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The relationship between capital structure and risk in emerging market banks

Abstract

The relationship between capital structure and risk in the banking industry received renewed attention after the recommendations on minimal capital requirements for banks made by the Basel Committee in 1988. A number of studies have been conducted on this relationship since, but few have focused on emerging markets. This study aims to identify the nature of the relationship between capital structure and risk-taking in emerging market banks. A three-stage least squares (3SLS) method of estimation is applied to a modified version of the capital model developed by Shrieves and Dahl and a modified version of Kwan and Eisenbeis' efficiency model. The relationship between changes in capital structure and risk and absolute levels of capital and risk are examined for 2 940 banks across 44 emerging market countries for the period of 1995 to 2003. Results show that no significant relationship exists between changes in capital and changes in risk, contrary to the positive relationship presented by developed market empirical evidence. A positive relationship between the absolute levels of capital and risk is, however, identified amongst emerging market banks. The evidence suggests that emerging market banks do not align capital and risk positively in the short term, but are able to make this alignment in the longer term.

Keywords: bank, capital, risk, 3SLS, emerging market.
JEL Classification: G21, G32.

Introduction

The relationship between capital structure and risk-taking has a direct bearing on the solvency of individual banks and on the soundness of the banking industry in general. The relationship between the capital ratio[1] and levels of risk[2] should be such that increases in business risk are offset by reductions in financial risk, and *vice versa*, thus, restoring the bank's probability of default to an acceptable level.

According to the Trade-off theory[3] of corporate finance, a positive relationship between a firm's capital ratio and risk is required to minimize the cost of capital. Firms might be encouraged to increase the percentage debt in the capital structure, because of the tax deductibility of interest charges and the lower cost of capital. Expected costs associated with financial distress provide an opposing force to the above-mentioned advantages offered by debt (Brealey and Myers, 2003). Investors, on the other hand, demand a premium to compensate for increased bankruptcy risk associated with the probability of financial distress and proportionately low capital ratios. Thus, increased risk requires greater proportions of equity in the firm's capital structure to prevent an inefficient cost of capital.

Similarly, the principles of the Basel Accord encourage a positive relationship between a bank's capital ratio and risk exposure. Equity capital is indicative of the willingness of shareholders to provide a 'cushion' to absorb possible bank losses (Reserve Bank of Australia, 1994). The greater the risk is, the greater the equity 'cushion' should be in order to maintain the solvency position of the bank. A positive relationship between capital ratio and risk provides stability, thus providing shelter to bank creditors (Basel Capital Accord, 1988).

Both the principles of the Basel Accord and the Trade-off theory suggest that a negative relationship or no relationship between capital ratios and risk should result in an inefficient cost of capital and possibly regulatory penalties. These consequences require the presence of market discipline and effective regulatory enforcement. An efficient market will penalize banks by requiring greater returns on investment or withdrawal of investment.

Additional factors however require consideration which provides deviations from Trade-off theory, particularly those of a behavioral nature such as moral hazard[4] and agency theory. The United States (US) sub-prime financial crisis is indicative of market behavior contrary to efficient market discipline assumed in the Trade-off theory which has been compounded by the growth of new unregulated, or lightly regulated, financial entities (Reinhart and Rogoff, 2008).

In this paper, the relationship between capital structure and levels of risk in emerging market banks is examined by testing two hypotheses. The first hypothesis states that a significant positive relationship exists between changes in capital and

[1] Capital ratio is defined as the ratio of total equity to total assets. Equity consists of the book value of common shares, share premiums, general and specific reserve funds and preference shares.

[2] Risk may be defined as reductions in firm value due to unexpected changes in the business environment (Pyle, 1984).

[3] For a full discussion of the Trade-off theory, see Brealey and Myers (2003).

[4] Moral hazard arises when banks increase both leverage and risk simultaneously. Also see Flannery (1991) for a discussion on moral hazard and unobserved risk.

changes in risk, and the second that a significant positive relationship exists between the absolute levels of capital and the absolute levels of risk amongst emerging market banks.

The remainder of this paper is organized as follows. Section 1 reviews the theoretical and empirical literature, followed by section 2 that describes the empirical models and discusses the statistical methodology. Section 3 provides an overview of the research data, section 4 reports the empirical results and the last section concludes the study.

1. Background

Following the introduction of prudential capital regulation by the Basel Committee in 1988, a significant amount of empirical work has been directed towards the effects and implications of regulation on the capital structure and risk-taking of banks. However, few studies directly address the relationship between capital structure and risk in the banking industry, particularly in emerging market countries.

The point of departure for any modern study of capital structure begins with the celebrated seminal paper by Modigliani and Miller (1958), henceforth M&M. The paper proposes that in a frictionless world of full information, where markets operate efficiently, a firm's capital structure is irrelevant in the determination of the firm's value. Amendments in the second paper take into consideration the benefit of the tax deductibility of interest charges associated with debt (Modigliani and Miller, 1963). Although insightful, its practical application leads to extreme results. It proposes that value-maximizing firms should be financed with 100% debt, which opposes empirical corporate finance evidence. Subsequently extensive academic research has focused on identifying debt-associated costs and departures from a frictionless and efficient world. Investigations by Harris and Raviv (1991), Masulis (1988), and Miller (1988) have identified factors such as financial distress[1], direct and indirect bankruptcy costs, agency costs and asymmetric information as drivers for departure from pure debt financing.

At high levels of financial leverage, as proposed by M&M's second proposition, large savings associated with the tax shield[2] may be achieved, however, costs of financial distress are maximized. These costs are reduced as debt levels subside and both principal and interest obligations are substituted by equity with residual claims. An efficient capital structure is reached when the costs of financial distress is in balance with the benefits associated with the corporate tax shields, minimizing the weighted average cost of capital (Brealey and Myers, 2003).

Financial intermediaries differ from non-financial firms as they encompass an additional friction in the form of prudential capital regulation. The Basel Committee's objectives were to strengthen the soundness and stability of international banking systems and to reduce competitive inequality primarily via minimum capital adequacy regulation. This brought about mixed reactions from banks.

Keeley's (1988) analysis of the 100 largest bank holding companies finds that regulation had the desired effect of aligning book capital ratios with risk-weighted assets[3], primarily by slowing asset growth. Studying a broad cross-section of banks, Shrieves and Dahl (1992) analyze the change in relationship between changes in capital structure and changes in portfolio risk for the US banking sector during the mid-eighties. Using a two-stage simultaneous equation methodology to account for the simultaneity of capital and risk, they find a positive relationship between changes in bank capital and changes in risk-taking. They conclude that this positive relationship is not strictly the consequence of capital regulation, as banks holding regulatory capital in excess of minimum requirement tend to emulate positive relationships. Both regulatory pressure and the private incentives of shareholders and/or managers are contributing factors.

Jacques and Nigro (1997) study the relationship between changes in capital and changes in risk-taking in the US subsequent to the adoption of Basel Committee's minimum capital regulation in 1991. They find increases in book capital ratios and decreases in risk exposure consistent with the findings of Shrieves and Dahl. Bichsel and Blum (2002) conducted a similar analysis of non-US banks. Their study of Swiss banks provides strong evidence in favor of a positive relationship during the period of 1990-2002.

[1] Financial distress occurs when a firm has difficulty in honoring its obligations. Direct costs include legal and other costs associated with bankruptcy and the transfer of ownership. Indirect costs arise as a result of perceptions of future defaults on obligations, even though bankruptcy may ultimately be avoided. In the banking industry, financial distress may lead to loss of market share and bank runs. Talented employees may leave, lines of credit may be closed and revenues from credit-risk-sensitive products such as long-term swaps and guarantees may decline (Berger, Herring, Szegö, 1995).

[2] The value of tax shield benefits may vary depending on amounts of taxable income, corporate tax rates and other tax shields at a firm's disposal.

[3] Assets of the bank are allocated to various risk weighting groups based on the underlying perceived credit risk. The Basel Capital Accord suggests that risk-weighted assets be matched by regulatory capital at a rate of 8% of the risk-weighted assets (Basel Capital Accord, 1988).

The above-mentioned empirical studies provide evidence of a positive relationship between changes in capital ratio and risk. However, other empirical studies have presented contradictory results. Brewer, Jackson and Moser (1996) show that when deposit insurance premiums are not risk sensitive, managers invest in high-risk assets at discounted rates, while simultaneously extending financial leverage[1], to enhance returns. Moral hazard bank behavior is indicative of a negative relationship between capital ratio and risk, as high risk-taking is combined with high leverage. Demirgüç-Kunt and Detragiache (2000) also find moral hazard to be prevalent in countries where banking regulation and supervision are substandard, indicating the possible presence of these conditions in emerging markets. A study conducted by Godlewski (2005) is one of the few that address the relationship between the changes in capital and risk in an emerging market context. Although Godlewski identifies weak evidence of a negative relationship between the changes under specific conditions, the results suggest that no significant relationship exists amongst emerging market banks.

Calem and Rob (1996) developed a dynamic model of a banking firm subject to moral hazard, using US bank empirical data for the years 1984 to 1993 and found a 'U-shaped' relationship between changes in capital and changes in risk-taking. This is explained by the fact that well-capitalized banks invest in high-risk assets; less well-capitalized banks pursue a more conservative risk approach, while poorly capitalized banks attempt to maximize risk-taking. Iwatsubo (2003) supports this view with evidence of a significant non-linear relationship between capital ratio and risk for Japanese banks.

A limited investigation into the relationship between the absolute levels of capital and risk was carried out by Altunbas et al. (2001) that examine the influence of bank efficiency on the capital and risk system. They provide evidence of a strong positive relationship amongst European banks.

Research into the relationship between the capital structure and risk-taking of banks provides conflicting and inconclusive results. The literature indicates that the relationship between changes in capital and risk is influenced by the time period under investigation and the environmental conditions to which banks are exposed. The results from investigations into the relationship between the absolute levels of capital and risk have consistently produced a significant positive relationship; however, these studies are limited in number and geographic location.

2. Methodology

Two separate models are utilized in this study. The first model is used to estimate the relationship between the changes in capital and risk (section 2.1) and the second model is designed to estimate the relationship between the absolute levels of capital and risk (section 2.2).

2.1. Model 1 – The relationship between changes in capital and changes in risk. The methodology proposed by Shrieves and Dahl (1992) was modified to examine the relationship between changes in capital and changes in risk. Their model consists of a partially adjusted simultaneous equations framework, taking cognisance that capital and risk changes may take place simultaneously. Two types of factors impact these changes, namely a discretionary factor and exogenously determined random shocks, resulting in a dual endogenous and exogenous interrelation between capital and risk. The endogenous component is attributed to capital (risk) target decisions requiring risk (capital) consideration. Both capital and risk levels are subjected to exogenous shocks. The discretionary adjustments towards target levels of capital and risk respectively, and the exogenous component are represented as:

$$\Delta CAPR_{j,t} = \beta_0 (CAPR^*_{j,t} - CAPR_{j,t-1}) + \varepsilon_{j,t}, \quad (1)$$

$$\Delta RISK_{j,t} = \alpha_0 (RISK^*_{j,t} - RISK_{j,t-1}) + \omega_{j,t}, \quad (2)$$

where $\Delta CAPR_{j,t}$ and $\Delta RISK_{j,t}$ are the observed changes in capital and risk exposures respectively for bank j in time period t as a result of changes in capital ($CAPR_{j,t-1}$) and risk ($RISK_{j,t-1}$) from the previous period toward the target levels of capital ($CAPR^*_{j,t}$) and risk ($RISK^*_{j,t}$). The exogenous shocks on changes in capital and risk levels are represented by $\varepsilon_{j,t}$ and $\omega_{j,t}$ respectively. The target levels of capital and risk exposures are not observable, but are assumed to be determined by observable variables. The levels of capital ($CAPR_{j,t}$) are measured by the ratio of total book equity/total assets and the level of risk ($RISK_{j,t}$) is measured by non-performing loans/total loans ratio. This measure of risk focuses on credit risk, which is the principal source of risk for banks.

In equation (1), the target level of capital ($CAPR*_{j,t}$) is influenced by capital levels in the previous period ($CAPR_{j,t-1}$), changes in risk ($\Delta RISK_{j,t}$), the bank's size ($SIZE_{j,t}$) and the bank's income ($ROAA_{j,t}$). In

[1] See Galai and Masulis (1976) and Green (1984) for a further discussion of moral hazard in the presence of high financial leverage.

(2), the same set of explanatory variables is used to explain the target level of risk ($RISK*_{j,t}$), except the levels of capital in the previous period ($CAPR_{j,t-1}$) and the changes in capital levels ($\Delta CAPR_{j,t}$) are substituted with ($RISK_{j,t-1}$) and ($\Delta RISK_{j,t}$) respectively. When substituting the observable variables for target levels of capital and risk, (1) and (2) can be re-stated:

$$\Delta CAPR_{j,t} = \beta_0 + \beta_1 SIZE_{j,t} + \beta_2 ROAA_{j,t} + \\ + \beta_3 \Delta RISK_{j,t} - \beta_4 CAPR_{j,t-1} + \varepsilon_{j,t}, \quad (3)$$

$$\Delta RISK_{j,t} = \alpha_0 + \alpha_1 SIZE_{j,t} + \alpha_2 ROAA_{j,t} + \\ + \alpha_3 \Delta CAPR_{j,t} - \alpha_4 RISK_{j,t-1} + \omega_{j,t}. \quad (4)$$

The system of equations is extended by including bank growth ($GROW_{j,t}$) in the changes in capital and risk equations and the cost of debt ($COD_{j,t}$) in the changes in capital equation. This is consistent with the adjustments made by de Bondt and Prast (2000) to the model developed by Shrieves and Dahl. Estimations are conducted for each of the individual countries included in this study. Estimation is also conducted on an emerging market level, the result of combining all the individual emerging market countries into a single sample. More detail on the country level and collective emerging market level samples included in this study are provided in section 3. Additional variables are included for the estimation on a collective emerging market level to account for differences in banking environments across countries. These variables include controls against inflation ($CPI_{i,t}$)[1], differences in bank liquidity ($LIQ_{i,t}$) and differences in regulatory stringency ($REG_{i,t}$). The model developed by Shrieves and Dahl includes a variable to capture the effects of regulation on changes in capital and risk, which is not included in the estimation of the system of equations on an individual country level due to data constraints, but is included on an emerging market level. The final model for estimating the relationship between changes in capital and risk is:

$$\Delta CAPR_{j,t} = \beta_0 + \beta_1 SIZE_{j,t} + \beta_2 ROAA_{j,t} + \\ + \beta_3 \Delta RISK_{j,t} - \beta_4 CAPR_{j,t-1} + \beta_5 GROW_{j,t} \quad (5) \\ + \beta_6 COD_{j,t} + \beta_7 CPI_{i,t} + \beta_8 LIQ_{i,t} + \beta_9 REG_{i,t} + \varepsilon_{j,t}$$

$$\Delta RISK_{j,t} = \alpha_0 + \alpha_1 SIZE_{j,t} + \alpha_2 ROAA_{j,t} + \\ + \alpha_3 \Delta CAPR_{j,t} - \alpha_4 RISK_{j,t-1} + \alpha_5 GROW_{j,t} \quad (6) \\ + \alpha_6 CPI_{i,t} + \alpha_7 LIQ_{i,t} + \alpha_8 REG_{i,t} + \omega_{j,t}$$

where $CPI_{i,t}$, $LIQ_{i,t}$ and $REG_{i,t}$ are cross-country controls for country i in period t.

[1] Definitions of the cross-country variables are provided in Appendix A.

2.2. Model 2 – The relationship between absolute levels of capital and risk. In order to examine the relationship between the absolute levels of capital and risk, the capital efficiency model proposed by Altunbas et al. (2001) was adapted, utilizing only the first two equations of the model where the absolute levels of capital and risk are the dependent variables respectively[2]. The last equation, in which bank efficiency is the dependent variable, is excluded as consistent estimates of the absolute levels of capital and risk are obtained with the first two equations (Biekpe and Floquet, 2006). Consistent with the model proposed by Shrieves and Dahl (1992), this model specifies a system of equations to be estimated simultaneously to recognize that decisions regarding the levels of capital and risk may be dependent on each other. The model used for estimating the relationship between the absolute levels of capital and risk for this study is:

$$CAPR_{j,t} = \lambda_0 + \lambda_1 SIZE_{j,t} + \lambda_2 ROAA_{j,t} + \\ + \lambda_3 RISK_{j,t} + \lambda_4 GROW_{j,t} + \lambda_5 COD_{j,t} \quad (7) \\ + \lambda_6 CPI_{i,t} + \lambda_7 LIQ_{i,t} + \lambda_8 REG_{i,t} + \mu_{j,t}$$

$$RISK_{j,t} = \delta_0 + \delta_1 SIZE_{j,t} + \delta_2 ROAA_{j,t} + \\ + \delta_3 CAPR_{j,t} + \delta_4 GROW_{j,t} + \delta_5 CPI_{i,t} + \quad (8) \\ + \delta_6 LIQ_{i,t} + \delta_7 REG_{i,t} + \nu_{j,t}$$

where $CAPR_{j,t}$ and $RISK_{j,t}$ are the absolute levels of total book equity/total assets and of non-performing loans/total loans respectively for bank j in country i for the period t. Exogenous random shocks to the capital and risk levels respectively for bank j in period t are represented by $\mu_{j,t}$ and $\nu_{j,t}$.

The set of exogenous explanatory variables included in equations (5) to (8) is well established in the literature to assist in explaining the changes and absolute levels of capital and risk of banks[3]. This includes bank size ($SIZE_{j,t}$), measured as the natural logarithm of bank total assets. Bank earnings ($ROAA_{j,t}$) are measured as the return on average assets. As proposed by de Bondt and Prast, bank

[2] Most empirical models only try to explain the changes in capital and risk levels, not their absolute levels. The main reason for this is that a theory of optimal capital structure for banks has not yet fully been identified. Consequently, models used to explain the absolute levels of capital and risk may not capture differences in the risk preferences of banks, as banks with a low risk aversion will try to increase leverage and risk, resulting in negative cross-sectional correlations between capital and risk levels (Heid, Porath and Stolz, 2003). In this study, it is assumed that the influence of differences in risk aversion between banks is minimized by excluding investment and other specialized banks to maintain a relatively homogeneous set of sample banks.

3 For example, see Shrieves and Dahl (1992), Jacques and Nigro (1997), De Bondt and Prast (2000) and Heid, Porath and Stolz (2003).

loan growth ($GROW_{j,t}$) may influence bank leverage as equity may be difficult to raise under conditions of fast bank growth, especially if poorer quality loans is sought to enable such growth. Bank loan growth is measured as the difference between total loans and total loans of the previous period/total loans. Finally, the cost of debt ($COD_{j,t}$) is included in (5) and (7) as different costs of capital may have a significant influence on the capital structure decisions of banks. The cost of debt is measured as total interest expense/total liabilities ratio.

The inclusion of endogenous explanatory variables in the system of simultaneous equations renders estimation by ordinary least squares inappropriate as it results in biased estimates. Two stage least squares (2SLS) or three stage least squares (3SLS) takes into account the endogeneity present in the system, providing unbiased and consistent estimates. In this study 3SLS was used for estimation, because it is asymptotically more efficient than 2SLS by using the information in the non-zero covariance between the error terms of the system of equations.

3. Data

Individual bank balance sheet and profit and loss account data extracted from the Bankscope database (Bureau van Dijk) are used. This study includes 2 940 banks from 44 emerging market countries. The banks are limited by specialization to commercial, savings, co-operative and mortgage banks and 89.1% of the banks are commercial ones. Annual data are used covering a 9-year period from 1995 to 2003 in an unbalanced panel. Emerging market countries, included in the analysis, represent the following regions: Africa, Eastern Europe, East Asia & Pacific Rim, South America, Central America & the Caribbean, South Asia, and Southern Europe & Central Asia.

The inclusion of a country into the sample is restricted to countries with a minimum of 35 observations. The country with the least number of banks included in the sample is Serbia with 23, and Brazil at 228 has the largest number of banks. In some instances, the provision for bad debt item reported in the profit and loss accounts for individual banks for specific periods is found to be more than half of the value of the banks' total advances made for that period. The variable $RISK_{j,t}$ has been bounded to -0.5 and 0.5 as amounts beyond these values are largely accounting adjustments and may not reflect the banks' risk profile. The analysis is conducted on two levels. Firstly, estimations are carried out on an individual country level for each of the 44 emerging market countries. Secondly, the individual emerging market countries are combined into a single market level sample to be estimated collectively. The combining of the individual countries into a single sample allows for aggregated results to be estimated, providing a comprehensive analysis of the emerging market countries included in this study.

Table 1 (Appendix A) presents descriptive statistics for the two variables of interest namely, capital structure ($CAPR_{j,t}$) and risk ($RISK_{j,t}$), for individual emerging market countries as well as on a market level (an aggregation of all emerging market countries). In addition, descriptive statistics for a set of 6 developed market countries on an individual country level, as well as a composite developed market level are included for comparative purposes.

It is clear from Table 1 that the mean $CAPR_{j,t}$ ratio of 13.9% for emerging markets does not differ significantly from the mean $CAPR_{j,t}$ ratio of 12.4% for the group of developed countries. The emerging markets, however, have a much greater $CAPR_{j,t}$ ratio standard deviation of 17.8% compared to the 12,7% of developed markets. This may be attributable to emerging market banks trying to match their more volatile risk exposures and capital levels. As expected, emerging market banks have a mean credit risk measure ($RISK_{j,t}$) of 3.1%, which is substantially greater than the 1.0% of the group of developed markets. The standard deviation of non-performing loans to total loans in emerging markets of 6.7% indicates far greater volatility in loan losses, providing further evidence of the greater risk faced. Assuming the theoretical and empirical evidence is applicable to emerging market banks and banks do try to match capital and risk exposures, the descriptive statistics indicate that emerging market banks will generally have greater difficulty in matching levels of capital and risk than developed markets. This is due to the substantially larger standard deviations of capital ratios and risk exposures.

4. Results and discussion

The results of estimating the simultaneous system of equations (5) and (6) are presented in Tables 3 and 4 respectively (Appendix B). When a change in capital ($\Delta CAPR_{j,t}$) is the dependent variable (equation 5), a significant negative relationship exists between $\Delta CAPR_{j,t}$ and $\Delta RISK_{j,t}$ at a 5% significance level for 8 of the 44 emerging market countries. However, in 3 of the countries a

significant positive relationship is identified. For the remaining 33 countries, the $\Delta RISK_{j,t}$ parameter is statistically insignificant. Estimating equation (5) on a collective emerging market level produces a statistically insignificant $\Delta RISK_{j,t}$ parameter. The results from estimating equation (6), where $\Delta RISK_{j,t}$ is the dependent variable, corroborate the results of equation (5). Eight countries are found to have significant positive $\Delta CAPR_{j,t}$ parameters, while another 8 countries are found to have significant negative parameters. The result of estimating equation (6) on a collective emerging market level produces a positive, but not statistically significant, $\Delta CAPR_{j,t}$ parameter. The results indicate that there is no statistically significant relationship between changes in capital and risk in the vast majority of emerging markets banks. This is true for 33 countries from the results in equation (5) and 28 out of 44 countries from results in equation (6). These results do no reflect the positive relationship identified by the empirical evidence presented for developed market countries, but does provide support for the evidence found for emerging markets[1].

The results of the simultaneous estimation of equations (7) and (8), presented in Tables 5 and 6 (Appendix B), provide evidence of the nature of the relationship between the absolute levels of capital and risk. The outcome from the estimation of equation (7), with $CAPR_{j,t}$ as the dependent variable, indicates that a significant positive relationship is present in 22 of the 44 individual emerging market countries. Similarly, significant positive relationships for 27 countries are identified in equation (8) where $RISK_{j,t}$ is the dependent variable. The results from the individual countries indicate that more than half of the sampled countries have significant positive relationships between the absolute levels of capital and risk. In support of this result, significantly positive relationships between absolute levels of capital and risk are found for equations (7) and (8) on a collective emerging market level. Little empirical evidence is available for a comparative analysis of these findings in other countries or markets, however, Altunbas et al. (2001) identify a positive relationship between the absolute levels of capital and risk for European banks, consistent with the findings of this study.

It is evident that banks match their levels of capital and risk in a positive way, but do not necessarily make positive adjustments to capital as a result of adjustments in risk, and *vice versa*. This phenomenon may be the result of the inability of emerging market banks to control short-term levels of capital and risk, but they have the ability to align capital and risk positively in the longer term.

The estimated parameters of the exogenous variables included in equations (5) to (8) provide the expected results consistent with empirical evidence. Bank size ($SIZE_{j,t}$) is statistically negatively related to changes in capital and the absolute levels of capital and risk, but does not seem to have a significant influence on changes in risk. Greater bank earnings ($ROAA_{j,t}$) are significantly and positively related to changes in capital levels and the absolute levels of capital and are significantly negatively related to changes and absolute levels of risk. Weak evidence is found to suggest that bank growth ($GROW_{j,t}$) is negatively associated with changes in capital, but no significant evidence exists of a relationship between growth and the absolute levels of capital. This result may support the view that emerging market banks are unable to adjust capital levels in the short term. Finally, higher costs of liabilities ($COD_{j,t}$) are significantly related to higher capital ratios, possibly due to banks trying to minimize their cost of capital.

Conclusions

The objective of this study is to provide evidence of the nature of the relationship between capital and risk exposures for emerging market banks. Corporate financial theory suggests that banks should match capital and risk in a positive way so as to minimize the frictions associated with higher leverage, while taking optimal advantage of the tax deductibility of debt. The results provide support for a positive relationship between capital and risk, consistent with corporate financial theory, but only in the longer term.

The lack of evidence of a positive relationship between changes in capital and changes in risk indicates that current movements in capital (risk) of emerging market banks do not reflect the adjustments made to risk (capital). Descriptive statistics indicate that the loan losses in emerging market banks are greater and significantly more volatile than those of developed markets. This may be indicative of the difficulties facing emerging market banks in trying to align capital and risk in a

[1] A positive relationship between changes in capital and changes in risk in developed markets has been presented in a number of research articles, see for example, Shrieves and Dahl (1992), Rime (2001) and Bichsel and Blum (2002). The study by Godlewski (2005) of emerging market banks finds no significant relationship between changes in capital and changes in risk where *CAPR* is the dependent variable, consistent with the results of this study. In the case of *RISK* as the dependent variable, Godlewski identifies a weak negative relationship under some conditions.

positive way over the short term. The less developed capital markets in many emerging market countries could inhibit a bank's ability to make short-term equity adjustments, while, the greater risk associated with emerging market advances makes the control and anticipation of risk exposures more intricate. The statistically significant positive relationship between the absolute levels of capital and risk identified suggests that over the longer term banks are able to match capital and risk in a positive way, reducing the frictions associated with the misalignment of capital and risk.

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Appendix A. Variables

Table 1. Descriptive statistics of *CAPR* and *RISK* variables

Country	*CAPR*, %		*RISK*, %	
	Mean	Std. dev.	Mean	Std. dev.
Argentina	19,94	28,45	5,71	10,73
Bangladesh	5, 94	10,48	1,18	1,35
Brazil	19,25	21,38	5,41	13,05
Bulgaria	17,97	16,50	4,87	10,87
Chile	17,02	18,65	1,58	3,34
China	10,32	15,18	0,74	1,74
Colombia	13,48	10,25	3,11	7,20
Costa Rica	17,04	15,74	1,13	1,54
Croatia	19,04	14,71	3,51	7,01
Cyprus	7,50	5,88	2,30	4,59
Czech Rep.	8,67	10,33	4,60	10,97
Ecuador	8,67	74,18	6,91	14,25
El Salvador	10,62	14,18	2,59	3,63
Greece	9,18	5,61	1,11	1,11
Guatemala	-4,86	108,82	0,74	0,40
Honduras	12,51	5,64	1,39	1,43
Hong Kong	25,14	27,06	-0,29	26,31
Hungary	10,68	8,13	1,27	2,91
India	7,16	6,78	1,66	1,72
Indonesia	8,78	21,09	5,67	15,39
Jamaica	18,66	19,10	3,66	7,50
Kazakhstan	19,59	22,49	4,00	5,18
Korea	6,12	9,47	2,46	2,99
Latvia	13,20	12,61	5,28	13,73
Malaysia	17,48	22,05	2,17	4,89
Mexico	17,29	17,86	2,49	6,88
Nigeria	10,88	15,72	4,45	6,05
Pakistan	6,19	4,02	1,59	2,84
Panama	12,47	14,46	1,98	8,20
Paraguay	16,70	11,16	3,67	9,48
Peru	11,34	6,45	3,30	4,71
Philippines	17,15	11,51	1,45	2,17
Poland	14,79	15,55	0,48	2,72
Romania	20,73	13,27	5,17	10,99
Russia	19,41	18,01	3,79	9,52
Serbia	20,99	16,69	12,85	20,37
Slovakia	15,05	20,08	2,19	6,96
Slovenia	11,49	4,83	2,14	2,30
South Africa	28,02	28,50	3,27	7,21
Sri Lanka	9,57	13,54	1,56	1,64
Taiwan	11,92	16,69	1,50	2,67
Thailand	6,11	3,65	3,05	6,53
Trinidad & Tobago	13,60	5.65	0,68	0,70
Turkey	13,00	16,12	3,32	6,06
Ukraine	16,98	10,52	5,69	8,50
Uruguay	14,85	26,48	3,94	9,16
Venezuela	26,01	27,09	5,07	8,06
Vietnam	13,95	12,78	1,61	3,66
Emerging markets	13,91	17,82	3,08	6,69
Belgium	14,24	23,96	0,99	3,43
Denmark	12,48	5,07	0,93	1,40
France	7,91	11,09	0,73	3,59
Italy	12,40	5,03	0,85	2,89
Japan	6,98	9,27	0,98	1,31
Singapore	20,63	22,23	1,37	4,89
Developed markets	12,44	12,78	0,98	2,92

Source: Raw data from Bankscope. Authors' calculations.

Table 2. Cross-country control variables

Variable	Definition	Source
CPI	Consumer price index (1995=100)	World Bank, World development indicators (2004)
LIQ	Bank liquid reserves to bank assets ratio	World Bank, World development indicators (2004)
SPREAD	Interest rate spread (lending rate minus deposit rate)	World Bank, World development indicators (2004)
REG	Overall capital stringency measure	Barth, Caprio and Levine (2001). The Regulation and Supervision of Banks around the World

Appendix B. Regression results

Table 3. Regression results of equation (5), ΔCAPR as dependent variable

Country	Dependent variable: ΔCAPR							
	Observations	SIZE	ROAA	ΔRISK	CAPR(-1)	GROW	COD	Adj rsq
Argentina	347	-0,010*	0,007*	0,068	-0,434*	-0,016*	0,636*	0,51
Bangladesh	84	-0,002	0,004**	0,733	0,045	-0,036*	0,110	0,83
Brazil	697	-0,001	0,002*	-0,086	-0,072	-0,003*	0,094*	0,19
Bulgaria	75	0,011	0,000	-0,106	-0,207**	-0,023*	0,235	0,41
Chile	150	-0,001	-0,001	-0,894*	-0,053*	-0,006	0,013	0,15
China	85	0,001	0,004	-0,763	-0,245**	-0,017*	0,291	0,34
Colombia	152	-0,003**	0,002*	-0,336*	-0,143**	-0,046*	0,001	0,33
Croatia	170	0.003	0,008*	-0,432	-0,135	-0,023*	0,817*	0,24
Cyprus	58	-0,002	0,008*	0,124	-0,221*	0,010	-0,033	0,57
Czech Rep.	106	0,000	0,007*	0,084	-0,820*	-0,002	-0,074	0,42
Ecuador	95	0,002	0,003	0,275	-0,120	0,004	0,009	0,03
El Salvador	73	-0,004*	0,000	0,168	-0,741*	0,022*	-0,226*	0,38
Greece	97	0,000	0,005	3,813	-0,468**	0,027**	0,347	0,25
Hungary	100	-0,003	-0,001	0,100	-0,249	-0,019	0,081	0,04
India	297	0,000	0,008*	0,073	-0,248*	0,000	0,068	0,38
Indonesia	150	-0,007*	0,017*	0,021	-0,620*	-0,017*	0,075	0,71
Jamaica	62	0,002	0,002	-0,289**	0,034	-0,045*	0,156	0,59
Kazakhstan	56	-0,001	0,009*	-0,178	-0,353**	-0,018*	1,468*	0,73
Korea	156	0,001*	0,003*	-0,105	-0,331	0,002	0,121*	0,63
Latvia	88	0,001	0,002	-0,197*	-0,301*	0,007	0,421*	0,46
Malaysia	279	-0,002*	0,014*	-0,330*	-0,555*	-0,013*	0,127**	0,63
Mexico	247	-0,005*	0,007*	0,239	-0,393*	-0,014*	0,050**	0,11
Nigeria	158	-0,006**	0,007*	0,372**	-0,637*	-0,010**	0,216*	0,30
Pakistan	80	-0,001	0,004*	-0,385*	-0,313*	-0,003	0,108**	0,45
Panama	183	0,003	-0,003	-0,705*	0,225	-0,018*	0,197	0,13
Paraguay	73	-0,011*	0,003**	0,104	-0,521*	-0,022**	-0,014*	0,09
Peru	127	-0,003	0,003	-0,407	-0,084	-0,039*	-0,053	0,25
Philippines	178	0,001	-0,001	0,500*	0,054	-0,014	0,031*	0,91
Poland	199	-0,001	0,006*	0,036	-0,357*	-0,022*	0,010	0,66
Romania	62	-0,001	0,004**	0,121	-0,107	0,002	0,033	0,11
Russia	235	0,002	0,004*	-0,014	-0,163**	-0,032*	0,153*	0,42
Serbia	35	-0,006	0,002**	-0,125	-0,172	-0,004	0,260	0,23
Slovakia	76	-0,010**	0,003	-0,350**	-0,363**	0,001	-0,247**	0,57
Slovenia	104	0,000	0,002	-0,200	-0,050	-0,011**	0,088	0,02
South Africa	69	-0,001	0,006*	-0,586*	-0,176**	-0,007	0,257*	0,34
Sri Lanka	88	0,001	0,009*	-0,048	-0,189*	-0,027*	0,161*	0,73
Taiwan	230	0,000	0,006*	-0,115**	-0,096**	-0,025*	0,071*	0,89
Thailand	85	0,001	0,000	-0,052	-0,220	0,018**	0,008	0,04
Trinidad	57	0,014	-0,003	-0,685	-0,100	-0,041	0,213	0,11
Turkey	119	0,002	0,004*	0,018	-0,243*	-0,014	-0,068*	0,39
Ukraine	82	0,000	0,010**	0,462**	-0,312**	-0,039*	0,218**	0,47
Uruguay	69	-0,006*	0,007*	0,033	-0,020	-0,001*	0,018*	0,76
Venezuela	133	-0,005	0,001	0,157	-0,609*	-0,012	0,546*	0,78
Vietnam	54	-0,008	0,009	-0,494	-0,474*	0,002	0,617	0,37
Emerging markets	3934	-0,005*	0,004*	0,080	-0,358*	-0,018*	0,043*	0,25

Notes: Table 3 reports estimated parameters. * and ** represent parameters significant at a 1% and 5% level respectively. Adj rsq = Adjusted r square. Control variables for collective emerging market level are not included in the table. Source: Authors' calculations.

Table 4. Regression results of equation (6), ΔRISK as dependent variable

Country	Dependent variable: ΔRISK						
	Observations	SIZE	ROAA	ΔCAPR	RISK(-1)	GROW	Adj rsq
Argentina	347	-0,005*	-0,009*	0,359*	-1,232*	0,002	0,63
Bangladesh	84	0,001**	0,000	-0,006	-0,142	0,001**	0,23
Brazil	697	0,000	-0,002*	0,306*	-0,595*	0,000	0,31
Bulgaria	75	-0,005	0,000	-0,223	-1,220*	-0,006	0,97
Chile	150	0,000	-0,002	-0,137	-0,439	-0,001	0,68
China	85	0,000	-0,005*	-0,178	-0,971*	-0,007*	0,25
Colombia	152	0,002	-0,002	-0,844*	-0,714*	-0,046*	0,05
Croatia	170	-0,001	-0,001	0,169	-0,965*	-0,003	0,62
Cyprus	58	0,003	-0,019**	0,948	0,191	-0,070*	0,03
Czech Rep.	106	0,005*	-0,012*	0,229	-0,959*	0,001	0,81
Ecuador	95	-0,002	-0,002	0,572	-0,298	-0,036*	0,04
El Salvador	73	0,000	-0,007*	-0,721	-1,036*	0,012	0,60
Greece	97	0,000	0,001**	0,025	-0,520*	-0,002	0,50
Hungary	100	-0,003	-0,003**	-0,013	-0,123	0,003	0,23
India	297	0,001*	-0,005*	-0,043	-0,966*	-0,003**	0,39
Indonesia	150	0,002	-0,002	-0,175**	-0,734*	-0,018*	0,79
Jamaica	62	0,000	0,003	-0,946*	0,304	-0,052*	0,01
Kazakhstan	56	0,005	-0,001	0,132	-0,473**	-0,001	0,60
Korea	156	0,000	-0,012*	0,944**	-1,047*	0,000	0,74
Latvia	88	0,001	-0,005*	-0,093	-1,198*	-0,009**	0,80
Malaysia	279	0,002*	-0,014*	0,500*	-1,036*	0,010**	0,79
Mexico	247	0,000	0,000	-0,033	-0,126	-0,001	0,11
Nigeria	158	-0,002	-0,003*	0,090	-0,465*	0,000	0,28
Pakistan	80	0,000	-0,002	-0,129	-0,812*	-0,005	0,72
Panama	183	0,001*	-0,001	-0,039	-1,336*	-0,003	0,78
Paraguay	73	0,013	-0,002	-0,849*	-1,380*	-0,075*	0,36
Peru	127	0,001	0,002	0,073	-0,385*	0,003	0,28
Philippines	178	0,001	-0,005*	0,068*	-1,494*	-0,013**	0,33
Poland	199	0,003*	-0,004*	-0,222*	-0,641*	-0,009	0,14
Romania	62	-0,007*	0,000	0,323	-0,951*	-0,007	0,84
Russia	235	0,000	-0,002	0,114	-0,890	0,003	0,57
Serbia	35	0,005	0,000	0,687	-0,983*	-0,005	0,64
Slovakia	76	0,000	-0,007*	-0,362*	-0,768*	-0,017*	0,82
Slovenia	104	0,001	0,000	-0,697*	-0,961*	-0,020*	0,23
South Africa	69	-0,018*	0,000	-0,097	-0,676*	-0,006*	0,74
Sri Lanka	88	0,006*	-0,002	-0,927*	-0,907*	-0,039*	0,61
Taiwan	230	0,002*	0,003	-1,647*	-0,778*	-0,049*	0,56
Thailand	85	0,000	-0,009*	-0,185	-1,096*	-0,007	0,85
Trinidad	57	0,001**	0,000	-0,021	-0,287	0,008**	0,36
Turkey	119	0,001	0,000	-0,073	-0,906*	0,000	0,52
Ukraine	82	-0,002	-0,007	0,380**	-0,411	0,009	0,76
Uruguay	69	0,000	-0,008*	0,137**	-1,236*	-0,001**	0,93
Venezuela	133	0,002	0,000	0,215*	-0,663*	-0,017*	0,51
Vietnam	54	0,001	-0,006*	-0,049	-0,980*	0,003	0,98
Emerging markets	3934	0,000	-0,003*	0,062	-0,269*	-0,002	0,30

Notes: Table 4 reports estimated parameters. * and ** represent parameters significant at a 1% and 5% level respectively. Adj rsq = Adjusted r square. Control variables for collective emerging market level are not included in the table. Source: Authors' calculations.

Table 5. Regression results of equation (7), CAPR as dependent variable

Country	Dependent variable: CAPR						
	Observations	SIZE	ROAA	RISK	GROW	COD	Adj rsq
Argentina	460	-0,017*	0,012*	0,852*	0,009*	0,738*	0,53
Bangladesh	11	-0,003	0,023*	0,228	0,001*	-0,503*	0,63
Brazil	859	-0,021*	0,015*	1,168*	0,001	-0,029	0,39
Bulgaria	98	-0,014**	0,013*	-0,107	-0,023*	0,756*	0,28
Chile	214	-0,022*	0,021*	1,229**	0,011**	-0,052	0,55
China	117	0,002	0,027*	0,812	-0,003	0,081	0,24
Colombia	176	-0,019*	0,011*	1,226*	-0,019	0,080	0,06
Croatia	204	-0,036*	0,016*	2,108*	-0,014	-0,070	0,50
Cyprus	70	-0,011*	0,010**	0,552	0,014	-0,272*	0,21
Czech Rep.	133	-0,002	0,011*	0,374*	0,000	-0,096**	0,29
Ecuador	124	-0,023*	0,014*	1,341**	-0,008	-0,117	0,18
El Salvador	82	-0,008**	0,003	0,773	0,016*	-0,322*	0,52
Greece	115	-0,009*	0,015*	-1,445	0,009	-0,080	0,40
Hungary	82	-0,019*	0,006*	0,352	-0,004	-0,299*	0,48
India	395	-0,001	0,027*	1,207*	0,013*	0,573*	0,36
Indonesia	235	-0,012*	0,016*	-0,134	0,001*	0,077	0,46
Jamaica	66	-0,020*	0,020*	1,851	0,023	-0,488	0,22
Kazakhstan	68	-0,012*	0,016*	-1,137	0,000	1,478*	0,68
Korea	234	0,000	0,004	-0,148	-0,001	0,167**	0,17
Latvia	108	-0,019*	-0,003	-2,277**	0,007	1,166*	0,09
Malaysia	359	-0,008*	0,020*	0,959**	0,000	-0,063	0,36
Mexico	257	-0,017*	0,009*	2,703*	0,004	0,075*	0,49
Nigeria	233	-0,011*	0,004*	0,044	-0,006	0,746*	0,50
Pakistan	124	-0,009*	0,009**	0,995	0,010	0,238	0,51
Panama	260	-0,003	0,019*	1,249	-0,013	-0,015	0,12
Paraguay	96	-0,044*	0,013*	1,541*	0,018	-0,037*	0,39
Peru	167	-0,011	0,007**	-0,097	-0,023	-0,481	0,18
Philippines	239	-0,030*	0,020*	5,163*	0,013	0,019*	0,47
Poland	249	-0,011*	0,016*	0,809**	0,014*	-0,297*	0,28
Romania	91	-0,023*	0,003	0,860	0,008	0,024	0,28
Russia	346	-0,009*	0,005*	1,526	0,003	0,239*	0,08
Serbia	39	-0,062*	0,001	1,203**	-0,001	1,800*	0,42
Slovakia	92	-0,018*	-0,012	-3,201*	0,012*	0,456**	0,21
Slovenia	129	-0,007*	0,014*	1,152**	-0,004	-0,463*	0,22
South Africa	118	-0,012*	0,009	0,434	0,003	0,356*	0,55
Sri Lanka	115	-0,037*	0,057*	4,680*	0,045**	0,288	0,61
Taiwan	305	-0,019*	0,059*	3,665*	0,006	0,247*	0,87
Thailand	126	-0,007*	0,014*	1,179*	0,022*	0,245*	0,31
Trinidad	67	-0,015*	0,019*	8,094*	-0,076*	0,247	0,47
Turkey	201	0,009*	0,003*	0,131	0,004	-0,146*	0,19
Ukraine	121	-0,026*	0,008*	2,009*	-0,010	-0,507*	0,32
Uruguay	81	-0,024*	0,018*	1,591*	0,016*	0,017*	0,53
Venezuela	196	-0,004	0,008*	2,444*	0,010*	0,254*	0,19
Vietnam	65	-0,012	-0,035	-6,542**	0,071**	0,176	0,22
Emerging markets	5243	-0,017*	0,013*	1,506*	-0,002	0,028*	0,30

Notes: Table 5 reports estimated parameters. * and ** represent parameters significant at a 1% and 5% level respectively. Adj rsq = Adjusted r square. Control variables for collective emerging market level are not included in the table. Source: Authors' calculations.

Table 6. Regression results of equation (8), RISK as dependent variable

Country	Dependent variable: RISK					
	Observations	SIZE	ROAA	CAPR	GROW	Adj rsq
Argentina	460	0,001	-0,006*	0,201*	-0,001*	0,44
Bangladesh	111	0,001	-0,001	0,012	0,000	0,01
Brazil	859	0,004*	-0,005*	0,199*	0,000	0,06
Bulgaria	98	-0,007**	0,000	0,039	-0,002	0,05
Chile	214	0,002*	-0,004*	0,032*	-0,002	0,21
China	117	0,000	-0,003*	0,007	-0,001	0,16
Colombia	176	0,007*	-0,004*	0,016	-0,009	0,39
Croatia	204	0,003*	-0,003*	0,139*	-0,004	0,29
Cyprus	70	-0,002*	-0,002*	0,018	-0,013*	0,16
Czech Rep.	133	0,005	-0,016*	0,539	0,000	0,46
Ecuador	124	-0,001	-0,004*	0,057	-0,021*	0,22
El Salvador	82	0,003*	-0,009*	-0,125**	0,003	0,76
Greece	115	-0,001	0,001*	-0,057**	0,002	0,11
Hungary	82	-0,001	0,000	-0,071**	-0,007	0,10
India	359	0,001*	-0,008	0,087*	-0,004*	0,30
Indonesia	235	0,006*	-0,011*	0,367*	-0,009	0,07
Jamaica	66	0,001	-0,009*	0,195*	-0,017	0,51
Kazakhstan	68	0,002	-0,001*	-0,059	0,000	0,01
Korea	234	0,002**	-0,009*	-0,029	0,005**	0,67
Latvia	108	-0,002	-0,003	-0,102*	-0,001*	0,28
Malaysia	359	0,002*	-0,009*	0,106*	-0,004*	0,66
Mexico	257	0,002*	-0,001	0,074*	-0,001	0,15
Nigeria	233	-0,003	-0,005*	0,055	0,000	0,11
Pakistan	124	0,002*	-0,002	0,151*	-0,005**	0,21
Panama	260	0,001*	-0,002*	0,042*	-0,001	0,09
Paraguay	96	0,012*	-0,005*	0,216	-0,040*	0,42
Peru	167	0,001	0,002	-0,080	0,000	0,03
Philippines	239	0,002*	-0,002*	0,077*	-0,002	0,21
Poland	249	0,004*	-0,006*	0,052*	-0,002	0,36
Romania	91	-0,001	-0,001**	0,113**	-0,006*	0,19
Russia	346	0,001	-0,001*	0,062*	0,001	0,02
Serbia	39	0,014	0,003	-0,002	-0,002	0,09
Slovakia	92	-0,003	-0,007*	-0,131*	0,001*	0,61
Slovenia	129	0,001	-0,002	0,099	-0,012*	0,07
South Africa	118	0,000	-0,005*	0,056*	0,001*	0,65
Sri Lanka	115	0,007*	-0,010*	0,162*	-0,006	0,67
Taiwan	305	0,005*	-0,015*	0,255*	-0,001	0,67
Thailand	126	0,003*	-0,010*	0,234*	-0,006**	0,84
Trinidad	67	0,001*	-0,002*	0,110*	0,009*	0,58
Turkey	201	-0,001	-0,001*	0,066**	0,000	0,06
Ukraine	121	0,001	-0,002	0,195*	-0,007	0,15
Uruguay	81	0,002	-0,006*	0,126*	-0,005*	0,73
Venezuela	196	0,001	-0,002*	0,261*	-0,002*	0,40
Vietnam	65	0,001	-0,005*	-0,042*	0,003	0,60
Emerging markets	5243	0,001*	-0,003*	0,076*	0,000	0,11

Notes: Table 6 reports estimated parameters. * and ** represent parameters significant at a 1% and 5% level respectively. Adj rsq = Adjusted r square. Control variables for collective emerging market level are not included in the table. Source: Authors' calculations.