Capital Regulation and Credit Risk Taking : Empirical Evidence from Banks in Emerging Market Economies

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Abstract

The primary purpose of this article is to investigate the relationship between bank capital and credit risk taking in emerging market economies. We also investigate the influence of several regulatory, institutional and legal features on the relationship between risk and capital. We apply a simultaneous equations framework following Shrieves and Dahl (1992) and Jacques and Nigro (1997). Our results corroborate the existing findings for US and other industrial economies, putting forward the impact of capital regulation on banks' behavior. We also show empirical evidence on the role of the regulatory, institutional and legal environment in driving bank capitalization and credit risk taking behavior in emerging market economies.

Keywords : bank capital and risk taking, bank regulation, emerging market economies, regulatory, institutional and legal environment.

JEL Classification : C31, F39, G21, G28.

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1 Introduction and literature survey

Bank capital regulation is usually explained in the literature by the negative externalities of bank default (Berger, Herring, and Szegö 1995, Benston 2000, Santos 2001). Bank default generates important costs : financial losses for the stakeholders (shareholders, clients, deposits insurance fund), loss of competitiveness, and a potential destabilization of the financial system, through the contagion mechanisms, when several individual failures lead to a banking crisis. The resolution of these failures is a waste of resources, particularly scarce in emerging market economies (EME) (Honohan 1997)[1]. Bank regulation aims mainly at limiting the exposure of the bank deposits insurer, and the banker's excessive risk taking incentives and therefore bank default risk.

The Basel Committee from the Bank for International Settlements proposed an Accord on bank capital minimum levels - the so-called Basel I Accord. It aimed at implementing regulatory requirements in terms of bank capital through the Cooke Ratio. The main aim of Basel I was to promote and achieve international convergence of standard minimum capital requirements. This was done by creating a level playing field among banks by raising capital ratios and promoting financial stability by adopting simple approach to credit risk. The primary purpose of the risk-based standards was to make bank capital requirements more sensitive and responsive to the bank's portfolio risk.

In recent years, a number of both theoretical and empirical studies have examined the impact of regulatory capital standards on bank portfolio risk.

Using the mean-variance framework, Kahane (1977), Koehn and Santomero (1980) and Kim and Santomero (1988) have shown that increased regulatory capital standards may have the opposite effect, causing bankers to increase their portfolio risk. In such framework, changes in capital and portfolio risk would be positively correlated. Blum (1999) comes to similar conclusions in a dynamic framework, proving the existence of an intertemporal effect of capital regulation, which may push an under-capitalized bank to increase risk in period t in order to meet regulatory requirements in period

[1]For example, the banking crisis in Indonesia (1997) and Thailand (1997-98) costed about 50-55% and 42.3% of the GDP respectively in term of restructurization (fiscal contribution).

$t+1$. Rochet (1992) uses the portfolio approach with bank's limited liability to show that insufficiently capitalized banks may exhibit risk-loving behavior, even if regulation makes uses of risk-related capital ratio.

Furlong and Keeley (1989) and Keeley and Furlong (1990) have argued that the mean-variance framework is inappropriate in the banking context because it ignores the option value of deposit insurance. Using a contingent-claims model, these authors show that increased capital standards won't push banks to increase their portfolio risk, because an increase in capital reduces the value of the option, reducing incentives for excessive risk taking.

More recently, Jeitschko and Jeung (2004) propose a unified approach to investigate the relationship between bank's capitalization and risk-taking behavior in a model which incorporates the incentives of the deposit insurer, the shareholder and the manager. Their results show that bank's risk can either decrease or increase with capitalization depending on the relative forces of these three agents.

1.1 The Basel I mechanism

The Basel I Accord focus on credit risk, which can be defined as the risk of loss due to borrower or counterparty default. The key to the Accord is the obligation for banks to continually meet two capital adequacy ratios : Tier 1 and total capital ratios. Both ratios have the same denominator which is a risk-weighted sum of the bank's on- and off- balance sheet activities. A simplified formula for the risk-weighted assets (RWA) may be $RWA = \sum_{i=1}^{4} \alpha_i A_i$, with α_i corresponding to the weight by risk category and A_i the volume of assets by category[2].

The Tier 1 ratio's numerator consists of the "core capital" which is the stakeholder equity capital and disclosed reserves. The total capital ratio's numerator consists of Tier 1 and Tier 2 capital, the latter being the "supplementary capital" including elements like undisclosed reserves and subordinated debt.

Basel I requires banks to have a Tier 1 ratio of at least 4% and a total capital ratio of at least 8% (with the contribution of Tier 2 not exceeding 50%). Banks that wish to meet the regulatory requirements can use mainly three types of balance-sheet adjustments : increase the capital level, decrease the risk-weighted assets as a proportion of total assets and / or decrease the

[2]The four risk categories are : zero default risk assets (e.g. cash, government bonds / securities) - weight of 0%, low rate default risk (e.g. loans to OECD banks) - weight of 20%, medium risk assets (e.g. residential mortgage loans) - weight 50% and remaining assets - weight 100%.

total assets[3].

1.2 Capital regulation and risk taking in EME

The relationship between capital and risk in the banking industry of emerging market economies has received less attention than in United States (e.g. Shrieves and Dahl 1992, Jacques and Nigro 1997), in Europe (e.g. Rime 2001, Ediz, Michael, and Perraudin 1998), or even in an international context (VanRoy 2003). However, this issue is particularly relevant in these countries.

These previous studies usually show that undercapitalized banks increase their capital adequacy ratios, result being consistent with the idea that regulatory pressure is effective and banks will maintain ratios above minimum requirements for precautionary and/or reputational reasons. There is much less consensus on whether banks (under or over capitalized) engaged in riskier activities. Changes in capital ratios and credit risk appear to be rather unrelated.

As well as the banking sector in developed countries, banks in emerging markets have also got through several waves of change, particularly within technological and regulatory areas. Banking crisis and the privatization process remain features which are specific to the emerging markets. Their banking industries remained highly regulated and protected for a long time, especially through rates and market entry regulation. During the 90's, the deregulation started, allowing foreign investors to entry into the market.

Among the main banking crisis factors which can be found in the literature (excessive loans growth, inadequate exchange rate regime, financial liberalization ...) (see Goldstein and Turner 1996, Caprio and Klingebiel 1996), an inadequate regulatory and supervisory regime and a weak legal and institutional framework are the most important (Bell and Pain 2000, Rojas-Suarez 2000, Rojas-Suarez 2001).

The banking industry remains regulated, and through substitution, its mechanisms may alter other disciplining mechanisms, like market or corporate governance. Capital regulation represents a costly mechanism and may be less efficient as a disciplining device, as bureaucratic and political prob-

[3]The Basel I Accord has several limitations, mainly the lack of sensitivity of the risk-weights to the effective asset's risk and simplified risk classification, leaving room for capital arbitrage. This mainly consists of shifting balance sheet positions (e.g. financial innovation allows to use off-balance sheet products like derivatives) from high to low risk categories in order to economize capital. Since 1999 a new Accord - Basel II Reform - is being elaborated in order to tackle these limitations, which should be implemented by 2006. This Reform and its implications for the banking industry is beyond the scope of this paper.

lems are usually present. Emerging markets usually have under-developed financial markets, accrued opacity within the banking industry which is also fragile and banks exhibit important volume of non performing loans (NPL), and sometimes inadequate regulatory, institutional and legal environment (Rojas-Suarez 2000, Rojas-Suarez 2001, Godlewski 2004).

Rojas-Suarez puts forward the main emerging markets' problem concerning capital regulation efficiency : lack of data and of accounting standards and rules, bad reporting systems, and inefficient financial markets. During the 90's, periods of financial crisis in emerging markets where correlated with bank capital growth. In the same time, banks usually preferred to hold public bonds instead of issuing loans, generating *credit crunches*, without any guarantee of bond's quality (compared to the agency rating of such issues), as the issuers where emerging states. Another problem was the regulation's impact on foreign capital volatility, as interbank loans weight was extremely low, and fostered its flow to emerging market economies.

The investigation into the relationship between bank regulation, bank strength and profitability and the legal, institutional and regulatory environment show mixed evidence. Usually, the main driving force for bank stability is the market discipline (Barth, Caprio, and Levine 1999, Barth, Caprio, and Levine 2000, Barth, Caprio, and Levine 2001), which is rather weak in EME and influenced by bank regulation. Legal, institutional, regulatory and supervisory devices usually influence and even alter other mechanisms like corporate governance, deepening for example the Asian Crisis (Hussain and Wihlborg 1999, Klapper and Love 2002, Mitton 2002).

Finally, because of its specific features, like short maturity debt and less diversification and funding opportunities (Allen and Gale 2000), and due to the global financial integration, any banking problems in emerging markets can spread to banking sectors from other countries, even developed.

Therefore, this study is motivated by several elements, and proposes their empirical investigation : lack of empirical evidence concerning the impact of capital regulation on bank risk taking in EME, as well as concerning the relationship between these capital and risk, and lack of empirical evidence on the influence of various legal, institutional and regulatory features on this relationship.

The rest of the paper is organized as follows. Section 2 presents the methodology and the data used in this study. Results and their discussion are provided in section 3. Finally, section 4 concludes the paper and gives several future research perspectives.

2 Methodology and data

2.1 Methodology

We follow the methodology proposed first by Shrieves and Dahl (1992) and further extended by Jacques and Nigro (1997). Is is a simultaneous equations framework, where capital and risk decisions are supposed to be taken simultaneously, and where risk-based capital standards may have an impact on both capital and risk.

Observed changes in bank capital and risk levels are decomposed into two components : a discretionary adjustment and a change caused by exogenous factors.

$$\begin{aligned} \Delta CAP_{j,t} &= \Delta^d CAP_{j,t} + E_{j,t}, & (1) \\ \Delta RISK_{j,t} &= \Delta^d RISK_{j,t} + F_{j,t}, & (2) \end{aligned}$$

where $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are the observed changes in capital and risk levels, respectively, in bank j for period t, and $\Delta^d CAP_{j,t}$ and $\Delta^d RISK_{j,t}$ represent discretionary adjustments in capital and risk. $E_{j,t}$ and $F_{j,t}$ are exogenously determined factors.

Under the hypothesis that banks may not be able to adjust their capital and risk levels instantaneously, Shrieves and Dahl (1992) modeled the discretionary changes using the partial adjustment framework.

$$\begin{aligned} \Delta^d CAP_{j,t} &= \alpha(CAP^*_{j,t} - CAP_{j,t-1}), & (3) \\ \Delta^d RISK_{j,t} &= \beta(RISK^*_{j,t} - RISK_{j,t-1}), & (4) \end{aligned}$$

where $CAP^*_{j,t}$ and $RISK^*_{j,t}$ are bank's j target levels of capital and risk. In this framework, the discretionary changes are proportional to the difference between the target and the existing levels in period $t-1$ level.

After substituting the equations from (3) into (1), we obtain

$$\begin{aligned} \Delta CAP_{j,t} &= \alpha(CAP^*_{j,t} - CAP_{j,t-1}) + E_{j,t}, & (5) \\ \Delta RISK_{j,t} &= \beta(RISK^*_{j,t} - RISK_{j,t-1}) + F_{j,t}. & (6) \end{aligned}$$

The observed changes in capital and risk are a function of their target levels, their lagged value levels and a set of exogenous factors.

In this study, the target capital ratio CAP^* is proxied by the ratio of EQUITY / TOTAL ASSETS and denoted EQTA, and $RISK^*$ is proxied by

the ratio of NON PERFORMING LOANS / TOTAL LOANS and denoted RISK. These proxies allow to focus exclusively on credit risk, which remains the principal source of risk for banks.

In equation (5), CAP^* is influenced by a number of explanatory variables which are the bank's size (SIZE=log(TOTAL ASSETS)), changes in RISK ($\Delta^d RISK_{j,t}$), lag of the capital level ($CAP_{j,t-1}$), the return on average assets (ROAA), and a dummy variable (MINCAR(CC)) if the bank's capital asset ratio (CAR) is below the country's minimum regulatory requirement, in order to control for the regulatory pressure and to investigate its impact on bank's behavior. This single regulatory pressure variable emphasizes one aspect : the level below which a bank should be regarded as undercapitalized and hence influenced by capital adequacy rules.

Following Jacques and Nigro (1997), we investigate the regulatory pressure more deeply, including two new dummies instead of MINCAR(CC), which are equal to $\frac{1}{CAP} - \frac{1}{MINCAR(CC)}$ if bank's CAR is strictly below the minimum CAR (CARLOW, otherwise CARLOW=0), and equal to $\frac{1}{MINCAR(CC)} - \frac{1}{CAP}$ otherwise (CARHIGH, otherwise CARHIGH=0). This allows to take into account the regulatory pressure in a "symmetric" way, as under and over capitalized banks should exhibit different behavior. We also include another proxy variable for profitability which is the net income (NETINC). Thus, through these double regulatory pressure variables, a second aspect of regulatory pressure may be investigated : the size of the gap between a bank's capital ratio and its level, hence the magnitude of regulatory pressure experienced by the bank. The use of these two regulatory pressure's variables recognizes the nonlinear relationship between the regulatory capital standards and either changes in credit risk or capital ratios.

Concerning $RISK^*$ in equation (6), the same explanatory variables are used as in equation (5), except that we introduce changes in CAP ($\Delta^d CAP_{j,t}$) and the lag of the risk level ($RISK_{j,t-1}$) instead.

In addition to these exogenous factors, we introduce several regulatory, institutional and legal factors (ENVFACTORS) in the regressions in order to investigate their impact on bank's capital and risk levels. We use several data sources, mainly Barth et al. (2001), LaPorta et al. (1997), Demirgüç-Kunt and Sobaci (2001) and PriceWaterhouseCoopers Transparency Project 2001 databases, and also the Bankscope database, which contents are presented in the next subsection.

Specifying variables to explain changes in capital and risk, we can rewrite the equations system (5, 6) as follows[4]

[4]We also include geographical area and time dummies. $\varepsilon_{j,t}$, $\mu_{j,t}$, $\eta_{j,t}$ and $\nu_{j,t}$ are white noises.

$$
\begin{aligned}
DEQTA_{j,t} &= \gamma_0 + \gamma_1 SIZE_{j,t} + \gamma_2 ROAA_{j,t} + \gamma_3 DRISK_{j,t} - \gamma_4 EQTA_{j,t-1} \\
&+ \gamma_5 MINCAR(CC)_{j,t} + \sum_j GEODUM_j + \sum_t YEARS_t \\
&+ \gamma_6 ENVFACTORS_{j,t} + \varepsilon_{j,t}, \qquad (7) \\
DRISK_{j,t} &= \theta_0 + \theta_1 SIZE_{j,t} + \theta_2 ROAA_{j,t} + \theta_3 DEQTA_{j,t} - \theta_4 RISK_{j,t-1} \\
&+ \theta_5 MINCAR(CC)_{j,t} + \sum_j GEODUM_j + \sum_t YEARS_t \\
&+ \theta_6 ENVFACTORS_{j,t} + \mu_{j,t}. \qquad (8)
\end{aligned}
$$

The equations' system for the extension following Jacques and Nigro (1997) may be rewritten as

$$
\begin{aligned}
DEQTA_{j,t} &= \lambda_0 + \lambda_1 SIZE_{j,t} + \lambda_2 ROAA_{j,t} + \lambda_3 NETINC_{j,t} + \lambda_4 DRISK_{j,t} \\
&- \lambda_5 EQTA_{j,t-1} + \lambda_6 CARLOW_{j,t} + \lambda_7 CARHIGH_{j,t} \\
&+ \sum_j GEODUM_j + \sum_t YEARS_t \\
&+ \lambda_8 ENVFACTORS_{j,t} + \eta_{j,t}, \qquad (9) \\
DRISK_{j,t} &= \phi_0 + \phi_1 SIZE_{j,t} + \phi_2 ROAA_{j,t} + \phi_3 NETINC_{j,t} + \phi_4 DEQTA_{j,t} \\
&- \phi_5 RISK_{j,t-1} + \phi_6 CARLOW_{j,t} + \phi_7 CARHIGH \\
&+ \sum_j GEODUM_j + \sum_t YEARS_t \\
&+ \phi_8 ENVFACTORS_{j,t} + \nu_{j,t}. \qquad (10)
\end{aligned}
$$

2.2 Data

The data used in this study was extracted from the Bankscope database for the 1996-2001 period and for 30 emerging market economies from three major geographic areas of Central and Eastern Europe, Asia, and South America. Bankscope provides balance sheet data in thousand of USD, as well as the nationality of the bank's first holding.

In order to clean up the data and get a relatively homogenous sample of banks, we have bounded the variables $EQTA_{j,t}$ and $RISK_{j,t}$ bilaterally at 1% (-32.13 and 74.74, and 0 and 129.27 respectively), and the variables $EQTA_{j,t-1}$ and $RISK_{j,t-1}$ unilaterally at 1% (-9.4 and 0 respectively). We have also excluded small banks, which size (TOTAL ASSETS) was less than the first percentile, equal to 47.181 MUSD. This leads to an initial pooled sample of 2779 banks.

A major part of the banks in our sample comes from the Latin America area (42.09%), followed by banks from East Asia and Pacific (24.54%) and South Asia (above 17.5%). Banks form Eastern Europe and Central Asia form the residual part of our sample (15.06%). Most of the data in our sample comes from the 1999 (19.16%), 2000 (22.83%) and 2001 (24.72%) years, the period from 1996-1998 being residual (less than 15% per year).

Table 1: Main variables descriptive statistics

Variables	N	mean	std.dev.	med.
CAR $\geq$ MINCAR8				
RISK	1722	10.65	14.15	6.11
EQTA	1722	14.15	7.28	11.89
L(RISK)	1722	12.42	71.56	5.69
L(EQTA)	1722	13.99	8.15	11.75
DRISK	1722	-1.78	70.94	0.10
DEQTA	1722	0.16	5.46	0.04
ROAA	1722	1.32	4.31	1.32
SIZE	1722	13.36	1.62	13.14
CAR $<$ MINCAR8				
RISK	1057	12.11	14.49	7.46
EQTA	1057	5.29	2.42	5.64
L(RISK)	1057	11.04	12.85	7.17
L(EQTA)	1057	6.47	4.39	6.06
DRISK	1057	1.07	12.26	0.05
DEQTA	1057	-1.18	4.51	-0.26
ROAA	1057	0.15	2.59	0.57
SIZE	1057	14.38	1.71	14.39

N.: number of observations, std.dev.: standard deviation, med.: median. Source : Bankscope.

From the descriptive statistics in table 1, we can see first that the means and medians for the RISK and L(RISK) variables are similar despite being under or above the minimum CAR. The conclusions are different concerning the EQTA variable, with means and medians at 14.15 and 11.89 for banks above minimum CAR, and 5.29 and 5.64 for banks being below. We can put these results in parallel to the statistics of the evolution of the RISK and EQTA variables : the means and medians of DRISK are -1.78 and 0.1 for above minimum CAR banks and 1.07 and 0.05 for below minimum CAR

banks, while these statistics for DEQTA are respectively 0.16 and 0.04 for well capitalized banks and -1.18 and -0.26 for undercapitalized banks.

From these results, we can conclude that undercapitalized banks in our sample had already lower capital ratios in the past while having a similar amount of credit risk in their assets compared to well capitalized banks. These banks show a negative evolution of their credit risk with a positive evolution of their capital, while undercapitalized banks show a inverse tendency, with positive evolution in risk and negative in capital. This suggests that such type of capital regulation may not be binding in emerging market economics, or it may have an adverse effect, influencing the banks to take excessive risks in order to meet the regulatory requirements. A gambling for resurrection behavior may also explain these statistics, as undercapitalized banks seem to have been in such a position in the past, and having "nothing to loose", they engaged in heavy risks in order to generate income in order to recapitalized themselves through reserves (although the mean and median values of ROAA are inferior for these banks compared to well capitalized), as external capital raising remains difficult in emerging markets, with underdeveloped and inefficient financial markets.

The mean value of the minimum CAR is 8.51%, with a majority of banks having a CAR requirement of 8% (51.9% of the sample), with 34.27% of banks having a CAR requirement above (for example : 10% CAR for 17.69% of the sample, and even 12% CAR for 4.77%).

Finally, regulatory, institutional and legal factors have been builded from several databases from Barth et al. (2001), LaPorta et al. (1997), Demirgüç-Kunt and Sobaci (2001) and PriceWaterhouseCoopers Transparency Project 2001. These environmental factors (ENVFACTORS) are introduced into the regressions in order to investigate their impact on capital and risk adjustments in emerging market economies. These variables proxy several dimensions of regulation, legal enforcement and institutional quality. Their selection has been made upon existing literature contributions and statistical significance, through *stepwise* regressions. Table 2 summarizes their notation, significance, and main statistics.

3 Results and discussion

3.1 Single regulatory pressure variable results

We first present the regression results for the equations system (7, 8), using both 2SLS and 3SLS techniques. The latter recognizes the endogeneity of both bank capital ratios and credit risk levels in a simultaneous equations

Table 2: Description of the environmental variables

Variables	Signification	Statistics
COVRATIO	Bank deposit insurance coverage ratio	m.: 3.35 (1.64)
PERSLIM	=1 if a personal limit exists	freq.: 82.31%
GOVBKFUND	=1 if the deposit insurance scheme is cofunded by the government and the banks	freq.: 25.4%
PRIVCREDREG	=1 if a private credit registry exists in the country	freq.: 61.62%
RISKDISCPUB	=1 if banks must disclose risk management procedures to public	freq.: 38.57%
DENAPPFOR	Number of denied foreign applications for a banking licence	m.: 3.45 (4.73)
DEPINSDEC	=1 if the deposit insurance authority make the decision to intervene a bank	freq.: 12.89%
LEGACTION	=1 if legal action against external auditors can be taken by supervisors for negligence	freq.: 55.14%
NBSUPERV	Number of professional supervisors per bank	m.: 5.66 (5.71)
REPMISCMGT	=1 if auditors are legally required to report misconduct by managers / directors to supervisory agency	freq.: 58.94%
FINHELD	=1 if a widely held financial corporation is the controlling shareholder	m.: 0.02 (0.06)
STATEHELD	=1 if a (foreign or domestic) state is the controlling shareholder	m.: 0.36 (0.39)
OTHERHELD	=1 if the controlling owner is not widely held, nor stateowned, or nor widely held by a financial or non-financial corporation	m.: 0.01 (0.03)
WIDELYHELD	=1 if there is no controlling shareholder	m.: 0.18 (0.21)
HOLDEME	=1 if the first holding comes from an emerging market country	freq.: 39.84%
HOLDIE	=1 if the first holding comes from a industrialized country	freq.: 16.34%
ECONOPACITY	Assessment of "how bankers were concerned that their government would impose new or additional controls or restrictions"	m.: 2.29 (0.25)
LEGALOPACITY	Assessment of "the transparency of government policies that regulate businesses"	m.: 2.45 (0.31)
JUDSYSEF	Assessment of "the efficiency and integrity of the legal environment, as it affects business particularly foreign firms"	m.: 6.5 (1.48)
RULEOFLAW	Assessment of "the law and order tradition"	m. 5.46 (1.86)
LEGFRENCHSYS	=1 if the legal system is based on the french one	freq.: 56.98%

Freq.: in sample frequency, m.: mean, standard deviation in brackets.

Source : Bankscope, Barth et al. (2001)), LaPorta et al. (1997), Demirgüç-Kunt and Sobaci (2001) and PriceWaterhouseCoopers Transparency Project 2001.

framework, thus, unlike OLS, providing consistent estimates of the parameters. It is also preferable to 2SLS because it is a full-information estimation technique which estimates all parameters simultaneously, incorporating the cross-equation correlation and thus producing asymptotically more efficient parameter estimates. However, 3SLS may be sensitive to misspecification or measurement error, suggesting comparison of the estimation results from 3SLS with 2SLS as a specification check. Here, both techniques produce essentially the same results.

Table 3: Simultaneous equations system (**??**) regression results with single regulatory pressure variable

Estim. Method	2SLS		3SLS	
Variables	DEQTA	DRISK	DEQTA	DRISK
INTERCEPT	9.1832^{***}	11.8148^{***}	9.1833^{***}	11.8139^{***}
	(1.1522)	(2.3356)	(1.1522)	(2.3356)
SIZE	-0.1482^{**}	-0.5408^{***}	-0.1482^{**}	-0.5406^{***}
	(0.0773)	(0.1721)	(0.0773)	(0.1721)
DRISK	0.0022		0.0021	
	(0.0089)		(0.0089)	
L(EQTA)	-0.4246^{***}		-0.4246^{***}	
	(0.0154)		(0.0154)	
DEQTA		0.0922^{**}		0.0914^{**}
		(0.0459)		(0.046)
L(RISK)		-0.5198^{***}		-0.5198^{***}
		(0.0176)		(0.0176)
ROAA	0.0021	-0.7855^{***}	0.002	-0.7856^{***}
	(0.0283)	(0.0619)	(0.0283)	(0.0619)
MINCAR(CC)	-4.6366^{***}	0.6571	-4.6367^{***}	0.6556
	(0.279)	(0.5958)	(0.279)	(0.5958)
N	1633	1633	1633	
F	65.55^{***}	84.75^{***}		
Adj. R^2	0.3394	0.4		
Sys. weight. R^2			0.3762	

N : number of observations, F : Fisher Statistic, Adj. R^2 : adjusted R^2,
Sys. weight. R^2 : system weighted R^2. Geographical and time dummies not shown.

Table 3 shows the results of 2SLS and 3SLS regressions with control variables and a single regulatory pressure variable only, the latter being the

Basel I standard in each country. MINCAR(CC) equals 1 if the bank has a capital ratio inferior to the national regulatory standard value.

From these results, we remark first that both estimation techniques yield similar results, inducing the use of the most efficient one (3SLS) in the rest of the study. The model's statistics are good, with significant Fisher statistics, and with a system weighted R^2 for the 3SLS regression close to 0.4.

The SIZE has a significantly negative impact on both DEQTA and DRISK. The variation DRISK has no significant impact on DEQTA, while the lag of the capital ratio (L(EQTA)) has a significant and negative impact, suggesting that capital accumulated in the past makes its progression less important. We observe a significantly negative correlation between DEQTA and DRISK, suggesting that banks with positive evolution of capital engage into risky activities and/or positive evolution in risk contributes to (re)capitalization. L(RISK) has a negative impact on DRISK, suggesting that past accumulation of credit risk in portfolio stopping the progression of credit risk taking. The profitability proxy ROAA has no significant on DEQTA while having a significantly negative influence on DRISK. The profitability seems to restrain credit risk taking activities, as the bank do not have to engage into more risks in order to generate return. Finally, the impact of the regulatory pressure is significantly negative for the DEQTA, and have no significant effect on DRISK, which is a rather surprising result, but corroborating the descriptive statistics in table 1. Concerning the latter estimate, it seems that bank capital regulation may not be the best suited regulatory device to bind excessive risk taking behavior in emerging markets, as MINCAR(CC) has no effect on DRISK. As to its effect on capitalization, the negative sign seems to indicate that when a bank runs into undercapitalization, it is usually "too late" to react properly (the variables DRISK and ROAA have not significant coefficients).

These first results show some surprising empirical evidence, which should be deepen. Therefore, we turn to the second type of specification, following Jacques and Nigro (1997), which implies estimating the simultaneous equations system (9, 10)[5].

3.2 Double regulatory pressure variables results

We now turn to the second specification following Jacques and Nigro (1997), equivalent to the system (9, 10). The 2SLS and 3SLS estimation results are given in the table 4.

[5]Due to lack of space, we skip the regression's results including regulatory, institutional and legal factors for the equations system (7, 8) following Shrieves and Dahl (1992), which

Table 4: Simultaneous equations system (**??**) regression results with double regulatory pressure variable

Estim. Method	2SLS		3SLS	
Variables	DEQTA	DRISK	DEQTA	DRISK
INTERCEPT	6.1236^{***}	10.2867^{***}	6.1232^{***}	10.3031^{***}
	(1.084)	(2.5467)	(1.084)	(2.5467)
SIZE	-0.1993^{***}	-0.3597^{**}	-0.1993^{***}	-0.3612^{**}
	(0.0713)	(0.1688)	(0.0713)	(0.1688)
DRISK	0.004		0.0055	
	(0.0084)		(0.0084)	
L(EQTA)	-0.5178^{***}		-0.5178^{***}	
	(0.0154)		(0.0154)	
DEQTA		0.0829^{*}		0.091^{**}
		(0.0455)		(0.0455)
L(RISK)		-0.5173^{***}		-0.5173^{***}
		(0.0175)		(0.0175)
ROAA	0.0174	-0.6893^{***}	0.0184	-0.6889^{***}
	(0.0293)	(0.0686)	(0.0293)	(0.0686)
NETINC	$-2.95E-7$	$-5.09E-6^{***}$	$-2.94E-7$	$-5.09E-6^{***}$
	(6.333E-7)	(1.519E-6)	(6.333E-7)	(1.519E-6)
CARHIGH	116.4035^{***}	-12.6588	116.4027^{***}	-12.9498
	(4.8731)	(10.2938)	(4.8731)	(10.2938)
CARLOW	-1.0303	-11.0319^{***}	-1.007	-11.0256^{***}
	(0.8431)	(1.9951)	(0.8431)	(1.9951)
N	1633	1633	1633	
F	83.29^{***}	77.59^{***}		
Adj. R^2	0.4305	0.413		
Sys. weight. R^2			0.4273	

N : number of observations, F : Fisher Statistic, Adj. R^2 : adjusted R^2,
Sys. weight. R^2 : system weighted R^2. Geographical and time dummies not shown.

Again, we observe similar results for the 2SLS and 3SLS estimation method, therefore the latter is retained for the rest of the study. Compared to the results of the first specification following Shrieves and Dahl (1992), we observe similar coefficients' signs and significance. The new added variable NETINC behaves in a similar manner as ROAA, with only significant negative sign for the DRISK equation.

The crucial point is the CARHIGH and CARLOW coefficients signs. We observe significant and positive coefficient for the CARHIGH variable in the DEQTA equation, and significant and negative coefficient for the CARLOW variable in the DRISK equation. Well capitalized banks seem to exhibit a positive correlation between the evolution of their capital ratios and their distance to minimum country CAR. This first result may be interpreted as a cautionary behavior, banks aiming at building precautionary excess capital cushion reserves while being well capitalized - above the minimum CAR. The second result seems to show an effective impact of this type of bank regulation, as undercapitalized banks exhibit a negative correlation between the evolution of their credit risk and their distance to the minimum country CAR. Such regulation tends to be effective in binding excessive risk taking behavior in undercapitalized banks in emerging market economies.

In the following subsection we use this specification (equations system (9, 10)) and add several regulatory, institutional and legal factors into the regressions in order to investigate their impact on the relationship between capital and risk in banks from emerging market economies.

3.3 Double regulatory pressure variables results including environmental factors

Following the existing literature and using *stepwise* regressions, we isolate the main environmental factors influencing the relationship between capital and risk[6].

These first results shown in table 5 provide some empirical evidence on the influence of some regulatory and market discipline factors on risk and capital in banks in emerging markets.

Concerning the variables already used and interpreted, we observe that DRISK is now significantly negative as well as ROAA in the DEQTA equation. CARLOW is now also significantly negative, which corroborates the findings using the first specification following Shrieves and Dahl (1992) shown

are available upon request.

[6]The number of observations may vary depending on data availability for the environmental factors.

Table 5: Simultaneous equations system (9, 10) regression results with double regulatory pressure variable and environmental factors - market and regulation influence 1

Variables	DEQTA	DRISK
INTERCEPT	9.5034^{***}	13.4514^{***}
	(2.8763)	(4.9617)
SIZE	0.0412	-0.5985^{***}
	(0.0938)	(0.1962)
DRISK	-0.0265^{*}	
	(0.0145)	
L(EQTA)	-0.7642^{***}	
	(0.0192)	
DEQTA		-0.0762^{*}
		(0.0431)
L(RISK)		-0.4415^{***}
		(0.0256)
ROAA	-0.0802^{**}	-0.4335^{***}
	(0.0378)	(0.0797)
NETINC	$-1.23E-6$	$9.223E-6^{***}$
	(1.443E-6)	(3.029E-6)
CARHIGH	270.3529^{***}	-0.3892
	(8.2876)	(14.0867)
CARLOW	-2.7721^{**}	-12.1974^{***}
	(1.1204)	(2.3183)
COVRATIO	-2.0159^{***}	-2.8891^{***}
	(0.4655)	(0.9916)
PERSLIM	6.2952^{***}	0.9623
	(1.3413)	(2.8046)
GOVBKFUND	-4.1514^{***}	-5.8507^{***}
	(0.8238)	(1.7365)
PRIVCREDREG	4.3985^{***}	8.0297^{***}
	(1.1777)	(2.4911)
RISKDISCPUB	0.6527	3.3214^{***}
	(0.4052)	(0.8655)
N	797	
Sys. weight. R^2	0.5997	

N : number of observations, Sys. weight. : system weighted. Geographical and time dummies not shown.

in table 3. In the DRISK equation, DEQTA becomes significantly negative.

As to the environmental factors, we have a significant and negative correlation between COVRATIO and DEQTA and DRISK, suggesting that a higher coverage ratio of the bank deposits requires more funds in the bank, therefore reducing its capitalization and its risk taking.

The existence of a personal limit in the deposit insurance scheme (PERSLIM) have a significant and positive impact on DEQTA, suggesting that such regulatory device generates some form of market discipline from the depositors (especially the big ones), and this seems to incite the banks to generate capital - in order to be able to respond to depositors withdrawals and/or to signal an adequate charter value which may be interpreted by depositors as a proxy of bank's strength.

Finally, we observe negative correlation between GOVBKFUND (the deposit insurance fund is cofinanced by the banks and the government) and DEQTA and DRISK. This particular type of deposit insurance scheme financing seems to influence negatively the evolution of bank capital, as the participation of the state reduces the need to signal financial strength to market, because deposits insurance is cofinanced by "free" public funds. However, the banks' participation to the fund seems to be disciplining enough on the risk side, as we observe a significantly negative sign in the DRISK equation, inducing the bank to adopt a rather conservative risk taking behavior in such environments.

The existence of private credit registries (PRIVCREDREG) implies counterintuitive positive coefficient signs in both equation. A negative sign was expected for the DRISK equation, as the existence of such registries contributes to the production and sharing of information on clients and the credit market as well, inducing higher transparency and better market discipline forces. Apparently, such effect may be found on the capital side, as the variable has the expected sign in the DEQTA equation, and we may interpret it in the same manner as for the PERSLIM variable. This disciplining effect is missing on the risk side, as we observe a positive sign in the DRISK equation, suggesting an adverse effect of this type of registries for credit risk taking behavior. Its information may be incomplete, inadequate or its use may be underdeveloped in emerging market economies' banks.

Finally, the obligation of risk management procedures' public disclosure (RISKDISCPUB) has a significant and positive impact on DRISK. This counterintuitive result may be interpreted in a similar manner as the PRIVCREDREG result. Or these procedures are incomplete and/or inadequate, therefore having no effect on market discipline efficiency, or even if publicly disclosed, the market participants don't have the necessary knowledge or skills to use it, and/or they don't trust it. Therefore, a bank engaged into

excessive risk taking will continue even if it discloses its risk management procedures.

In table 6 we show results of further investigations into other regulatory and market discipline features impact on capital and risk in banks.

We observe a significant and negative correlation between the number of denied foreign applications for a banking licence (DENAPPFOR) and DEQTA and DRISK. Conditional on an efficient "screening" of the banks' applications by the authorities, such device reduce market discipline and provides banks a comfortable and quasi-monopolistic position on the market, generating great charter value, and therefore permitting to reduce the evolution of capital and risk.

We also observe a significantly negative correlation between DEPINSDEC (the deposits insurer decides to intervene in a troubled bank) and DEQTA, and no significance for DRISK. Such regulatory device seems to affect capitalization without influencing risk taking behavior.

Environments where legal action against auditors for negligence (LEGACTION) exhibit significant and positive correlation with DEQTA and no significance for DRISK. Again, such device affects capitalization, but not risk taking.

As to the legal obligation to report miscmanagement by the auditors to the regulator (REPMISCMGT), we observe significant and positive signs for both equation DEQTA and DRISK. This result is counterintuitive, as such regulatory device should bind risk taking behavior, because if excess risk (due to miscmanagement) is discovered by the auditors, it will be reported to the regulator which will intervene into the bank. Including this variable with LEGACTION allows us to control both for the disciplining of the auditors by the regulator and the legal environment, and for the disciplining of the banks by the auditors. Obviously, such regulatory features generate adverse effects in emerging markets, probably because of lack of efficient and strong legal environment, problems of collusion between the auditor and the bank, corruption, or lack of usefulness of auditor's report for the regulator, the latter being unable or unqualified to make efficient use of it for his supervisory purposes.

Results shown in table 7 allows us to investigate the impact of some corporate governance features, mainly ownership structure and nationality, on the relationship between capital and risk in banks.

Except the DRISK in DEQTA equation and DEQTA in DRISK equation, all the coefficients of the standard variables remain the same.

Concerning the environmental factors, we observe first that the nationality of the first holding doesn't seem to matter, as both coefficients (HOLDEME and HOLDIE) are positively correlated with DRISK. Concerning the coun-

Table 6: Simultaneous equations system (9, 10) regression results with double regulatory pressure variable and environmental factors - market and regulation influence 2

Variables	DEQTA	DRISK
INTERCEPT	6.7019^{***}	9.0225
	(2.4433)	(5.6466)
SIZE	-0.2478	-0.6092^{***}
	(0.1011)	(0.229)
DRISK	-0.036^{***}	
	(0.0115)	
L(EQTA)	-0.6318^{***}	
	(0.0205)	
DEQTA		-0.1478^{***}
		(0.0536)
L(RISK)		-0.5726^{***}
		(0.0229)
ROAA	-0.075^{**}	-0.565^{***}
	(0.0343)	(0.0772)
NETINC	$-1.87E-6^{*}$	$3.915E-6^{*}$
	(9.774E-7)	(2.223E-6)
CARHIGH	187.7736^{***}	10.673
	(7.77)	(15.0741)
CARLOW	-1.7108	-1.2176
	(1.1205)	(2.5485)
DENAPPFOR	-0.4288^{***}	-0.8681^{***}
	(0.0745)	(0.1715)
DEPINSDEC	-14.1896^{***}	-2.4525
	(1.0704)	(2.2916)
LEGACTION	5.189^{***}	2.1895
	(0.6591)	(1.5098)
REPMISCMGT	3.0343^{***}	3.2^{**}
	(0.5912)	(1.3292)
NSUPERV	0.448^{***}	-0.0617
	(0.0699)	(0.1556)
NPLDEF	-1.7164^{***}	0.7654
	(0.5304)	(1.2067)
N	851	
Sys. weight. R^2	0.5386	

N : number of observations, Sys. weight. : system weighted. Geographical and time dummies not shown.

Table 7: Simultaneous equations system (9, 10) regression results with double regulatory pressure variable and environmental factors - corporate governance influence

Variables	DEQTA	DRISK
INTERCEPT	11.4545^{***}	21.5513^{***}
	(1.7173)	(3.2544)
SIZE	-0.0572	-0.9332^{***}
	(0.0856)	(0.2281)
DRISK	0.002	
	(0.0091)	
L(EQTA)	-0.6933^{***}	
	(0.0172)	
DEQTA		0.0697
		(0.0506)
L(RISK)		-0.576^{***}
		(0.024)
ROAA	-0.0261	-0.6159^{***}
	(0.0298)	(0.0773)
NETINC	$-2.06E-7$	$-6.24E-6^{***}$
	(5.996E-7)	(1.609E-6)
CARHIGH	216.532^{***}	-27.218^{*}
	(6.8147)	(15.2906)
CARLOW	-0.137	-9.2718^{***}
	(0.968)	(2.5689)
FINHELD	-22.5989^{***}	36.6397^{***}
	(2.834)	(7.6968)
STATEHELD	-7.0618^{***}	-0.1895
	(0.9714)	(2.5623)
OTHERHELD	18.6245^{***}	-44.3431^{***}
	(4.3142)	(11.5345)
WIDELYHELD	-1.1653^{*}	-9.5022^{***}
	(0.7006)	(1.8991)
HOLDEME	0.1351	1.52^{**}
	(0.2728)	(0.7314)
HOLDIE	0.2569	2.3949^{**}
	(0.4041)	(1.0819)
N	1166	
Sys. weight. R^2	0.5418	

N : number of observations, Sys. weight. : system weighted. Geographical and time dummies not shown.

try's banks ownership structure, a bank having a financial institution as a controlling shareholder (FINHELD) will exhibit respectively negative and positive correlation with DEQTA and DRISK. Such shareholder may serve as a capital provider in an environment with lack of other sources of fresh capital injection due to financial markets underdevelopment, and therefore we observe a negative coefficient sign in the DEQTA equation. On the contrary, such shareholder may incite the bank to engage into excessive risk taking activities.

When the state is a controlling shareholder (STATEHELD), we observe the same behavior on the capital side : public assistance in case of troubles seems to be anticipated, with a negative coefficient sign in the DEQTA equation.

Dispersed shareholders (WIDELYHELD) seem to implement some kind of discipline, as we observe negative and significant signs in both DEQTA and DRISK equations.

Finally, the only ownership structure implementing a "perfect" discipline, with a positive sign on the capital side and a negative one on the risk side, is the OTHERHELD shareholders type, which seems to be a family type of ownership structure (such type of ownership structure remains still important in emerging market economies).

Finally, the results shown in table 8 provide some insight into the influence of economic and legal opacity, as well as rule of law and legislation, on capital and risk in banks. The first two variables - ECONOPACITY and LEGALOPACITY - are outputs from a survey done by PWC which aim was to evaluate the level of opacity perceived by bankers. We observe a significant and positive coefficient sign for ECONOPACITY in DRISK equation and for LEGALOPACITY in DEQTA equation. The economic opacity seems to be positively related to credit risk taking and legal opacity to capitalization. The first result suggests that a higher level of perceived economic and business environment opacity favors excessive credit risk taking in banks, as higher transparency would alleviate adverse incentives. Additional restrictions and controls imposed by the authorities tend to "secure" such excessive risk taking behavior. The second result suggests that legal opacity which drives policies dealing with business environment favors bank capitalization, as in such an opaque environment banks should hold a cushion of capital in case of adverse evolution of the legislation.

The last three variables deal exclusively with legal enforcement and judical environment. The RULEOFLAW index appears significantly negative only in the DRISK equation, as credit risk taking should be negatively related to higher levels of rule of law.

The JUDSYSEF index appears to be significantly positive in the DE-

Table 8: Simultaneous equations system (9, 10) regression results with double regulatory pressure variable and environmental factors - economic and legal opacity influence

Variables	DEQTA	DRISK
INTERCEPT	-14.1733^{***}	15.3285^{*}
	(3.6549)	(8.8454)
SIZE	-0.0103	-0.7793^{***}
	(0.0951)	(0.2608)
DRISK	-0.0072	
	(0.0101)	
L(EQTA)	-0.7315^{***}	
	(0.0196)	
DEQTA		0.0705
		(0.0576)
L(RISK)		-0.5708^{***}
		(0.0282)
ROAA	-0.0821^{***}	-0.6963^{***}
	(0.0315)	(0.0842)
NETINC	$4.213E-8$	$-2.59E-6$
	(6.84E-7)	(1.882E-6)
CARHIGH	233.6252^{***}	-6.1612
	(7.9259)	(18.5361)
CARLOW	-1.354	-9.5115^{***}
	(1.0485)	(2.8663)
ECONOPACITY	2.1632	17.3938^{***}
	(1.8636)	(5.1364)
LEGALOPACITY	2.2788^{***}	-2.2953
	(0.7457)	(2.0457)
RULEOFLAW	0.1555	-1.6752^{***}
	(0.2179)	(0.6007)
JUDSYSEF	0.9228^{***}	-0.943^{**}
	(0.1604)	(0.4485)
LEGFRENCHSYS	-4.1131^{**}	-18.5816^{***}
	(1.8816)	(5.1796)
N	918	
Sys. weight. R^2	0.5575	

N : number of observations, Sys. weight. : system weighted.
Geographical and time dummies not shown.

QTA equation and negative in the DRISK equation. The latter result may be interpreted as in the RULEOFLAW case - a more efficient judical system restrains excessive risk taking incentives. The former result seems less intuitive. It may be interpreted in the following manner : in a more efficient judical environment, bankers may need to hold excess capital cushion in order to meet regulatory requirement and also to signal financial strength, showing abilities to meet potential economic or legal problems.

Finally, the french origin of the legal system (LEGFRENCHSYS) is negatively correlated to both DEQTA and DRISK, as such a system is mainly a *Civil Law* system, thus giving a better protection of state's interests and not private and individual debtholders, therefore increasing their market disciplining power.

4 Conclusion and future research perspectives

The objective of this paper was twofold. The first aim was to investigate the relationship between capital and credit risk in banks from emerging markets, using methodologies following Shrieves and Dahl (1992) and Jacques and Nigro (1997). Empirical evidence on this issue shouldn't be neglected, as these markets are gaining importance each day, and healthy banking industries remain a core elements of their economic prosperity. The second aim was to investigate the influence of regulatory, institutional and legal factors on this relationship between capital and risk. This topic didn't receive much attention, but it remains crucial to understand the role of this regulatory and legal environment in driving bank capitalization and risk taking behavior, especially in emerging market economies, where building such an environment is still an ongoing process.

Our results corroborate empirical findings from other studies (e.g. Shrieves and Dahl 1992, Jacques and Nigro 1997, VanRoy 2003), proving the importance of bank capital regulation for healthy banking industry in emerging market economies. We also prove the role of the regulatory, institutional and legal environment in driving bank capitalization and credit risk taking behavior.

This study proposes a first sketch of investigation of these issues. More environmental factors should be investigated, in order to put forward the crucial ones at driving bankers behavior in emerging market economies. Comparisons with industrial economies could also shed some light on the relationship between capital and risk, and the role of environmental factors in it. Finally, more precise econometric investigation of non linearities, as well as causality, in the relationship between risk and capital are further research perspectives.

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