relationship between banking competition and capital ratios. Schaeck and Cihák (2012) use data from ten European countries to test the hypothesis that competition creates incentives for greater capital retention. Their paper arose partly out of Allen *et al.* (2011), who analyze the credit side of banks, and characterize capital holdings as a means of signaling commitment to monitoring in the presence of market discipline. According to their model, when banks compete for good lending opportunities, borrowers may demand that banks use their own capital for loans, thus incentivizing proper monitoring. As some borrowers do not fully internalize the cost to banks of raising capital, the resulting capital level could be above the regulatory requirement. Indeed, Schaeck and Cihák (2012) find that market competition increases bank capital holdings. Moreover, market power may be associated with lower capital holdings if large banks enjoy lower adjustment and capital costs, and larger margins and profitability, with increasing bank revenues reducing the role of capital as a buffer to absorb future losses (Elizalde and Repullo, 2007)[5]. As noted above, Lindquist (2004) also finds that in Norway bank competition increases buffer holdings. This suggests that banks probably use excess capital to signal solvency and stability. It may also be the case that banks with market power are more vulnerable to systemic risk during large downturns, as the experience of the recent global financial crisis has shown (Demsetz and Strahan, 1997).

To summarize, our assessment of the status of knowledge regarding the determinants of capital buffers lead us to assume that regional and country effects are at play with regard to both the cycle and market competition. This calls for an empirical approach able to systemically capture this complex interplay. With this in mind, we use a partial adjustment framework to explore:

1. The cyclical patterns of capital buffers, both globally and in developed and developing economies.
2. The influence of levels of competition in national markets in determining the level of capital buffers.

We presume that, given well-documented differences across regions in both dimensions, observed capital buffers should also reflect differential patterns.

3. *A Partial Adjustment Framework*

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[5] Elizalde and Repullo (2007) also claim that, on the one hand, larger margins and profitability increase the bank's franchise value and therefore reduce shareholders' incentives to contribute capital. They find a net positive effect of margins and profitability on economic capital.

Given the evidence that capital buffer levels are persistent (see Figure 2), we use a partial adjustment framework to model banks' decisions regarding the optimum target for capital buffers. In line with previous literature (Ayuso *et. al.*, 2004; Jokipii and Milne, 2008; Shim, 2012; Carvallo *et al.*, 2015), the partial adjustment model can be represented as:

$$\Delta BUF_{i,t} = \alpha\left(BUF_{i,t}^* - BUF_{i,t-1}\right) + \eta_i + u_{i,t} \tag{1}$$

where $BUF_{i,t}$ and $BUF_{i,t}^*$ denote the actual and target capital buffer of bank i at time t, respectively. Coefficient α measures the speed of adjustment of the actual capital buffer towards its target level. Factors η_i are bank-specific and permanently affect banks' capital structure decisions. $u_{i,t}$ is independently distributed with zero mean.

<center>**<Insert here Figure 2>**</center>

Adding the lag of $BUF_{i,t}$ to both sides of Eq. (6), we obtain:

$$BUF_{i,t} = \alpha BUF_{i,t}^* + (1-\alpha)BUF_{i,t-1} + \eta_i + u_{i,t} \tag{2}$$

The optimum level of capital buffer ($BUF_{i,t}^*$) is not observable. It is approximated by the business cycle and bank-specific characteristics, as in the related literature (Jokipii and Milne, 2008; Stolz and Wedow, 2005; Shim, 2012; Garcia-Suaza *et al.*, 2012). In addition, in the empirical analysis we also control for the level of competition, the regulatory environment, and the country's financial depth as potential determinants of the optimal capital buffer level. Hence the empirical model is specified as follows:

$$BUF_{i,t} = \alpha_0 + \alpha_1 BUF_{i,t-1} + \delta^i X_{i,t} + \eta_i + u_{i,t} \tag{3}$$

Where $X_{i,t}$ is a vector with variables that we assume influence bank i's optimal buffer at time t, with $\alpha_1 = 1 - \alpha$ reflecting the costs of adjustment. The idea behind this specification is to evaluate the effect of such variables on the accumulation of capital buffers (Jokipii and Milne, 2008; Stolz and Wedow, 2011; Shim, 2012; Garcia-Suaza *et. al.*, 2012; Carvallo *et. al.*, 2015; Fonseca and Gonzales, 2010). While much of this literature has focused on the impact of the business cycle on buffers, we also look at other determinants, both through independent channels or through their interaction with the business cycle.

The introduction of a lagged dependent variable among the right-hand-side variables in Eq. (3) creates an endogeneity problem, since the lagged dependent variable might be correlated with the disturbance term. To solve this problem, Arellano and Bond (1991) developed a difference GMM estimator for the coefficients in

the above-mentioned equation, where the lagged levels of the regressors are the instruments for the equation in first differences. However, Arellano and Bover (1995) and Blundell and Bond (1998) suggest differencing the instruments instead of the regressors in order to make them exogenous to the fixed effects. This leads to a shift from the difference GMM to the system GMM estimator, which is a joint estimation of the equation in levels and in first differences. We therefore use two-step system GMM estimators, with the Windmeijer (2005) corrected standard error.

4. Data and Empirical Results

4.1 Data

This study combines data from an unbalanced annual bank panel with a set of country regulatory and macroeconomic variables for 3,461 banks from 79 countries for the period 2001-2013. First, we use Bankscope[6] data for all bank-specific variables. Second, we consider a set of macroeconomic and regulatory variables publicly available on the World Bank database as the "The Regulation of Banks around the World": surveys I, II, III and IV. After merging these data sets, the initial sample of banks in which we are able to calculate the dependent variable (i.e., capital buffer) is 7,090[7]. However, after estimating our baseline specifications (Table 2, below), we obtain subsamples ranging from 10,632 (3,461 banks) to 6,538 observations (2,193 banks), depending on specifications. Nonetheless, the resulting sample represents a wide set of countries and a relevant amount of observations and banks from developed and developing countries (see Table C/Appendix C for representativeness of the sample). Accordingly, the average number of countries represented in those baseline specifications is 54 developing and 25 developed. The average time length for both groups of countries is similar: around 3 years. Given the unbalanced nature of the panel, including gaps, we use a forward orthogonal deviations transformation in estimation, an alternative to differencing proposed by Arellano and Bover (1995). This method helps preserve the sample size in panels with gaps. A detailed description of the variables considered in the regressions is displayed in Table B, Appendix B[8].

Table 1 reports descriptive statistics that aggregate countries into a developed and a developing group. Following Claessens and Van Horen (2013, 2015), we classified "developed" countries as OECD-non-emerging plus Other High Income (OHI) (labeled as OECD), while the rest of the countries are classified as "developing" (labeled as DEV + EME). Using this income aggregation, our sample shows buffers, profitability and risk to be larger in developing economies, whereas developed economies present greater financial depth. The countries

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included in our baseline specifications that are classified as developed are: Australia, Austria, Belgium, Canada, Cyprus, France, Germany, Greece, Hong Kong SAR (China), Iceland, Israel, Italy, Kuwait, Luxembourg, Macao SAR (China), Malta, Netherlands, New Zealand, Portugal, Qatar, Slovenia, Spain, Switzerland, United Kingdom, and United States; the countries classified as developing are: Argentina, Armenia, Bangladesh, Belarus, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Chile, Colombia, Croatia, Dominican Republic, El Salvador, Ghana, Guatemala, Guyana, Honduras, Hungary, India, Indonesia, Jamaica, Kenya, South Korea, Latvia, Lebanon, Lithuania, Macedonia (FYR), Malawi, Malaysia, Mauritius, Moldova, Mozambique, Namibia, Nicaragua, Oman, Pakistan, Panama, Peru, Philippines, Poland, Romania, Serbia, Sierra Leone, Slovak Republic, South Africa, Sri Lanka, Tanzania, Thailand, Trinidad and Tobago, Turkey, Uganda, Uruguay, Venezuela, and Zimbabwe.

<Insert here Table 1>

4.2 Empirical results

Tables 2 to 6 show our Blundell-Bond two step GMM estimated for capital buffers, for the years 2001-2013. Because of the large number of US banks in our sample (15% of the total), and given the complexity of this market, we ran our regressions first using all the banks in the sample, and then excluding US banks (last five columns in Tables 2-6). In Table 2, we show the results of our baseline specification for the overall global sample and the sample excluding banks operating in the US. We check the robustness of our main results by incorporating different sets of country variables, namely: regulatory indicators plus the financial depth variable (M2 as a percentage of GDP - MCM); the block of equations incorporating the average return of assets (ROAA); and the cost of funds variable (interest income paid/total funding - CF).

In Table 2, the coefficient on the lagged buffer (L.BUF) is highly significant in all specifications, revealing the presence of significant adjustment costs for banks to change their capital buffers to their target amounts. Coefficients are in the range of 0.47-0.50, which are slightly below the coefficients of 0.65-0.67 obtained by Saadaoui (2014) for a sample of 50 developing economies. The coefficients are also larger than the 0.22-0.31 range estimated in Fonseca and Gonzalez (2010), but much lower than the 0.906 coefficient estimated in Chen *et al.* (2014), both for global samples. Another result that is quite robust through all the regressions exercises is the one concerning the variable "SizeCo", which measures the bank's relative size. It is a dummy variable that takes the value 1 if the natural logarithm of the bank's total assets belongs to the top quartile nationally. The coefficient on this variable is significantly negative across all specifications, indicating that the average global bank has lower capital buffers if it belongs to the top national quartile in size. This result is persistent in all the studies registered in the literature, regardless of whether their analysis is performed at the country, regional or global level. Furthermore, this result is also consistent with several of the theoretical hypotheses advanced in the literature, in particular those related to implicit public guarantees (the "too big to fail" view), as well as

those similar to the hypothesis of Elizalde and Repullo (2007), which states that larger banks with larger margins, lower adjustment costs, and higher profitability could exhibit lower capital holdings.

A key variable in our analysis is the Boone indicator (Boone 2001, 2008), which is calculated as the elasticity of profits to marginal costs. Its rationale is that higher profits can be achieved by more efficient banks. Appendix A has more details about this indicator. The more negative the Boone indicator, the higher the degree of competition, because the effect of reallocation is stronger. Throughout all of our results this market power indicator is significant and positive, indicating that in banking markets where more competitive conditions prevail, banks tend to have lower capital buffers (Table 2). This result is reminiscent of theories based on the "charter value" of banks and the detrimental effect of competition with regard to bank risk attitudes (Keeley, 1990).

<Insert here Table 2>

However, as Table 3 shows, these general results are sensitive to the bank's location in either developed or developing regions, with a sign reversal in the former. More competition is now associated with higher capital buffers in developed countries and lower buffers in developing ones. The evidence suggests that the "competition-stability" view is correct in developed economies, whereas the "competition-fragility" view is correct in developing countries. Our result for developed countries is consistent with the empirical evidence for Europe (Schaeck and Cihák, 2012) and the US (Saunders and Wilson, 2001), which finds that banks facing fiercer competition have higher capital buffers. It is also consistent with theoretical models such as Boyd and De Nicoló (2005), where more competition is associated with increasing risk-taking, and the model in Allen *et al.* (2011), which illustrates that, in highly competitive markets, banks can find it optimal to use costly capital to signal commitment to monitoring. A commitment to monitoring attracts good borrowers and leads to a higher surplus. Crucially, this disciplining mechanism depends on market transparency, which is consistent with our evidence regarding bank accounting transparency. The evidence for developing countries is more consistent with the "charter value" hypothesis and its recent rationalizations on the market power side (Keeley, 1990; Boyd and Prescott, 1986; Méon and Weill, 2005; Allen and Gale, 2004; Matutes and Vives, 2000; Cordella and Yeyati, 2003). Large banks in these countries can enjoy increased profit buffers or more easily engage in "credit rationing", thus enhancing stability as they choose fewer but higher quality investments (Boot and Thakor, 2000).

<Insert here Table 3>

The average global bank capital buffer is negatively correlated with the growth of economic activity (GGDP) – in other words, it behaves pro-cyclically. This strongly supports Basel's III proposed counter-cyclical buffer tools and is also consistent with findings from several country-level and other more general studies (Ayuso *et al.*, 2004; Lindquist, 2004; Bikker and Metzemakers, 2004; Jokipii and Milne, 2008; Shim, 2012; and Chen *et al.*, 2014)[9]. The results for the sample excluding the US are generally the same as those from the global sample (Table 2).

To uncover cross-national differences in the effect of these factors on buffer levels, we first analyzed the variation in income or economic development across countries. We thus grouped countries according to income and classified them as either "developed" or "developing". We introduced a dummy equal to one for the developing country region and interacted it with the business cycle variable, the growth rate of real GDP. The average coefficient for developing countries is significantly negative, which indicates that on average the buffer levels for developing banks are pro-cyclical (Table 4). Notably, the average effect for banks in developed countries is counter-cyclical (positive sign), although mostly insignificant. These results indicate that pro-cyclicality is generally more of a problem in developing countries. This is particularly worrying as capital buffers have been rapidly decreasing in developing countries during the recent economic slowdown (Figure 1).

<Insert here Table 4>

For robustness, we replicate the specifications in Table 3, but use alternative measures of market power. First we use country averages of banks' Lerner indexes (Table 5). Next we use the asset market share of the five largest banks, a measure of market concentration (Table 6)[10]. The effect of the average Lerner indexes on buffers is found to be statistically insignificant for seven out of the ten specifications. Moreover, the concentration measure is found to be statistically significant only for the regressions that exclude US banks, presenting a positive sign.

One of the factors that complicate this picture is the complexity inherent in the relationship between bank concentration and effective competition. On both a theoretical and empirical basis, it has become clear in recent years that concentration and effective competition measure different dimensions of the competitive landscape. A range of papers has concluded that using concentration as a measure of competition can be misleading (see e.g., Carbo-Valverde *et al*, 2009). Numerous studies have shown that concentration and competition may be uncorrelated or even positively correlated (Claessens and Laeven, 2004)[11]. In light of these developments, more

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[9] A surprising result in our regressions is the sign of Official Supervisory Power (OSP). It is meant to capture "whether the supervisory authorities have the authority to take specific actions to prevent and correct problems". This variable generally has a negative sign, which seems counterintuitive, although its significance is not robust across specifications. It could indicate some form of substitution between private and public risk-control mechanisms. Fonseca and Gonzales (2010) get a similar result via its interaction with the cost of capital.

[10] To the extent that Bankscope does not have 100% coverage of banking systems, and is limited to commercial banks, all these measures share potential selection biases equally.

[11] Bikker and Haaf (2002) study the interrelation between market structure and competitiveness, using cross-country data. They provide support for the conventional view that concentration reduces competitiveness. Claessens and Laeven (2004), however, find that competition

recent studies have focused on non-structural measures of competition, i.e., measures that do not rely on the link between structure and conduct to infer market power. Both the Boone and Lerner indicators fall within this category. However, one of the theoretical weaknesses of the country-wide Lerner indices is that they are averages of the market power of individual banks. Even if individual Lerner indices decrease with competition, the average degree of market power may increase, decrease or remain stable due to relocation effects from inefficient firms to efficient firms (Boone, 2008). Thus, within the context of this global study, we consider our Boone indicators to be superior measures of the effective level of competition in banking systems.

<Insert here Table 5>

<Insert here Table 6>

It might also be argued that, because of our particular sample's time window, which includes the global financial crisis, our results may capture reverse causality from the banking system to the economic cycle. We examine this possibility in two ways, and make use of Laeven and Valencia's (2013) global database on the occurrence of crises and, in particular, systemic banking crises. First, we ran our set of regressions for the pre-global financial crisis period (2001-2006), and considered this period to be "tranquil times". Then we ran our regressions only for countries that did not experience systemic crises during the 2007-2009 period, and called these "tranquil countries" (tranquil, that is, with respect to the global financial crisis). For both cases, we found that our results regarding the cycle held. We also looked at the cyclical behavior of different components of capital buffers, by running the previous set of regressions on three key buffer components: (1) the actual regulatory capital ratio itself; (2) the tier 1 capital ratio; and (3) the ratio of loan-to-total assets, which is a key determinant of risk-weighted assets. We found global banks behave pro-cyclically with respect to the regulatory capital ratio. They do so by increasing (decreasing) tier 1 capital ratios during periods of decreased (increased) economic activity and by reducing (increasing) lending ratios during periods of decreased (increased) economic activity. However, for most specifications, the magnitude of the adjustment effect seems to be larger for the loan ratio than for the tier 1 adjustment effect[12].

5. *Conclusions*

In this paper, we look for the determinants of bank capital buffers at a global scale, using a large dataset of 3,461 banks from 79 countries for the 2001-2013 period. The world average bank exhibits pro-cyclical behavior. This would seem to underline a global need for extensive and effective implementation of Basel III's proposed counter-cyclical buffer tools. The average coefficient for developing countries is, however, consistently larger

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is not negatively related to market concentration.

[12] Results available upon request.

than the average effect worldwide (Table 6). Of note is the fact that the average effect for banks in developed countries is mostly insignificant, with a positive sign. This result indicates that pro-cyclicality seems to be a more generalized problem in developing countries.

Another important result relates to competition. Throughout all of our results, the Boone indicator is significantly and positively associated with buffers, indicating that in banking markets where more competitive conditions prevail, banks tend to have lower capital buffers. This result is reminiscent of theories based on the "charter value" of banks and the detrimental effect of competition on bank risk attitudes (Keeley, 1990; Boyd and Prescott, 1986; Méon and Weill, 2005; Allen and Gale, 2004; Matutes and Vives, 2000; Cordella and Yeyati, 2003). This general result is, however, sensitive to whether banks are located in developed or developing regions, with a sign reversal in the former. More competition is thus associated with higher capital buffers in developed countries, and lower buffers in developing ones. This evidence supports the "competition-stability" view for developed economies and the "competition-fragility" view for developing countries.

This asymmetric result may have important policy implications, particularly with regard to the new globally-negotiated capital adequacy standards. The initial conditions for regulatory revamping differ across regions. Since the global financial crisis there has been substantial deleveraging and capitalization levels have strengthened. However, higher pro-cyclicality in developing countries implies that capitalization levels are actually more compromised than previously thought. Transaction costs and market power are known to be greater in the financial systems of developing economies. Furthermore, in these countries, given the absence of correctly-functioning liquid capital markets and market discipline, market power remains critical for sustaining higher capital buffer levels. These differences should be considered while deploying regional efforts to revamp the regulatory landscape by creating more systemic and cycle-sensitive capital regulation. As an increasing number of countries prepare for full implementation of Basel III, the optimal sequencing and mix of instruments and priorities should therefore consider simultaneously the competitive and prudential aspects of particular countries. Competition-enhancing regulation in developing countries should go hand in hand with market reform aimed at reducing transaction costs and information asymmetries. This would improve financial market depth, liquidity and discipline. A comprehensive approach must also consider the stringency of capital regulations, along with policies aimed at improving competition and capital market reform.

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Tables

Table 1: Sample descriptive statistics by sub-regions (Country averages 2001-2013)

	Total			OECD+OHI (1)			DEV+EME (2)			Diff. in means
	Mean	Sd.	Countries	Mean	Sd.	Countries	Mean	Sd.	Countries	(1) - (2)
BUF	10.58	5.60	79	9.20	3.97	25	11.22	6.13	54	-1.50
Size	14.22	1.49	79	15.34	1.04	25	13.71	1.38	54	5.28***
ROAA	1.09	1.08	79	0.67	0.65	25	1.29	1.18	54	-2.42**
ROAE	11.22	7.22	79	8.41	5.04	25	12.52	7.73	54	-2.42**
CF	4.23	2.87	79	3.86	2.67	25	4.41	2.96	54	-0.78
LLRGL	4.30	2.42	79	3.16	1.93	25	4.82	2.46	54	-2.96***
BOONE	-0.07	0.19	79	-0.034	0.16	25	-0.088	0.20	54	1.21
Lerner	0.26	0.09	75	0.232	0.12	25	0.278	0.09	50	-2.23**
5-conc	77.67	14.99	77	82.83	15.55	24	75.33	14.26	53	2.07**
OCS	4.74	1.46	79	4.66	1.43	25	4.77	1.48	54	-0.31
OSP	11.29	1.72	79	10.72	1.64	25	11.56	1.71	54	-2.07**
BACC	3.65	0.39	79	3.69	0.37	25	3.64	0.40	54	0.60
MCM	87.56	79.01	79	156.08	102.8	25	55.83	34.07	54	6.48***

Two sample mean comparison t-test for unequal variances $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Sd denotes the standard deviation. We also separate the data into four groups: OECD non-emerging, OHI (other high income, non-OECD), emerging, and other developing, following a recent classification in Claessens and Van Horen, (2015). Initial regression results indicate that the effects of variables are similar in OECD (non-emerging) and OHI (non-OECD), and in emerging and developing. "OECD" only includes the core OECD countries and "OHI" includes all those countries classified as high-income by the World Bank in 2000 but that do not belong to OECD. SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile in its national size distribution; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; BOONE is the competition index; Lerner is an index of market power; 5-conc represents the assets of the country's five largest banks as a share of total commercial banks; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; and BACC is a dummy for bank accounting. Notice these statistics are different from those in Table 1, since they are un-weighted averages of country variable averages.

Table 2. Estimation Results: Blundell-Bond Two-Step System GMM Estimates for Capital Buffer, 2001-2013

	A. Whole sample					B. Excluding US banks				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
BUF (-1)	0.564***	0.564***	0.505***	0.497***	0.497***	0.565***	0.563***	0.478***	0.472***	0.472***
	(0.0891)	(0.0893)	(0.0927)	(0.0952)	(0.0950)	(0.0910)	(0.0912)	(0.0986)	(0.0990)	(0.0988)
SizeCo	-0.956***	-0.937***	-1.058***	-1.075***	-1.064**	-1.191***	-1.181***	-1.628***	-1.546***	-1.434***
	(0.331)	(0.329)	(0.389)	(0.398)	(0.413)	(0.367)	(0.455)	(0.439)	(0.436)	(0.436)
GGDP	-0.119***	-0.0996***	-0.0973***	-0.103***	-0.0886***	-0.0934***	-0.0648**	-0.0846***	-0.0689**	-0.0588*
	(0.0229)	(0.0246)	(0.0287)	(0.0286)	(0.0293)	(0.0271)	(0.0295)	(0.0311)	(0.0325)	(0.0327)
ROAA	0.520***	0.533***	0.563***	0.558***	0.568***	0.531***	0.551***	0.537***	0.541***	0.543***
	(0.102)	(0.106)	(0.118)	(0.120)	(0.122)	(0.127)	(0.131)	(0.134)	(0.138)	(0.138)
LLRGL	0.195***	0.203***	0.160***	0.172***	0.185***	0.210***	0.224***	0.190***	0.203***	0.211***
	(0.0464)	(0.0480)	(0.0467)	(0.0480)	(0.0493)	(0.0520)	(0.0543)	(0.0528)	(0.0546)	(0.0560)
BOONE	2.362***	2.380***	2.833***	2.942***	2.871***	2.194***	2.199***	2.927***	2.785***	2.790***
	(0.749)	(0.766)	(0.745)	(0.945)	(0.959)	(0.738)	(0.753)	(0.962)	(0.969)	(0.969)
OCS	0.246***	0.261***	0.280***	0.247***	0.243***	0.0952**	0.104**	0.0742	0.0321	0.0408
	(0.0471)	(0.0475)	(0.0590)	(0.0609)	(0.0604)	(0.0478)	(0.0475)	(0.0613)	(0.0641)	(0.0642)
OSP	-0.0581*	-0.0267	-0.00939	0.0130	-0.0174	-0.0795**	-0.0439	-0.0879*	-0.0490	-0.0653
	(0.0299)	(0.0322)	(0.0407)	(0.0457)	(0.0469)	(0.0400)	(0.0401)	(0.0507)	(0.0520)	(0.0538)
BACC	0.336**	0.449***		0.371**	0.403**	-0.192	-0.0663		-0.267	-0.178
	(0.149)	(0.148)		(0.184)	(0.198)	(0.169)	(0.161)		(0.235)	(0.239)
MCM		0.00400***					0.00544***			
		(0.00154)					(0.00166)			
CF			-0.0247	-0.0287*	-0.0231			-0.0222	-0.0148	-0.0120
			(0.0161)	(0.0165)	(0.0169)			(0.0184)	(0.0215)	(0.0218)
Cooperative					0.417					0.428
					(0.262)					(0.288)
Savings					1.159***					-0.449
					(0.394)					(0.528)
Cons	1.768**	0.330	2.833**	1.439	1.411	4.426***	2.721*	4.959***	5.416***	5.054***
	(0.813)	(1.012)	(1.126)	(1.195)	(1.267)	(1.343)	(1.419)	(1.443)	(1.767)	(1.788)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10632	10556	6880	6538	6538	7275	7199	5316	4974	4974
Panels	3461	3440	2316	2193	2193	2930	2909	1885	1762	1762
j	84	85	84	85	87	84	85	84	85	87
Hansen	80.34	80.20	70.47	69.33	68.67	69.24	68.29	63.05	61.88	61.30
Hansen-p	0.0816	0.0831	0.270	0.302	0.322	0.305	0.334	0.510	0.552	0.572
AR1	-4.698	-4.687	-3.764	-3.676	-3.680	-4.367	-4.346	-3.687	-3.632	-3.634
AR1-p	0.00000263	0.00000277	0.000168	0.000237	0.000233	0.0000126	0.0000139	0.000227	0.000281	0.000279
AR2	1.675	1.683	0.941	0.940	0.924	1.514	1.518	0.706	0.683	0.674
AR2p	0.0939	0.0924	0.347	0.347	0.355	0.130	0.129	0.480	0.495	0.500

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The Hansen is a test of the over-identifying restrictions for the GMM estimator. AR1 and AR2 are tests for the first-order and second-order serial correlation. N denotes number of observations, Ng number of banks and J number of instruments. Year denotes if year dummy variables were introduced in the regressions. BUF(-1) is the lag of bank's capital buffer; SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; BOONE is the competition index; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; BACC is a dummy for bank accounting; MCM is the ratio of money and quasi-money to GDP; and Cooperative and Savings are dummy variables that identify the type of bank.

Table 3. Estimation Results: Blundell-Bond Two-Step System GMM Estimates for Capital Buffer, 2001-2013: Buffers and Competition

	A. Whole sample					B. Excluding US banks				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
BUF(-1)	0.564***	0.566***	0.507***	0.499***	0.499***	0.566***	0.566***	0.481***	0.476***	0.475***
	(0.0892)	(0.0894)	(0.0921)	(0.0945)	(0.0942)	(0.0913)	(0.0915)	(0.0985)	(0.0988)	(0.0987)
SizeCo	-1.033***	-1.015***	-1.185***	-1.180***	-1.164***	-1.163***	-1.158***	-1.616***	-1.534***	-1.429***
	(0.337)	(0.334)	(0.397)	(0.408)	(0.423)	(0.369)	(0.370)	(0.453)	(0.436)	(0.433)
GGDP	-0.100***	-0.0825***	-0.0869***	-0.0920***	-0.0793***	-0.0886***	-0.0620**	-0.0800**	-0.0670**	-0.0582*
	(0.0236)	(0.0253)	(0.0289)	(0.0289)	(0.0295)	(0.0273)	(0.0297)	(0.0311)	(0.0324)	(0.0325)
ROAA	0.538***	0.549***	0.584***	0.581***	0.589***	0.538***	0.557***	0.547***	0.550***	0.551***
	(0.104)	(0.107)	(0.120)	(0.123)	(0.124)	(0.128)	(0.132)	(0.135)	(0.139)	(0.139)
LLRGL	0.209***	0.215***	0.168***	0.178***	0.190***	0.211***	0.223***	0.188***	0.200***	0.209***
	(0.0481)	(0.0492)	(0.0472)	(0.0484)	(0.0496)	(0.0525)	(0.0545)	(0.0531)	(0.0549)	(0.0563)
OCS	0.258***	0.257***	0.294***	0.272***	0.267***	0.130***	0.125**	0.114*	0.0716	0.0784
	(0.0474)	(0.0469)	(0.0595)	(0.0619)	(0.0610)	(0.0488)	(0.0600)	(0.0631)	(0.0631)	(0.0632)
OSP	-0.0625**	-0.0397	-0.0204	-0.00138	-0.0282	-0.0635	-0.0367	-0.0776	-0.0435	-0.0585
	(0.0296)	(0.0316)	(0.0408)	(0.0457)	(0.0468)	(0.0400)	(0.0404)	(0.0501)	(0.0516)	(0.0533)
BACC	0.267*	0.400***		0.224	0.263	-0.154	-0.0223		-0.272	-0.191
	(0.147)	(0.145)		(0.180)	(0.195)	(0.169)	(0.162)		(0.236)	(0.240)
MCM		0.00383**					0.00517***			
		(0.00152)					(0.00166)			
CF			-0.0146	-0.0169	-0.0126			-0.0173	-0.0103	-0.00800
			(0.0169)	(0.0174)	(0.0178)			(0.0186)	(0.0217)	(0.0220)
Cooperative					0.380					0.388
					(0.263)					(0.289)
Savings					1.072***					-0.450
					(0.391)					(0.523)
BOONE	-6.304***	-6.661***	-7.700***	-7.087***	-6.622***	-3.851**	-3.470**	-3.575	-2.837	-2.646
	(1.748)	(1.690)	(2.278)	(2.292)	(2.267)	(1.766)	(1.708)	(2.245)	(2.299)	(2.301)
BOONE*Developing	9.323***	9.577***	11.14***	10.63***	10.06***	6.493***	5.985***	6.842***	5.955**	5.758**
	(1.986)	(1.928)	(2.398)	(2.578)	(2.551)	(1.839)	(1.749)	(2.318)	(2.412)	(2.411)
Cons	1.809**	0.519	2.588**	1.828	1.770	3.831***	2.338	4.409***	5.103***	4.775***
	(0.811)	(1.010)	(1.090)	(1.217)	(1.287)	(1.361)	(1.447)	(1.420)	(1.752)	(1.771)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10632	10556	6880	6538	6538	7275	7199	5316	4974	4974
Panels	3461	3440	2316	2193	2193	2930	2909	1885	1762	1762
j	85	86	85	86	88	85	86	85	86	88
Hansen	79.06	79.48	70.08	68.92	68.00	70.07	69.52	63.97	62.70	62.06
Hansen-p	0.0973	0.0919	0.281	0.315	0.343	0.281	0.297	0.478	0.523	0.545
AR1	-4.687	-4.686	-3.779	-3.697	-3.701	-4.369	-4.354	-3.696	-3.646	-3.649
AR1-p	0.00000277	0.00000278	0.000157	0.000218	0.000215	0.0000125	0.0000133	0.000219	0.000266	0.000264
AR2	1.693	1.694	0.957	0.958	0.942	1.520	1.520	0.726	0.702	0.693
AR2p	0.0905	0.0903	0.339	0.338	0.346	0.129	0.129	0.468	0.483	0.488

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The Hansen is a test of the over-identifying restrictions for the GMM estimator. AR1 and AR2 are tests for the first-order and second-order serial correlation. N denotes number of observations, Ng number of banks and J number of instruments. Year denotes if year dummy variables were introduced in the regressions. BUF(-1) is the lag of bank's capital buffer; SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile in its national size distribution; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; BOONE is the competition index; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; BACC is a dummy for bank accounting; MCM is the ratio of money and quasi-money to GDP; and Cooperative and Savings are dummy variables that identify the type of bank.

Table 4. Estimation Results: Blundell-Bond Two-Step System GMM Estimates for Capital Buffer, 2001-2013: Cyclicality in Developed and Developing Economies

	A. Whole sample					B. Excluding US banks				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
BUF(-1)	0.558***	0.559***	0.503***	0.495***	0.495***	0.562***	0.562***	0.479***	0.473***	0.473***
	(0.0894)	(0.0897)	(0.0935)	(0.0960)	(0.0956)	(0.0900)	(0.0904)	(0.0981)	(0.0987)	(0.0986)
SizeCo	-1.065***	-1.040***	-1.167***	-1.166***	-1.155***	-1.198***	-1.187***	-1.652***	-1.573***	-1.463***
	(0.337)	(0.337)	(0.396)	(0.406)	(0.420)	(0.366)	(0.366)	(0.455)	(0.441)	(0.436)
GGDP*Developing	-0.204***	-0.186***	-0.180***	-0.166***	-0.160***	-0.199***	-0.166***	-0.122***	-0.107***	-0.105***
	(0.0354)	(0.0340)	(0.0375)	(0.0390)	(0.0382)	(0.0372)	(0.0339)	(0.0362)	(0.0382)	(0.0381)
GGDP	0.0578	0.0554	0.0512	0.0378	0.0480	0.0766*	0.0705*	0.0189	0.0240	0.0319
	(0.0373)	(0.0370)	(0.0416)	(0.0436)	(0.0439)	(0.0398)	(0.0386)	(0.0378)	(0.0422)	(0.0430)
ROAA	0.524***	0.530***	0.581***	0.576***	0.584***	0.537***	0.549***	0.545***	0.549***	0.551***
	(0.103)	(0.106)	(0.121)	(0.124)	(0.125)	(0.128)	(0.131)	(0.135)	(0.139)	(0.139)
LLRGL	0.203***	0.208***	0.166***	0.178***	0.191***	0.220***	0.228***	0.193***	0.205***	0.214***
	(0.0469)	(0.0479)	(0.0479)	(0.0488)	(0.0498)	(0.0518)	(0.0537)	(0.0527)	(0.0544)	(0.0556)
BOONE	2.320***	2.330***	2.756***	2.869***	2.797***	2.179***	2.187***	2.901***	2.767***	2.770***
	(0.750)	(0.769)	(0.740)	(0.939)	(0.953)	(0.727)	(0.748)	(0.740)	(0.944)	(0.952)
OCS	0.208***	0.224***	0.249***	0.224***	0.221***	0.0850*	0.0948**	0.0708	0.0316	0.0401
	(0.0460)	(0.0462)	(0.0591)	(0.0610)	(0.0604)	(0.0483)	(0.0479)	(0.0611)	(0.0638)	(0.0640)
OSP	-0.0405	-0.0201	0.0113	0.0301	-0.000858	-0.0443	-0.0220	-0.0710	-0.0384	-0.0547
	(0.0298)	(0.0321)	(0.0403)	(0.0454)	(0.0463)	(0.0386)	(0.0394)	(0.0506)	(0.0518)	(0.0534)
BACC	0.310**	0.389***		0.297	0.331*	-0.135	-0.0451		-0.271	-0.185
	(0.151)	(0.147)		(0.185)	(0.198)	(0.166)	(0.160)		(0.235)	(0.239)
MCM		0.00274*					0.00426***			
		(0.00149)					(0.00159)			
CF			-0.0181	-0.0219	-0.0166			-0.0199	-0.0131	-0.0103
			(0.0168)	(0.0173)	(0.0178)			(0.0187)	(0.0218)	(0.0222)
Cooperative					0.413					0.419
					(0.261)					(0.285)
Savings					1.174***					-0.423
					(0.394)					(0.527)
Cons	1.951**	0.928	2.806**	1.676	1.644	3.970***	2.695*	4.846***	5.399***	5.043***
	(0.796)	(1.002)	(1.117)	(1.190)	(1.261)	(1.325)	(1.408)	(1.446)	(1.781)	(1.801)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10632	10556	6880	6538	6538	7275	7199	5316	4974	4974
Panels	3461	3440	2316	2193	2193	2930	2909	1885	1762	1762
j	85	86	85	86	88	85	86	85	86	88
Hansen	80.73	81.38	69.48	67.93	67.08	66.11	66.36	61.80	60.48	59.88
Hansen-p	0.0772	0.0703	0.298	0.345	0.372	0.404	0.395	0.555	0.602	0.623
AR1	-4.621	-4.617	-3.732	-3.645	-3.650	-4.359	-4.340	-3.700	-3.639	-3.641
AR1-p	0.00000383	0.00000389	0.000190	0.000268	0.000262	0.0000131	0.0000143	0.000216	0.000274	0.000272
AR2	1.725	1.730	0.979	0.975	0.960	1.557	1.557	0.748	0.724	0.714
AR2p	0.0845	0.0836	0.328	0.330	0.337	0.119	0.120	0.454	0.469	0.475

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The Hansen is a test of the over-identifying restrictions for the GMM estimator. AR1 and AR2 are tests for the first-order and second-order serial correlation. N denotes number of observations, Ng number of banks and J number of instruments. Year denote if year dummy variables were introduced in the regressions. BUF(-1) is the lag of bank's capital buffer; SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile in its national size distribution; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; BOONE is the competition index; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; BACC is a dummy for bank accounting; MCM is the ratio of money and quasi-money to GDP; and Cooperative and Savings are dummy variables that identify the type of bank.

Table 5. Estimation Results: Blundell-Bond Two-Step System GMM Estimates for Capital Buffers, 2001-2013

	A. Whole sample					B. Excluding US banks				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
BUF(-1)	0.543***	0.543***	0.473***	0.467***	0.467***	0.555***	0.554***	0.465***	0.457***	0.456***
	(0.0794)	(0.0792)	(0.0878)	(0.0876)	(0.0871)	(0.0866)	(0.0872)	(0.0897)	(0.0884)	(0.0882)
SizeCo	-0.929***	-0.933***	-1.183***	-1.071***	-1.115***	-1.145***	-1.156***	-1.752***	-1.629***	-1.575***
	(0.292)	(0.293)	(0.359)	(0.362)	(0.378)	(0.325)	(0.330)	(0.397)	(0.389)	(0.393)
GGDP	-0.0918***	-0.0780***	-0.0797***	-0.0615**	-0.0497	-0.0504*	-0.0312	-0.0515*	-0.0110	-0.00990
	(0.0240)	(0.0250)	(0.0289)	(0.0305)	(0.0313)	(0.0264)	(0.0285)	(0.0304)	(0.0341)	(0.0343)
ROAA	0.490***	0.499***	0.532***	0.542***	0.549***	0.476***	0.485***	0.512***	0.539***	0.538***
	(0.0947)	(0.0962)	(0.105)	(0.106)	(0.106)	(0.106)	(0.107)	(0.118)	(0.119)	(0.119)
LLRGL	0.176***	0.182***	0.209***	0.232***	0.241***	0.185***	0.191***	0.245***	0.271***	0.272***
	(0.0437)	(0.0443)	(0.0589)	(0.0602)	(0.0608)	(0.0477)	(0.0492)	(0.0637)	(0.0648)	(0.0656)
Lerner	-1.354*	-0.270	0.763	-0.644	-0.298	-2.573***	-1.406*	-0.358	-1.622	-1.446
	(0.708)	(0.805)	(0.681)	(0.881)	(0.957)	(0.766)	(0.829)	(0.743)	(0.999)	(1.072)
OCS	0.268***	0.260***	0.277***	0.286***	0.268***	0.119**	0.109**	0.105*	0.0610	0.0602
	(0.0521)	(0.0517)	(0.0709)	(0.0716)	(0.0706)	(0.0497)	(0.0492)	(0.0629)	(0.0640)	(0.0641)
OSP	-0.0595*	-0.0169	-0.0266	0.0124	-0.0131	-0.0868**	-0.0434	-0.128**	-0.0769	-0.0788
	(0.0317)	(0.0339)	(0.0438)	(0.0458)	(0.0468)	(0.0407)	(0.0393)	(0.0514)	(0.0498)	(0.0510)
BACC	0.221	0.284*		0.158	0.123	-0.159	-0.104		-0.502**	-0.490**
	(0.148)	(0.147)		(0.194)	(0.198)	(0.165)	(0.162)		(0.215)	(0.218)
MCM		0.00527***					0.00577***			
		(0.00167)					(0.00168)			
CF			-0.0383**	-0.0377**	-0.0314*			-0.0328*	-0.0177	-0.0174
			(0.0176)	(0.0181)	(0.0185)			(0.0196)	(0.0228)	(0.0227)
Cooperative					0.326					0.139
					(0.284)					(0.298)
Savings					1.347***					-0.571
					(0.403)					(0.477)
Cons	2.724***	1.131	2.992***	2.004*	2.195*	5.111***	3.477***	5.288***	6.451***	6.361***
	(0.884)	(0.966)	(0.952)	(1.166)	(1.222)	(1.277)	(1.276)	(1.167)	(1.505)	(1.552)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13124	13063	8289	7840	7840	9400	9339	6367	5918	5918
Panels	3745	3739	2302	2182	2182	3206	3200	1863	1743	1743
j	97	98	97	98	100	97	98	97	98	100
Hansen	102.3	102.8	95.60	92.03	91.32	88.91	89.99	80.72	74.37	74.43
Hansen-p	0.0237	0.0220	0.0638	0.102	0.111	0.148	0.130	0.334	0.532	0.529
AR1	-5.320	-5.328	-4.158	-4.086	-4.095	-4.861	-4.833	-4.270	-4.213	-4.214
AR1-p	0.000000104	9.91e-08	0.0000320	0.0000439	0.0000421	0.00000117	0.00000134	0.0000195	0.0000252	0.0000251
AR2	1.273	1.262	0.352	0.347	0.318	0.975	0.961	-0.0536	-0.101	-0.106
AR2p	0.203	0.207	0.725	0.728	0.750	0.330	0.336	0.957	0.919	0.916

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The Hansen is a test of the over-identifying restrictions for the GMM estimator. AR1 and AR2 are tests for the first-order and second-order serial correlation. N denotes number of observations, Ng number of banks and J number of instruments. Year denote if year dummy variables were introduced in the regressions. BUF(-1) is the lag of bank's capital buffer; SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; Lerner is the market power index; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; BACC is a dummy for bank accounting; MCM is the ratio of money and quasi-money to GDP; and Cooperative and Savings are dummy variables that identify the type of bank.
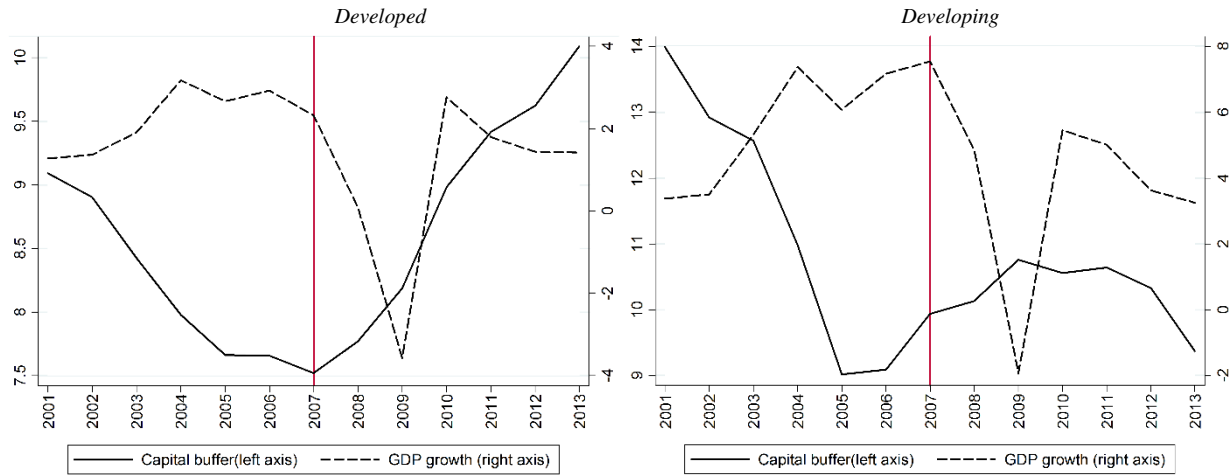
Table 6. Estimation Results: Blundell-Bond Two-Step System GMM Estimates for Capital Buffers, 2001-2013

	A. Whole sample					B. Excluding US banks				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
BUF(-1)	0.555***	0.558***	0.386***	0.395***	0.395***	0.555***	0.559***	0.398***	0.405***	0.404***
	(0.0671)	(0.0662)	(0.0745)	(0.0790)	(0.0787)	(0.0792)	(0.0791)	(0.0722)	(0.0764)	(0.0763)
SizeCo	-0.972***	-0.958***	-1.507***	-1.449***	-1.452***	-1.190***	-1.175***	-1.985***	-1.879***	-1.772***
	(0.265)	(0.259)	(0.329)	(0.350)	(0.360)	(0.310)	(0.306)	(0.347)	(0.359)	(0.351)
GGDP	-0.0910***	-0.0633***	-0.0495	-0.0570*	-0.0357	-0.0577**	-0.0275	-0.0111	0.00755	0.0192
	(0.0223)	(0.0244)	(0.0323)	(0.0321)	(0.0344)	(0.0252)	(0.0280)	(0.0339)	(0.0357)	(0.0383)
ROAA	0.415***	0.436***	0.483***	0.485***	0.492***	0.399***	0.418***	0.427***	0.441***	0.442***
	(0.0883)	(0.0916)	(0.115)	(0.117)	(0.117)	(0.105)	(0.109)	(0.123)	(0.126)	(0.126)
LLRGL	0.178***	0.188***	0.218***	0.233***	0.247***	0.188***	0.195***	0.251***	0.260***	0.268***
	(0.0425)	(0.0434)	(0.0601)	(0.0612)	(0.0614)	(0.0469)	(0.0479)	(0.0641)	(0.0644)	(0.0653)
5-conc	0.00607	0.00338	0.00124	-0.00496	-0.00205	0.0258***	0.0227***	0.0298***	0.0272***	0.0279***
	(0.00532)	(0.00565)	(0.00767)	(0.00902)	(0.00896)	(0.00611)	(0.00611)	(0.00872)	(0.00993)	(0.00998)
OCS	0.252***	0.259***	0.317***	0.263***	0.262***	0.100**	0.104**	0.106	0.0670	0.0753
	(0.0497)	(0.0500)	(0.0741)	(0.0766)	(0.0774)	(0.0508)	(0.0512)	(0.0689)	(0.0734)	(0.0739)
OSP	-0.0382	-0.0114	-0.0373	-0.00177	-0.0299	-0.0501	-0.0227	-0.0566	-0.0452	-0.0591
	(0.0365)	(0.0363)	(0.0542)	(0.0546)	(0.0562)	(0.0395)	(0.0389)	(0.0535)	(0.0546)	(0.0573)
BACC	0.200	0.322**		0.195	0.221	-0.304*	-0.165		-0.598***	-0.525**
	(0.144)	(0.143)		(0.204)	(0.218)	(0.159)	(0.153)		(0.229)	(0.231)
MCM		0.00468***					0.00505***			
		(0.00158)					(0.00156)			
CF			-0.0451**	-0.0455**	-0.0390**			-0.0367*	-0.0212	-0.0188
			(0.0182)	(0.0188)	(0.0189)			(0.0197)	(0.0227)	(0.0231)
Cooperative					0.420					0.393
					(0.302)					(0.315)
Savings					1.482***					-0.520
					(0.444)					(0.496)
Cons	1.930	0.643	3.940***	3.254**	2.966*	2.913**	1.581	2.842**	4.766***	4.394***
	(1.214)	(1.234)	(1.313)	(1.577)	(1.608)	(1.427)	(1.468)	(1.236)	(1.618)	(1.632)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13515	13374	8686	8226	8226	9791	9650	6764	6304	6304
Panels	3818	3791	2421	2296	2296	3279	3252	1982	1857	1857
j	97	98	97	98	100	97	98	97	98	100
Hansen	87.50	87.97	100.7	97.01	95.41	82.07	82.67	85.68	80.37	79.73
Hansen-p	0.173	0.164	0.0307	0.0524	0.0655	0.297	0.281	0.210	0.344	0.362
AR1	-5.729	-5.762	-3.949	-3.844	-3.851	-5.052	-5.065	-4.246	-4.113	-4.108
AR1-p	1.01e-08	8.32e-09	0.0000786	0.000121	0.000118	0.000000436	0.000000408	0.0000218	0.0000391	0.0000399
AR2	1.615	1.648	0.724	0.740	0.715	1.363	1.389	0.420	0.397	0.383
AR2p	0.106	0.0993	0.469	0.459	0.475	0.173	0.165	0.675	0.691	0.701

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The Hansen is a test of the over-identifying restrictions for the GMM estimator. AR1 and AR2 are tests for the first-order and second-order serial correlation. N denotes number of observations, Ng number of banks and J number of instruments. Year denote if year dummy variables were introduced in the regressions. BUF(-1) is the lag of bank's capital buffer; SizeCo is a dummy variable that takes 1 if bank's size belongs to the top quartile; ROAA is the return on assets; ROAE is the return on equity; LLRGL is the ratio of non-performing loans to total bank assets; 5-conc is the market share of total assets held by the 5 largest banks; CF is the cost of funding; OCS is an index that measures overall capital stringency; OSP is an index that measures regulatory authority power; BACC is a dummy for bank accounting; MCM is the ratio of money and quasi-money to GDP; and Cooperative and Savings are dummy variables that identify the type of bank.
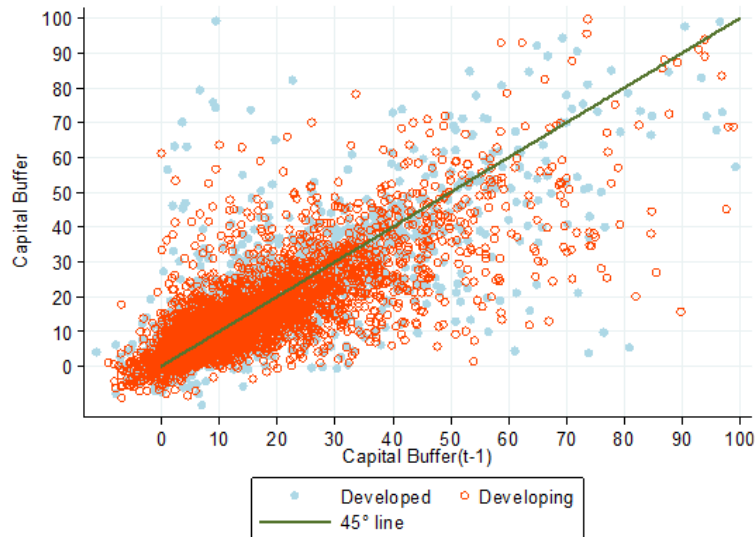
Figures

Figure 1: Bank capital buffers and GDP growth by sub-regions (in percentages)

Averages at sub-regions level. Own calculations based on initial data from 7,090 banks, from 106 developing and 37 developed countries.

Figure 2: Bank capital buffers at time *t-1* versus capital buffers at time *t*

Own calculations based on initial data from 7,090 banks, from 106 developing and 37 developed countries.

Appendix A: Technical note, the Boone and Lerner indicators

The Boone Indicator

The measure of competition used in this paper is the Boone indicator. The Boone index model is based on the idea that competition enhances the performance of efficient banks and weakens less efficient ones. This effect is stronger the more competitive a given market is. Boone (2001, 2008) shows that more efficient banks with lower marginal costs gain higher market shares. The Boone indicator is estimated by using the following empirical model:

$$\ln(ms_{it}) = \alpha + \sum_{t=1,\ldots,(T-1)} \beta_t D_t \times \ln(mc_{it}) + \sum_{t=1,\ldots,(T-1)} \theta_t D_t + \varepsilon_{it}$$

Where ms and mc denote, respectively, market shares and marginal costs in the loans market. To measure the evolution of competition over time, time dummies, D, can be included. ε_{it} is the disturbance term. The coefficient β denotes the Boone indicator. Market shares increase for banks with lower marginal costs (i.e., $\beta < 0$). There is an alternative formulation that measures the elasticity of a bank's profits to changes in marginal costs, with a similar interpretation.

More competition raises the market share of a more efficient bank relative to a less efficient one. A larger negative value of β is an indication of more competitive conditions. However, positive values of β are also possible, implying either that the market has an extreme level of collusion or that banks are competing on quality.

The Lerner Index

The Lerner index is a bank-level alternative measure of market power, used for robustness purposes in our empirical exercise. It is positively correlated with market power. It is averaged at the country level. It can be defined as the difference between marginal price and marginal cost divided by marginal price, as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}}$$

where P_{it} is the average price of output, and MC_{it} is the marginal cost of producing this output.

Appendix B

Table B: Variables description

Variable	Description	Source
Dependent variable:		
Buffer (BUF)	Following Jokipii and Milne (2008), we define the capital buffer as the bank capital ratio less the Minimum Capital Ratio (MCR). The bank capital ratio is approximated by the Total Capital Ratio (TCR), which measures the actual regulatory capital ratio in each jurisdiction.	TCR: Bankscope. MCR: WB database "The Regulation of Banks around the World", surveys I, II, III and IV. Barth *et al.* (2001, 2004, 2006, 2012).
Banks' variables:		
Bank size (Size)	Logarithm of bank's total assets.	Bankscope.
Top quartile biggest banks (SizeCo)	Dummy variable that takes 1 if the bank size belongs to the top quartile in their national size distribution.	Bankscope.
Return Over Average Assets (ROAA)	Measured as Net Income/Average Total Assets	Bankscope.
Return Over Average Equity (ROAE)	Measured as the ratio of net income to average total equity.	Bankscope.
Loan Loss Reserve Gross Loans (LLRGL)	Measured as the ratio of non-performing loans to total bank assets.	Bankscope.
Cost of Funding (CF)	Measured as the ratio of interest expenses to total funding.	Bankscope.
Country variables:		
Boone Indicator (BOONE)	Measure of competition used in this paper, based on profit-efficiency in the banking market. It is calculated as the elasticity of profits to marginal costs. An increase in the Boone indicator implies a deterioration of the competitive conduct of financial intermediaries. See Appendix A for technical details.	World Bank/ Global Financial Development. http://data.worldbank.org/data-catalog/global-financial-development
Lerner Index (Lerner)	Measure of market power in the banking market. It compares output pricing and marginal costs (that is, markup). An increase in the Lerner index indicates a deterioration of the competitive conduct of financial intermediaries. Country average.	World Bank/ Global Financial Development. http://data.worldbank.org/data-catalog/global-financial-development
Concentration (5-conc)	Measure of concentration based on the total assets of five largest banks as a share of total commercial banking assets. Total assets include total earning assets, cash and due from banks, foreclosed real estate, fixed assets, goodwill, other intangibles, current tax assets, deferred tax, discontinued operations and other assets.	World Bank/ Global Financial Development. http://data.worldbank.org/data-catalog/global-financial-development
Overall Capital Stringency (OCS)	Index that measures the extent of regulatory requirements regarding the amount of capital banks must hold. Higher values indicate greater stringency.	WB database "The Regulation of Banks around the World", surveys I, II, III and IV. Barth et al. (2001, 2004, 2006, 2012).
Official Supervisory Power (OSP)	Index that measures the extent to which official supervisory authorities have the authority to take specific actions to prevent and correct problems. Higher values indicating greater power.	WB database "The Regulation of Banks around the World", surveys I, II, III and IV. Barth et al. (2001, 2004, 2006, 2012).

Variable	Description	Source
Bank Accounting (BACC)	Dummy variable that takes a value of 1 when the income statement includes accrued or unpaid interest or principal on nonperforming loans and when banks are required to produce consolidated financial statements and zero otherwise.	WB database "The Regulation of Banks around the World", surveys I, II, III and IV. Barth et al. (2001, 2004, 2006, 2012).
Growth rate of Gross Domestic Product (GGDP)	Growth rate of Gross Domestic Product. Our measure of the business cycle.	World Bank/ World Development Indicators. http://data.worldbank.org/data-catalog/world-development-indicators
Money and Quasi Money (MCM)	Money and Quasi Money (M2) as percentage of GDP.	World Bank/ Global Financial Development. http://data.worldbank.org/data-catalog/global-financial-development

Notes: The construction of the regulatory variables are explained in detail by Barth, Caprio and Levine (2004).

Appendix C

Table C: Country and bank representativeness in the sample in Table 2's baseline regressions

Countries and Banks	Initial dataset	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Total banks	7,090	3,461	3,440	2,316	2,193	2,193
N° of developing countries	106	54	53	55	54	54
N° of developed countries	37	25	25	26	25	25
N° of developing countries' banks	2,157	1,011	996	906	901	901
N° of obs. developing in sample	11,188	3,146	3,104	2,567	2,560	2,560
N° of developed countries' banks	4,933	2,450	2,444	1,410	1,292	1,292
N° of obs. developed in sample	28,908	7,486	7,452	4,313	3,978	3,978
N° of developed countries' banks (Non-US banks)	4,124	1,919	1,913	979	861	861
N° of obs. developed in sample (Non-US)	22,443	4,129	4,095	2,749	2,414	2,414
Average T for developed countries' banks	5.860	3.056	3.049	3.059	3.079	3.079
Average T for developed countries' banks (Non-US banks)	5.442	2.152	2.141	2.808	2.804	2.804
Average T for developing countries' banks	5.187	3.112	3.116	2.833	2.841	2.841