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Capital, risk and efficiency tradeoffs in Cameroonian banking

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This paper analyzes the relationship between capital, risk and efficiency for a sample of 10 Cameroonian banks between 2014 and 2020. To reach the authors' target, they specify a system of equations and estimate it using the two stage least squares panel data estimator technique. The empirical analysis shows that increases of bank capital do not reduce risk taking in Cameroonian commercial banks. Moreover, cost efficiency does not explain risk taking in the Cameroonian commercial banks. There is however a negative impact of change in risk taking on the bank cost efficiency. Finally, changes in bank capital contribute positively to the yearly change in bank efficiency. Hence, policies aiming at ensuring that bankers are not tempted to play by the rules or inducing commercial banks behavior towards injection of more capital might help to improve bank efficiency and stability in this country.

Key words: Financial reforms in banking, bank capital, risk, efficiency, Cameroonian banks.

INTRODUCTION

Cameroon is an African country belonging to the Community of Central African States (CEMAC). Following the economic and banking crisis at the end of the 1980s and as a component of the structural adjustment program (SAP) implemented mostly in response to the external pressure of the International monetary fund (IMF), this country underwent financial reforms during the 1990s. These reforms were considered as a means to build more efficient, robust and deeper financial systems. Indeed, for their proponents, such reforms would bring about significant economic benefits through improved bank efficiency and effectiveness to guarantee a more effective mobilization and efficient allocation of resources among various economic activities. Consequently, implemented measures aimed at addressing governance, risk management and more efficiency in banking and were around financial deregulation, banks restructuring and firming up capitalization to improve soundness in banking. As a result, over the last decades, banking industry in Cameroon has experienced major structural and institutional transformations that alter governance of banks operating on this country.

Domestic mergers, acquisitions and increase in foreign capital participation were among major observed structural changes in this country. The last state-owned bank in Cameroon was sold in January 2000 and this was the last step in a Structural Adjustment Programmed (SAP) recommended by the Bretton Woods Institutions

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for the country to reach the completion of the Highly Indebted Poor Countries Initiative (HIPC).This initiative was recommended to re-launch the country's economy after a decade of economic crisis that seriously affected its banks. This crisis also led to liquidation of giants such as Cameroon Bank, Banque Meridien, Rural Development Fund and the split- winding of the Bank of Credit and Commerce of Cameroon (BCCC), with transfers of its good assets to Standard Chartered Bank of Cameroon (SCBC).

Relative to institutional changes going with financial reforms, an attention was given to strengthening the regulatory and supervisory institution. The power to supervise the banking system initially carried out by the Cameroonian Loans National Council (CNC) was transferred to a community institution: The Banking Commission of Central African States (COBAC) created in 1992. As a result of this institutional change, observed failure of banks during this period was followed by a raising of the initial capital requirement of commercial banks from CFAF 300 million to CFAF 1 billion and later by an increase of the bank's minimum capital requirement vis a vis their risk- weighted assets, 8 per cent as prescribed by the Basle committee of banking in 1995.

Moreover since the early 1990s, financial liberalization implementation in Cameroon, driven by financial deregulation and technological change, has made Cameroonian banking markets increasingly more competitive. As a result, there has been tremendous emphasis on the importance of improved efficiency in the banking sector. But at the same time, this increase in competition could lead to incentives for greater bank risk-taking implying potential risk- efficiency tradeoffs in Cameroonian banking. To address this potential threat to the bank system stability, the banking commission of Central African states gave capital adequacy a more preeminent role in the prudential regulatory process. The question then arises of whether or not the level of bank capital has a significant impact on risk-efficiency tradeoffs in Cameroonian banking?

This question is of real importance in Cameroon for at least two reasons: Firstly, despite the great number of papers dealing with the issue of whether or not higher capital ratios reduces or increases overall banking risk, this issue remains largely unsolved. Moreover, the recent streams of the literature introducing the efficiency of banks into the debate just led to conflicting theoretical hypothesis. For a significant part of researchers convinced by the bad luck hypothesis, increase in risk determined by exogeneous factors negatively affects bank efficiency. Conversely, for the proponents of the bad management hypothesis, bank efficiency is determined by internal behavior in banks. Therefore, it is the reduction of efficiency caused by bad management that induces increase in bank risk taking. In the third hypothesis (the skimping hypothesis), if this negative relationship between efficiency and bank risk taking exists in the short term, it turns into a positive one in the long term. As the empirical evidence remains contradictory, this paper will therefore add empirical evidence in the Cameroonian context and allow comparisons with what is observed in other countries. Furthermore, despite the importance of this topic, with regard to financial instability and systemic bank crises observed in this country during the 90s and recent reported cases of bank distress (IMF, 2018), there is a lack of subsequent research to guide bank authorities' interventions.

Secondly, despite underwent reforms, if the excess liquidity of banks is a striking feature of the Cameroonian banking system at the end of the restructuring process as pointed by Avom and Eyeffa Ekomo (2007), in recent years the question of loan quality and of its implicit risk consequences still occupy a prominent place. In the Cameroonian context, the level of non-performing loans first declined from an average of 405 of total credit in 1995 to around 12% at the end of 2006 following the restructuring of the banking sector and the transfer of impaired loans to a loan recovery agency in the late 1990s.

But, Cameroon's structurally high ratio of non-performing loans was later aggravated in the first quarter of 2018 to 15 percent far from observed averages in North America (0.07%), Europe and Central Asia (3.8%) or even Sub-Saharan Africa (11.7%) (IMF, 2018). In more recent years and according to COBAC statistics, non-performing loans have increased by 45 billion between 2020 and 2021.

This observed increase in bad loans might not rely on the bad luck hypothesis of Berger and DeYoung (2007) in Cameroon. As IMF (2018) noted, the Cameroonian banking system has proven its resilience to exogeneous shocks even resulting from foreign economic behavior. Face to the twin recent oil price and security shocks, bank reaction was an improvement of prudential ratios. More specifically, after a declining to 9 per cent at the end of 2016, the system wide capital adequacy ratio increased to 10.7% at the end of March 2018 (IMF, 2018). Indeed, there are variations across banks on meeting the prudential ratios. In 2015 seven banks did not have enough capital to meet capital requirement of the bank Commission of Central Africa states (COBAC), and four banks (13% of banks' total assets) were in distress in 2018 with 3 of them having negative capital. This seems to be in relation with bank ownership. Following the restructuring process in the Cameroonian banking system, the capital ownership structure was modified in favor of foreign participation. Table 1 illustrates the selected banks in Cameroon, and the ownerships structure of capital in 2019.

This preeminence of foreign capital in banking can potentially expose the country to external shocks, as investors might at any time move their funds to correct imbalances in their domestic economies. But this was not

Table 1. Ownership structure of capital in selected Cameroonian banks (2019).

Banks	Government	Foreign capital	Domestic capital	Others
BICEC	17,50	70	7.5	5
SGBC	25,60	58,06	16,32	
AFRILAND		74	4	22
CBC	98,09		1,91	
BGFI BANK	20	70,69		9,31
ECOBANK		79,80	9,35	10,85
UBC		54	37	9
UBA	17.5	70	7.5	5
SCBC		100		
SCB	2.49	97.51		
CITIBANK		99,98%	0,02%	

Source: COBAC.

the case in Cameroon even during the international financial crisis of subprime. Indeed, despite the importance of foreign banks with parents that have been hit, the reaction of commercial banks in Cameroon to this external shock was to increase collateral requirements, to widen their spread and refocus their portfolios on blue chip companies and high network clients, making access to credit even more difficult for SMEs.

Overall, faced with exogeneous shocks, the reaction of banking authorities is, in many cases, to increase capital adequacy ratios to cope with bank risk taking. This shows their adhesion is not only to the idea of a negative relationship between bank capital and risk-taking behavior of banks in accordance with traditional theoretical banking models, but also to the idea that such an action can help reaching at the same time more efficiency as required by the reforms. Furthermore, by arguing that non-performing loans are not linked to external shocks, IMF (2018) implicitly suggests a determining role of the dynamics observed at the very level of Cameroonian commercial banks as described by the bad management hypothesis.

The following hypotheses can therefore be formulated;

H1: Increase in bank capital reduces commercial banks' risk taking in Cameroonian banking system
H2: There are tradeoffs between bank efficiency and bank risk taking in Cameroonian banking system
H3: Inefficient banks run with higher level of capital in Cameroonian banking system.

THEORETICAL ARGUMENTS

For a great number of researchers, risk-taking behavior and cost efficiency are adversely related in banking. At least, two alternative theoretical arguments allow the rationality of such a position to be established.

Firstly, the Berger and DeYoung (1997)'s bad luck hypothesis in which, an external event increasing the amount of problem loans may result in efforts to service these loans. This implies higher incurred costs. According to this argumentation, such exogenously determined increase in risk therefore impacts negatively the observed cost efficiency of banks: hence the idea of efficiency-risks tradeoffs in banking. Thereby, the causality runs from increase in bank risk due to external shocks to cost efficiency decrease.

Secondly, the bad management hypothesis in this alternative argument is an increase in the amount of problem loans caused by unwished internal bank behaviors. In such a case, the lower cost efficiency is a signal of poorly performing management, which has also poor control over its loan portfolio. Moreover, decrease in efficiency can motivate the bank to boost its risk in order to offset the lost levels of efficiency (Nguyen and Nghiem, 2015). Bank risk taking and efficiency relationships are therefore negative. Finally, as noted by Tan and Floros (2013), a part from credit, poor managerial practice can tarnish banks' reputation and cause market problems. Therefore, and unlike the bad luck hypothesis, in the bad management hypothesis, internal lower cost efficiency leads to an increase in problem loans.

Unlike the arguments developed so far, let us now differentiate short term from long term consequences. Monitoring of loans has an impact on both the amount of non-performing loans and cost efficiency, and this would imply possible intertemporal tradeoff between the quality of loans and the cost efficiency of the bank. In fact, bank may skimp on the resources devoted to underwriting and monitoring loans, reducing operating cost and increasing cost efficiency in the short run. But such a behavior may have an impact on the riskiness of the portfolio in the long run because non-performing loans increase as poorly monitored borrowers fall behind in loan repayment. Hence, banks that do not spend resources for instance in problem loans monitoring appear to be more efficient in

Table 2. Theoretical bank capital, risk taking and efficiency interlinks.

Risk-Capital - Risk-efficiency	Negative relationship (hazard moral hypothesis)	positive relationship (Regulatory theory)	No relationship
Trade offs			
Bad management hypothesis Bad luck hypothesis	Lower efficiency	Higher efficiency	No effect
No trade offs			
Skimping hypothesis	Higher efficiency	Lower efficiency	No effect
No relationship	No effect	No effect	No effect

Source: Authors.

the short term (Bashir and Hassan, 2017; Kolia and Papadopoulos (2020). But in the long term, they take on higher risk as this management behavior affects the quality of future loans. This theoretical position called skimping hypothesis in the literature implies a positive relationship between the considered variables and consequently a rejection of the idea of tradeoffs between efficiency and bank risk taking in banking.

The mediating effect of risk taking in the capital-efficiency relationship

Seminal researches to test the alternatives theoretical predictions in any US (Berger and DeYoung, 1997; Kwan and Eisenbeis, 1997) or European countries (Williams, 2004; Altunbas et al., 2007; Fiordelisi et al., 2011) yield contradicting results most explained by the differences in econometric methods. An alternative explanation in this paper is that the rationality of capital, risk and efficiency relationships builds both on the long-lasting bank capital-bank risk controversy in the banking literature, and in the more recent idea of bank risk-efficiency tradeoffs.

Two dominant and opposed hypotheses characterize the capital-risk relationships in the banking literature. For the proponents of negative relationship or proponents of moral hazard hypothesis (Lee and Hsieh, 2013), banks may have the incentives to increase their portfolio risk and leverage due to moral hazard because financial contracts are incomplete. In fact, bank managers usually exploit the rights of depositors that they primarily favor their interest in managerial compensation and support the benefit of shareholders for their wealth maximization. On the contrary, proponents of the regulatory approach suggest that banks are required to increase their capital in increased risk taking. Regulators therefore suggest the positive bank capital- risk relationship to reduce the problem of bankruptcy owing to higher risk and lower capital.

Hence, linking these two strands of the banking literature might help to establish the mediating effect of risk in the capital efficiency relationships, connecting definitively the three variables. We clearly distinguish the case tradeoffs hold from the case tradeoffs is rejected.

If the tradeoffs hold and bank capital and risk are related negatively, an increase in capital requirements will result in a deterioration of bank risk taking behavior. The higher level of bank risk will in turn decrease bank cost efficiency. Let us now suppose in the same case, a positive capital-risk relationship. An increase in capital requirements in this case improves the bank risk-taking behavior (decrease of risk) and hence, leads to higher bank cost efficiency in the long term.

Let us now suppose that the bank efficiency-bank risk tradeoffs do not hold. If bank capital and risk are related negatively, an increase in capital requirements improves bank risk behavior. The lowering of risk deteriorates in this case bank cost efficiency. On the contrary, if there is a positive capital-risk relationship, changes in capital requirements affect in the same direction bank risk. Therefore, increase in capital requirements results in higher bank cost efficiency. Table 2 summarizes the theoretical relationships between the three variables in the banking literature.

Empirical review

Bank capital and risk taking

Empirical evidence on the relationship between capital requirement and risk taking is far from being conclusive. In the case of USA, Calem and Rob (1999) quantified the effect of capital-based regulation and find that an increased capital requirement, whether flat or risk based, tends to induce more risk taking by ex-ante well capitalized banks that comply with the new standard. In fact, undercapitalized banks took higher risk because the cost of bankruptcy is shifted to deposit insurance. But well capitalized banks also took higher risk because it is more profitable and there is low probability of bankruptcy. Koehn and Santomero (1980) and Kahane (1977) concluded that risk-based capital boosts risk-taking. Shrieves and Dahl (1992) and Jokipii and Milne (2011) confirm the positive relationship between capital and risk changes while studying the USA banking data. Blum

(1999) advocates that capital adequacy requirements increase the riskiness of banks. Matajesak et al (2009) favor a positive association between risk-taking and capital ratio in the case of US and 15 European countries. This is also the conclusion of Ugwuanyi (2015), who examined the relationship between risk and capital in the post-crisis setting. In contrast, Jacques and Nigro (1997) and Aggarwal and Jacques (1998) applied a similar methodology and concluded on an inverse relationship between risk and capital. Lee and Hsieh (2013) examined the effect of capital ratio on risk-taking of Asian commercial banks covering 1994 and 2008. They documented an inverse relationship between risk and capital ratio in support of the moral hazard hypothesis. Tan and Floros (2013) found an inverse relationship between capital and risk. Recent empirical contributions also favor the negative relationship between risk-taking and bank capital (Ding and Sickles, 2018; Jiang et al., 2020).

Bank efficiency and bank risk

If the aforementioned empirical contributions were mainly interested in the relation between risk and capital, for Hughes and Mester (1998), the stress should also be on the analysis of the tradeoff between risk and efficiency. The result of their empirical test shows a negative relationship between the two variables. More generally, empirical test of the efficiency-risk trade off yields conflicting results in the banking literature. For instance, in examining the same link in a large sample of European banks between 1992 and 2000, Altunbas et al. (2007) noted that inefficient European banks seem to undertake less risk. William (2004), Le (2018) and Tan and Floros (2013), in their empirical contributions, confirm this result and suggest that efficiency and risk are adversely related. Deelchand and Padgett (2009) using a sample of 263 Japanese cooperative banks over the period 2003 through 2006, confirm the belief that risk, capital and efficiency are simultaneously determined, but suggest a positive relationship between efficiency and risk in banking as argued in the hazard moral hypothesis. In fact, the results of their research show that inefficient Japanese cooperative banks take more risk, contrasting with evidence in Europe. This result is also in line with that of Kwan and Eisenbeis (1997) in the case of US commercial banks. For Bashir and Hassan (2017) or Nguyen and Nghiem (2015) the relation is also positive. They argue that banks not spending resources on risk monitoring seem to be more efficient in the short term, but, they take higher risks in medium and long term.

Bank capital and bank efficiency

The empirical evidence on bank efficiency and bank capital also remains mixed even in recent contributions of literature. Berger and Di Patti (2006), in their study of the relationships between capital ratio and profit efficiency in US banking industry over the period 1990-1995, find that higher capital has negative effect on efficiency. Also interested by profit efficiency, Fiordelisi et al. (2011), using granger tests of causality in a GMM dynamic panel framework, examine the reverse causality between the two variables. Their findings emphasize that the less efficient banks tend to take more risk and better capitalized banks perform better in terms of efficiency.

However, Barth et al. (2013), in their study of whether or not bank supervision, regulation and monitoring enhances or impedes bank operating efficiency in a sample of 72 countries over the period 1992-2007, find that a more stringent capital requirement is marginally and positively associated with bank efficiency. This was also the result of Haque and Brown (2017)'s study while Triki et al. (2017) find this true only for large banks. Pasouiras (2008) also states that capital stringency improves efficiency but their result was not robust over all specifications. Sufian (2016), in the case of Malaysian banks for the period 199-2008 or Banker et al. (2010) in the case of Korean banking institutions, suggest that efficiency is positively related to capital. Pasouira et al. (2009) discuss the impact of capital stringency not only on cost efficiency, but also on profit efficiency. As a result, capital stringency increases cost efficiency and decreases profit efficiency. Onio (2017) seems to confirm Berger and Di Patti (2006)'s findings of a negative association between capital and financial performance in the case of European banks. Bashir and Hassan (2017) state that an increase in capital increases agency costs and the free cash at the disposal of managers, leading to a decrease of efficiency. More recently, Djalilov and Piesse (2019), in their study of the impact of bank regulation on bank efficiency, consider 04 regulations: activity restrictions, capital requirements, market discipline and supervisory power. The paper finds bank activity restrictions to be the only regulation improving banking efficiency, using a sample of 21 transition countries for the period 2002-2014.

Finally, Miah and Sharmeen (2015) using a sample of banks from year 2001 to 2011 in the case of Bangladesh concluded that, capital, risk and efficiency are interrelated. One explanation of such a situation is that, the tree variables could depend on other factors such as moral hazard, asymmetric information, ownership structure and agency problems.

MATERIALS AND METHODS

Research design and sample size

At the end of 2020, 15 commercial banks operated in Cameroun. As the bank population is not large enough, the authors are constraint to test their hypotheses using a small sample. Small

Table 3. Sample representativeness.

Banks	Capital	Assets	Deposits	Loans
BICEC	49.1	726,5	602,7	320,9
SGBC	12,5	1055,4	830,2	621,1
AFRILAND	20	1260,1	997,6	603,7
CBC	12	458,1	336,6	311
BGFI BANK	20	376,5	250	273,5
ECOBANK	10	466	369,2	191,7
UBC	20	118,1	57,8	2,8
UBA	10	480,6	376,3	136,9
SCBC	10	224,3	168,8	93,1
SCB	10,5	624	509,5	324,1
Sample	174,1	4733,6	4498,7	2878,7
All banks	260,9	7010,7	5398,8	3443,7
Percentage	66,84	67,51	83,32	83,59

Source: Authors calculations.

samples are generally associated with low statistical power and increased margin of errors that can render the study meaningless.

Furthermore, there is also a possibility of vibration effects with small samples. Vibration effects refer to a situation of change of results as a consequence of even minor analytical manipulation. In the case of Cameroonian commercial banks, the authors expect a very low sampling variability as commercial banks share the same regulatory environment imposed by the Banking Commission of Central African States (COBAC). A major challenge raised notably by Van de Schoot and Miocević (2020) remains however to increase information in data by using reliable measures and a smart sampling approach. In this study, they use a non-probabilistic sampling approach. They therefore excluded five banks because of unavailability of information and data on key variables included in the model. Their panel is therefore constituted of 10 banks with yearly data in millions of Fcfa from 2014 to 2020 on all the variables included in their econometric model. The authors therefore have enough observations to obtain reliable results when estimating their econometric model. COBAC database is used to obtain banks' balance sheets data and income statements. The financial statements published on the website of each bank are also used to have reliable data on included variables. In this case, data are first converted in Fcfa when needed, and then presented in millions of Fcfa. In 2020, four of the banks considered in the sample (Afriland First Bank, SGBC, BICEC and SCB) remain the most important banks in the Cameroonian banking system in terms of activity. These four institutions account for 52% of the banking system's consolidated balance sheet, 54.3% of total loans and 54.5% of total customer deposits. As shown in Table 3, taken together, the sample banks represent 83.3% of deposits 83.59% of loans and almost 68% of assets of the whole banking industry.

Measurement of variables

The measure of endogenous variables was discussed briefly (Bank risk, capital and efficiency) and included control variables.

Bank risk measure

There is until now no consensus on how to measure bank risk in the literature. If some recent papers are based on insolvency risk (Moyo, 2018), (Barra and Zotti, 2018), others still rely on more traditional measures. Insolvency risk is measured by distance to default indicator as follows: $Risk = log(\frac{eq_{it}+roa_{it}}{\sigma roa_{it}})$ where $eq = \frac{equity}{total\ assets}$ and $\sigma roa \quad the$ Standard deviation of ROA. Concerning more traditional approaches, the most widely used indicator is portfolio risk. Bank risk measure is hereby given by the ratio of risk-weighted assets to total assets (Jacques and Nigro, 1997; Rime, 2001; Aggarwal and Jacques, 2001). The standardized approach to calculating risk-weighted assets consists in multiplying the amount of an asset by the standardized risk weight associated with that type of asset. A high proportion of RWA indicates a higher share of riskier assets. However, a limit generally reported of the risk weighting methodology is that it can be manipulated.

Liquidity risk is generally measured by the loans to deposits ratio (LDEP). Banks with higher loans to deposits are usually viewed as riskier due to potential shortage of liquidity. In the Cameroonian case, bank excess liquidity observed in recent years does not comply with the use of such indicator. Moreover this over-liquidity goes with credit rationing accentuated by the risk aversion of bankers, suggesting that bank risk indicator based on credit risk might be more appropriate in Cameroonian banking. This last option includes among others, as in Abedifar et al. (2013), Tan and Floros (2013) or Bitar et al. (2018), the possibility to use loan loss reserves as a fraction to total assets as a proxy of credit quality. Higher values of this ratio can be a sign of a precautionary reserve policy in the bank or an anticipation high non performing revenues (Anginer and Demirguc-Kunt, 2014). The problem with this ratio in the Cameroonian case is that its variations between banks may be related to different banking policies regarding non-performing loans, reserves and write-offs.

Following Bashir and Hassan (2017) and Kabir and Worthington (2017), non-performing loan ratio was used in this paper that is, the non-performing loans as a fraction of total loans as a risk indicator. The advantage of this ratio in Cameroonian banking is that it might contain information on risk differences between banks not caught notably by RWA.

Non-performing loans are measured by loans past due 90 days or more and non-accrual loans and reflect the ex-post outcome of lending decisions. As noted by Ding and Sickles (2018), higher values of the NPL ratio indicate that banks ex-ante took higher lending risk and, as a result, have accumulated ex-post higher bad loans.

The measure of capital

Capital ratio is generally measured in three ways. Tier1 risk based - ratio based (proportion of total capital to risk-weighted assets), total risk-based ratio (proportionoftier1 and tier2 capital of risk weighted assets) and tier 1 leverage ratio (ratio of tier1 capital on total assets). Following Nguyen and Nghiem (2015) and Zheng et al. (2017), the authors calculated capital as the ratio of core capital to total assets (capital adequacy ratio).

Efficiency scores

The authors further computed Individual bank efficiency (EFF) as the distance of a firm's observed operating costs to the minimum or 'best-practice' efficient cost frontier. Efficiency scores are derived using the stochastic frontier approach. Based on Aigner et al. (1977), the cost function of a firm is as follows:

$$CT_i = c(Y_i; P_j, \epsilon_j) \quad (1)$$

Where CTi represents the bank i total operational costs, Yi the vector of quantity of bank output variables and Pj the vector of prices of bank input variables. ϵ_j hereby denotes the compound random error. This error is divided into endogenous (u_b) and exogeneous factors (e_b) that influence bank production costs. Endogenous factors or inefficiency factors are therefore related to an increase of bank production cost because of an error of management that causes inefficiency. Exogeneous factors represent an increase or a decrease of bank cost due to random factors (mistakes on data's, on measurement of unexpected or uncontrolled factors). u_b *and* e_b are supposed separable. Taking the logarithmic form of the relation (2), we then have:

$$LnCT_i = f(Y_i, P_j) + Lnu_b + Lne_b \quad (2)$$

One remaining problem to solve to estimate this relation is that of the functional form of the production function.

To measure cost efficiency in Cameroonian banking, the authors specify a cost frontier model with two outputs and three inputs. In fact, they suppose that, in this country, bank's production function uses labor and physical capital to attract deposits. The collected deposits are used to fund loans and other earning assets. Inputs and outputs are therefore specified using the intermediation model presented by Sealey and Lindley (1977). The translog specification of the used cost frontier model (relation 3) is as follows:

$$\text{Ln}(CT_{it}) = \beta_0 + \beta_y \ln(Yit) + \frac{1}{2}\beta_{yy}[\ln(Yit)][\ln(Yit)] + \sum_j \beta iyln(P_{jit}) + \frac{1}{2}\sum_j \sum_k \beta_{jk} \ln(P_{jit}) \ln(P_{kit}) + V_{it} + U_{it} \quad (3)$$

In this relation, *i* stands for banks and *CTit* is the total cost of bank i at the year t *where t* represents years. As *j* is an index for labor (lab), physical capital (cap) or financial capital (fin), *Plabit denotes* labor price in bank at the year t, *Pcapit* the price of physical capital of bank at year t and *Pfinit* the remuneration of financial capital of bank i at time t. The authors further noted *Yit* the output of bank *i* at the year *t*, v the random error term that incorporates measurements errors and luck and *u* a firm effect representing the bank inefficiency level, that is the distance of an individual to the efficient cost frontier. Indeed, cost efficiency measures the distance of a bank relative to the cost of the best practice bank when both banks produce the same output under the same conditions. The cost efficiency scores are therefore computed as: $CostEFF^b = \frac{exp[u^{min})]}{exp[\,u^b\,]}$ $Where\ U^{\min}$ denotes the lower value taken by U^b among sample banks. Table 4 recapitulates variables included in the cost function and their measure. Table 5 presents the cost frontier estimated efficiency scores in the Cameroonian banking.

The level of estimated efficiency scores varies all along the study period and between banks. The highest level is attained in 2017. Concerning bank analysis, Commercial Bank Cameroon (CBC) with more than 98% state participation in the capital, that was not regulatory compliant in 2009 and goes into a restructuring process and a temporarily management until 2018 is also the less efficient bank of the studied sample.

Control variables

For the explanatory variables the authors used a broad range of bank-specific and country - specific variables that are believed to be important in explaining performance and risk. These include loans growth (loang) as rapid loan growth may increase risk and impact adversely on capital and bank efficiency. Bank size, through economies of scale, may influence the relationship between capital, risk and efficiency so we control for the assets size of banks (size). Big banks, typically hold less capital than smaller banks; they may also be more diversified and gain from other size advantages so it is important to control for this factor. Table 6 provides a synthetized description of the variables includes in the system of equation to be estimated.

Modelling framework

The modelling framework adopted to test the hypotheses in this study is based on the various approaches suggested by the strand of the literature aiming to criticize the earlier causality approach proposed by Berger and DeYoung (1997) in their seminal contribution and implemented by several researchers. As a response to causality approach and taken all together, a significant part of proposed approaches in this empirical literature implicitly suggest that, as bank capital risk and efficiency are determined simultaneously, examining the investigated relationships should best be evaluated in an appropriate system of simultaneous equations, further estimated by efficient estimators (Tan and Floros, 2013), Altunbas et al. (2007), Moudud-Ul-Huq (2019), Moudud-Ul-Huq (2020). The authors therefore specify a system of equations and estimate these using the three stage least squares panel data estimator technique. This allows for simultaneity between banks' risk, capital and efficiency while also controlling for important other bank specific factors and endogeneity. The system of equations estimated is as follows:

$$\Delta risk_{i,t} = \alpha_0 + \alpha_1 risk_{i,t-1} + \alpha_2 \Delta eff_{i,t} + \alpha_3 \Delta cap_{i,t} + \alpha_4 size_{i,t} + \alpha_5 loang_{i,t} + \varepsilon_{it} \quad (4)$$

$$\Delta eff_{i,t} = \beta_0 + \beta_1 eff_{i,t-1} + \beta_2 \Delta risk_{i,t} + \beta_3 \Delta cap_{i,t} + \beta_4 size_{i,t} + \varepsilon_t + v_{it} \quad (5)$$

$$\Delta cap_{i,t} = \gamma_0 + \gamma_1 cap_{i,t-1} + \gamma_2 \Delta risk_{i,t} + \gamma_3 \Delta eff_{i,t} + \gamma_4 size_{i,t} + \gamma_5 ROA_{i,t} + w_{it} \quad (6)$$

The relations (4), (5), and (6) satisfy the order conditions required for the identification in simultaneous equations system.

RESULTS AND DISCUSSION

Bank risk equation results

In this equation, the authors are interested by the sign of

Table 4. Cost frontier inputs and output description.

Variable	Notation	Description
Total cost	CT	Total of interest and non interest cost
Output		
Total loans	Y	Gross loans-reserves for loan loss provisions
Inputs prices		
Price of physical capital	Pcap	Expenditures on premises and fixed assets/premises and fixed assets
Price of labor	Plab	Salaries on full time equivalent employees
Price of borrowed funds	Pfin	Interest expenses paid on deposits/total deposits

Source: authors.

Table 5. Cost frontier efficiency scores in Cameroonian banking (%**).**

Year	Mean	Med	Sd	Min	Max
2014	0.595	0.634	0.114	0.356	0.754
2015	0.660	0.650	0.145	0.448	0.857
2016	0.746	0.749	0.126	0.514	0.897
2017	0.791	0.810	0.075	0.672	0.881
2018	0.727	0.757	0.149	0.420	0.872
2019	0.718	0.759	0.172	0.351	0.859
2020	0.773	0.759	0.095	0.620	0.937

Source: Author's calculations based on Frontier 4.1.

Table 6. Variables included in the model.

Variable	Description
Eff	Estimated efficiency scores
risk	Non-performing Loans ratio
cap	Capital adequacy Ratio
size	natural logarithm of total assets
NIM	Net interest margin
ROA	Return on assets
loang	Loans annual's growth rate

Source: Authors.

the capital variable coefficient. If this coefficient is significant and negative, they will assert that Hypothesis H1 is validated. The estimated coefficient of bank capital variable (ΔCAPt) is however significantly positive on 5% level, suggesting that the changes in risk and capital are positively related. The hypothesis H1 is therefore not validated. This result is consistent with Abbas et al. (2021), but do not confirm the findings of Ding and Sickles (2018) or Jiang et al. (2020). Therefore, faced with more stringent capital requirements in difficult times as noted during the 2007 crisis or Covid 19 pandemic, commercial banks in Cameroon seem to structure their activities in a way to reduce the regulation burden without a corresponding reduction in the underlying risk. This can explain the high level of non-performing loans observed in this country in recent years despite measures taken by COBAC.

The authors are also interested by the sign and of the coefficient of the efficiency variable. A negative and significant coefficient would indicate that there is a tradeoff between the efficiency and risk and that this is explained by the bad management hypothesis. The results of the risk equation presented in Table 7 do not support any relationship between the changes in bank's efficiency and bank risk position in Cameroonian commercial banking. The coefficient is not statistically

Table 7. Risk equation results.

Variable	Coef.	SE	t-stat	Prob
C	-1.194***	0.409	-2.917	0.004
ΔCAP	0.256**	0.105	2.441	0.016
ΔEFFIC	-0.067	0.183	-0.365	0.715
Risk (-1)	0.153***	0.031	4.852	0.000
Size	0.044**	0.018	2.418	0.017
Loang	1.001***	0.085	11.725	0.000

Source: Authors calculations based on EViews 12 software.

Table 8. Efficiency equation results.

Variable	Coef	SE	t-stat	Prob
C	0.926***	0.241	3.839	0.000
Δcap	0.127**	0.056	2.262	0.025
ΔRisk	0.063*	0.037	1.675	0.096
Effic (-1)	-0.972***	0.134	-7.220	0.000
Size	-0.009	0.009	-0.969	0.334

Source: Authors calculations based on EViews 12 software.

significant, albeit negative.

This suggests that changes in bank's efficiency do not lead to changes in bank risk-taking behavior in Cameroonian commercial banks.

Moving to control variables, the change in the bank risk behavior is positively dependent on the net interest margin of a given year. When facing favorable interest rate environment, commercial banks in Cameroon might be tempted to increase the amount of loans provided at the expense of decreased quality of such loans. The results also imply that the change in RISK variable is determined by the loan growth (significant at 1% level) and bank size (significant at 5% level). Large banks are therefore less averse to risk in Cameroon.

Bank efficiency equation results

Table 8 presents the results of the second equation in the authors' system, where the change in the bank's cost efficiency is the dependent variable. They are interested in the estimated coefficient of the risk variable ($\Delta RISK_t$) since this estimate is related to the bad luck explanation of the tradeoff's hypothesis between bank efficiency and bank risk-taking behavior. For H2 to be validated, the estimated coefficient of the bank risk variable should be negative. This is the case in Table 8. This coefficient is negative with a value of -0.063 and significant at 10% level. They may infer from this that change in bank's cost efficiency is negatively affected by any change in bank risk taking behavior in Cameroon.

Hypothesis H2 is therefore validated. As IMF (2018) suggests that exogeneous shocks are not linked to commercial bank risk taking in Cameroon, this might be explained by unskilled management that is losing control over both the cost structure of the bank and the administration of its loan portfolio.

From the table, it can be seen that the coefficient of bank capital (ΔCAP_t) is significant at 5% level and presents a positive sign with a value of 0.012. This result suggests that commercial banks with higher capital operate more efficiently in Cameroon. This finding seems consistent with Shrieves and Dahl (1992), Berger and DeYoung (1997) Altunbar et al. (2007) or more recently Haque and Brown (2017), but do not support Bashir and Hassan (2017).

Based on the estimate of size variable ($SIZE_t$) coefficient, we might observe that the changes in the cost efficiency are not related to the size of the bank. This might suggest that behavior of the banks with respect to cost efficiency does not vary with increasing balance sheet size. This result is not consistent with the findings of Wheelock and Wilson (2012) or Hughes and Mester (2013).

Capital equation results

Let us move to the results of the capital equation presented in Table 9. The results show a negative and significant relationship between change in capital and change in bank efficiency. Inefficient banks run therefore

Table 9. Capital equation results.

Variable	Coef	SE	t-stat	Prob
C	0.642	0.504	1.273	0.205
ΔEffic	-0.551**	0.212	-2.591	0.010
ΔRisk	-0.525***	0.047	-11.047	0.000
CAP (-1)	-0.182***	0.055	-3.274	0.001
Size	-0.026	0.022	-1.153	0.251
ROA	0.028	0.017	1.629	0.105

Source: Authors calculations based on EViews 12 software.

Table 10. Capability of the model.

Equation	OBS	PARMS	RMSE	R-SQ	F-STAT	P
Efficiency	54	5	0.131	0.479	12.59	0.000
Risk	54	6	0.116	0.535	11.19	0.000
Capital	54	5	0.472	0.513	14.27	0.000

Parms=parameters RMSE=Root mean square error
Source: Authors calculations.

with higher level of capital in Cameroonian banking. H3 is validated. The authors also have a negative one with risk taking meaning that capital regulation is not binding strictly in Cameroon. In fact, there is a possibility that banks escape from COBAC's measures. Banks with significant amount of non-performing loans are forced to provide more provisions leading to consequent evolution of their capital. Similarly, as observed in the risk equation, results of the estimation of the capital equation suggest a negative and significant relation with the size of the bank as generally found in the literature and notably by Aggrawal et al. (1998) or Rime (2001). The change in the bank capital is however not related to the bank's return on assets in a given year. This last result is not consistent with Altunbas et al. (2007) who found that ROA and bank capital are sharply and positively related. It therefore seems that banks in Cameroon do no rely on earnings in order to increase their capital.

Table 10 presents the capability of our model to link efficiency, capital and risk in Cameroonian commercial banks. All X^2 are significant at 1% level. This means that at least one instrumental variable (IV) has non zero relationship with endogenous variables (Efficiency, Risk and Capital).

Conclusion

In the aftermath of the financial deregulation aiming to improve bank efficiency in Cameroon, to address the potential implicit threat to the banking system stability, the Central African States banking commission (COBAC) placed a more emphasis on bank governance considerations and notably on a more preeminent role of capital adequacy ratios in the implementation of prudential regulation. However, neither theoretical studies nor empirical papers are until now conclusive on the effect of more stringent capital requirements on bank efficiency and risk behavior.

In this paper, the interrelationships between risk-taking, capital regulation and efficiency In Cameroonian commercial banks were examined. To reach target, based on theoretical contributions and an analysis of the Cameroonian context, three hypotheses are formulated:

H1: Increase in bank capital reduces commercial banks risk taking in Cameroonian banking.
H2: There are tradeoffs between bank efficiency and bank risk taking in Cameroonian banking.
H3: Inefficient banks run with higher level of capital in Cameroonian banking.

These hypotheses are tested on a sample of representative Cameroonian commercial banks from 2014 to 2020 in a system of simultaneous equations approach. Estimation of the system relies on the use of the two stages panel data estimator technique to account for potential endogeneity and simultaneity and small samples approaches. Cost technical inefficiency is derived using the computer program named Frontier Version 4.1 developed by Coelli (1996). The authors also use proxy risk taking by a credit risk measure, capital by the capital adequacy ratio and control for bank-level variables that affect the relationship between the three considered variables.

As a result, their empirical analysis shows that bank

capital does not lead to bank risk taking behavior in Cameroonian banking. In fact, there is a positive and significant relationship between the two variables (H1 is not validated). Moreover, there is a trade -off between bank risk and bank efficiency in Cameroonian banking explained by the bad luck hypothesis (H2 is validated). Finally, there is a negative impact of change in efficiency on the yearly change in bank capital meaning that inefficient banks run with higher level of capital in Cameroonian banking (H3 is validated).

Therefore, for a better contribution of bank policy to efficiency improvements, banking authorities in Cameroon might create conditions of bankers' regulation arbitrage mitigation. In this sense measures aiming to ensure that no risk spill over from non-regulated financial institutions to the banking system might be privileged. Specially, COBAC should look at the link between banks and insurance companies and address step-in risk. Furthermore, COBAC should also develop policies aiming to scrutinize more deeply what bankers do and examine individual transactions to see whether they might be an attempt to play by the rule.

There are some limitations of this paper that need to be improved in future research. First, the analysis period is too short; it should be extended. Also the sample is limited. It can be extended to CEMAC countries. Secondly, an analysis at the macro-level might help taking into account many economic environmental variables not considered in this study. Finally, future researches might take into consideration bank capital structure as the literature suggests significant relationships with bank efficiency or bank risk.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abbas F, Ali S, Moudud-Ul-Huq S, Naveed M (2021). Nexus between bank capital and risk-taking behaviour: Empirical evidence from US commercial banks. Cogent Business and Management 8(1):1947557.

Abedifar P, Molyneux P, Tarazi A (2013). Risk in Islamic banking. Review of Finance 17(6):2035-2096.

Aggarwal R, Jacques KT (1998). Assessing the impact of prompt corrective action on bank capital and risk. Economic Policy Review 4(3).

Aggarwal R, Jacques KT (2001). The impact of FDICIA and prompt corrective action on bank capital and risk: Estimates using a simultaneous equations model. Journal of Banking and Finance 25(6):1139-1160.

Aigner D, Lovell CAK, Schmidt P (1977). Formulation and estimation of stochastic frontier production function models. Journal of Econometrics 6(1):21-37.

Altunbas Y, Carbo S, Gardener EPM, Molyneux P (2007). Examining the relationships between capital, risk, and efficiency in European banking. European Financial Management 13(1):49-70.

Anginer D, Demirguc-Kunt A (2014). Bank capital and systemic stability. World Bank Policy research working paper (6948).

Avom D, Eyeffa Ekomo SML (2007). Quinze ans de restructuration bancaire dans la CEMAC: Qu'avons-nous appris ? Revue d'Economie Financière 89:183-205.

Banker RD, Chang H, Lee S (2010). Differential impact of Korean banking system reforms on bank productivity. Journal of Banking and Finance 34(7):1450-1460.

Barra C, Zotti R (2018). Bank performance, financial stability and market concentration: evidence from cooperative banks. Annals of Public Cooperatives Analysis 90:103-139.

Bashir A, Hassan A (2017). Interrelationship among Basle capital regulation, risk and efficiency in Pakistani commercial banks. Business Economic Review 9:165-186.

Barth JR, Lin C, Ma Y, Seade J, Song F (2013). Do bank regulation, supervision, and monitoring enhance or impede bank efficiency? Journal of Banking and Finance 37(8):2879-2892.

Berger AN, De Young R (1997). Problem loans and cost efficiency in commercial banking. Journal of Banking and Finance 21:849-870.

Berger AN, Di Patti EB (2006). Capital structure and firm performance a new approach to testing Agency Theory and an application to banking industry Journal of Banking and Finance 30:1065-1102.

Bitar M, Pukthuanthong K, Walker T (2018). The effect of capital ratios on the risk, efficiency and profitability of banks: Evidence from OECD countries. Journal of international financial Markets, Institutions and Money 53:227-262.

Blum J (1999). Do capital adequacy requirements reduce risk taking in banking? Journal of Banking and Finance 23(5):755-771.

Calem P, Rob R (1999). The impact of capital- based regulation on bank risk taking. Journal of Financial Intermediation 8(4):317-352.

Coelli TJ (1996). A guide to FRONTIER Version 4.1: A computer program for Stochastic Frontier Production and Cost Function Estimation. CEPA Working Paper No. 7/96, Department of Econometrics, University of New England, Armadale.

Deelchand T, Padgett C (2009) The relationship between risk, capital and efficiency: evidence from Japanese cooperative banks.SSRN Electronic Journal.

Djalilov K, Piesse J (2019). Bank regulation and efficiency: Evidence from transition countries. International Review of Economics and Finance 64:308-322.

Ding D, Sickles RC (2018). Frontier efficiency, capital structure and portfolio Risk: an empirical analysis of US Banks. BRQ Business Research Quarterly 21(4):262-277.

Fiordelisi F, Marques-Ibanez D, Molyneux P (2011). Efficiency and risk in European banking. Journal of Banking and Finance 35(5):1315-1326.

Haque F, Brown K (2017). Bank ownership, regulation and efficiency perspectives from middle east and north Africa (MENA) region. International Review of Economics and Finance 47:273-293.

Hughes JP, Mester LJ (1998). Bank capitalization and cost: Evidence of scale economies in risk management and signaling. Review of economics and statistics 80(2):314-325.

Hughes JP, Mester LJ (2013). Who said large banks don't experience scale economies? Evidence from a risk return driven cost function. Journal of Financial Intermediation 22:559-585.

IMF (2018) Country report N°18/235. https://www.imf.org/-/media/Files/Publications/CR/2018/cr18235.ashx

Jacques K, Nigro P (1997). Risk-based capital, portfolio risk, and bank capital: a simultaneous equations approach, Journal of Economics and Business 49(6):533-547.

Jiang H, Zhang J, Sun C (2020). How does capital buffer affect bank risk-taking? New evidence from China using quantile regression. China Economic Review 60:101300.

Jokipii T, Milne A (2011). Bank capital buffer and risk adjustment decisions. Journal of Financial Stability 7(3):165-178.

Kabir MN Worthington AC (2017). The Competition-Stability/fragility nexus: a comparative analysis of Islamic and conventional banks International. Review of Financial Analysis 50:111-128.

Kahane Y (1977). Capital adequacy and the regulation of financial intermediaries. Journal of banking and finance 1:207-218.

Koehn M, Santomero A (1980). Regulation of bank capital and portfolio risk. Journal of Finance 35(5):1235-1244.

Kolia DL, Papadopoulos S (2020). The levels of bank capital, risk and efficiency in the Eurozone and the US in the aftermath of the financial crisis. Quantitative Finance and Economics 4(1):66-90.

Kwan S, Eisenbeis RA (1997). Bank risk, capitalization and operating efficiency, Journal of Financial Services Research 12:117-131.
Le T (2018). Bank risk, capitalization and technical efficiency in Vietnamese banking system. Australian Accounting and Business Finance 12(3):41-61.
Lee CC, Hsieh MF (2013). The impact of bank capital on profitability and risk in Asian banking. Journal of International Money Finance and Banking 32:251-281.
Matajesak M, Teply P, Cernohorsky J (2009). The impact of regulation of banks in the US and the UE-15 countries. Ekonomie a Management 12(3):58-68.
Miah MD, Sharmeen K (2015). Relationship between capital risk and efficiency: comparative study between Islamic and conventional banks of Bangladesh. International Journal of Islamic and Middle Eastern Finance and Management 8(2):203-221.
Moudud-Ul-Huq S (2019). Banks' capital buffers, risk, and efficiency in emerging economies: are they counter-cyclical? Eurasian Economic Review 9(4):467-492.
Moudud-Ul-Huq S (2020). Does bank competition matter for performance and risk-taking? Empirical evidence from BRICS countries. International Journal of Emerging Markets. Doi:10.1108/IJOEM-03-2019-0197
Moyo B (2018). Analysis of competition, efficiency and soundness in south African banking sector" South African Journal of Economics and Management Science 21. Doi:101108/mf-12-2013-0354
Nguyen TP, Nghiem SH (2015). The interrelationships among default risk, capital ratio and efficiency. Managerial finance 41:507-525.
Onio L (2017). Impact of regulatory capital on European banks financial performance: a review of post global financial crisis research. International Business and Finance 44:309-318.
Pasouiras F (2008). International evidence on the impact of regulation and supervision on banks' technical efficiency: an application of two stage data envelopment analysis. Review of Quantitative Finance and Accounting 30:187-223.
Pasouira F, Tanna S, Roupounidis C (2009). The impact of banking regulations on banks cost and profit efficiency: Cross country evidence. International Review of Financial Analysis 18:284-302.
Rime B (2001). Capital requirements and bank behavior: Empirical evidence for Switzerland, Journal of Banking and Finance 25:789-805.
Sealey CW, Lindley JT (1977). Inputs outputs and the theory of production and cost at depository financial institutions. the Journal of Finance 32(4):1251-1266.
Shrieves RE, Dahl D (1992). The relationship between risk and capital in commercial banks, Journal of Banking and Finance 16:439-457.
Sufian T (2016). Determinants of efficiency in the Malaysian banking sector: evidence from semi parametric data envelopment analysis method. Studies in Microeconomics 4:151-172.
Tan Y, Floros C (2013). Risk, capital, and efficiency in Chinese banking. Journal of International Financial Markets, Institutions, and Money 26:378-393.
Triki T, Kuoki I, Dhaou MB, Calice P (2017). Bank regulation and efficiency What works better for Africa? Research in international Business and Finance 39:183-205.
Ugwuanyi G (2015). Regulation of bank capital requirements and bank risk taking behavior: evidence from the Nigerian banking industry. International Journal of Economics and Finance 7(8).
Van de Schoot R, Miocević M (2020). Small sample size solutions: A guide for applied researchers and practitioners. Taylor & Francis. P 284.
Wheelock DC, Wilson PW (2012). Do large banks have lower costs? New estimations of returns to scale for US banks. Journal of Money Credit and Banking 44:171-199.
Williams J (2004). Determining management behavior in European Banking. Journal of Banking and Finance 28(10):2427-2460.
Zheng C, Moudud-Ul-Huq S, Rahman M, Ashraf BN (2017). Does the ownership structure matter for banks' capital regulation and risk-taking behavior? Empirical evidence from a developing country. Research in International Business and Finance 42:404-421.